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MINNESOTA COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

BIENNIAL REPORT

JANUARY 2011—DECEMBER 2012

U.S. Geological Survey

University of Minnesota

Minnesota Department of Natural Resources

The Wildlife Management Institute

U.S. Fish and Wildlife Service

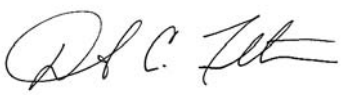
The Minnesota Cooperative Fish and Wildlife Research Unit was established in 1987 on the St. Paul Campus of the University of Minnesota as part of the Cooperative Research Units Program. The Cooperative Research Units program was established over sixty years ago to facilitate cooperation among the U.S. Department of the Interior (currently through the U.S. Geological Survey), universities, state fish and wildlife agencies, and private organizations, by developing and conducting programs of research and education related to fish and wildlife resource conservation. That mission continues today, with support from both long-standing and new partners. At the Minnesota Cooperative Fish and Wildlife Research Unit, we emphasize research on impacts of human activities on aquatic and terrestrial ecosystems that are of state, regional, and national significance. Our research program addresses not only the biological, but also social and economic aspects of both game and nongame fisheries and wildlife management in the context of maintenance of biological diversity, and integrity and sustainability of ecosystems.

This is the twelfth biennial report produced by the Minnesota Coop Unit and summarizes Unit activities during 2011 and 2012. 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. We are currently fully staffed, and 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 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,

Dr. David E. Andersen
Leader

Dr. Bruce Vondracek
Assistant Leader - Fisheries



Dr. David C. Fulton
Assistant Leader - Wildlife

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Personnel and Cooperators

Unit Personnel

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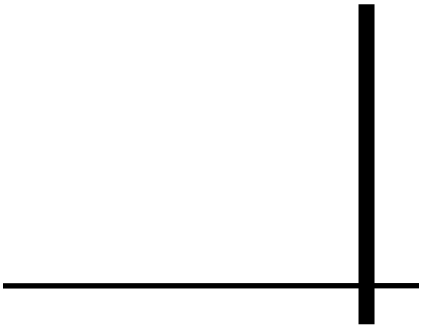

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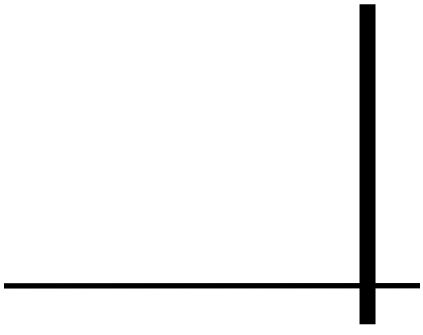

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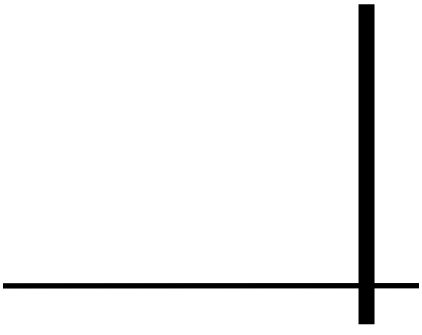

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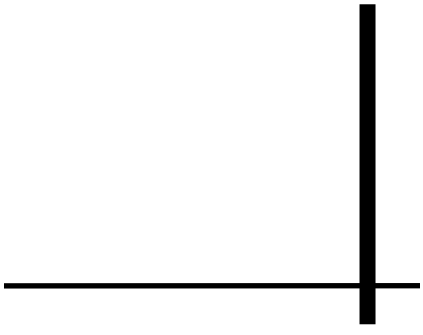
Department of Fisheries, Wildlife, and Conservation Biology
Department of Forest Resources
Department of Genetics, Cell Biology and Development
Integrated Biosciences Graduate Program (University of MN—Duluth)
Natural Resources Science and Management Graduate Program
University of Minnesota Graduate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

Cooperating Organizations

Legislative Citizens Committee on Minnesota Resources
Minnesota Department of Natural Resources
University of Minnesota
    Cargill Fellowship
    MacArthur Fellowship
    Natural Resources Research Institute
U.S. Bureau of Land Management
U.S. Fish and Wildlife Service
    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
    Northern Prairie Wildlife Research Center
    Science Support Partnership
Voyageurs National Park
Wapusk National Park of Canada
Wisconsin Department of Natural Resources
Woodcock Minnesota



Completed Research

Applied Ecology

Determining the Olfactory Sensitivity of Asian Carp (*Hypophthalichthys* spp.) to Putative Hormonal Sex Pheromones

Investigator:	Peter Sorensen (Cooperating Faculty)
Staff:	Hangkyo Lim, Joe Leese; Postdoctoral Researchers
Students:	Brian Moe, B.S. (Fisheries and Wildlife, subplan Fisheries)
	Elizabeth Fox, B.S. (Molecular and Cell Biology)
Duration:	October 2010 to March 2012
Funding Source:	U.S. Geological Survey (Columbia Environmental Research Center)
Project Location:	University of Minnesota

Two species of Asian or Bigheaded carps (*Hypophthalmichthys* spp.) threaten to invade the Upper Mississippi River from Iowa yet fisheries managers presently lack any species-specific tools with which to sample or control these highly damaging invasive fish. This study served as a proof-of-concept test of whether sex pheromones, chemical cues that travel between members of the same species and serve key roles in reproduction, might be isolated and identified in the bigheaded carps and thus could be used in their control. We tested and then confirmed the hypothesis that select hormonal products likely serve as potent sex pheromones in both the silver (*H. molitrix*) and bighead (*H. nolibilis*) carp, much as they do in other carps. In particular, we used electro-olfactogram (EOG) recording (Figure 1) to test the olfactory specificity and sensitivity of these species to 216 steroids and eight prostaglandins and discovered that less than a dozen were detected and then with extreme specificity. Slight differences were found between bigheads and silvers and the products they both detect differ from all other fish tested in this manner: very likely these species rely strongly on unique hormonal pheromones which could be developed for use in control. A synopsis of our finding for each species follows.

Figure 1. *Electro-olfactogram recording (EOG) from the olfactory epithelium of a silver carp while odors are pulsed over its nose. This multi-unit extracellular technique measures olfactory receptor potentials.*

The olfactory sensitivity of silver carp was determined to 21 mixtures of sex steroids (216 steroids in total) and eight individual prostaglandins along with various controls using EOG recording. Seven mixtures elicited notable responses (greater than 50% of that to 10^{-5}Molar L-serine, a food odor; Figure 2). When the components in these 7 mixtures when subsequently broken up and tested on their own, just nine were found to be detected with high sensitivity (data not shown). Cross-adaptation studies next demon-

strated that all 9 sex steroids were detected by their own unique receptor mechanisms, typical of hormonal sex pheromones in other fishes. Amongst this group were an androgen and several unique sulfated progestational steroids, suggesting that this species employs male–derived sex pheromones and that its females likely use a complex pre-ovulatory priming pheromone to synchronize mass spawning. In addition to detecting sex steroids, silver carp were also found to be extremely sensitive to three F-prostaglandins that are known to serve as releasing sex pheromones in other fishes. This hypothesis was reinforced by our finding that silver carp treated with androgens to masculinize them were much more sensitive to these products than immature fishes. Ongoing experiments demonstrate that F prostaglandins are both released by silver carp and that they are attractive to masculinized fish.

The olfactory sensitivity of bigheaded carp was also determined to 21 mixtures of sex steroids (216 steroids in total) and eight individual prostaglandins alone using EOG recording. The same seven mixtures that elicited notable responses in silver carp did so in this species although one additional sex steroid (a 4-pregene steroid) was also detected with extreme sensitivity. This overlap may explain why hybridization is relatively common in these species. In addition to detecting sex steroids, bighead carp, like silver carp, were also found to be extremely sensitive to three F-prostaglandins. Sensitivity was strongly enhanced by androgen treatment (methyltestosterone [MT]) suggesting these compounds, which were also found to be detected at concentrations approaching picomolar (Figure 3), serve as releasing sex pheromones. Future studies will describe behavioral responses to F prostaglandins, their release patterns, and whether and how they might be species-specific.

In summary, both species of bigheaded carps detected unique, but slightly different assortments of hormonal products that they likely use as species-specific sex pheromones. These cues have clear potential for use as attractants and stimulants in Asian carp control. Future studies are planned using both USGS and State of Minnesota funding to investigate these possibilities and develop these promising cues for Asian carp control.

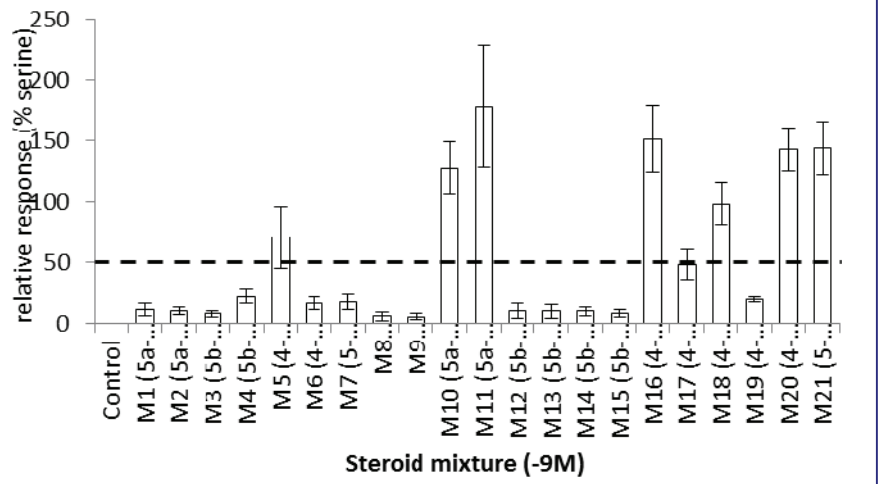


***Figure 2**. EOG responses of silver carp to 21 sex steroids mixtures and control. Responses are shown relative to control (10^{-5} M L-Serine). Results demonstrate that just few types of sex steroids elicit strong responses. Nine steroids were eventually found to explain all activity.*

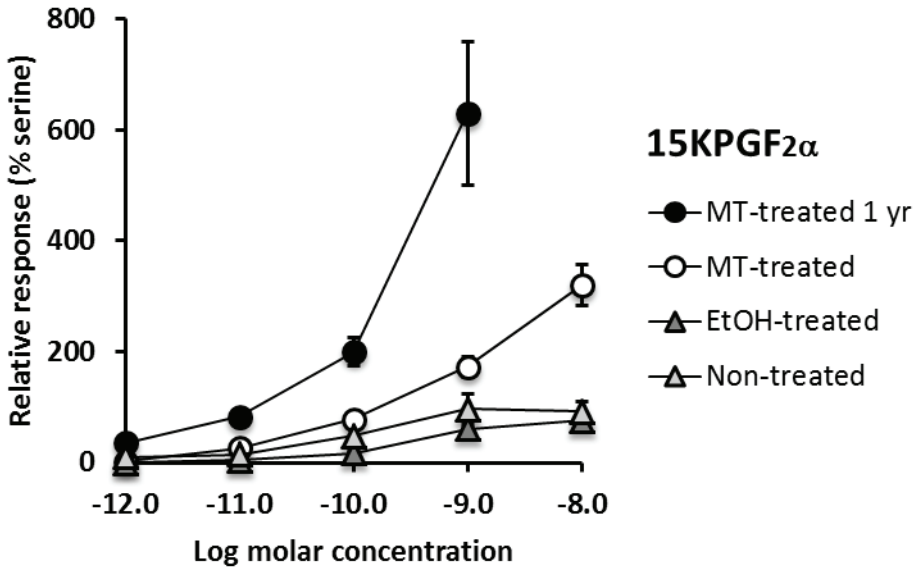


Figure 3. *EOG responses of bighead carp treated with various controls or an androgen (MT) to different doses of 15keto prostaglandin (15KPGF2a), a putative sex pheromone in this species.*

Factors Affecting Detection of American Woodcock on Singing-ground Surveys

Investigator: David E. Andersen

Student: Stefanie Bergh, M.S. (Natural Resources Science and Management)

Duration: May 2008 to December 2011

Funding Source: U.S. Fish and Wildlife Service, Webless Migratory Gamebird Research Program

U.S. Geological Survey

Project Location: Pine County, Minnesota

Minnesota Cooperative Fish and Wildlife Research Unit

American woodcock (*Scolopax minor*) are migratory game birds that occur in forested landscapes in eastern and central North America. Woodcock are cryptically colored shorebirds found in a variety of early successional forest habitats that include a mix of open habitats where woodcock display. Male woodcock use different types of openings (natural openings, clearcuts, agricultural fields, etc.) as singing-grounds for their spring courtship display. Woodcock populations are monitored via the Singing-ground Survey (SGS), coordinated by the U. S. Fish and Wildlife Service (FWS) and the Canadian Wildlife Service. This survey has been conducted throughout the primary woodcock breeding range since 1968 and is used as an index of abundance and population trend. The survey is made up of approximately 1,500 routes that are 3.6 miles in length with 10 equally spaced listening points. Observers begin surveys shortly after sunset and record the number of woodcock heard peenting (a vocalization made during courtship displays by male woodcock) at each listening point during a 2-minute listening period.

The SGS was designed to incorporate factors that influence the male mating display and in turn the counts from the survey. However, the relationship between the number of woodcock heard on surveys and the number of woodcock present is unknown. One important underlying and untested assumption of the SGS is that all male breeding woodcock at each listening point are heard peenting on the night of the survey, or that a constant proportion of birds present are detected among years. As with most indices of abundance, the SGS is based on an assumed relationship between counts and population size that is not well documented. Spatial and temporal variation in detection probability introduces potentially significant noise into the relationship between counts and population size. There are many factors that can influence detection probability of displaying male woodcock in the SGS including weather conditions, observer error, woodcock behavior, woodcock density, change in singing-ground sites, and the distance from and orientation of a peenting woodcock relative to the listening point. Behavioral studies of woodcock suggest that male breeding woodcock can display at more than one singing

ground per night and subdominant males will display at a singing ground when the dominant male is absent. The spatial extent of surveys is also not well established, limiting the ability to estimate density of displaying male woodcock based on counts from the SGS. Currently, the effective area surveyed at a listening stop is not known, and may vary as a function of landscape type (e.g., forest, agriculture, urban, etc.), environmental conditions under which surveys are conducted, abilities of observers, and other factors.

Beginning in 2008, we conducted assessments of factors related to detection probability of American woodcock during crepuscular surveys, following the protocol of the SGS. In 2009 and 2010, we surveyed four existing SGS routes in east-central Minnesota, and established four additional reference routes. We developed occupancy models that incorporated detection probability, and conducted controlled trials to estimate the effective area surveyed at listening points. Detection probability was relatively high (approximately 0.62 pooling across years), although considerably less than perfect (1.0). Factors that influenced detection probability included woodcock abundance at a listening point, observer, time during the spring surveys were conducted, ambient noise level, and wind speed. We estimated effective area surveyed at listening points to be 12.3 ha in forested landscapes and 46.3 ha for open landscapes. Finally, we used this information to derive estimates of density of singing male woodcock along survey routes in east-central Minnesota, and to suggest ways to incorporate detection probability and effective area surveyed into analysis of SGS data.

Long-term Monitoring of Colonial Waterbird Populations in the Great Lakes: Improving the Scientific Basis for Conservation and Management

Investigator: Francesca Cuthbert (Cooperating Faculty)
Staff: Linda Wires, Research Fellow
Duration: June 2007 to February 2011
Funding Source: U.S. Fish and Wildlife Service
Project Location: University of Minnesota

Double-crested cormorant colony

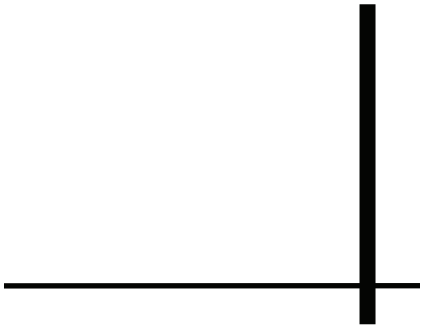
Colonial waterbirds are a significant natural resource in the North American Great Lakes and information on their distribution and population trends is essential for their conservation and management, as well as for studying ecosystem change. Beginning in the mid-1970s, the U.S. Fish and Wildlife Service and the Canadian Wildlife Service have conducted four survey efforts for colonial waterbirds in the Great Lakes region. We conducted the fourth survey during breeding seasons 2007-2009, and surveyed shoreline and islands in the U.S. Great Lakes and their connecting waters to obtain information on distribution and estimates of number of breeding pairs of colonial waterbirds. These data were compared to population estimates obtained during previous survey efforts in the 1970s, 1980s and 1990s. Additionally, we evaluated survey methodology (ground counts vs. counts from aerial photographs), applied results from an earlier detection probability study to improve survey accuracy, and used a previously developed prioritization method to identify the most important waterbird colony sites in the U.S. Great Lakes and to recommend modifications for future survey and monitoring efforts.

Approximately 413,000 pairs of 14 species of colonial waterbirds nested at 310 locations in the U.S. Great Lakes during 2007-2009. These results represent an 11% increase in number of pairs but a decrease of 24% in number of nesting sites from the third survey. The Great Lakes colonial waterbird community is dominated by three species: ring-billed gull (*Larus delawarensis*), herring gull (*L. argentatus*) and double-crested cormorant (*Phalacrocorax auritus*). During the 2007-2009 survey period, population estimates for these species in the U.S. Great Lakes were approximately 306,000, 38,000 and 53,000 breeding pairs, respectively. Ring-billed and herring gulls increased by about 12% and 9%, respectively, since the third survey. Cormorant numbers in

the U.S. Great Lakes increased by only 8%, which indicates the exponential growth rate of this population observed through the third survey has slowed. Five species, great blue heron (*Ardea herodias*), great egret (*A. alba*), black-crowned night-heron (*Nycticorax nycticorax*), Caspian tern (*Hydroprogne caspia*) and common tern (*Steran hirundo*) have population sizes ranging from approximately 1,600 to 4,500 pairs. Three species, common tern, great egret and black-crowned night-heron, increased by 31%, 25%, and 12%, respectively. The Caspian tern population remained essentially stable, and the great blue heron population decreased by 27%. Three species have population sizes ranging from 129 (black tern [*Chlidonias niger*]) to 533 (Forster's tern [*Steran forsteri*]) and 875 pairs (American white pelican [*Pelecanus erythrorhynchos*]). Of these species, pelicans increased by 500% since the third survey and both of the marsh nesters declined; Forster's tern by 56% and black tern by 42%. Fewer than 20 pairs of three species (little blue heron [*Egretta caerulea*], cattle egret [*Bululcus ibis*] and snowy egret [*Egretta thula*]) were found nesting during the survey. Two species (great back-backed gull [*Larus marinus*], little gull [*Larus minutus*]), previously recorded nesting in small numbers in the study area, were not reported and no new species were found nesting during the fourth survey period.

Ring-billed gull colony

Comparisons of ground counts and estimates from aerial photographs demonstrated that estimates obtained from both methods within the same period produce very similar results for a suite of species nesting under conditions where incubating birds are not concealed by substrate or vegetation. Therefore, either method is acceptable if a standard protocol is followed. Identification of colony sites that currently capture a high percentage of nesting birds of all species (76% for herring gulls to 100% for American white pelicans, excludes marsh terns) resulted in selection of 102 sites. Additional analyses to compare growth rates of select species at all sites versus the prioritized sites, yielded very similar growth rates. Based on population coverage and similarity of growth rates, we recommend transition from the complete decadal count to more frequent, less intensive surveys focused on a subset of important sites for the general colonial waterbird group and common terns.



Completed Research

Human Dimensions, Management, and Conservation

The 2010 Waterfowl Hunting Season in Minnesota: a Study of Hunters' Opinions and Activities

Investigator: David C. Fulton

Staff: Susan A. Schroeder, Research Associate

Duration: September 2010 to December 2011

Funding Source: Minnesota Department of Natural Resources

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

Minnesota has generally had the largest 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 have been compared to those in other states. More recently, reports documenting hunter activity and opinions following the 2000, 2002, 2005, and 2007 waterfowl hunting seasons were completed. In addition, a series of surveys looking at hunter recruitment and retention were completed following the 2005 waterfowl hunting season. Information from these reports has been used to inform management decisions.

This study of the 2010 Minnesota waterfowl-hunting season was conducted to assess waterfowl hunters': participation and activities, satisfaction, motivations, constraints, identification and involvement with the activity, and attitudes about waterfowl management and seasons. These results were compared to results from previous Minnesota surveys and other hunter surveys. The questionnaire was similar to the 2000, 2002, 2005, and 2007 questionnaires. In 2011, states could select a zone/split combination for the 2011-2015 period. This survey provided essential information for selecting the best option for Minnesota. A study report was finalized in March 2012, and complete study results are available in that report.

The survey was distributed to 4,000 waterfowl hunters; 1,946 completed surveys were used for this analysis. After adjusting for undeliverable surveys and invalid respondents, the response rate was 50%. Over half of hunters (58%) reported being satisfied with their general waterfowl-hunting experience. Younger hunters and hunters who have been hunting for fewer years reported higher levels of satisfaction. Over half of respondents were satisfied with their 2010 duck-hunting experience. However, about 60% of respondents were dissatisfied with their duck-hunting harvest. Satisfaction with duck-hunting regulations fell between satisfaction levels for experience and harvest. About one in four respondents felt neither satisfied nor dissatisfied about the duck-hunting regulations, compared to < 10% for duck-hunting experience or harvest. There was a significant positive relationship between the number of ducks bagged and satisfaction with duck-hunting harvest. Hunters were asked to compare the 2010 waterfowl season to the 2009 season. Nearly one-third of respondents indicated that their general waterfowl hunting experience was better in 2010 than in 2009, while 46.5% felt it was worse, and 24% felt neither year was better than the other. Results were similar for duck-hunting experience. A slightly smaller proportion of respondents indicated that duck hunting harvest was better in 2010. The large majority of respondents (68%) felt that 2010 duck regulations were neither better nor worse than 2009 regulations. About one-fourth (26%) of respondents felt that the number of

ducks seen in 2010 was better than in 2009, while over half (56%) felt the number was worse.

Management Strategies

Respondents were asked to indicate their opinion about the six-duck bag limit, one-hen mallard (*Anas platyrhynchos*) bag limit, and two-wood duck (*Aix sponsa*) bag limit. About two-thirds of respondents felt the six-duck bag limit was about right, with 5.2% indicating that it was too low, 15% too high, and 12% had no opinion. Nearly six in 10 respondents felt the one-hen mallard bag limit was about right, compared to 17% too low, 24% too high, and 11% no opinion. Over half of respondents felt the two-wood duck bag limit was about right, compared to 27% who felt it was too low, 7.5% who thought it was too high, and 11% who had no opinion.

Respondents were asked to indicate their level of support for six management strategies. Over half of respondents opposed, with 29% supporting, ending shooting hours at 4 pm for the first part of the season. Nearly three-fourths of respondents supported moist soil management, with only 7.1% opposing. About 42% of respondents supported limiting the use of mud motors on certain public hunting areas, while 41.4% were neutral and 17% opposed. Nearly four in 10 respondents supported restrictions on open water hunting, while 33% were neutral and 28% opposed. Over half of respondents opposed restrictions on hunting within 100 yards of surface water during the early Canada goose (*Branta Canadensis*) season, with 21% supporting this restriction and 25% neutral. About six in 10 respondents supported providing easier access to waterfowl hunting sites on Wildlife Management areas, with only 8.1% opposed, and 31% neutral.

Season Dates and Zones

Respondents were asked to view a map and select the area of the state where season dates were most important to them. The largest proportion (24%) selected the west-central region, followed by east-central (20%), southwest (19%), northeast (11%), northwest (11%) and southeast (8.7%); about 5% had no preference. Study participants were asked to select a straight season, a split season, or no preference for a 60-day duck season in 2011. Statewide, 46% preferred a straight season (Saturday 1 October to Tuesday, 29 Nobember), 36% preferred a split season (Saturday 24 September to Sunday 25 September, close 5 days and reopen Saturday 1 October to Sunday 27 November), and 17% had no preference. Survey participants were asked to select their three preferred 10-day periods, in the case of a 30-day duck season. Statewide, the most preferred time periods were: Early October (1-10 October) (preferred by 53% of respondents) and Late October (21-31 October) (52%), followed by Mid-October (11-20 October) (41%), although there were significant differences in date preferences by region.

The 2011 Waterfowl Hunting Season in Minnesota: a Study of Hunters' Opinions and Activities

Investigator: David C. Fulton

Staff: Susan A. Schroeder, Research Associate

Duration: December 2011 to December 2012

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 series of surveys looking at hunter recruitment and retention were completed following the 2005 waterfowl hunting season and a study of former waterfowl hunters was completed following the 2009 season. Information from these reports has been used to inform management decisions. We conducted a survey following the 2010 waterfowl season, but changes in waterfowl hunting regulations in 2011 required an additional hunter survey. Specifically, duck season opened one week earlier, shooting hours on opening day began at ½ hour before sunrise instead of 9 a.m., wood duck (*Aix sponsa*) daily bag limit was increased from two to three, and the hen mallard (*Anas platyrhynchos*) daily bag limit was increased from one to two. In addition, 2010 was the first year Minnesota used zones for duck seasons. In 2011 we have the opportunity to add an additional zone. This study provided and assessment of how hunters perceived the 2010 zones, and obtained recommendations for the 2011 zones. Data were collected in the spring of 2012 and a report was finalized in October 2012.

The survey was distributed to 3,600 waterfowl hunters; 1,815 completed surveys were used for this analysis. After adjusting for undeliverable surveys and invalid respondents, the response rate was 51.7%. An additional 264 shortened surveys used to gauge nonresponse were also received for a total response rate of 59.2%. Respondents were asked to select the area of the state where season dates were most important to them. The largest proportion (41.6%) selected the west-central region, followed by north (26.4%), south (17.6%), and southeast (8.6%). About 6% had no preference. Study participants were asked to select between a straight season, one of two split seasons, or no preference for a 60-day duck season in 2012. Statewide, 38.3% preferred a straight season (Saturday 22 September to Tuesday, 20 November), 26.6% preferred a split season with a later split (Saturday 29 September to Sunday 30 September, close 5 days and reopen Saturday 6 October to Sunday 2 December), 20.1% preferred a split season with an earlier split (Saturday 22 September to Sunday 23 September, close five days and reopen Saturday 29 September to Sunday 25 November), and 15.0% had no preference. Study participants were asked to select between a straight season, one of two split seasons, or no preference for a 30-day duck season in 2012. Statewide, 34.8% preferred a straight season (Saturday 29 Septem-

ber to Sunday, 28 October), 31.9% preferred a split season with a late split (Saturday 29 September to Sunday 7 October, close 10 days and reopen Thursday 18 October to Wednesday, 7 November), 16.7% preferred a split season with an earlier split (Saturday Sept. 29 to Sunday Sept. 30, close 5 days and reopen Saturday Oct. 6 to Friday, Nov. 2), and 16.6% had no preference. Study participants were asked to select between two straight September goose seasons of different lengths, or no preference for a September goose season. Choices for the September goose season were fairly evenly divided. Statewide, 37.2% had no preference, while 35.1% preferred the longer Saturday 1 September to Friday 21 September season, and 27.7% preferred the shorter Saturday 1 September to Sunday 16 September season.

Comparison with Earlier Study Results. Respondents reported significantly higher satisfaction levels for the 2011 season than for the 2005, 2007, or 2010 seasons. Satisfaction was not significantly different from the 2000 and 2002 seasons. Six identical measures of trust in the Minnesota Department of Natural Resources were asked in both 2010 and 2011, and two identical measures were asked in 2002. Average trust was significantly higher in 2011 than 2010 for several measures, and average trust in 2011 was significantly lower than 2002 for the two measures that were consistent between those years. Reported memberships in Ducks Unlimited, Delta Waterfowl, the Minnesota Waterfowl Association, and local sportsmen's clubs were higher in 2011 than in previous study years.

Bass Management in Minnesota

Investigator: David C. Fulton
Staff: Susan A. Schroeder, Research Associate
Duration: June 2011 to September 2012
Funding Source: Minnesota Department of Natural Resources
Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

This study sought to gather angler opinions about black bass (*Micropterus* spp.) angling and management in Minnesota. Specifically, the purpose of this study was to better understand the opinions of black bass anglers and non-bass anglers about management of black bass populations. Anglers who target black bass—including largemouth (*M. salmoides*) and smallmouth bass (*M. dolomieu*) —in Minnesota are not well understood. Black bass range expansion, and bass-fishing regulations and tournaments, affect bass populations and angler behavior. However, managers have only a basic understanding of these issues and little insight into how they affect bass populations or anglers.

The study included two research strata: (a) individuals who specifically fish for bass—either largemouth or smallmouth, and (b) individuals who don't specifically fish for bass. Throughout the report we refer to respondents to the survey distributed to individuals in the first research stratum as "bass anglers," and we refer to respondents to the survey distributed to individuals in the second research stratum as "non-bass anglers" or "general anglers." The survey samples were drawn from the Minnesota Department of Natural Resources' (DNR) electronic licensing system (ELS). An initial sample of 10,000 Minnesota residents who purchased any type of resident fishing license for the 2011 fishing season, which ran from 1 March, 2011 through 28 February 2012, was drawn from the ELS. These 10,000 individuals received cover letters describing the study, along with postage-paid reply postcards that asked recipients to indicate whether they had fished for largemouth or smallmouth bass during the previous year. Response to postcards was used to identify samples of bass anglers and non-bass anglers. Of 2,576 postcards returned, 1,137 (11.4%) were returned by individuals who did not target bass, 583 were returned by individuals who targeted either largemouth (415) or smallmouth (168) bass, and 842 were returned by individuals who targeted both largemouth and smallmouth bass. Data were collected using mail-back surveys following the process outlined by Dillman (2000) 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 March 2012 and May 2012. Of the 1,832 full-length questionnaires mailed to prescreened bass or non-bass anglers, 12 were undeliverable. Of the remaining 1,820 surveys, a total of 1,252 full-length surveys was returned, resulting in an overall response rate of 68.8%.

On average, bass anglers had been fishing in the state for 37 years compared to 44 years for non-bass anglers. Bass anglers had purchased a license in 8.9 of the past 10 years, while non-bass anglers had purchased a license in 8.4 of the past 10 years. Bass anglers fished significantly more days during the past 12 months than non-bass anglers did (39 vs. 20 days). About two-thirds of bass anglers reported fishing with children during the past year, compared to about half of re-

spondents who didn't target bass. Bass anglers reported greater use of artificial lures compared to non-bass anglers who reported greater use of live bait. A great majority of bass anglers report releasing most or all of the bass that they catch. About 10% of bass anglers report keeping most of the bass they catch and only about 5% of bass anglers report keeping all of the bass they catch. In contrast, a minority of non-bass anglers release most or all of the fish they catch. Over half of these general anglers keep most of the fish they catch, and 12.7% report keeping all of the fish they catch. Bass angling respondents were asked to report sizes for "keeper," preferred, and trophy bass. On average, largemouth bass anglers indicated 13.3" for the minimum "keeper" size, 14.6" for minimum preferred size, and 20.3" for minimum trophy size. Smallmouth sizes were somewhat smaller; the minimum keeper size was 12.7," the minimum preferred size was 13.7," and the minimum trophy size was 18.6." Respondents were also asked to report the minimum number of bass for a "good" day. On average, the minimum number of largemouth bass for a "good" day was 7.0, and the number of smallmouth bass for a "good" day was 6.1.

Bass and non-bass anglers were asked to respond to a number of questions about bass and invasive species management in Minnesota. Questions addressed expansion of black bass populations, introduction of black bass, walleye (*Sander vitreus*) versus bass management, and aquatic invasive species. There was no significant difference between bass and non-bass anglers in items asking whether largemouth and smallmouth bass were expanding into new areas of Minnesota. However, bass anglers were more likely to agree that the expansion of largemouth and smallmouth bass into new areas would be a good thing. Bass anglers were less likely to agree that the DNR should try to prevent the expansion of largemouth and smallmouth bass.

Bass anglers more strongly agreed that protecting habitat for largemouth and smallmouth bass was important to them, and they agreed more strongly that the DNR should try to introduce largemouth and smallmouth bass into new waters. Bass anglers were less likely to agree that black bass are negatively impacting walleye populations, and more likely to agree that too many lakes and rivers are being managed for walleye instead of black bass. Bass anglers were slightly more likely to agree that aquatic invasive species have a negative impact on black bass, and that the DNR should enforce regulations and educate people to minimize the expansion of aquatic invasives.

Bass anglers were also asked a number of questions about bass regulations in Minnesota. In general, bass anglers supported the statewide black bass regulations in Minnesota. Respondents were fairly neutral in their response to whether there were too many special black bass regulations on different lakes and streams in Minnesota, and on whether there should be more special regulations. A slight majority of respondents agreed that the DNR should manage largemouth and smallmouth bass separately. On average, respondents were largely neutral about whether special regulations for black bass were too complex, and whether the same statewide regulations should apply to smallmouth and largemouth. Bass anglers were asked about their preferences for bass management using the scale 1 (strongly do not prefer), 2 (do not prefer), 3 (neither), 4 (prefer) and 5 (strongly prefer). Bass anglers were largely neutral about catch-and-release only fishing for bass, with 43.6% not preferring, 20% neutral, and 36.5% preferring. There was a very slight preference for a 12-20" protected slot with only 1 over 20," and a slight preference for a 14-20" protected slot and only 1 over 20." Many bass anglers did not prefer a maximum size limit of 12" or 14." There was also less preference for lakes and streams without special regulations.

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

Investigator: David C. Fulton

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

Duration: January 2011 to December 2012

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 on-going specific projects include a statewide general angler study and a statewide waterfowl hunter study.

Minnesota Climate Change Vulnerability Assessment

Investigator: Bruce Vondracek

Staff: Kristen Blann, Postdoctoral Researcher

Duration: July 2012 to December 2012

Funding Source: Minnesota Department of Natural Resources

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

The Minnesota Department of Natural Resources convened expert panels to conduct ecosystem-scale climate change vulnerability assessments for selected habitats using a systems mapping process. The mapping process identified key drivers of change, relationships among drivers, stressors and their relative strength of influence, including the assignment of vulnerability, and confidence scores. The goal was to compile the data gathered from the expert panels to incorporate adaptation strategies relative to climate change scenarios into Minnesota's State Wildlife Action Plan.

Scaleable Indices of Watershed Health

Investigators: Bruce Vondracek and Paul Bolstad (Cooperating Faculty)

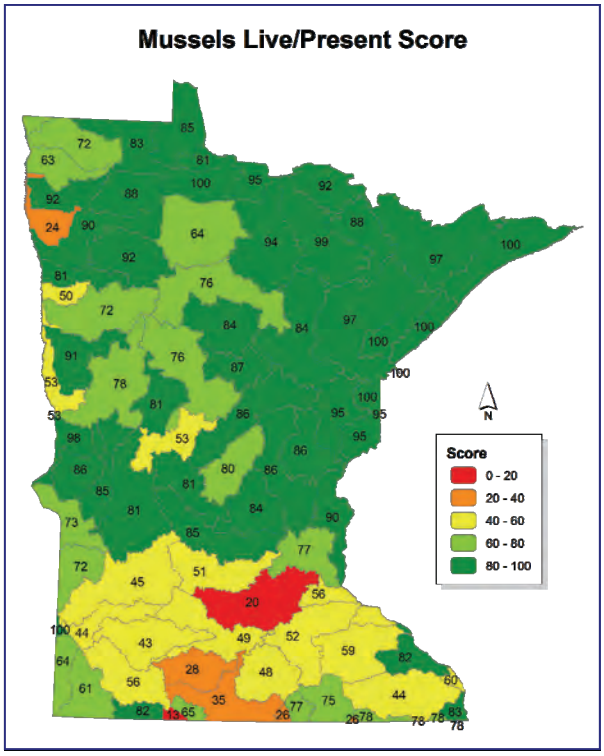
Student: Bethany Blick, M.S. (Water Resources Science Program)

Duration: July 2008 to June 2011

Funding Source: Minnesota Department of Natural Resources

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

A watershed-based approach is increasingly recognized as the most comprehensive framework for understanding and managing natural resource systems, including streams and lakes. However, for this approach to be successful, a large amount of information regarding the current state of watershed resources is necessary. Unfortunately, despite the large amount of existing geographic information system (GIS) information that could be utilized, this information is not readily available for managers in an easily accessible, broadly applicable, summarized form. The Watershed Assessment Tool Project was designed to bridge this gap by acquiring background information on watershed concepts and developing a comprehensive series of GIS layers. This information was organized in a five-component framework of hydrology, geomorphology, biology, connectivity, and water quality to facilitate quantification of healthy watershed function and interactions. We developed a meta-analyses and syntheses to support the broad-scale, long-term quantification of watershed health in major Minnesota watersheds (eight-digit hydrologic unit code boundaries), the selection of a set of health indices, and the application of these health indices for all such watersheds in Minnesota. This work is specifically designed to support the development of the Minnesota Department of Natural Resources watershed assessment tool.



The number of live mussels across the 81 watersheds in Minnesota

Understanding General Public Beliefs, Attitudes, and Perceptions regarding Climate Change Impacts and Adaptation in Northeast Minnesota

Investigator: David C. Fulton

Student: Alexander Heeren, M.S. (Natural Resources Science and Management)

Duration: April 2011 to February 2012

Funding Source: Minnesota Department of Natural Resources

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

As Minnesota develops strategies for adaptation to climate change, a human dimensions approach integrating both social and natural sciences is critical for understanding the values, basic beliefs, and risk-perceptions of climate change; societal vulnerabilities and reactions to climate change; the societal consequences; and acceptability of adaptation alternatives. Developing a thorough understanding of these topics is a complex task. As a starting point, we conducted a pilot study to provide important baseline understanding of the public concerning climate change and adaptation to climate change in northeast Minnesota. At a national level, several studies have documented beliefs about climate change, its causes, and its potential consequences. Although a few regional and local studies have been completed, there had been no studies focused on Minnesotans' beliefs about climate change. Just as understanding the regional and local biophysical impacts of climate change will require downscaled analysis, understanding what social policy options are available and will be viable will require downscaled human dimensions analysis. The purpose of this study was to provide a thorough understanding of the values, beliefs, risk perceptions, and attitudes that influence people's preferences for adaptation alternatives as well as their behavioral adoption of alternatives in northeast Minnesota.

The target populations for the study were northeast Minnesota residents and landowners. We collected data in two phases of research: focus groups and a general public survey. We completed 5 focus groups in June 2011 in Duluth (2), Ely, Grand Marais, and Virginia, MN, and finalized a report in August 2011. The objective of the focus groups was to elicit information concerning climate change and climate-change adaptation that was relevant at the regional level. This information was used together with previously conducted national studies to design a survey questionnaire implemented September 2011 through January 2012. Complete results are available in the final study report completed in February 2012. Heeren completed an M.S. in August 2012 using the data from the study.

We mailed survey questionnaires to 1,383 valid addresses in Cook, Lake, and St. Louis counties. A total of 437 completed, identifiable surveys were returned for a response rate of 31.6%. Non-respondents tended to be more politically conservative and less sure that climate change was happening. Almost 72% of respondents were at least somewhat sure climate change is happening. About 13% were at least somewhat sure climate change is not happening. Just over 15% were not sure whether climate change is or is not happening. Over half of the respondents believed that climate change was the result of

both human activities as well as natural changes in the environment. The majority of respondents believed that the effects of climate change are already occurring in the United States as well as northeast Minnesota. Over 80% of the respondents believed they could find more information about climate change if they wanted. However, just under half indicated that they intended to seek such information in the future. Less than 10% indicated that they avoided learning about climate change, or that learning about climate change is a waste of time. Out of the list of climate change adaptation strategies respondents were most supportive of preventing the spread of invasive species to offset climate change impacts as well as protecting native habitats. Overall, respondents were supportive of most adaptation strategies. Respondents were less supportive of strategies that involved moving fish, wildlife, or plant species around. Support for strategies varied by the degree to which respondents believed climate change was occurring. Those who indicated that they did not believe in climate change were generally less supportive of all management actions.

Understanding Human Behaviors Concerning Lake Shoreline Management

Investigator: David C. Fulton

Student: Edgar Rudberg, Ph.D. (Natural Resources Science and Management)

Duration: November 2010 to February 2012

Funding Source: Minnesota Department of Natural Resources

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

Shoreland management is of particular concern to natural resource managers. This concern stems from the fragility of the shoreland habitat and the potential for land use decisions to directly affect water quality. Thus, it is of great importance to understand landowner behaviors in the management of shorelines. Since 1980, lakeshore development has increased by over 800% in central Minnesota. As residential development increases around lakes, human behaviors and activities in the immediate riparian area lead to loss of shoreland habitat and to physical alteration of aquatic habitats. Naturally vegetated shorelines provide critical feeding, nesting, resting, and breeding habitat for many species. The subsequent loss of near-shore habitat and physical reshaping of the shoreline and shallow areas is well documented in the scientific literature and these changes also create new, compromised habitats that in turn aid in the establishment of non-native species.

This study was the third phase of a long-term research project to understand the values, attitudes, norms, and beliefs that lead to household behaviors about how privately held residential land will be managed around lakes. Ultimately, understanding the psychological and social factors that drive these decisions can help to design strategies to decrease undesirable behaviors and increase desirable behaviors such as restoration of native vegetation on residential properties. The purpose of this third phase of the study was

to test the influence of communications strategies on homeowner behavior in restoring and/or conservation of native vegetative buffers on lake shores. We used an experimental design with treatments based upon findings from previous research. This research assisted the Minnesota Department of Natural Resources (MN DNR) in prioritizing how outreach messages are communicated, grant dollars are allocated, and restoration sites are selected. Data were collected during the fall of 2012. A study report was completed in April 2012.

Our research study addressed the following specific research questions:

1) To what extent do a communication message, educational information, and knowledge of current shoreland conditions have on one's subsequent information-

seeking behaviors?

2) To what extent do a communication message, educational information, and knowledge of current shoreland conditions have on one's attitudes, behavioral intent to restore one's shore, and reported behavior?

We used findings from the earlier research to guide development of an experimental communication strategy, and our the study reported here was an evaluation of the effectiveness of that communication strategy. For this research project we randomly selected 11 lakes per ecotype to survey. We randomly assigned respondents to be in either the control group or one of two experimental groups. Our sample size for the control was *n* = 817, for experimental group 1 *n* = 815, and for experimental group 2 *n* = 1305 with a total *N* = 2,937. The control group received no additional information. Experimental group 1 received an outreach brochure without additional information on the "Restore Your Shore" website (http://www.dnr.state.mn.us/restoreyourshore/index.html) and experimental group 2 received an outreach brochure with information on "Restore Your Shore".

We found no significant differences among the study groups on demographic or property characteristics, including past restoration and removal activities, indicating that the groups were equivalent upon entry into the study. For this reason, differences in groups on subsequent variables can be attributed to the experimental treatments. We found that the experimental group 2 had a higher intention to restore a buffer over the control and the experimental group 1 had a higher self-efficacy to restore a buffer than the control. The experimental group 2 members were more likely to believe that restoring a buffer would be attractive (compared to the control) and that buffers would create privacy (control and experimental group 1). Both the experimental groups 1 and 2 had a higher belief that they could maintain a buffer when compared to the control. Experimental group 1 had a higher belief that they could obtain information than the control.

Statewide Minnesota General Angler Study 2011

Investigator: David C. Fulton

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

Duration: April 2011 to June 2012

Funding Source: Minnesota Department of Natural Resources

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

The goal of fisheries management is to provide for long-term conservation of fisheries resources while at the same time optimizing the benefits that people obtain from the resources. For this reason, fisheries management involves the management of biological resources and of people. Understanding the concerns and desired experiences of anglers is an important aspect of maintaining satisfying fishing experiences for anglers and a successful fishery.

In 1998, the Minnesota Department of Natural Resources (MN DNR) conducted a statewide assessment of resident angler satisfaction with fishing experiences and attitudes and beliefs concerning fisheries management issues in the state. In 2005, a follow-up statewide survey was completed for the MN DNR by the Minnesota Cooperative Fish and Wildlife Research Unit. This study was the third cross-sectional statewide resident angler assessment that will allow exploration of changes, trends, and new conditions.

The purpose of this study was to provide a current update of angler attitudes and behaviors that can be compared with existing information over the past 13 years.

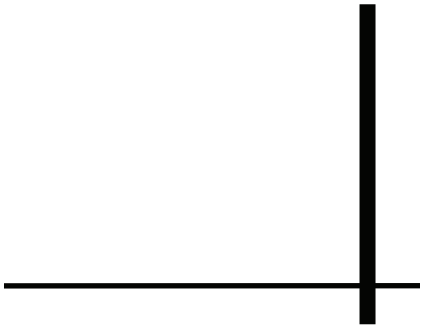
The specific objectives of this study were to:

1) Determine anglers' values, attitudes, norms, and behaviors concerning fishing experiences, issues, and management.
2) Develop and refine a battery of items based on research studies in Minnesota and other states that will be used to track trends in anglers' preferences and attitudes on key issues and perceptions including satisfaction with the general fishing experience, satisfaction with the number and size of fish caught, perceptions of crowding, and other key indicators of the quality of fishing experiences.
3) Continue baseline data for tracking trends in angler perceptions and attitudes on various fisheries issues in Minnesota.
4) Determine differences between resident male and female anglers concerning values, attitudes, and behaviors.

We collected data using a mail-out survey instrument from an initial sample of 5,000 adult licensed anglers drawn from the Minnesota Electronic License System. Data were collected between August 2011 and January 2012. A total of 2,026 full-length surveys was returned, resulting in an overall response rate of 42.8%, adjusting for invalid and deceased participants. Sample sizes of ~400 provided estimates within each of the 5 study strata (n=400) with a margin of error of ±5% with a confidence level of 95%. Non-respondents were slightly younger and less involved with fishing than respondents.

A project summary report was completed in February 2012. In summary, we found that over 70% of the respondents were satisfied with their overall fishing experience during 2010. Over half of respondents were satisfied with the size of fish they caught, the number of fish they caught, and the behavior of other anglers. Just over 40%

of respondents reported being satisfied with the behavior of anglers and the behavior of nonanglers. Nearly three-fourths of respondents were satisfied with access at lakes and streams, and just over 60% were satisfied with facilities. On average, respondents were most satisfied with their overall fishing experience and with access at lakes and streams, and they were least satisfied with the number of fish they caught and the behavior of others. Nearly half of respondents indicated that the quality of fishing had stayed about the same over the past 10 years; 36.6% said quality had declined, while 17.7% said quality had improved. Looking into the future, 28.2% of respondents indicated that the quality of fishing will decline in the next 10 years, with 48.5% saying it will stay the same, and 23.3% saying it will improve.



Ongoing Research

Applied Ecology

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 Wildlife 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 (≈200 – 800 ha) will result in positive growth in local woodcock populations. This assumption has not been tested. Our objective is 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 are:

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 woodcock 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.

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 December 2013
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 chrysoptera*) 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 habitats 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 included 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 mature forest and mid-successional aspen (*Populus* spp.) more often than expected relative to availability, and they selected those habitat types significantly over all other habitat 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 four primary literature publications, with two manuscripts currently under review/revision, three manuscripts in late stages of preparation, and four others in early stages of preparation. The project was also featured in a story by Dan Gunderson on Minnesota Public Radio and a story by Gustav Axelson in Living Bird Magazine (both available online).

Determining the Olfactory Sensitivity of Asian Carp (*Hypophthalichthys* 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 bighead 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_{2a} is attractive to masculinized (androgen-treated) silver carp (Figure 1a) allowing us to conclude it is a sex pheromone. Studies now focus on feeding stimulants in both bighead species. These studies have shown that both species exhibit reflexive ingestion behaviors via a process known as buccal pumping (Figure 1b) when exposed to food. These responses appear to be stimulated by a unique structure known as the epibranchial 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 (Figure 1c). Future studies will identify the unique components that stimulate food search and 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 stimulated by chemostimulants*

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

Malheur Lake and its surrounding areas were designated as a national wildlife refuge in 1908 because of its unique importance as a habitat for waterfowl in the Pacific Flyway. Once characterized by clear water, lush vegetation, and abundance of macro-invertebrates, this shallow lake ecosystem is now extremely turbid and completely void of submersed vegetation as a result of common carp (*Cyprinus carpio*) invasion. It has been recently recognized that the refuge is no longer able to provide the habitats for waterfowl for which it was established, unless the population of carp is controlled. One possible strategy to reduce carp population abundance is to increase the density of small predatory fish that were once abundant in Malheur Lake to increase predation on carp eggs and larvae. Such a natural control strategy has been recently developed in Midwestern lakes.

Figure 1: Experimental enclosures in Benson Pond at Malheur National Wildlife Refuge

Surveys conducted in the refuge in 2011 showed that while local species of fish are not abundant in Malheur Lake, they are commonly found in other parts of the Refuge. Furthermore, locations with more abundant populations of these native species appeared to have lower abundance of carp. The aim of this study is to conduct a controlled experiment to determine whether local fish species found within the Refuge could potentially control the recruitment of the carp by consuming their eggs. In 2012, we completed a first experiment in which we tested the predation of tui chub (*Gila bicolor*), redsided shiner (*Richardsonius balteatus*), pumpkinseed sunfish (*Lepomis gibbosus*), and black bullhead (*Ameiurus melas*) on carp eggs. The experiment was conducted in 1.8x1.8 m mesh enclosures that were stocked with carp eggs (Figure 1). We used 20 enclosures that included 4 controls (no fish) and four replicates for each of the species that we tested.

Preliminary results showed that black bullheads exhibited the highest predation rates on carp eggs. In enclosures stocked with bullheads < 2% of eggs survived to hatching and 84% disappeared within the first 24th (Figure 2). Egg disappearance in other fish treatments was lower and resembled rates observed in the controls (Figure 2), but an increase in carp egg disappearance was also noted in tui chub enclosures during the last three days of the experiment (Figure 2). This experiment will be repeated in 2013 to obtain statistically testable results.

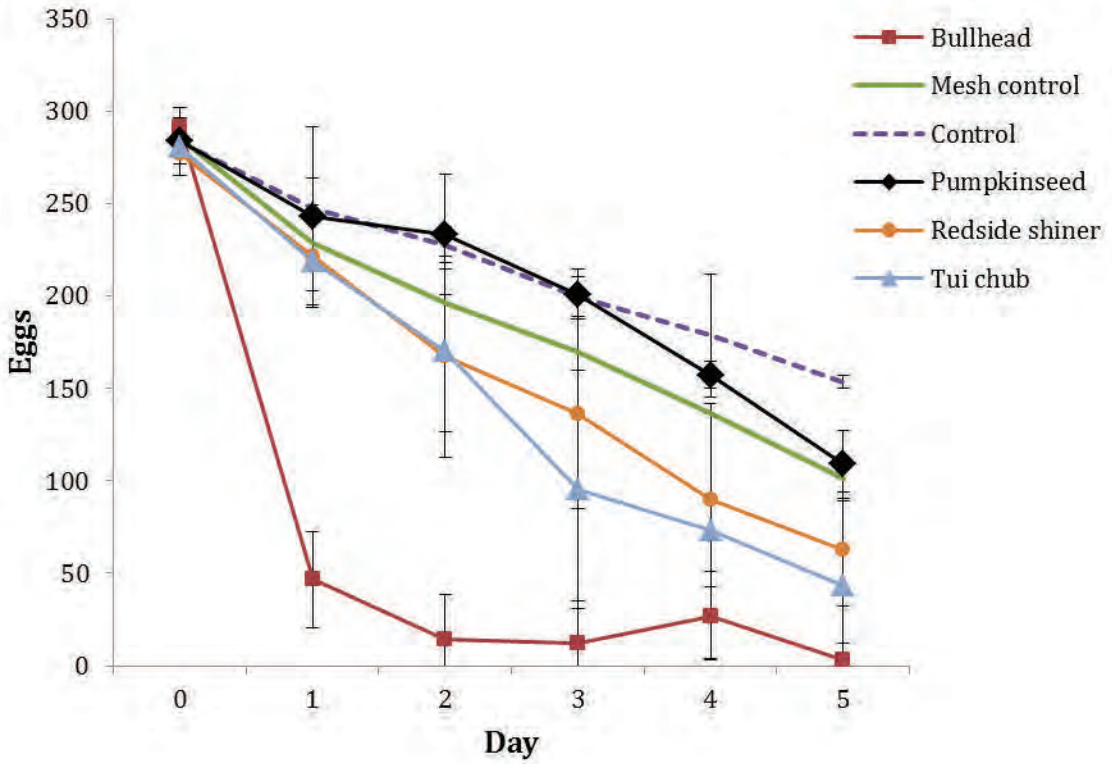


Figure 2. The mean number of carp eggs remaining in each of the experimental treatments on days 0-5 of the experiment. Eggs were placed in the enclosures on day 0 and hatched on day 6. Vertical bars show standard deviations.

Survival and Recovery Rates of Webless Migratory Game Birds

Investigator: Todd Arnold (Cooperating Faculty)

Student: Hannah Specht, Ph.D. (Conservation Biology)

Duration: July 2012 to December 2013

Funding Source: U.S. Geological Survey

Project Location: University of Minnesota

For hunted species, recovery rates represent the proportion of banded birds that are shot or found dead and subsequently reported to the USGS Bird Banding Laboratory. Estimates of recovery rates from banding studies are important for assessing harvest, survival, and movement patterns. However, few published estimates of adult survival exist for webless migratory shore and upland game birds, and many of these estimates are based on obsolete methods (e.g., composite dynamic life tables). The objectives of this study were to: 1) summarize existing banding data for 16 species of webless migratory game birds, 2) estimate encounter rates by species and region to determine adequacy of historical banding effort, and 3) where possible, utilize existing data to provide estimates of annual survival. Our analysis has identified four species with sufficient data to estimate annual survival rates, and for which robust estimates based on modern analytical methods are currently unavailable; these include American coots (*Fulica americana*) (3,803 encounters), sandhill cranes (*Grus canadensis*)(1,402), clapper rails (*Pallus lonirostris*) (779), and Wilson's snipe (*Gallinago delicate*) (417).

Preliminary analyses with American coots, sandhill cranes, and Wilson's snipe illustrate the importance of carefully considering which data to include in such an analysis. For example, survival rates estimated from hunter-shot birds can be very different from estimates based on birds dying of other causes (Figure 1).

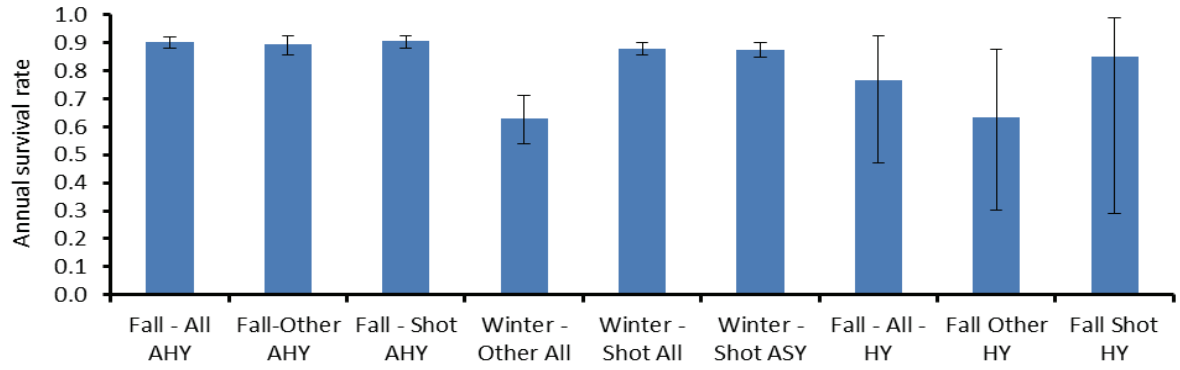


Figure 1. Annual survival of sandhill cranes based on band recovery models, illustrating the importance of different inclusion criteria based on time of banding (fall vs. winter), method of recovery (shot vs. other mortality), and age class (AHY-adult, HY-young, all).

Moose Habitat Use and Activity in Voyageurs National Park

Investigator:	Ron Moen (Cooperating Faculty)
Students:	William Chen, Ph.D. (Integrated BioSciences Program, UMD)
	Amanda McGraw, Ph.D. (Integrated BioSciences Program, UMD)
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 GPS collars on moose in Voyageurs National Park to evaluate changes in habitat use as related to changes in ambient temperature. These GPS collars collect locations at 20 minute intervals and transmit those locations via Argos satellite network. The collars were recovered from moose in winter 2013. We collected about 104,000 locations in 2010 and over 200,000 locations in 2011 from 25 different moose, and compared these data to data collected between 1995 and 1997.

We used these GPS locations to characterize moose home range size and cover-type composition in Voyageurs National Park in northeastern Minnesota. Home ranges were calculated for both snow and snow-free seasons. The large numbers of locations obtained for each animal allowed for both minimum convex polygon (MCP) and kernel density home range estimates. We also identified differences in movement characteristics between deployments. Home range size did not change over the 15-year period. Summer home range area estimates for the 1995-97 deployment were 12.0 ± 7.2 km^2 for 95% kernel, 1.3 ± 1.3 km^2 for 50% kernel and 19.9 ± 9.9 km^2 for 95% MCP. Home range estimates for the 2010-12 deployment were 10.3 ± 6.6 km^2 for 95% kernel, 1.0 ± 0.8 km^2 for 50% kernel and 17.2 ± 6.9 km^2 for 95% MCP. Standard errors for the 95% kernel and MCP estimates suggest individual variability of movement behavior among study animals. These areas fit within the broad range of summer home-range size estimates of other studies in North America and Scandinavia (mean: 23.7 km^2, min: 0.9 km^2, max: 141 km^2), as well as in northern Minnesota (mean: 28.5 km^2). 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.

These results will be presented by William Chen at the 2013 North American Moose Conference and Workshop, and the paper will be submitted to the journal *Alces*.

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 2013
Funding Source: U.S. Bureau of Land Management
Project Location: Alaska's North Slope

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 propose to (1) summarize and evaluate existing CRSA peregrine nesting data to assess nesting habitat use and related productivity, and (2) implement additional data collection efforts focused on assessing nesting area occupancy related to habitat and other factors associated with productivity.

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

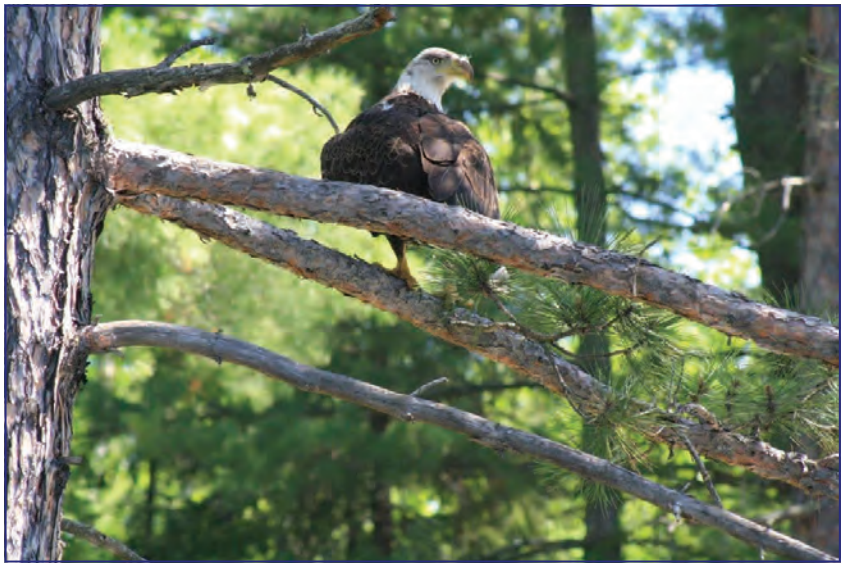
Investigators: David E. Andersen

Staff: Jason E. Bruggeman, Postdoctoral Researcher

Duration: November 2010 to June 2013

Funding Source: U.S. Fish and Wildlife Service

Project Location: U.S. Western Great Lakes region



Although bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chryseatos*) were delisted pursuant to the Endangered Species Act in 2007, they 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 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 compiled and

summarized so biologists 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 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 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.

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 February 2014

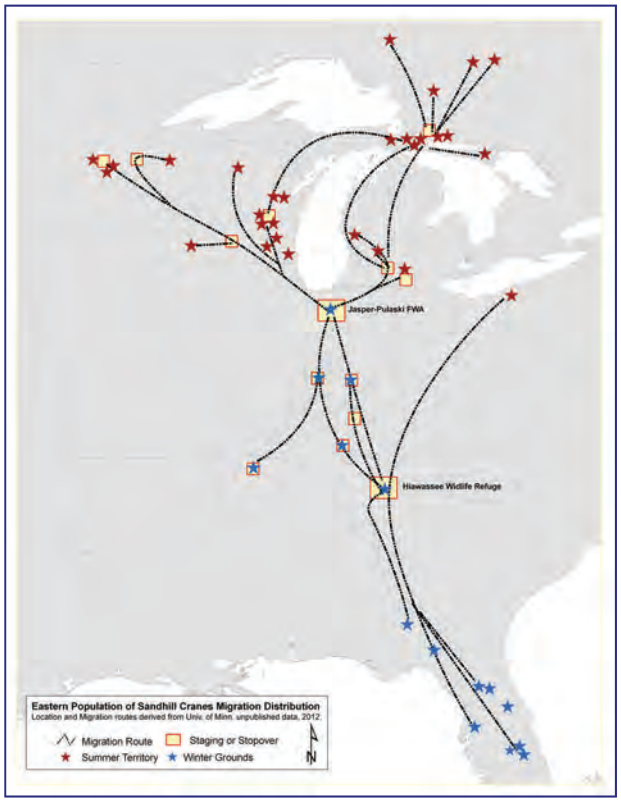
Funding Source: U.S. Fish and Wildlife Service, Webless Migratory Gamebird Research Program

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) as well as 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 are based on the priority information needs set by the MSUGB Support Task Force. Our first objective is to use satellite telemetry to delineate breeding range and migration patterns of EP sandhill cranes. That aspect of the project is ongoing. Our second objective is to evaluate existing survey protocols used to monitor population size, and that aspect of the project has been completed.



To date, we have deployed 27 GPS satellite transmitters on EP sandhill cranes during the winter months of 2009, the spring and fall months of 2010, and again through the winter months of 2010-2011. We captured cranes with the aid of rocket nets at locations that included major staging and stopover sites throughout the range where cranes concentrated during fall migration. In total, we captured and banded 190 sandhill cranes during the 2009-2011 study period.

Preliminary results indicate that the distribution of summer areas for marked EP sandhill cranes extends across three states and one province in the Great Lakes region. Three birds settled in Minnesota, 10 settled in Wisconsin, eight settled in Michigan, six settled in Ontario. During fall migration, EP cranes utilized multiple stopover sites in Indiana, Kentucky, and Tennessee before reaching their winter terminus. The distribution of winter areas for marked EP sandhill cranes extended from Indiana to Florida—well north of the areas described by previous studies. The majority of marked cranes wintered in southeastern Tennessee centered around Chickamauga Reservoir and in Obion County in northwestern Tennessee. South of Tennessee, cranes wintered throughout central Florida and southern Georgia. North of Tennessee, cranes wintered within the south and north-central portions of Kentucky and in both northwestern and southern Indiana. During spring migration, cranes followed the same routes and used the same stopover areas as during fall migration. However, they tended to stopover for a period at Jasper-Pulaski Fish and Wildlife Area and surrounding area along the Kankakee River in northwest Indiana until weather conditions were conducive for movement to their summer areas.

Work is continuing by evaluating satellite telemetry data to fulfill the migration chronology analysis objective. This project is anticipated to be completed by September of 2013.

Ongoing Research

Human Dimensions, Management, and Conservation

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

Human structures related to shoreline development, such as docks, boatlifts, and other structures, and disturbance from recreational activity may have a cumulative impact on aquatic ecosystems. Few studies have addressed the effects of incremental changes on lake ecosystems despite ongoing concerns about the rate and extent of near-shore, in-water habitat alterations, and expansion of in-lake structures. 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 are developing a framework to assess cumulative impacts on 30 whole-lake systems. We will use aerial photos and existing Minnesota Department of Natural Resources data to measure whole-lake disturbances of 114 lakes in the Northern Lakes and Forests Ecoregion. We will use our research to develop a model to predict the cumulative impact of development on macrophyte species composition and biovolume, fish species composition and abundance, and the amount of coarse woody structure (trees or branches greater than 10 cm in diameter) at sites with and without docks. Our data will provide a tool to guide lake managers toward sustainable near-shore, in-water development.

Deer Management on Private Lands in Southeast Minnesota

Investigator: David C. Fulton, 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 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 gathers 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 populations.

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 (2009) tailored design method. Participants were contacted multiple times to enhance response rates. Participants were contacted three times between October 2012 and January 2013.

Effects of Imperfect Detectability on Inferences from Monitoring

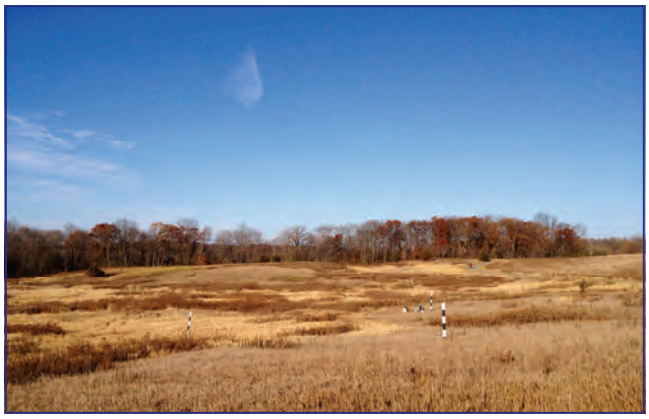
Investigators: David E. Andersen and Douglas H. Johnson (Cooperating Faculty)

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, time of 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 addresses detectability questions in a simulated context. Graduate student Elizabeth Rigby is constructing 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 is modeled by assigning a percentage of suitable habi-

tat (as opposed to matrix, or non-suitable habitat) to each site. Species are assigned a Specialist Index value (range: 0-1), where complete generalists (index value equals zero) use suitable and non-suitable habitat in proportion to their availability and complete specialists (index value equals 1) exclusively use suitable habitat. The number of birds *j* at each survey area is generated using a Poisson distribution, given the amount of habitat in the survey area, the Specialist Index for the species, and the overall abundance in the area of inference.

To enable simulation of distance sampling and spatially dependent factors affecting detectability, positions of each bird within and around the survey area must be known throughout the survey. Simulated birds may move between time intervals, where an interval is a short period during which a bird may be available (e.g., three seconds, during which a bird may sing or not). Locations of birds are generated based on elliptical territories defined by a bivariate normal distribution. The center of each territory is determined using a bivariate uniform distribution. Movement between any survey interval *k* and interval *k*+1 is Bernoulli-distributed with a species-specific probability of movement. Movements away from the observer can be simulated between survey intervals 0 and 1 and are dependent on the distance of the bird from the observer.

Availability during any interval *k* is Bernoulli-distributed, with a probability of vocalization affected by phenology, time of day, density of conspecifics, weather, and distance to observer. Perceptibility of any vocalization is Bernoulli-distributed, with a probability of detection affected by vocalization type, habitat or structural conditions, density of conspecifics, weather or ambient noise, distance to observer, and observer skill. Distributions modeling factors affecting availability and perceptibility are under development.

The completed simulation will be used to analyze the effect of analysis type (e.g., index method or double observer method) on abundance estimates. The model will be used to test various scenarios, such as long trends in habitat density or ambient noise (trends expected with climate change and increasing human development) or surveys of "problem" species with highly variable spatial abundance, low overall abundance, or low availability.

In addition to the computer simulation, Elizabeth has 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.

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 December 2013

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 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 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 recorders 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. Our hypothesis is that the number of fatalities found per search interval will be correlated with the number of calls recorded during that search interval.
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 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 bird and/or bat activity

varies with distance from turbines. We will test the hypothesis that bird and 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 (50m, 200m, and 500m) 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 co-location with 2 FWS radar units), and shipped data cards to us in St. Paul 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 overall. Data processing has been underway since the summer of 2010. With increasing data collection from new field sites, the processing system was upgraded in the fall of 2011, and a full-time data technician was hired to assist with the processing. Over 2 million bird and bat passes have been extracted from the raw data. We have begun working on a process to automate the categorization of these confirmed calls by species or species group. All collaborators have received results including complete pass counts from the recordings

they helped collect.

Data analyses are currently underway. Initial results regarding objective (2) have provided some evidence of a positive linear relationship between fatality estimates and call activity. Landscape sites addressing objective (3) have shown elevated activity near forested corridor edges with decreasing activity out to 500 m. Also, activity at the Great Lakes sites is substantially higher than landscape (and other) sites in central and southern Minnesota, with extremely high activity at some coastal sites. No clear relationship with distance from grassland edge has emerged. One out of three prospective wind farm sites (Oak Glen) addressing objective (4) underwent construction during the study. To date, data do not suggest any clear differences in activity after construction compared to before; however, we have data from only one season after construction (2012) and those data have not been completely processed. Recordings from sites addressing objective (5) do not show a clear pattern of elevated call activity closer to turbines, but some analysis of the distribution of call activity over the course of the study period at the Fowler Ridge Wind Farm indicates that there may be a shift in activity levels from farther distances to closer distances as the season progresses.

Current activities and priorities include completing data processing and call categorization, formal data analysis, dissertation and manuscript writing, and communication of our findings via conference presentations and publications.

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

Table 1. *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 15 March to 1 June, and fall recording took place from 1 August to 15 November, but often when working with collaborators we recorded only during their data collection period.*

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

Investigator: David C. Fulton

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

Duration: 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; 2 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.

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

Investigator: David C. Fulton

Staff: Susan A. Schroeder, 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 is home to over about 1.6 million sportspeople, including 500,000 white-tailed deer (*Odocoileus virginianus*) hunters. Approximately 13% of Minnesota residents (16 years and older) hunt. This study sought to gather information from hunters about deer hunting in southeastern 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' electronic licensing system. 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. 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 (2000) 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:

1) Your 2012 3A or 3B Minnesota Deer Hunting Season;
2) Experiences and Opinions Regarding Your 2012 3A or 3B Minnesota Deer Hunting Season;
3) Deer Populations and Harvest Management Strategies in Southeastern Minnesota;
4) Opinions About Alternative Deer Regulations

Minnesota Wolf Hunters and Trappers 2012

Investigator: David C. Fulton
Staff: Susan A. Schroeder, 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 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 Minnesota Department of Natural Resources 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 Minnesota Department of Natural Resources' electronic licensing system. 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 (2000) 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.

Predicting and Mitigating Vulnerability of Trout Streams

Investigators:	Bruce Vondracek, Leonard Ferrington Jr., and James A. Perry (Cooperating Faculty)
Students:	Jennifer Biederman, Ph.D. (Conservation Biology Program), William French, Ph.D. (Conservation Biology Program) Jane Mazack, M.S. (Water Resources Science 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:	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 are to: (1) develop air-water temperature relationships for 40 streams in southeastern Minnesota; (2) determine winter diets and growth of trout populations; and (3) determine kinds, abundances, and timing of growth patterns of cold-adapted insects that are essential in winter diets of trout in 36 trout streams in the Driftless Area Ecoregion. 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 (*Salmo trutta*) had higher growth rates in winter in streams that remained relatively isothermal. Macroivertebrate abundance was higher in winter in streams that remained relatively isothermal.

Trout Angling in Minnesota

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

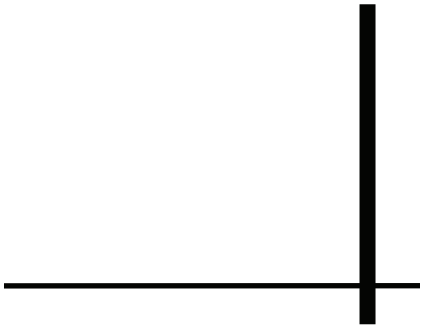
This study sought to gather information from anglers about trout fishing in Minnesota, with emphasis on the rainbow trout (*Oncorhynchus mykiss*) fishery (Kamloops and steelhead) in Lake Superior and its tributaries. Specifically, the purpose of this study was to better understand angler participation 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 (2000) 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 was 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, while 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, while 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 (*Oncorhynchus* spp.) and brook trout (*Salvelinus 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 Minnesota 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 (*Oncorhynchus 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.



Activities

Publications

Peer-Reviewed

2011

Andersen, D. E., M. E. Reiter, K. E. Doherty, and D. C. Fulton. 2010 (Released in 2011). Magnitude and spatial distribution of American woodcock hunting pressure in a central Minnesota Wildlife Management Area. Pages 203-212 *in* C.A. Stewart and V.R. Frawley (eds.) and D.E. Andersen, J.G. Bruggink, T.R. Cooper, D.R. Dessecker, D.G. Krementz, S.L. Mayhew, M.W. Olinde, and G.J. Roloff (assoc. eds.). Proceedings of the 10th American Woodcock Symposium, Michigan Department of Natural Resources and Environment, Lansing, Michigan, U.S.A.

Bruggeman, J.E., **D.E. Andersen**, and J.E. Woodford. 2011. Northern goshawk monitoring in the western Great Lakes region. *Journal of Raptor Research* 45:290-303.

Chizinski, C. J., A. Peterson, J. Hanowski, C. Blinn, **B. Vondracek**, and G. Niemi. 2011. Breeding bird response to partially harvested riparian management zones in northern Minnesota. *Forest Ecology and Management* 261:1892-1900.

Cornicelli, L.J., **D.C. Fulton**, Grund, M.D. and Fieberg, J. 2011. Hunter perceptions and acceptance of alternative deer management regulations. *The Wildlife Society Bulletin*, 35, 323-329.

Dolph, C. L., D. D. Huff, C. J. Chizinski, and **B. Vondracek**. 2011. Implications of community concordance for assessing stream health at three nested spatial scales in Minnesota, USA. *Freshwater Biology* 56:1652–1669.

Huff, D. D., L. M. Miller, C. J. Chiziniski, and **B. Vondracek**. 2011. Mixed-source reintroductions lead to outbreeding depression in the second-generation descendents of a native North American fish. *Molecular Ecology* 20:4246–4258.

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D.G. Krementz, S.L. Mayhew, M.W. Olinde, and G.J. Roloff (assoc. eds.). Proceedings of the 10th American Woodcock Symposium, Michigan Department of Natural Resources and Environment, Lansing, Michigan, U.S.A.

Raymond, K. L. and **B. Vondracek**. 2011. Relationships among rotational and conventional grazing systems, stream channels, and macroinvertebrates. *Hydrobiologia* 669:105-117.

Reiter, M.E. and **D.E. Andersen**. 2011. Arctic foxes, lemmings, and Canada goose nest survival at Cape Churchill, Manitoba. *Wilson Journal of Ornithology* 123:266-276.

Streby, H.M. and **D.E. Andersen**. 2011. Seasonal productivity in a population of migratory songbirds: why nest data are not enough. *Ecosphere* 2:Article 78.

Streby, H.M., S.M. Peterson, and **D.E. Andersen**. 2011. Invertebrate availability and vegetation characteristics explain use of non-nesting cover types by mature-forest songbirds during the post-fledging period. *Journal of Field Ornithology* 82:406-414.

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2012

Bruskotter, J.T. and **D.C. Fulton** 2012. Will hunters steward wolves? A comment on Treves and Martin. *Society and Natural Resources*, 25, 97-102.

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Book Chapters, Symposium Proceedings

Eells, L., R. Vondracek, and **B. Vondracek**. 2012. Fishing the deep web: the search for information. Pages 47-63 *in* C. Jennings, T. E. Lauer, and B. Vondracek (eds.). Scientific communication for natural resource professionals, American Fisheries Society, Bethesda, Maryland, U.S.A.

Oppelt, E., J. G. Bruggink, K. E. Doherty, **D. E. Andersen**, J. Meunier, and R. S. Lutz. 2010 (Released in 2011). Fall survival of American Woodcock in western Great Lakes region. Pages 107-108 *in* C.A. Stewart and V.R. Frawley (eds.) and D.E. Andersen, J.G. Bruggink, T.R. Cooper, D.R. Dessecker, D.G. Krementz, S.L. Mayhew, M.W. Olinde, and G.J. Roloff (assoc. eds.). Proceedings of the 10th American Woodcock Symposium, Michigan Department of Natural Resources and Environment, Lansing, Michigan, U.S.A.

Book Editor

Jennings, C., T.E. Lauer, and B. Vondracek (eds.). 2012. Scientific communication for natural resource professionals, American Fisheries Society, Bethesda, Maryland, U.S.A.

In Press, Review, or Revision

Bruggeman, J.E., **D.E. Andersen**, and J.E. Woodford. *In Review*. Factors related to northern goshawk landscape use in the western Great Lakes region. *Journal of Raptor Research*.

Bruggink, J.G., E. Oppelt, K.E. Doherty, **D.E. Andersen**, J. Meunier, and R.S. Lutz. *In Press*. Fall survival of American woodcock in the western Great Lakes region. *Journal of Wildlife Management*.

Mannan, R.N., G. Perry, **D.E. Andersen**, and C.W. Boal. *In Review*. An assessment of call broadcasting as an anuran survey method in the tundra. *North American Journal of Herpetology*.

Nelson, M.R. and **D.E. Andersen**. *In Press*. Do Singing-ground Surveys reflect American woodcock abundance in the western Great Lakes region? *Wildlife Society Bulletin*.

Reiter, M.E., **D.E. Andersen**, A.H. Raedeke, and D.R. Humburg. *In Press*. Species associations and habitat influence the range-wide distribution of breeding Canada geese on western Hudson Bay. *Waterbirds*.

Streby, H.M. and **D.E. Andersen**. *In Press*. Movements, cover-type selection, and survival of fledgling ovenbirds in managed deciduous and mixed-coniferous forests. *Forest Ecology and Management*.

Streby, H.M. and **D.E. Andersen**. *In Press*. Survival of fledgling ovenbirds: influences of habitat characteristics at multiple spatial scales. *Condor*.

Streby, H.M. and **D.E. Andersen**. *In Press*. Testing common assumptions in studies of songbird nest success. *Ibis*.

Streby, H.M., S.M. Peterson, C.F. Gesmundo, M.K. Johnson, A.C. Fish, J.A. Lehman, and **D.E. Andersen**. *In Press.* Radio-transmitters do not affect seasonal productivity of female golden-winged warblers. *Journal of Field Ornithology.*

Streby, H.M., S.M. Peterson, J.A. Lehman, G.R. Kramer, K.J. Iknayan, and **D.E. Andersen**. *In Press*. The effects of force-fledging and premature fledging on the survival of nestling songbirds. *Ibis*.

Streby, H.M., S. M. Peterson, J.A. Lehman, G.R. Kramer, B.J. Vernasco, and **D.E. Andersen**. *In Review*. Do digestive contents preclude body mass as a measure of relative condition in nestling songbirds? *Wildlife Society Bulletin*.

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Streby, H.M, J.M. Refsnider, S.M. Peterson, and **D.E. Andersen**. *In Review*. A risk-tolerance threshold explains deviation for stabilizing selection in songbird nest-site choice. *Proceedings of the Royal Society B*.

Awards and Honors

U.S. Fish and Wildlife Service Region 3 Award for Strategic Conservation (Notable Projects/Team Achievement category – 2011) – **David E. Andersen** and Henry M. Streby

Fellow of the American Ornithologists' Union (peer election in 2012) – **David E. Andersen**

2012 Minnesota Award, Minnesota Chapter of The Wildlife Society (2013) – **David E. Andersen**

Cooperating Faculty Publications

In Press, Review, or Revision

Sorensen, P. W., Lim, H.K, Leese, J. and E. Fox. *In Preparation*. Extreme olfactory and behavioral sensitivity of silver carp, *Hypophthalmichthys molitrix,* to putative sex pheromones. *Journal of Chemical Ecology.*

Lim, H.K, and **Sorensen, P.W.** *In Preparation*. Extreme olfactory sensitivity of bighead carp (*Hypophthalmichthys nobilis)* to putative sex pheromones. *Transactions of the American Fisheries Society.*

Completed Theses and Dissertations of Minnesota Coop Unit Students

2010

Streby, H. M. 2010. Survival and habitat use by post-fledging forest-nesting songbirds in managed mixed northern hardwood-coniferous forests. Ph.D. (Natural Resources Science and Management), University of Minnesota, St. Paul, Minnesota, USA. 148pp. (David Andersen)

Until recently, studies of breeding migratory songbirds have been primarily limited to the nesting season. Therefore, there is very little information about songbird survival and habitat use during the post-fledging period (i.e. the time between nesting and fall migration) available to those making management decisions. I expanded on the traditional nest-monitoring study and used radio telemetry to monitor survival and habitat use of fledgling songbirds in managed northern hardwood-coniferous forests of northern-Minnesota. In addition, I used mist-nets to sample use of early-successional forest stands (regenerating clearcuts) and forested wetlands by mature forest-nesting birds during the post-fledging period. I found that many assumptions of songbird nesting studies are unreliable, including the common assumption that the presence of a family group is confirmation of a successful nest in an occupied territory. In addition, I found that annual fledgling survival can vary considerably, and does not vary consistently with nest productivity, a finding with broad implications for models of songbird population growth. Furthermore, I found that habitat used by birds during the post-fledging period can be considerably different than that used for nesting, and that post-fledging habitat use can affect fledgling survival. In addition, I found that factors commonly affecting nest productivity (e.g. edge effects) can affect fledgling survival differently. From mist-netting, I found that many mature-forest birds used non-nesting cover types during the post-fledgling period, but most of that use was by only a few species, and hatch-year birds rarely used non-nesting cover types before independence from adult care. Models of capture rates in non-nesting cover types indicated that use of non-nesting cover types by mature-forest birds was primarily related to food availability and secondarily to cover in the form of relatively dense vegetation. My results indicated that nearly every conclusion made about breeding population ecology of mature-forest birds based only on nesting data was contradicted by data from the post-fledging period. My results clearly demonstrate that data from the entire breeding season (nesting and post-fledging) are necessary to understand songbird seasonal productivity and habitat associations.

2011

Bergh, S.M. 2011. Factors influencing detection of American woodcock during Singing-ground Surveys. M.S. (Natural Resources Science and Management), University of Minnesota, St. Paul, Minnesota, USA. 64pp. (David Andersen)

Chapter 1:--During the spring breeding season, male American woodcock (*Scolopax minor*) perform a conspicuous aerial display along with a distinctive vocalization in an open area called a singing ground. The American Woodcock Singing-ground Survey (SGS) was designed to exploit these breeding-season behaviors in an effort to monitor these otherwise inconspicuous birds. The SGS was standardized in 1968 and has been conducted annually to derive an index of abundance and population trend. Counts of singing male American woodcock on the SGS have generally declined through time, but without knowledge of the relationship between counts and woodcock density and the factors affecting detection, considerable uncertainty remains in interpretation of SGS data. To address some of these issues, in the springs of 2009 and 2010, I conducted repeated surveys on four established SGS routes and four randomly selected reference routes in Pine County, Minnesota. I used SGS protocols for surveying and developed models to assess factors associated with occupancy and detection probability. The intercept-only model (i.e., constant detection and occupancy probabilities across sites and no covariates) had an overall detection probability of 0.59 (SE = 0.018) in 2009 and 0.66 (SE = 0.017) in 2010 and an overall occupancy of 0.74 (SE = 0.049) for 2009 and 0.81 (SE = 0.044) for 2010. The best-supported model of detection probability for both years combined included detection as a function of woodcock density, observer, date, disturbance level (i.e., ambient noise that interfered with detecting woodcock), and wind speed. High wind speeds were negatively related to detection, different observers had different detection probabilities, date was quadratically related to detection, and high woodcock density and low disturbance levels were positively related to detection. These results can be used to build predictive models, which will inform interpretation of trends in counts and indices of abundance currently resulting from the SGS.

Chapter 2:--The Singing-ground Survey (SGS) is conducted during the American woodcock (*Scolopax minor*) breeding season and is designed to exploit the males' distinctive vocalization in an effort to monitor these otherwise inconspicuous birds. Survey points on SGS routes are set 0.4 mile (0.65 km) apart to avoid counting individual birds from >1 listening location. The effective area surveyed (EAS) at a listening point is not known, and may vary as a function of land-cover type, environmental conditions, and other factors. To define the relationship describing distance between vocalizing woodcock and detection by an observer, I broadcast a recording of woodcock vocalizations in two land-cover types (forest and field) at distances unknown to an observer. I evaluated the proportion of call broadcasts detected as a function of distance and fit regression curves to detection data to estimate a distance (r*) where the area above the curve at distances < r* was equal to the area under the curve at distances > r*, which allowed determination of the radius of an area where detection probability was effectively 1.0. This EAS had a radius (r*) of 198 m for forest, 384 m for field, and 309 m for both of these land-cover types combined and an estimated size of 12.3 ha for forest, 46.3 ha for field, and 30.0 ha for both land-cover types combined. I used this information to estimate density of displaying male woodcock based on counts from the SGS.

Rudberg, E.A. 2011. Losing our lakes: an assessment of the human dimensions of lakeshore landowner shoreland management. Ph.D. (Natural Resources Science and Management), University of Minnesota, St. Paul, Minnesota, USA. 171pp. (David Fulton)

The fragility of shorelines and the impact of residential development on habitat and water quality led to the Minnesota Department of Natural Resource's interest in promoting native vegetative buffers. First, I used the Integrative Model (IM) (Fishbein and Yzer, 2003) to evaluate lakeshore homeowners' attitudes, norms and self-efficacy for restoring a native vegetative buffer. Five belief evaluations (decrease maintenance $\beta = .05$, increase water quality $\beta = .058$, be attractive $\beta = .103$, impede recreation $\beta = .046$, and create privacy $\beta = -.028$), one self-efficacy evaluation (ability to keep up with maintenance $\beta = .23$), and three normative influences (family $\beta = -.097$, friends $\beta = .051$ and Minnesota DNR $\beta = .065$) were significant pre-

dictors of intention (R^2 = .36). Secondly, I used the Theory of Normative Social Behavior (TNSB) (Rimal and Real, 2005) as an alternate model and compared the results with the IM (Fishbein and Yzer 2003). My findings indicated that the IM (R^2 = .241) had a greater explanation of variance, when compared to the TNSB, and that a greater amount of the variance was explained by the inclusion of descriptive norms, group ID and injunctive norms (R^2 = .323). Finally, I sought to connect risk theory with behavioral theory and propose a framework for doing so. I used a case study of Minnesota shoreland landowners with native vegetative buffers for integrating risk and behavioral theory to segment audiences. My findings showed that 22.5% of survey respondents reported having a vegetative buffer on their shoreland and 10% of respondents had removed native vegetation in the past. I did not find a significant difference between the attitudes towards buffers of those that have removed vegetation and those that have not. However, the findings showed that having a negative attitude towards buffers increased one's odds of not having a native vegetative buffer by 2 ½ times. The analysis also showed that evaluation of buffers significantly predicted respondents' attitudes towards buffers (R^2 =.22, $F[2, 11] = 8.69$, $p < .001$). Compared to respondents without native vegetative buffers, the beliefs that buffers create an attractive shore ($\beta = -.143$, $p = .019$), create habitat ($\beta = .32$, $p < .001$), and create privacy ($\beta = .146$, $p = .020$) were predictive of attitude towards buffers for respondents that have buffers.

2012

Blick, B.L. 2012. Knife River stressor identification, Kanabec County, Minnesota. M.S. (Water Resources Science), University of Minnesota, St. Paul, Minnesota, USA. 97pp. (Bruce Vondracek)

The Environmental Protection Agency (EPA) developed the Stressor Identification (SI) process to identify stressors causing biological impairment. The SI process precedes a TMDL (Total Maximum Daily Load) and offers a means by which developers of a TMDL can more confidently identify stressor(s) causing impairment. The EPA's Causal Analysis/Diagnosis Decision Information System (CADDIS) framework was utilized to develop a SI for the Knife River Basin, Kanabec County, Minnesota. Data collected by the Minnesota Pollution Control Agency (PCA) during biomonitoring and the STORET database were analyzed using non-metric multidimentional scaling (NMDS) ordination to evaluate the relationships between fish species and abundance, and environmental and chemical stressors. A least-squared regression between fish index of biotic integrity (IBI) scores and environmental variables was also calculated. The NMDS analysis suggests there is similarity between the two headwater sites, which are correlated with low gradient and a high percent fines, agriculture, urban, and rangeland. High gradient, percent forest, and percent riffles were correlated with the mid-stream reaches of the Knife River. Only pH was significantly correlated with fish IBI scores (p=0.034). The Knife River SI identified three potential stressors; low dissolved oxygen (DO), high pH, and excess bedded sediment.

Dolph, C.L. 2012. Defining stream integrity using biological indicators. Ph.D. (Water Resources Science), University of Minnesota, St. Paul, Minnesota, USA. 178pp. (Bruce Vondracek)

Biological indicators may offer the most comprehensive and accurate means to assess the integrity of streams and rivers, as changes in a biological community represent an integrated response to all environmental stressors present in an ecosystem. Biological indicators are typically designed to quantify and/or summarize important aspects of either ecosystem *structure* – the types and abundance of organisms found in a given habitat – or ecosystem *function* – rates and patterns of ecological processes such as primary and secondary production, nutrient cycling, and decomposition of organic matter. Increasingly, resource managers use such indicators to assess whether surface waters fulfill the requirements of their

designated uses under the Clean Water Act.

Despite the recognition that biological indicators can aid management decisions, critical questions remain regarding the best way to design, apply, and interpret them. In this dissertation, I used a suite of statistical and empirical approaches to evaluate the design and application of several different biological indicators of stream condition in various contexts and scales across Minnesota. Specifically, I used a bootstrap approach, together with a database of fish, macroinvertebrate, and environmental data collected by the Minnesota Pollution Control Agency (MPCA) between 1996 and 2006 from approximately 1500 stream sites across Minnesota, to quantify variability associated with an Index of Biological Integrity (IBI) developed by MPCA for fish communities in streams of two Minnesota river basins. I placed this variability into a management context by comparing it to impairment thresholds used in water quality determinations for Minnesota streams. I used the same MPCA dataset to develop predictive taxa richness models for fish and macroinvertebrates as additional indicators of the biological integrity of Minnesota streams, and evaluated these models for sensitivity and precision. I further determined whether fish and macroinvertebrate assemblages exhibited significant community concordance, and whether significantly concordant communities yielded equivalent indications of stream integrity at three nested spatial scales (statewide, ecoregion and catchment) in Minnesota. Finally, I used data from the MPCA database to evaluate relationships between selected environmental variables and the composition of fish and macroinvertebrate assemblages at all three spatial scales.

I collected a second dataset of macroinvertebrate samples over the course of one year (2010) from three agricultural streams in southern Minnesota to evaluate relationships between structural and functional indicators of stream condition in response to a common stream conservation practice (i.e., reach-scale restoration). Specifically, I examined whether reach-scale restoration in disturbed agricultural streams in southern Minnesota was associated with changes in (1) macroinvertebrate taxa richness, (2) seasonal variability in macroinvertebrate community composition, and (3) secondary production (i.e., macroinvertebrate biomass over time).

SUMMARY OF FINDINGS:

1) I found that 95% confidence intervals for IBIs scored on a 0-100 point scale ranged as high as 40 points. However, on average, 90% of IBI scores calculated from bootstrap replicate samples for a given stream site yielded the same impairment status as the original IBI score. I suggest that sampling variability in IBI scores is related to both the number of fish and the number of rare taxa in a field collection. A comparison of the effects of different scoring methods on IBI variability indicates that a continuous scoring method may reduce the amount of bias in IBI scores.

2) Predictive taxa-loss models for fish and macroinvertebrates both distinguished reference from non-reference sites. Predictive models for fish assemblages were less sensitive and precise than models for invertebrate assemblages, likely because of a relatively low number of common fish taxa. Significant concordance between fish and invertebrate communities occurred at the statewide scale as well as in six of seven ecoregions and 17 of 21 major catchments examined. However, concordance was not consistently indicative of significant relationships between rates of fish and invertebrate taxa loss at those same scales. Fish and invertebrate communities were largely associated with different environmental variables, although the composition of both communities was strongly correlated with stream size across all three scales.

3) I found no difference in macroinvertebrate taxa richness between restored and unrestored reaches of

agricultural streams in southern Minnesota. However, both compositional similarity and secondary production were higher in restored reaches relative to unrestored reaches, suggesting that reach-scale restoration may have ecological effects beyond influences on diversity. These findings highlight the added complexity conveyed by a consideration of functional, as well as structural, indicators of stream condition. Higher productivity in the restored reaches was due largely to the disproportionate success of a small number of dominant taxa. Secondary production estimates were considerably lower than those reported for other similar-sized prairie streams; these low values may be indicative of stressful conditions for biotic life in the study streams.

Heeren, A. 2012. Change we can believe in? The role and implications of culture and environmental values on climate change perceptions. M.S. (Natural Resources Science and Management), University of Minnesota, St. Paul, Minnesota, USA. 123pp. (David Fulton)

Climate change poses many ecological and social challenges to natural resource agencies. One great challenge that resource managers face is how to manage, or adapt to, climate change in a socially acceptable way. To meet this challenge, it is necessary to understand how public perceptions about climate change are formed and whether the public will support climate change management strategies. This issue was examined at the regional level (northeast Minnesota) using a conceptual framework tested with the results of focus groups and a mail survey.

Kocian, M.J. 2012. Assessing the accuracy of GIS-derived stream length and slope estimates. M.S. (Conservation Biology Program, Fisheries and Aquatic Biology track), University of Minnesota, St. Paul, Minnesota, USA. 81pp. (Bruce Vondracek)

Stream slope is a critical component in lotic systems research. It is commonly associated with fish and invertebrate distribution, and is prominently used in many stream classification schemes. Stream slope is also required to compute other stream variables, such as stream power, a fundamental component in stream sediment dynamics. Due to its importance, stream slope is regularly estimated remotely using a Geographic Information System (GIS). However, the accuracy of GIS-derived stream slope estimates is not well established, especially in low-slope regions. Additionally, little is known about variables that may influence the accuracy of GIS-derived slope estimates.

In this study, the accuracy of eight GIS methods for estimating stream slope was evaluated by comparison to "true" field-surveyed values. Several novel GIS methods for estimating stream slope are presented. Five stream variables were assessed for their contribution to error in GIS-derived stream slope estimates. To demonstrate practical applicability, GIS-derived stream slope estimates were used to calculate stream power.

GIS-derived stream slope estimates produced using 1:24,000 USGS topographic maps and Light Detection and Ranging (LiDAR) Digital Elevation Models (DEMs) were most accurate. Estimates derived from 1- and 1/3-Arc Second National Elevation Dataset DEMs were less accurate. The application of a *focal statistics* tool to LiDAR-derived DEMs improved stream slope estimate accuracy. Consistent sources of error in GIS stream slope estimates were not identified. The utility of GIS-derived stream slope estimates was demonstrated by presenting an association between stream power and depth of fine sediment.

Student Awards

Marcus Beck. 2011. Best Student Presentation. 44th Annual Meeting of the Minnesota Chapter of the American Fisheries Society.

Kyle Daly. 2012. Student Conservationist Award of the Minnesota Chapter of the Wildlife Society.

Christine Dolph. 2010. Environmental Protection Agency STAR 'Science to Achieve Results' 3-year Graduate Fellowship.

Alexander Heeren. 2012. Best Student Presentation. 2012 Annual Meeting of the Minnesota Chapter of the Society for Conservation Biology.

Alexander Heeren. 2010-2011. Graduate School Fellowship, University of Minnesota.

Henry Streby. 2012. National Science Foundation Postdoctoral Research Fellowship in Biology.

Presentations

Invited Presentations

2011

Biedermann, J., L. C. Ferrington, Jr., **B. Vondracek**, Jim Perry, J. Magner, W. French, J. Louwsma, L. Krider, P. Sherman, and P. Kranzfelde. 2011. Predicting and mitigating vulnerability of trout streams to climate change. 4th Annual Driftless Stream Restoration Symposium, La Crosse, Wisconsin.

Fulton, D.C. 2011. Understanding what leads to waterfowl hunting dropout. Minnesota Waterfowl Association, Minneapolis, Minnesota.

Fulton, D.C. 2011. Models for improving hunter and angler recruitment. Wyoming and Colorado Chapters of The Wildlife Society Annual Meeting, Fort Collins, Colorado.

Huff, D. D., L. M. Miller, and **B. Vondracek**. 2011. A simulated reciprocal transplant experiment: local adaptation in reintroduced populations of a native North American fish. 141st Annual Meeting of the American Fisheries Society, Seattle, Washington.

Raymond, K. L. and **B. Vondracek**. 2011. Grazing systems, stream channels, and macroinvertebrates. 4th Annual Driftless Stream Restoration Symposium, La Crosse, Wisconsin.

Streby, H.M. and **D.E. Andersen**. 2011. What the post-fledging period tells us that the nesting season does not. 129th Stated Meeting of the American Ornithologists' Union. Jacksonville, Florida.

Streby, H.M., S.M. Peterson, and **D.E. Andersen**. 2011. Golden-winged warblers in the Upper Midwest: productivity, habitat associations, and management implications. Wisconsin Bird Conservation Initiative 2011 Statewide Meeting. Green Bay, Wisconsin.

Vondracek, B., B. Blick, P. Bolstad, I. Chisholm, B. Knudson, P. Nacionales, D. O'Shea, and H. Wan. 2011. The current state of the Watershed Assessment Tool. 44th Annual Meeting of the Minnesota Chapter of the American Fisheries Society, Sandstone, Minnesota.

2012

Cooper, T. and **D.E. Andersen**. 2012. American woodcock: current status and research in the Midwest. 9th Annual Forestry, Wildlife, and Natural Resources Research Review. Cloquet, Minnesota.

Fulton, D.C. 2012. Use of socioeconomic data in conservation decisions concerning shallow lakes management. 142nd Annual Meeting of the American Fisheries Society, St. Paul, Minnesota.

Fulton, D.C. and S. Schroeder. 2012. Towards outcomes focused management of fisheries: developing a framework for Minnesota anglers. 142nd Annual Meeting of the American Fisheries Society, St. Paul, Minnesota.

Heeren, A. and **D.C. Fulton**. 2012. Understanding climate change beliefs and communicating adaptation strategies. 142nd Annual Meeting of the American Fisheries Society, St. Paul, Minnesota.

Streby, H.M., T. Will, S. Peterson, W. Brininger, J. Loegering and **D.E. Andersen**. 2012. Golden-winged warbler: Minnesota demography and landscape ecology. 9th Annual Forestry, Wildlife, and Natural Resources Research Review, Cloquet, Minnesota.

Streby, H. M., S. M. Peterson, and **D. E. Andersen**. 2012. Thinking outside the nest: the importance of the post-fledging period for understanding productivity and habitat associations in songbirds. Fisheries, Wildlife, and Conservation Biology seminar series, University of California, Berkeley, California.

French, W., J. Biederman, J. Mazack, P. Sherman, L. Krider, L. C. Ferrington, Jr., **B. Vondracek**, and J. Perry. 2012. Winter foraging and growth of brown trout in southeastern Minnesota streams. 5th Annual Driftless Area Symosium, LaCrosse, Wisconsin.

French, W., J. Biederman, J. Mazack, P. Sherman, L. Krider, L. C. Ferrington, Jr., **B. Vondracek**, and J. Perry. 2012. Winter foraging and growth of brown trout in southeastern Minnesota streams. 142nd Annual Meeting of the American Fisheries Society, St. Paul, Minnesota.

Mazack, J., L. Krider, **B. Vondracek**, and L. C. Ferrington, Jr. 2012. Winter invertebrate community dynamics in groundwater-fed streams of southeastern Minnesota. 142nd Annual Meeting of the American Fisheries Society, St. Paul, Minnesota.

Contributed Presentations

2011

Andersen, D.E., J.E. Bruggeman, J.E. Woodford, and C.W. Boal. 2011. Northern goshawk population size in the western Great Lakes region. Annual Meeting of the Raptor Research Foundation, Duluth, Minnesota.

Beck, M., **B. Vondracek**, and L. Hatch. 2011. Image analysis techniques to evaluate effects of nearshore lake development on aquatic macrophytes. 44th Annual Meeting of the Minnesota Chapter of the Ameri-

can Fisheries Society, Sandstone, Minnesota. (Best Student Presentation)

Beck, M., **B. Vondracek**, and L. Hatch. 2011. Image analysis techniques to evaluate effects of nearshore lake development on aquatic macrophytes. 72nd Midwest Fish and Wildlife Conference, Des Moines, Iowa.

Beck, M., **B. Vondracek**, and L. Hatch. 2011. Image analysis techniques to evaluate effects of nearshore lake development on aquatic macrophytes. 141st Annual Meeting of the American Fisheries Society, Seattle, Washington.

Beck, M., **B. Vondracek**, and L. Hatch. 2011. Image analysis techniques to evaluate effects of nearshore lake development on aquatic macrophytes. Minnesota Water Resources Conference, St. Paul, Minnesota. *(Poster)*

Carlson, A., W. French, L. C. Ferrington, Jr., **B. Vondracek**, and J. Perry. 2011. Age structure and growth rates of brown trout in southeast Minnesota streams. 72nd Midwest Fish and Wildlife Conference, Des Moines, Iowa. *(Poster)*

Dolph, C., **B. Vondracek**, and J. Magner. 2011. Linking ecosystem processes to macroinvertebrate community structure in a restored stream in the Minnesota River Basin. 44th Annual Meeting of the Minnesota Chapter of the American Fisheries Society, Sandstone, Minnesota. *(Poster)*

Dolph, C. L., **B. Vondracek**, L. C. Ferrington, Jr., and J. Magner. 2011. Beyond diversity: reach-scale restoration may lead to more stable macroinvertebrate community composition in highly disturbed agricultural streams. 72nd Midwest Fish and Wildlife Conference, Des Moines, Iowa.

French, W., J. Biederman, J. Louwsma, P. Sherman, L. Krider, L. C. Ferrington, Jr., **B. Vondracek**, and J. Perry. 2011. Winter diets and dynamics of brown trout in groundwater dominated streams. 72nd Midwest Fish and Wildlife Conference, Des Moines, Iowa. *(Poster)*

French, W., J. Biederman, J. Louwsma, P. Sherman, L. Krider, L. C. Ferrington, Jr., **B. Vondracek**, and J. Perry. 2011. Winter diets and dynamics of brown trout in groundwater dominated streams. 141st Annual Meeting of the American Fisheries Society, Seattle, Washington. *(Poster)*

French, W., J. Biederman, J. Louwsma, P. Sherman, L. Krider, L. C. Ferrington, Jr., **B. Vondracek**, and J. Perry. 2011. Winter diets and dynamics of brown trout in groundwater dominated streams. Minnesota Water Resources Conference, St. Paul, Minnesota. *(Poster)*

French, W., L. Ferrington, **B. Vondracek**, J. Perry, J. Magner, J. Biederman, J. Louwsma, L. Krider, and P. Kranzfelder. 2011. Mitigating the effects of climate change on cold water streams in southeastern Minnesota. 44th Annual Meeting of the Minnesota Chapter of the American Fisheries Society, Sandstone, Minnesota.

Fulton, D.C. and S. Schroeder. 2011. The role of agency trust on satisfaction. The Wildlife Society Annual Meeting, Waikoloa, Hawaii.

Heeren, A. and **D.C. Fulton**. 2011. A framework for addressing the human dimensions of climate change adaptation. International Symposium on Society and Resource Management, Madison, Wisconsin.

Lepore, J., J. Keville, D. Dustin, C. Tomko, and **B. Vondracek** . 2011. Cumulative impacts of residential lakeshore development on littoral habitat. 44th Annual Meeting of the Minnesota Chapter of the American Fisheries Society, Sandstone, Minnesota. *(Poster)*

Lepore, J., J. Keville, D. Dustin, C. Tomko, and **B. Vondracek.** 2011. Cumulative impacts of residential lakeshore development on littoral habitat. Minnesota Water Resources Conference, St. Paul, Minnesota. *(Poster)*

Louwsma , J., W. French, J. Biederman, P. Sherman, L. Krider, **B. Vondracek**, J. Perry., and L. C. Ferrington, Jr. 2011. Winter invertebrate dynamics in trout streams of southeastern Minnesota. Minnesota Water Resources Conference, St. Paul, Minnesota.

Louwsma , J., **B. Vondracek**, J. Perry, J. Biederman, W. French, L. Krider, and L. C. Ferrington, Jr. 2011. Predicting and mitigating vulnerability of trout streams to climate change. 2011 Upper Midwest Stream Restoration Symposium, Oconomowoc, Wisconsin. *(Poster)*

Peterson, S.M., H.M Streby, J.A. Lehman, and **D.E. Andersen**. 2011. High-tech or field techs: an analysis of cost and bias in golden-winged warbler nest searching techniques. 72nd Midwest Fish and Wildlife Conference, Des Moines, Iowa. *(Poster)*

Reiter, M.E., **D.E. Andersen**, A.H. Raedeke, and D.D. Humburg. 2011. Species interactions and habitat influence the range-wide distribution of breeding Canada geese in northern Manitoba. Churchill Northern Studies Centre and Parks Canada Science Symposium, Winnipeg, Manitoba, Canada.

Rudberg, E. and **D.C. Fulton**. 2011. Losing our lakes: an assessment of lakeshore homeowners' attitudes toward vegetative buffers. International Symposium on Society and Resource Management, Madison, Wisconsin.

Schroeder, S.A. and **D.C. Fulton**. 2011. Intricate conflicts: how environmental values, risk perception and responsibility influence hunter attitudes about lead shot. The Wildlife Society Annual Conference, Waikoloa, Hawaii.

Schroeder, S.A. and **D.C. Fulton**. 2011. Waterfowl hunting identification among lapsed waterfowl hunters. International Symposium on Society and Resource Management, Madison, Wisconsin.

Streby, H.M., S.M. Peterson, and **D.E. Andersen**. 2011. Golden-winged warbler demography: productivity and survival in Minnesota and Manitoba. The Wildlife Society Annual Conference, Waikoloa, Hawaii.

Streby, H.M., S.M. Peterson, and **D.E. Andersen**. 2011. Golden-winged warbler demography: nest productivity and adult and fledgling survival. Northwest Golden-winged Warbler Working Group Meeting, Winnipeg, Manitoba, Canada.

Streby, H.M. and **D.E. Andersen**. 2011. Demographic response of golden-winged warbler to habitat and management across a climate-change gradient at the core of the species'range. Conserving the Future: Wildlife Refuges and the Next Generation, Madison, Wisconsin.

Streby, H.M., S.M. Peterson, and **D.E. Andersen**. 2011. Golden-winged warbler demography and habitat use in Manitoba and Minnesota. 72nd Midwest Fish and Wildlife Conference, Des Moines, Iowa.

Streby, H.M., S. M. Peterson, and **D.E. Andersen**. 2011. Golden-winged warbler research at Tamarac and Rice Lake National Wildlife Refuges. Minnesota Ornithologists' Union Annual Meeting, Minneapolis, Minnesota.

2012

Beck, M., **B. Vondracek**, and L. Hatch. 2012. Image analysis techniques to evaluate effects of lakeshore development on aquatic habitat. Minnesota Water Resources Conference, St. Paul, Minnesota.

Beck, M., **B. Vondracek**, and L. Hatch. 2012. Identifying covariates of a lake assessment index to improve biological assessment. Annual Meeting of the Minnesota Chapter of the Society for Conservation Biology, West St. Paul, Minnesota.

Beck, M., **B. Vondracek**, and L. Hatch. 2012. Image analysis techniques to evaluate effects of nearshore lake development on aquatic macrophytes. 142nd Annual Meeting of the American Fisheries Society, St. Paul, Minnesota.

Beck, M., **B. Vondracek**, and L. Hatch. 2012. Image analysis techniques to evaluate effects of nearshore lake development on aquatic macrophytes. 142nd Annual Meeting of the American Fisheries Society, St. Paul, Minnesota. *(Poster)*

Carlson, A. K., W. French, L. C. Ferrington, Jr., **B. Vondracek**, and J. Perry. 2012. Age structure and growth dynamics of brown trout in southeast Minnesota streams. 73rd Annual Meeting of the Midwest Fish and Wildlife Conference, Wichita, Kansas. *(Poster)*

Carlson, A. K., W. French, L. C. Ferrington, Jr., **B. Vondracek**, and J. Perry. 2012. Age structure and growth dynamics and age structure of brown trout in southeast Minnesota streams. 142nd Annual Meeting of the American Fisheries Society, St. Paul, Minnesota. *(Poster)*

Daly, K.O., **D. E. Andersen**, and W.L. Brininger, Jr. 2012. Effects of radio transmitters on survival of juvenile American woodcock. 73rd Midwest Fish and Wildlife Conference, Wichita, Kansas. *(Poster)*

Dolph, C., S. Eggert, J. Magner, L. Ferrington, and **B. Vondracek**. 2012. The response of macroinvertebrate community structure and function to reach-scale restoration in agricultural streams of southern Minnesota. Minnesota Water Resources Conference, St. Paul, Minnesota.

Keville, J., J. Lepore, D. Dustin, C. Tomko, **B. Vondracek.** 2012. Cumulative impacts of residential lakeshore development on littoral habitat. 142nd Annual Meeting of the American Fisheries Society, St. Paul, Minnesota. *(Poster)*

Krider, L., J. A. Magner, J. Perry, L. C. Ferrington, Jr., and **B. Vondracek**. 2012. Air-water temperature relationships in the trout streams of southeastern Minnesota's carbonate - sandstone landscape. 5th Annual Driftless Area Symposium, LaCrosse, Wisconsin.

Lepore, J, J. Keville, D. Dustin, C. Tomcko, and **B. Vondracek**. 2012. Cumulative impacts of lakeshore residential development on littoral habitat. Minnesota Water Resources Conference, St. Paul, Minnesota. *(Poster)*

Mazack, J., L. Krider, **B. Vondracek**, and L. C. Ferrington, Jr. 2012. Winter invertebrate community dynamics in groundwater-fed streams of southeastern Minnesota. 60th Annual Meeting of the Society for Freshwater Science, Lexington, Kentucky.

Mazack, J., L. Krider, **B. Vondracek**, J. Perry, and L. C. Ferrington, Jr. 2012. Winter invertebrate community dynamics in groundwater-fed streams of southeastern Minnesota. 5th Annual Driftless Area Symosium, LaCrosse, Wisconsin.

Mazack, J., W. French, P. Sherman, J. Biederman, L. Krider, **B. Vondracek**, J. Perry, and L. C. Ferrington, Jr. 2012. The unique role of winter invertebrate communities in trout streams of southeastern Minnesota. Upper Midwest Stream Restoration Symposium, Minneapolis, Minnesota.

Peterson, S.M., H.M. Streby, J.A. Leman, and **D. E. Andersen**. 2012. High-tech or field techs: an analysis of cost and bias in golden-winged warbler nest searching techniques. 73rd Midwest Fish and Wildlife Conference, Wichita, Kansas.

Cooperating Faculty Presentations

2012

Heist, K. W. and D. H. **Johnson**. 2012. Siting wind farms for wildlife: predicting bird and bat fatality risk at prospective wind farm sites using call recorders. Joint Annual Meeting of the North Dakota Chapter and the Minnesota Chapter of The Wildlife Society, Fargo, North Dakota. *(Poster)*

Heist, K. W. and **D. H. Johnson**. 2012. Predicting bird and bat fatality risk at prospective wind farm sites using acoustic-ultrasonic recorders. The Wildlife Society Annual Conference, Portland, Oregon. *(Poster)*

Heist, K. W. and **D. H. Johnson**. 2012. Predicting bird and bat fatality risk at prospective wind farm sites using acoustic-ultrasonic recorders. National Wind Coordinating Collaborative Wind and Wildlife Research Meeting IX, Broomfield, Colorado. *(Poster)*

Leese, J.L., H. K. Lim, E. Fox and **P.W. Sorensen**. 2012. Silver carp (*Hypophthalmichthys molitrix*) detect and use novel mixtures of sex steroids and F prostaglandins as hormonal pheromones. 10th International Congress on the Biology of Fish, Madison, Wisconsin.

Leese, J.L., H. K. Lim, E. Fox and **P.W. Sorensen**. 2012. Invasive silver carp detect and use novel mixtures of sex steroids and F prostaglandins that likely function as sex pheromones. 142nd Annual Meeting of the American Fisheries Society, St. Paul, Minnesota.

Rigby, E.A. and **D.H. Johnson**. 2012. Factors affecting detection of recorded bird songs in mid-continent grasslands. 73rd Midwest Fish and Wildlife Conference, Wichita, Kansas.

Unit News

It seems that every two years, as we prepare our biennial report, the story is the same except that all of the details have changed! We continue to enjoy strong support from Cooperators and maintain a productive research and education program. But compared to two years ago, we have less financial resources available from the federal end, more restrictive policies for meeting participation, and evolving federal policies and protocols related to publication and safety-training requirements. The Minnesota Department of Natural Resources continues to support the MN Coop Unit, and recent license-fee increases may improve their financial status, with resulting opportunities for collaboration. The University of Minnesota faces financial challenges familiar to many Land Grant Universities, but new models of finances are likely to continue or increase support for the MN Coop Unit. We 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. Our assessment is that we are neither better nor worse off, but things have changed.

Some changes of note are that Francie Cuthbert stepped down as the Head of the Department of Fisheries, Wildlife, and Conservation Biology at the University of Minnesota at the end of 2012. We thank Francie for her efforts and support of the MN Coop Unit during her tenure. Sue Galatowitsch replaced Francie as Department Head, and we look forward to collaborating with Sue to increase the profile of the MN Coop Unit both within and outside the University. Another notable change on its way is that potential for new and different space for the Department of Fisheries, Wildlife, and Conservation Biology, which portends a move of some of the MN Coop Unit offices. If all goes according to plan, David Andersen, David Fulton, and Hattie Saloka will relocate to the space formerly occupied by the Departmental Office, which will relocate to Skok Hall. This will result in windows for David, David, and Hattie—all will have to acclimate to natural light, which in some cases hasn't been experienced for more than 24 years!

Familiar faces are still evident at the MN Coop Unit. Bruce Vondracek (Assistant Leader-Fisheries) continues to be involved in running the fisheries graduate program, now the Fisheries and Aquatic Biology Track in the Conservation Biology Graduate Program. He insists (and has promised his wife) that he does not plan to advise additional students or take on new projects, and is more seriously practicing for retirement by spending time using his travel trailer to get closer to fishing holes. David Fulton (Assistant Leader- Wildlife) was promoted to Adjunct Professor and GS-14 Research Ecologist in the federal system within the past two years. He continues to work closely with the Minnesota Department of Natural Resources to address information needs, and Sue Schroeder continues to assist him in these efforts in her position as a Research Associate. David Andersen's (Leader) long-term involvement in data collection related to Eastern Prairie Population Canada geese in northern Manitoba wound down in 2011, so instead of spending time on the tundra in Manitoba, he has gotten involved in work in Alaska's North Slope, to compare strategies used by mosquitoes across northern landscapes. Finally, Hattie Saloka, who as everyone familiar with the MN Coop Unit knows, keeps everything humming along, had her position reclassified to more appropriately reflect her responsibilities. This was a long time coming, but a well-deserved promotion.