

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

University of Minnesota  
Department of Fisheries, Wild-  
life, and Conservation Biology  
200 Hodson Hall  
1980 Folwell Avenue  
St. Paul, Minnesota 55108  
Phone: (612) 624-3421  
Fax: (612) 625-5299

[mncoopunit.cfans.umn.edu](http://mncoopunit.cfans.umn.edu)  
[www.coopunits.org/Minnesota](http://www.coopunits.org/Minnesota)



**BIENNIAL REPORT**  
**JANUARY 2019—DECEMBER 2020**



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





The Minnesota Cooperative Fish and Wildlife Research Unit was established in 1987 on the St. Paul Campus of the University of Minnesota as part of the Cooperative Research Units Program and is hosted by the Department of Fisheries, Wildlife, and Conservation Biology. The Cooperative Research Units program was established over eighty years ago to facilitate cooperation among the U.S. Department of the Interior (currently through the U.S. Geological Survey), universities, state fish and wildlife agencies, and private organizations, by developing and conducting programs of research and education related to fish and wildlife resources conservation. That mission continues today, with support from both long-standing and new partners. At the Minnesota Cooperative Fish and Wildlife Research Unit, we emphasize research on aquatic and terrestrial ecosystems that are of state, regional, and national significance, including issues related to human activity. Our research program addresses both the biological and social aspects of both game and nongame fisheries and wildlife management in the context of maintenance of biological diversity, and integrity and sustainability of ecosystems.

This is the sixteenth biennial report produced by the Minnesota Coop Unit and summarizes Unit activities during 2019 and 2020. Over the past two years, support for the Unit program has remained strong, with a considerable increase in federal funding. The University of Minnesota was instrumental in lobbying Congress in support of additional funding for the Cooperative Research Units Program, and as a result of increased funding, we were able to fill our Assistant Leader-Fisheries position that has been vacant since 2015. Following a search and interviews to fill this position supported by the Department of Fisheries, Wildlife, and Conservation Biology; the U.S. Fish and Wildlife Service; the Minnesota Department of Natural Resources; and the U.S. Geological Survey; Dr. Lynn Waterhouse was selected for and accepted this position—she will officially start in this position in June 2021. We are excited to have Dr. Waterhouse join the Minnesota Cooperative Fish and Wildlife Research Unit and look forward to rebuilding the aquatic portion of our program.

We continue to enjoy support from our Minnesota Department of Natural Resources, University of Minnesota, Wildlife Management Institute, and U.S. Fish and Wildlife Service partners. We are also fortunate to work with a wide range of cooperators; outstanding graduate students and postdoctoral researchers; and university, federal, state, and non-governmental scientists and resource managers to further our research and teaching missions, and to provide technical assistance to partners and clients. Please view our University of Minnesota website (<http://mncoopunit.cfans.umn.edu/>) or Cooperative Units Program website (<http://www.coopunits.org/Minnesota/>) for more information about our activities and to download copies of reports and publications. We invite you to review the summary of our Unit's accomplishments in this biennial report and to contact us with comments or to request additional information. Finally, thanks to our many partners and collaborators for their continued support, and we look forward to continuing a productive relationship to further our mission and shared interests.

Dr. David E. Andersen  
Leader

Dr. David C. Fulton  
Assistant Leader - Wildlife







# Table of Contents

Introduction .....	iii
Personnel and Cooperators .....	vii
Unit Students .....	viii
Unit Affiliated Staff and Students .....	ix
Unit Coordinating Committee .....	x
Unit Cooperators .....	xi
Cooperating Organizations .....	xii
Completed Research .....	1
Applied Ecology .....	1
Evaluating Nest-site Selection of Arctic Peregrine Falcons in the Colville River Special Area .....	3
Improving Survival of Juvenile Winged Mapleleaf Mussels ( <i>Quadrula fragosa</i> ) through Identification of Host Fish Over-wintering Areas .....	5
Insecticide Exposure Risk for Grassland Wildlife on Public Lands .....	8
Human Dimensions, Management, and Conservation .....	11
Airspace as Habitat: Methods for Assessing Use by Animals .....	13
Long-term Research and Monitoring of Human Dimensions Information on Fisheries and Wildlife Management Issues in Minnesota .....	15
Minnesota Deer Hunter Survey—Chronic Wasting Disease .....	16
Minnesota Residents’ Attitudes Towards Wolves .....	17
Restoration of Elk to Northeastern Minnesota .....	19
Ongoing Research .....	21
Applied Ecology .....	21
Modeling with Long-term Datasets to Inform Management of National Park Grasslands .....	23
Red-headed Woodpeckers: Indicators of Oak Savanna Health .....	25
Minnesota Trumpeter Swan Migration Ecology and Conservation .....	27
Human Dimensions, Management, and Conservation .....	29
Assessing Attitudes towards Chronic Wasting Disease .....	31
Chronic Wasting Disease Targeted Outreach to Engage Culturally Diverse Hunting Communities .....	33
Understanding Perceptions of Risk from Chronic Wasting Disease for Tribal Communities in the Midwest .....	34

Activities.....	37
Publications.....	39
Completed Theses and Dissertations of Minnesota Coop Unit Students.....	45
Student Awards and Grants.....	46
Presentations.....	47
Unit News.....	51





# PERSONNEL AND COOPERATORS

## Unit Personnel

### UNIT STAFF – U. S. GEOLOGICAL SURVEY – COOPERATIVE RESEARCH UNITS

Dr. David E. Andersen, Unit Leader

Dr. David C. Fulton, Assistant Leader – Wildlife

### UNIT STAFF – UNIVERSITY OF MINNESOTA

Dr. Jason Bruggeman, Postdoctoral Research Fellow (Andersen)

Shalesa Johnson, Student Office Worker

Tatum Nobrega, Student Office Worker

Dr. Alexandria Safiq, Postdoctoral Research Fellow (Fulton)

Hattie Saloka, Program/Project Specialist

Dr. Susan A. Schroeder, Research Associate (Fulton)

Dr. Elena West, Postdoctoral Research Fellow (Andersen)



## UNIT STUDENTS

Katelin Goebel, M.S. (Andersen)

Nina Hill, M.S. (Andersen)

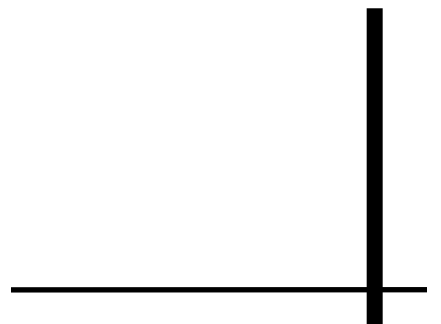
Leslie McInenly, Ph.D. (Fulton)

Evan Salcido, M.S. (Fulton, graduated 2019)

Kyle Smith, Ph.D. (Fulton)

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

David Wolfson, M.S. (Andersen and Fieberg, graduated 2018), Ph.D. (Andersen and Fieberg)



## UNIT AFFILIATED STAFF AND STUDENTS

Briana Burke, Undergraduate Student (Hove)

Alex Franzen, Undergraduate Student (Hove)

McKenna Rodine, Undergraduate Student (Hove)



# Unit Coordinating Committee

## **University of Minnesota**

Head, Department of Fisheries, Wildlife,  
and Conservation Biology  
Dr. Susan Galatowitsch  
135D Skok Hall, 2003 Upper Buford Circle  
St. Paul, MN 55108  
(612) 624-3242

Dean, College of Food, Agricultural and Natural  
Resource Sciences  
Dr. Brian Buhr  
277 Coffey Hall  
1420 Eckles Ave.  
St. Paul, MN 55108  
(612) 624-1234

## **MN Department of Natural Resources**

500 Lafayette Road,  
St. Paul, MN 55155

Fisheries Chief  
Brad Parsons  
(651) 259-5229

Wildlife Research and Policy Manager  
Dr. Lou Cornicelli  
(651) 259-5202

Deputy Director for Fish and Wildlife  
Pat Rivers  
(651) 259-5224

Director for Fish and Wildlife  
Jim Leach (retired 2019)  
Dave Olfelt  
(651) 259-5180

Fisheries Research and Policy Manager  
Melissa Trembl  
(651) 259-5231

## **Wildlife Management Institute**

President  
Dr. Steven A. Williams  
1440 Upper Bermudian Road  
Gardners, PA 17324-9766  
(717) 677-4480

Midwest Field Representative  
Dr. Bill Moritz  
1608 Packwood Road  
Fairfield, IA 52556  
(989) 413-3115

## **U.S. Geological Survey**

Eastern Region Supervisor, Cooperative Research  
Units  
Dr. Michael W. Tome  
Leetown Science Center  
1700 Leetown Road  
Kearneysville, WV 25430  
(301) 834-8054

Division Chief, Cooperative Research Units  
Dr. John Organ (retired 2019)  
Dr. Jonathan Mawdsley  
12201 Sunrise Valley Drive, MS 303  
Reston, VA 20192  
(703) 648-4261

**U.S. Fish and Wildlife Service** (non-voting)  
U.S. FWS, Region 3, BHW Federal Building  
1 Federal Drive  
Fort Snelling, MN 55111-4056

Chief, Migratory Birds  
Dr. Tom Cooper  
(612) 713-5338

# Unit Cooperators

## Cooperating Investigators in Unit Research

Dr. Tom Cooper (U.S. Fish and Wildlife Service)  
Dr. Nicole Davros (Minnesota Department of Natural Resources)  
Dr. John Fieberg (University of Minnesota)  
Dr. James Forester III (University of Minnesota)  
Dr. Susan Galatowitsch (University of Minnesota)  
Dr. Howie Harshaw (University of Alberta)  
Christine Hertwig (Minnesota Department of Natural Resources)  
Mark Hove (University of Minnesota)  
Dr. Douglas H. Johnson (U.S. Geological Survey, emeritus; University of Minnesota)  
Dr. Patricia L. Kennedy (Oregon State University)  
Dr. Adam Landon (Minnesota Department of Natural Resources)  
Dan Licht (National Park Service)  
Dr. James A. Perry (University of Minnesota)  
Dr. Andrew Raedeke (Missouri Department of Conservation)  
Dr. Pam Rice (U.S. Department of Agriculture)  
Mike Schrage (Fond du Lac Tribe)  
Dr. Rudy Schuster (U.S. Geological Survey)  
Dr. Henry Streby (University of Toledo)  
Dr. Tiffany Wolf (University of Minnesota)



## Cooperating University of Minnesota Academic Units

Cedar Creek Ecosystem Science Reserve  
College of Food, Agricultural and Natural Resource Sciences  
College of Veterinary Medicine  
Conservation Sciences Graduate Program  
Department of Fisheries, Wildlife, and Conservation Biology  
Natural Resources Science and Management Graduate Program  
University of Minnesota Graduate School

## Cooperating Organizations

Canadian Wildlife Service  
Fond du Lac Band of Lake Superior Chippewa  
Great Lakes Indian Fish and Wildlife Commission  
Legislative-Citizen Committee on Minnesota Resources  
Manitoba Conservation  
Michigan Department of Natural Resources  
Minnesota Department of Natural Resources  
Missouri Department of Conservation  
Human Dimensions Working Group  
Iowa Department of Natural Resources  
National Flyway Council  
Ohio Department of Natural Resources  
Oregon State University  
Trumpeter Swan Society  
University of Alberta  
University of Toledo  
U.S. Bureau of Land Management  
U.S. Fish and Wildlife Service  
    Division of Migratory Birds, Region 3  
U.S. Geological Survey  
    Fort Collins Science Center  
    Geosciences & Environmental Change Science Center  
    Upper Midwest Environmental Sciences Center  
U.S. National Park Service  
    Midwest Region  
Wisconsin Department of Natural Resources





# Completed Research



# Applied Ecology





---

# Evaluating Nest-site Selection of Arctic Peregrine Falcons in the Colville River Special Area

**Investigator:** David E. Andersen  
**Postdoc:** Jason Bruggeman  
**Duration:** August 2016 to July 2019  
**Funding Source:** U.S. Bureau of Land Management  
**Location:** Colville River Special Area, Alaska  
Minnesota Cooperative Fish and Wildlife Research Unit

Arctic peregrine falcon (*Falco peregrinus tundrius*) and other peregrine falcon populations suffered drastic declines during the 1950s–1970s owing, in part, to DDT-related reproductive failures. Arctic peregrines were listed in 1973 under the U.S. Endangered Species Act (ESA) and recovered sufficiently enough to be removed from the ESA in 1994. A key part of Arctic peregrine recovery in the U.S. was establishment of BLMs Colville River Special Area (CRSA) in 1977, which was formed to conserve Arctic peregrine nesting and foraging habitat. The CRSA is located within the National Petroleum Reserve-Alaska (NPR-A), which allows for oil and gas mining and exploration. 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 fulfills the requirement for a management plan for the area. In accordance with its designation in 1977 and the CRSAMP, the Colville River Special Area will be managed to provide maximum protection to the Arctic peregrine falcon while allowing other activities including oil and gas development, recreation, subsistence, and scientific research.



Protective regulations for Arctic peregrines exist under the CRSA Management Plan to minimize disturbance and preserve nesting and foraging habitat. However, additional information needs were identified in the CRSA Management Plan to improve knowledge of Arctic peregrine ecology in the CRSA, better inform management decisions, and evaluate possible changes to protective regulations.

The primary objective of this study was to develop a Resource Selection Function (RSF) model using 24 years of Arctic peregrine nest-site location data along the Colville River to predict and map the intensity of nest-site use throughout the portion of the Colville River that has been repeatedly surveyed for Arctic peregrines since 1981. The RSF model incorporates modeled productivity data from nest sites. Previous work helped identify some of the abiotic and biotic covariates related to Arctic peregrine occupancy

of nest sites and nesting cliffs and abundance on cliffs in the CRSA. We used information from that work to help select covariates of nest-site attributes (e.g., habitat; topography; surrounding prey habitat availability) to evaluate productivity and RSF models for this study. The resulting RSF model can be used to map and identify areas along the Colville River predicted to have higher intensity of use for Arctic peregrine nesting and examine characteristics of these areas relevant to Arctic peregrine nesting ecology.

To derive an RSF, we used zero-inflated negative binomial regression models and covariates describing nest-site productivity, area of surrounding prey habitat, geology, topography, and land-cover type to model intensity of Arctic peregrine falcon nest-site use along the Colville River, and developed a predictive map of intensity of use. Regions of higher predicted intensity of use were characterized by steeper slopes, greater area of prey habitat, and higher average productivity, which are likely

attributed to minimizing predation risk, gaining advantages for hunting, having sufficient prey resources, site quality, and overall fitness. The CRSA Management Plan provides guidance for protection of Arctic peregrine falcon nest sites, nesting cliffs, and foraging habitat based on the same regulations for all nest sites and habitat. Areas predicted to have higher intensity of use by our model can be used to help focus efforts of continued protection and preservation of these cliffs, particularly those with frequently occupied and productive nest sites. Furthermore, our results suggest that relaxing some protective measures around cliffs with no predicted use, especially where no used nest sites have been located during surveys, would have minimal effects on Arctic peregrine falcon ecology in the CRSA. Overall, our assessment provides an example of applying a long-term dataset of occupancy and productivity to model, predict, and map nest-site selection of a once endangered population during its recovery.

---

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

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

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

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

We followed standard methods to study winged mapleleaf brooding period, and utilized recent developments in underwater video and computer recording systems to video interactions between brooding winged mapleleaf and fishes. We worked with Upper Mississippi River Conservation Committee's

Mussel Conservation Team divers to check mussels 2–3 times per week from late August through early October at Interstate State Park, and we checked mussels twice a week between during the same period at Lakeland, Minnesota. During each check the presence of displaying winged mapleleaf was recorded. To observe interactions between brooding winged mapleleaf and fishes we used underwater video. We used an underwater video system (Aqua-Vu AV Multi-Vu HD [720p] system) to record 3–12 hours of video per field session from dusk on into the night or the next morning throughout the winged mapleleaf display period.

During the fall of 2017 we documented winged



Mark Hove (left) Alex Franzen (middle) and Briana Burke (right) at Lakeland study site



mapleleaf brooding period at Interstate State Park and collected video data from Lakeland, Minnesota. During this time we observed what appeared to be a cessation of brooding behavior during a brief high water event and the first channel catfish interacting with a brooding winged mapleleaf. These events are described in *Ellipsaria*, the newsletter of the Freshwater Mollusk Conservation Society (Hove et al., 2018). Note the student coauthors who helped collect and analyze data, and review manuscript drafts.

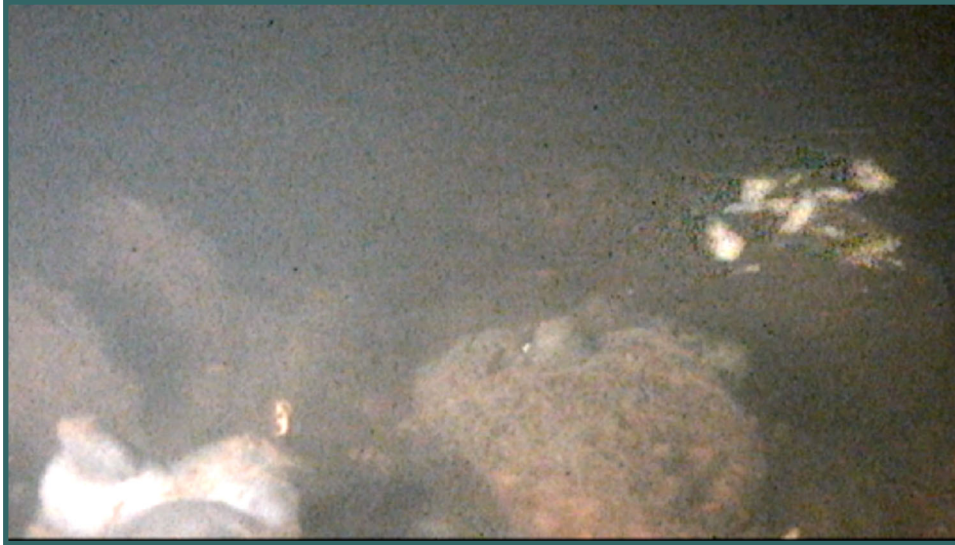


Alex Franzen (left) and Mark Hove at Lakeland, MN

During fall 2018 we observed winged mapleleaf brood glochidia primarily from late August through mid-September at Interstate State Park. Water temperature generally rose through the spring, varied between 22–26 °C during the summer, and began dropping in August with a warm spell in September. Displaying winged mapleleaf were observed at Interstate State Park when they were first checked on 28 August through 7 September with one interesting individual displaying on 21 September. State, federal, and academic biologists working together on winged mapleleaf propagation efforts at Interstate agreed that the winged mapleleaf brooding period ended by 24 September.

Also during fall 2018 we videoed brooding winged mapleleaf and co-occurring fishes in the St. Croix River at Lakeland, Minnesota. Displaying winged mapleleaf were observed for a short period at Lakeland between 7–14 September. However, we expended extra effort to make long video recordings by sleeping overnight with the cameras at the study site. With this extra effort we observed several interesting interactions. The placement of chicken livers upstream of the displaying winged mapleleaf appeared to draw channel catfish (*Ictalurus punctatus*), redhorse (*Moxostoma* sp.), freshwater drum (*Aplodinotus grunniens*), and buffalo (*Ictiobus* spp.) as these fishes seemed to aggregate in the area just upstream of the cameras

near the chum containers and would circle around to this location repeatedly. Channel catfish were observed once during the first video recording (7–8 September), four times during the second (11–12 September), and many times on the third shooting (14–15 September). Channel catfish were observed passing by brooding winged mapleleaf nearly 90 times over this time period. Although the barbels of individual catfish appeared to brush brooding winged mapleleaf and possibly the mantle magazine at least 11 times we never observed a channel catfish bite down on a magazine. During one evening we observed two partially displaying winged mapleleaf release small numbers of broken conglomerates and possibly individual glochidia numerous times over several hours. Although we never saw any fishes eat freshly released conglutinate fragments, we observed two occasions where fishes inhaled what appeared to be aggregations of winged mapleleaf conglutinates. The first instance involved a channel catfish change the direction it was swimming to use its barbels to touch a small clump of conglutinates drifting downstream. The catfish briefly returned to its original swimming direction but then turned back to the conglutinates, moved in to strike the conglutinate mass, and then drew the mass into its mouth. As the channel catfish swam away we did not see it spit



*Winged mapleleaf releasing conglutinates*

out the conglutinates although the fish was difficult to observe in the faded background and it didn't stay in view for long. The other occasion involved what appeared to be a large aggregation of conglutinates presumably released by a nearby winged mapleleaf. The conglutinates came to rest on a partially displaying winged mapleleaf. In near dark conditions a bluegill (*Lepomis macrochirus*) looked at the conglutinates, drew them in its mouth, and

full displays were not disturbed by changes in light intensity, shadows, or being bumped by a fish, as compared to winged mapleleaf with minor or partially inflated mantles, which would briefly draw in their magazines in response to changes in camera light intensity, passing shadows, or when channel catfish barbels, other fish, or softshell turtles (*Apalone mutica*) would brush them.

then spit them out. Occasionally we observed channel catfish, buffalo, and a logperch (*Percina* sp.) apparently feed on something on the shells of partially displaying winged mapleleaf. This activity did not touch the magazine and the mussel did not release glochidia or conglutinates in response, rather, it usually drew its mantle magazine in between its valves. As observed in previous years, winged mapleleaf with

---

# Insecticide Exposure Risk for Grassland Wildlife on Public Lands

**Investigator:** David E. Andersen, Nicole Davros (Minnesota Department of Natural Resources)

**Students:** Katelin Goebel, M.S. (Natural Resources Science and Management)

**Duration:** September 2016 to September 2019

**Funding Source:** Minnesota Department of Natural Resources

**Project Location:** Southwestern Minnesota  
Minnesota Cooperative Fish and Wildlife Research Unit

\*Increasing evidence suggests that pesticides may be an important factor explaining declines in grassland-dependent wildlife in agricultural landscapes. Minnesota Department of Natural Resource (MN DNR) wildlife managers and members of the public have reported concerns about drift from foliar-application insecticides in particular. Such insecticides are used on a variety of crops but their use has been especially important for controlling soybean aphid outbreaks in Minnesota. Lab studies have shown chlorpyrifos (a broad spectrum organophosphate) and other insecticides used to target aphids are highly toxic to non-target organisms, including economically important game species and pollinators, but few studies have investigated the environmentally-relevant exposure of free-ranging wildlife to these chemicals. Our objectives were to assess the direct and indirect exposure of grassland wildlife to the 3 most common soybean aphid insecticides (i.e., chlorpyrifos, lambda-cyhalothrin, and bifenthrin) along a gradient from soybean field edge to grassland interior. During summer 2017 and 2018, we sampled 5 treatment and 4 control sites across western and southern Minnesota. We detected chlorpyrifos at all distances examined (0–400 m) at both treatment and control sites, suggesting that some background level of chlorpyrifos exposure is occurring in the environment regardless of landowner activities in the adjacent row crop

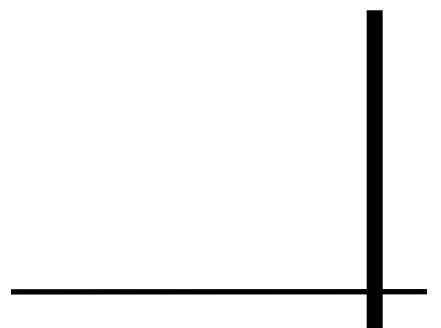
field. Deposition was higher near field edges than the grassland interior. We also found higher residue amounts on mid-canopy samples than ground-level samples. We detected chlorpyrifos residue amounts on arthropods that were below the acute oral LD<sub>50</sub> values for birds; however, residue amounts were above the contact LD<sub>50</sub> for honey bees up to 50 m from the row crop edge. We quantified arthropod abundance, consumable dry biomass, and family richness of insects and spiders pre- and post-spraying to evaluate the indirect effects of spraying on bird food resources. We found short-term reductions in overall arthropod abundance, bird prey abundance (specifically, individuals in the orders Araneae, Coleoptera, Lepidoptera larvae, and Orthoptera), and Coleopteran family richness in treatment sites but our other arthropod measures (i.e., overall consumable dry biomass, bird prey biomass, and richness of other families important in the diets of birds) did not differ between treatment and control sites post-spraying. Overall, our results indicate that wildlife within 25 m of a grassland/row crop edge are more likely to be exposed to drift from foliar-application insecticides, and bees within 50 m of an edge may be exposed to dosages that can cause mortality by contact. Furthermore, reductions in arthropod food abundance for grassland birds may occur up to 21 days post-spraying. Natural resource managers can reduce wildlife



exposure to drift from insecticide applications in nearby row crop fields by minimizing the perimeter-area ratio of grasslands. Additionally, management regimes that increase the percent canopy cover in grasslands also have the potential to decrease exposure of grassland wildlife to these insecticides.

\*Project description revised from Geobel, K. and N. Davros. 2020 Minnesota Department of Natural Resources Research Summaries, with permission.








---

## Completed Research



Human Dimensions,  
Management, and Conservation





---

# Airspace as Habitat: Methods for Assessing Use by Animals

**Investigator:** James Perry (Cooperating faculty)  
**Collaborator:** Douglas H. Johnson (U.S. Geological Survey - retired)  
**Duration:** March 2014 to March 2019  
**Funding source:** U.S. Geological Survey —Geosciences & Environmental Change Science Center  
**Project Location:** University of Minnesota, Twin Cities Campus  
Upper Midwest

Bats are critical to the health of ecosystems and agricultural systems in the United States, but North American bats currently face many threats, including white nose syndrome and impacts from wind energy. Improving knowledge of the spatial distribution of these poorly understood species will help direct conservation efforts to secure the future viability of populations. Due to their utility for studying small, nocturnally active species and recent advancements in both recording and species identification technologies, the use of acoustic detectors to study spatial and temporal patterns of airspace use by bats has become common. However, interpreting acoustic data can be problematic because acoustic activity is temporally variable and provides only an imperfect index of bat abundance. To uncover spatial patterns among individual sampling locations, we leveraged a machine-learning approach to build bat activity models that included temporal and spatial covariates at multiple scales. We used these models to produce maps of predicted acoustic activity level across the Great Lakes region of the Upper Midwest United States. We estimated the uncertainty of our predictions by analyzing how model accuracy varied across the region according to each location's representation in the training data. Models including temporal and spatial predictors performed relatively well, with prediction  $R^2$  values for hourly pass rate between 0.53 and 0.74. Although spatial variables alone explained less than 40% of the variation in bat activity, our findings suggest that the Great Lakes serves as an

ecological barrier to migrating bats and provide empirical evidence that smaller, less mobile, forest-dwelling *Myotis* species are more closely associated with finer-scale spatial features. Migratory species activity appears more influenced by coarse-scale physiographic features. Maps illustrating responses to spatial covariates indicated highest activity levels near Great Lakes coasts and in the Upper Peninsula of Michigan. This approach builds a pathway for modeling the distribution of bat species based on automated acoustic recordings to further understanding of the spatial and temporal dynamics of bat landscape use and broad movement patterns.

From fall 2010 to spring 2018, Wildlife Acoustics (Maynard, MA) SM2BAT+ detectors were deployed at 241 sites to record acoustic activity of bats across the Great Lakes region of the Upper Midwest United States, including sites near Great Lakes coasts and at locations up to 470 km inland (Figure 1). Data were aggregated from several different studies in a long-term collaborative effort between the University of Minnesota and the U.S. Fish and Wildlife Service (e.g., Heist 2014, Cryan et al. 2014, Wells et al. 2018).

Bat acoustic activity varied greatly across the region (Figure 1), with a general pattern of higher pass rates recorded at sites closer to Great Lakes coasts. Low-to-medium nightly pass rates (mean pass count per night) were recorded in southern and central Minnesota, with the lowest overall

pass rates recorded in southwestern Minnesota. Medium-to-high rates were recorded at sites closer to Great Lakes coastlines, with the highest overall mean pass rates being recorded at the northern end of Lake Michigan.

#### Literature Cited

Cryan, P. M., et al. 2014. Behavior of bats at wind turbines. *Proceedings of the National Academy of Sciences* 111:15126-15131.

Heist, K. W. 2014. Assessing bat and bird fatality risk at wind farm sites using acoustic detectors. Ph.D. Dissertation, University of Minnesota.

Wells, M.T., T. S. Bowden, K.W. Heist, R. L. Horton, D. C. Nolfi, E. C. Olson, Rathbun N. A., and J. C. Gosse. 2018. Great Lakes Avian Radar Technical Report Lake Huron Lakeshore: Alcona and Presque Isle, MI, Fall 2015 and Spring 2016. U.S. Department of the Interior, Fish and Wildlife Service, Biological Technical Publication FWS/BTP-XXXXX-2018.

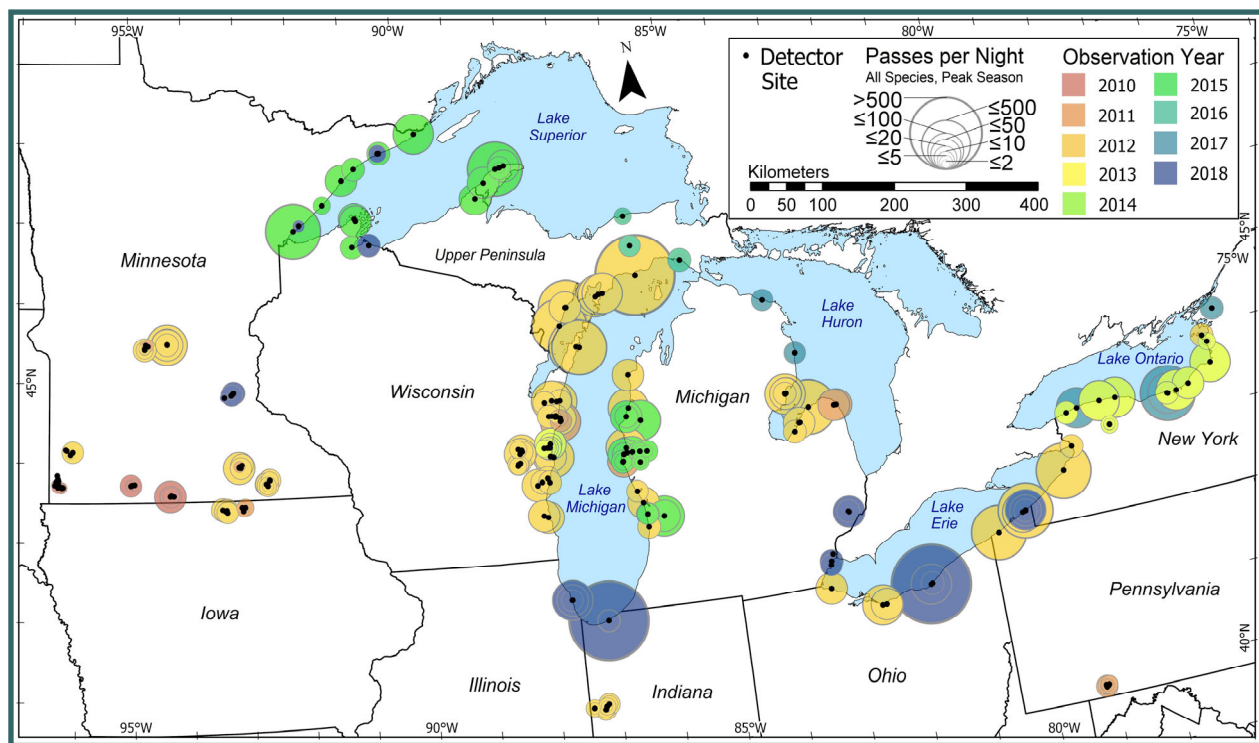


Figure 1. Location of acoustic detector sites within the study area with observation year(s) and activity level indicated. Black dots at the center of each circle are locations where detectors were placed. Symbol color indicates which year(s) data were collected at each site. For multi-year sites, mean year is displayed. Circle size indicates mean bat passes per night during peak seasons: spring (4 May to 12 June) and fall (28 July to 26 September). Peak season was defined as nights when 1) mean nightly pass rates among all sites and all years was above 30, and 2) a total of 40 or more detectors had been deployed on that day of the year, among all years combined.



---

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

**Investigator:** David C. Fulton  
**Staff:** Susan A. Schroeder, Ph.D. Research Associate  
**Duration:** July 2012 to December 2020  
**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 provided funding for a full-time Research Fellow to work closely with Minnesota Department of Natural Resources (MN DNR) wildlife researchers and managers to collect timely information to assist in the evaluation of management programs. The primary focus of this position was on developing social science information for fisheries and wildlife management in Minnesota and to use this information to support MN DNR management, planning, and decision-making processes. The

project provided funding to support a Ph.D. research associate and operating funds to conduct two studies during 2019–2020: 1) understanding hunter and land-owner issues related to the management of chronic wasting disease (CWD) in Minnesota; and 2) developing social science information to support the development of a MN DNR statewide management plan for wolves. More detail about these specific studies are provided elsewhere in this report.



---

# Minnesota Deer Hunter Survey – Chronic Wasting Disease

**Investigator:** David C. Fulton  
**Research Fellow:** Susan A. Schroeder  
**Duration:** January 2019 to September 2019  
**Funding Source:** Minnesota Department of Natural Resources

Chronic wasting disease (CWD) is a neurological disorder that affects species of the family cervidae, including deer (*Odocoileus* spp.), elk (*Cervus canadensis*), moose (*Alces alces*), and caribou (*Rangifer tarandus*). The disease is always fatal and as such represents a significant threat to the health of wild cervid populations, and the sustainability of the flow of benefits Minnesotans obtain from them. Managing CWD requires the cooperation of multiple stakeholders beyond the Department of Natural Resources and partner agencies. This situation is especially true in the context of southeastern Minnesota where the disease is primarily found in deer that live on privately owned land. Facilitating access for hunters and maintaining participation in deer hunting is critical for meeting disease management goals, including lower deer density. With these circumstances in mind, this study was conducted to better understand southeastern Minnesota landowners' attitudes toward CWD and preferences for CWD management, especially the use of financial incentives to facilitate access for hunters and to maintain hunter participation.

A study of 2018 southeastern Minnesota firearm deer hunters was conducted to assess:

1. participation, involvement, and satisfaction with deer hunting in southeastern Minnesota,
2. opinions and preferences for deer populations and management in southeastern Minnesota,
3. knowledge and information sources related to CWD,

4. feelings and concerns about CWD,
5. opinions and preferences related to CWD management, and
6. trust in the MNDNR generally, and specifically related to CWD management.

A questionnaire was distributed to 4,995 deer hunters in southeastern Minnesota. This sample included all firearms deer hunters who identified the CWD management zone (permit area 603) as their primary deer hunting area ( $n = 2,195$ ), and a random sample of hunters who identified one of the 300-series permit areas surrounding the CWD management zone ( $n = 2,800$ ) as their primary deer hunting area at the time of license purchase. The number of full-length survey respondents for the two samples were: 880 for the CWD management zone, and 1,206 for the surrounding permit areas. Total response numbers including shortened, nonresponse surveys were: 993 for the CWD management zone, and 1,346 for the surrounding permit areas. After adjusting for undeliverable surveys and invalid respondents, the response rate for the full-length survey was 42% for the CWD management zone and 45% for the surrounding permit areas.

A detailed summary of the study findings are available from the Minnesota DNR in: Landon, A.C., Schroeder, S.A., Cornicelli, L.J., and McInenly, L. 2019. Study of southeast Minnesota landowners' attitudes toward chronic wasting disease and its management. Minnesota Department of Natural Resources, Division of Fish and Wildlife, Saint Paul, MN.



---

# Minnesota Residents' Attitudes Toward Wolves

**Investigator:** David C. Fulton  
**Research Fellow:** Susan A. Schroeder  
**Duration:** August 2019 to June 2020  
**Funding Source:** Minnesota Department of Natural Resources  
**Project Location:** Minnesota Cooperative Fish and Wildlife Research Unit

The Division of Fish and Wildlife, Minnesota Department of Natural Resources is engaged in an update to the Minnesota Wolf Management Plan. Public input and engagement are at the forefront of these efforts. Understanding the values, beliefs, attitudes, and behaviors of stakeholders can enhance the legitimacy and efficacy of agency decisions with respect to wolf management, while helping to minimize conflict. This is particularly important in a context like wolf (*Canis lupus*) management where diverse publics hold divergent preferences and values and the public discourse surrounding wolves is dominated by stakeholders at the extremities of beliefs. Therefore, collecting statistically representative data is of critical importance. To better understand the potential impacts of wolf management decisions and to assess public preferences, a comprehensive study of stakeholder attitudes early in the management plan revision process was conducted. These data have informed the technical and stakeholder committee review, the tenability of proposed actions in the social arena, and avenues for further communication with stakeholders on the topic of wolf management.

We assessed stakeholder attitudes toward wolves in Minnesota in general, their preferences for potential management priorities, their values toward wildlife, preferred options for funding wolf management, and tolerance of wolves on the landscape. Questionnaires were distributed to 9,750 individuals, including 5,250 residents, 2,000 resident deer hunters, and 2,500 livestock producers. Sample sizes were based on expected response rates for each group and minimum samples need-

ed for statistical generalizability. The number of respondents for the three samples were: 1,466 for the resident sample, 895 for the hunter sample, and 1,139 for the livestock producer sample. After adjusting for undeliverable surveys and invalid respondents, the response rates for the questionnaires were 32.8% for residents, 46.6% for hunters, and 53.4% for livestock producers. Because some segments of the population (males, hunters, older individuals, and residents from certain regions) were overrepresented among resident respondents, weights were calculated and applied to resident responses

Residents, hunters, and livestock producers reported substantively different experiences and attitudes associated with wolves in Minnesota. Compared to residents, larger proportions of livestock producers and hunters reported experiences with wild wolves in the state. When asked, in general, how important wolves in Minnesota are to them personally, both livestock producers and hunters rated wolves slightly to somewhat important, while residents rated them somewhat to moderately important. Looking at values associated with having wolves in the state, livestock producers generally reported less agreement with reasons for valuing wolves in Minnesota than hunters and residents. Two exceptions were that hunters rated values associated with wolves for tourism and hunting/trapping higher than the other groups. Livestock producers tended to disagree with the value of having wolves in Minnesota. Similar patterns appeared for attitudes toward wolves, with livestock producers holding negative attitudes, residents having positive attitudes, and

hunters expressing attitudes closer to neutral. Finally, respondents from the different groups felt different emotions about wolves, and perceived different risks associated with them.

Respondents were asked to indicate their preferences for wolf populations in Minnesota relative to the estimated 2,655 (range: 1972–3387) wolves in Minnesota in winter of 2017–2018. On average, livestock producers preferred to see fewer or many fewer wolves, hunters preferred fewer, and residents preferred to see about the same number of wolves in the future. Similarly, livestock producers and hunters wanted wolves to occupy less territory in the state, and residents wanted them to occupy about the same amount of territory. Nearly 70% of residents moderately or strongly agreed with the importance of maintaining a wolf population, compared to nearly half of hunters and less than a third of livestock producers.

Residents, hunters, and livestock producers had differing preferences for wolf management. All respondents felt research and education, compensating livestock producers for animals lost to wolves, and killing wolves that threaten people or attack livestock were important management actions. Residents felt that promoting diverse animal communities and public opportunities to see and hear wolves, along with protecting individual wolves were important, whereas hunters and livestock producers did not. Alternatively, residents did not think it was important to reduce the wolf popula-

tion to protect deer or hunting dogs. Respondents were asked to rate the acceptability of five possible actions the Minnesota Department of Natural Resource could take in three scenarios involving human-wolf conflict. The three scenarios were: (a) if a wolf was seen near a residential neighborhood, (b) if a wolf killed someone's pet (e.g., domestic dog or cat), and (c) if a wolf killed livestock (e.g., cow, sheep, goat). The five possible actions were: (a) do nothing, (b) monitor the situation, (c) try to frighten the wolf away, (d) capture and relocate the wolf, or (e) kill the wolf. Doing nothing was not acceptable to any of the groups in any of the scenarios. Killing the wolf was acceptable to hunters and livestock producers in all three scenarios, but it was unacceptable to residents in any of the scenarios.

The project has been completed and peer-review manuscripts are in review. A final report and a summary report authored by Dr. Sue Schroeder and Minnesota DNR collaborators summarizing study results are available from the Minnesota DNR:

[https://files.dnr.state.mn.us/fish\\_wildlife/wildlife/wolves/attitude\\_report\\_final.pdf](https://files.dnr.state.mn.us/fish_wildlife/wildlife/wolves/attitude_report_final.pdf)

[https://files.dnr.state.mn.us/fish\\_wildlife/wildlife/wolves/summary\\_attitude\\_report.pdf](https://files.dnr.state.mn.us/fish_wildlife/wildlife/wolves/summary_attitude_report.pdf)

---

# Restoration of Elk to Northeastern Minnesota

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

Elk (*Cervus canadensis*) historically ranged over most of the state of Minnesota but were functionally extirpated in the early 1900s due to overharvest and habitat loss (Hazard 1982). Although two small populations have been restored to northwestern Minnesota, they are currently managed at low levels to reduce human-wildlife conflict (Minnesota Department of Natural Resources [MNDNR] 2016). Forested areas of the state, however, might avoid some of these conflicts and see significant ecological and economic benefits from returning elk to the landscape. Re-establishing this keystone herbivore could help restore the state's traditional wildlife heritage, diversify the large mammal community, increase tourism from wildlife viewers, and eventually provide additional hunting opportunities. Additional benefits include adapting to future climate change through assisted dispersal of a climate hardy species like elk and protecting against unforeseen events that could lead to the extirpation of Minnesota's current small and isolated elk populations. Finally, a landscape actively managed for elk will benefit other species adapted to young forests and brushlands. Evidence from other eastern states indicates elk restoration can be successful, but success is dependent on active forest management and public support for elk by local communities.

Understanding the public's attitudes and acceptance of elk and their potential impacts are key components of assessing the viability of elk restoration.

Long-term management of elk will require an adaptive impact approach in which management objectives and strategies are guided by the preferences of the impacted public. The University of Minnesota, in collaboration with the Fond du Lac Band of Lake Superior Chippewa, conducted a self-administered mail-back questionnaire of landowners and local residents in northeastern Minnesota to determine their attitudes toward restoring an elk population.

## STUDY PURPOSE AND OBJECTIVES

The goal of this study was to understand the attitudes of private landowners and local residents toward potentially restoring elk to northeastern Minnesota.

Specific objectives were to:

- understanding citizens' attitudes toward elk and elk restoration;



- acceptance and tolerance of potential elk impacts;
- preference for management objectives concerning elk restoration including elk population size and geographic distribution; and
- preferences for management strategies to address potential conflicts with elk.

We surveyed 4,500 private landowners and 4,000 local residents in northeastern Minnesota to describe landowner and local resident attitudes toward potentially restoring an elk population to northeastern Minnesota. The population of interest in this study was private landowners and local residents within the study area that covered portions of Carlton, Pine, and St. Louis counties. Three potential restoration areas for elk were identified based on recommendations from local natural resource professionals. These areas were selected due to abundant public land, while minimizing potential conflict from other land uses (e.g., agriculture). A random sample was used for: (1) private landowners ( $\geq 10$  acres) within five miles of the restoration areas, and (2) local residents matched to census blocks within four areas that correspond to county boundaries and major landmarks (e.g., roads, river). Among landowners, we had an adjusted response rate of 60% for full-length surveys, and a total response rate of 67% including nonresponse surveys. Among local residents, we had an adjusted response rate of 46% for full-length surveys, and a total response rate of 49% including nonresponse surveys.

#### SUPPORT FOR ELK RESTORATION

Overall, landowners and local residents within the study areas strongly supported restoring wild, free-ranging elk to the study areas in northeastern Minnesota (80% and 81%; Figure S-1 in report) and Minnesota in general (78% and 78%). About 12% of landowners and 9% of local residents were unlikely to support elk restoration. Landowner support for restoration in northeastern Minnesota was highest in the Cloquet Valley Study Area (82%) and lowest in the Fond du Lac Study Area (75%). Support from landowners in the Nemadji Study Area was 81%. Among local residents support was highest in southern St. Louis County (83%) followed by Duluth

(82%), northern Pine County (78%), and Carlton County (75%). Overall, a majority of landowners were supportive of restoring elk on their own property (70%) and within five miles of their property (76%). Landowners and local residents within each study area and group strongly supported restoring elk, although landowners were slightly less supportive of restoring elk within close proximity to their own property.

Landowners and local residents were presented with a series of 14 potential outcomes from restoring a wild, free-ranging elk population within the study areas in Minnesota and asked the likelihood of each outcome. Respondents believed that the most likely outcomes from restoring an elk population were: (1) providing opportunities to view elk, (2) restoration of a native wildlife species, and (3) providing opportunities to hunt elk. Respondents believed that the least likely outcomes from restoring an elk population were: (1) negatively impact other wildlife populations, (2) increase risk of disease transmission to livestock and wildlife, and (3) increase damage to trees and forest vegetation. The beliefs that had the largest positive influence on landowner and local resident support for elk restoration included: (1) restoration of a native wildlife species; (2) providing economic opportunities; (3) increase youth involvement and interest in the outdoors; (4) providing hunting opportunities for elk; and (5) providing opportunities to view elk. Beliefs that had the largest negative influence on support included: (1) negatively impact other wildlife populations, (2) increase risk of disease transmission to livestock and wildlife, and (3) increase damage to trees and forest vegetation.

The project has been completed, the PhD student is working on draft peer-reviewed publications, and a summary report has been produced:

Walberg, E., J. Forester, and M. Schrage. 2019. Northeastern Minnesota elk: a study of landowner and public attitudes toward potential elk restoration in Minnesota. University of Minnesota, Minnesota Cooperative Fish and Wildlife Research Unit, Department of Fisheries, Wildlife, and Conservation Biology, St. Paul, Minnesota, U.S.A.



---

## Ongoing Research



## Applied Ecology







---

# Modeling with Long-term Datasets to Inform Management of National Park Grasslands

**Investigator:** David E. Andersen  
**Postdoc:** Jason Bruggeman  
**Duration:** October 2017 to December 2019  
**Funding source:** National Park Service and U.S. Geological Survey  
**Project Location:** Great Plains National Parks  
Minnesota Cooperative Fish and Wildlife Research Unit

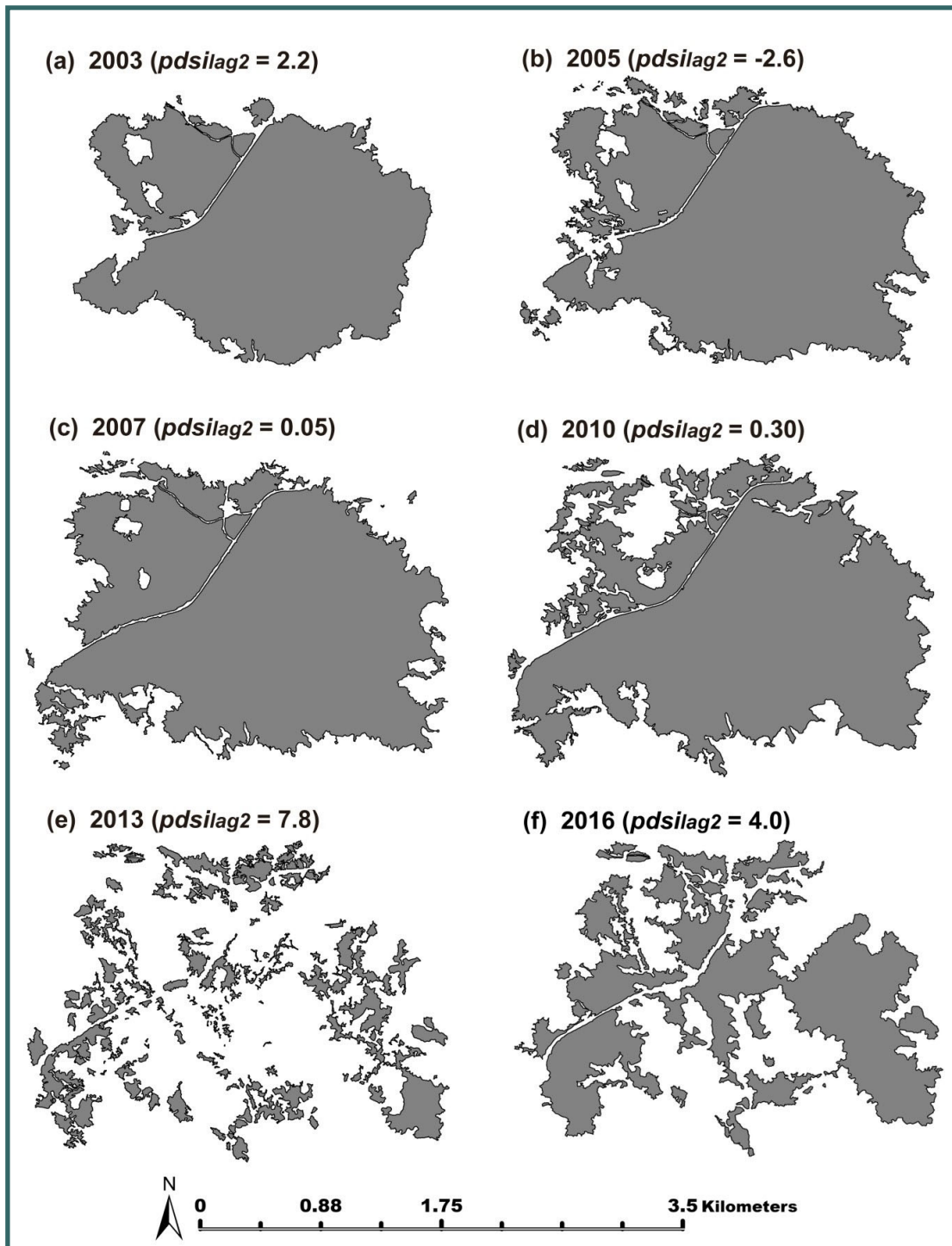
Populations of many mammal species living in grassland ecosystems across North America have been reduced greatly over the past 200 years due to conversion of native prairie to human-related uses. Foremost among these species is the black-tailed prairie dog (*Cynomys ludovicianus*), populations of which have declined an estimated 98% during that time. In addition to anthropogenic factors including plague, black-tailed prairie dog populations can vary in size in response to grazing by native ungulates, fire, and precipitation. Colonies in the Northern Great Plains have expanded and contracted during dry and wet periods, respectively. Drought reduces vegetation height; tall vegetation is known to limit colony expansion, possibly due to increased predation risk. We used mixed-effects models to analyze datasets of colony areas of black-tailed prairie dogs spanning 16–22 years and 983 total colony counts, from 142 unique colonies at Badlands National Park and Wind Cave National Park, South Dakota, USA, and Scotts Bluff National Monument, Nebraska, USA, to relate areal dynamics of colonies over time to total annual precipitation, drought stress, and plague. We also analyzed the relationship between active-burrow densities and precipitation and drought stress using seven years of data from 271 colony counts at Badlands National Park. Black-tailed prairie dog colonies expanded in response to drought conditions in all three national parks,



with colonies in Wind Cave National Park exhibiting a time-delayed response (Figure 1). In addition, colony area was negatively related to total accumulated precipitation for the preceding 12 months for Scotts Bluff National Monument. Active-burrow density at Badlands National Park decreased in response to drought stress with a time lag of 24–36 months. Plague first was reported at Badlands National Park in 2008 and colony areas decreased dramatically and rapidly during plague epizootic events. Our results support observations that black-tailed prairie dog colonies in the Northern Great Plains expand and contract in response to drought stress and wet weather.

Results from this project were published in the Journal of Mammalogy:

Bruggeman, J.E. and D.S. Licht. 2020. Drought-mediated changes in black-tailed prairie dog colonies in the Northern Great Plains. Journal of Mammalogy 101:1189-1204.



**Figure 1.**—Changes in black-tailed prairie dog (*Cynomys ludovicianus*) colony boundaries and area during (a) 2003, (b) 2005, (c) 2007, (d) 2010, (e) 2013, and (f) 2016 of the Bison Flats colony in Wind Cave National Park, South Dakota. Average Palmer Drought Severity Index values for the July–June period 24–36 months prior to surveys ( $pdsilag2$ ) are provided.



---

# Red-headed Woodpeckers: Indicators of Oak Savanna Health

**Investigator:** David E. Andersen  
**Postdoc:** Elena West  
**Duration:** July 2019 to June 2021  
**Funding Source:** Legislative-Citizen Commission on Minnesota Resources  
**Project Location:** Minnesota Cooperative Fish and Wildlife Research Unit

Red-headed woodpeckers (*Melanerpes erythrocephalus*) are a flagship species of oak savanna ecosystems and play a crucial role in maintaining healthy oak savanna by creating habitat for other species in live and dead trees. Red-headed woodpeckers are considered ecosystem engineers and a keystone species, and their presence may have far-reaching effects on species richness and ecosystem health. Historically, red-headed woodpeckers were common across the Midwest,



but populations have experienced dramatic regional declines estimated at 67% since 1970. The situation in Minnesota is even grimmer: since 1967, this species has experienced an average annual decline of 6%, representing a cumulative loss of nearly 95% of the population. Although the rate at which red-headed woodpeckers are declining has slowed since 1990, populations in Minnesota do not appear to have stabilized.

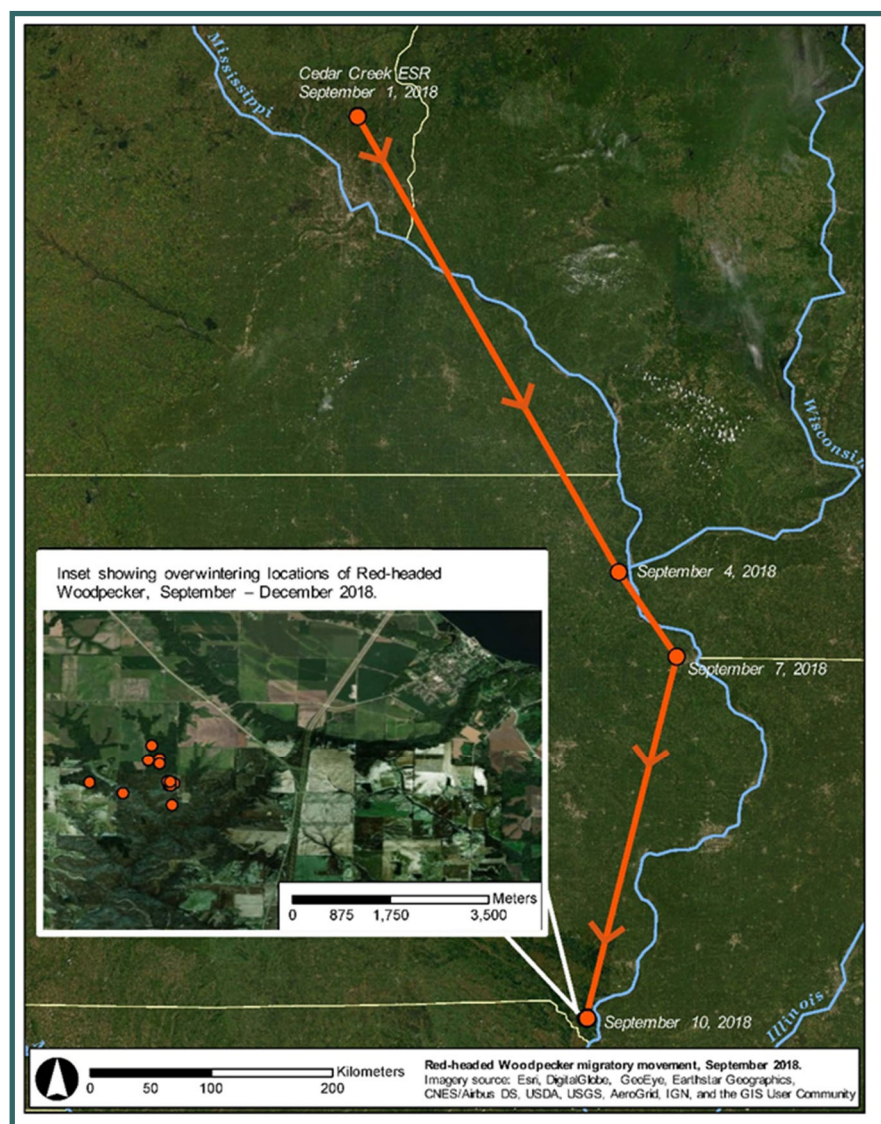
Fragmented patches of oak savanna exist across Minnesota, and there is considerable interest and effort from public and private land managers to preserve and restore this rare ecosystem. Efforts to support red-headed woodpeckers and other oak savanna specialists through habitat restoration are ongoing at a number of sites, but

these initiatives have been challenged by a general lack of information on the factors that make savannas desirable for red-headed woodpeckers. Fortunately, red-headed woodpeckers occur in relatively stable numbers (>100 breeding adults annually) at the Cedar Creek Ecosystem Science Reserve (hereafter “Cedar Creek”) despite dramatic declines in surrounding areas. Since 2008, a citizen-driven initiative of the Audubon Chapter of Minneapolis has been monitoring this species at Cedar Creek, and has generated some basic information on population size and nest cavity use. In 2017, a formal research collaboration was established with partners at the University of Minnesota and the University of Toledo in Ohio to address key information gaps about red-headed woodpecker ecology, with a particular

emphasis on identifying the aspects of oak savannas that support nest success, survival, and migration patterns. Our goals are to address population declines in a charismatic species of great conservation concern, to assess the outcomes of ongoing management and conservation efforts in an endangered ecosystem, and to develop a unified management plan for restoring oak savanna for red-headed woodpeckers and other oak habitat specialist species in Minnesota and throughout the Midwest.

Our specific goals are to:

1. Identify oak savanna characteristics and adult condition and behaviors associated with successful production of young, the factors related to whether and where individuals migrate, and the consequences of migratory status on productivity and survival.
2. Develop a long-term management plan for restoring oak savanna to support red-headed woodpeckers and other oak-savanna specialists in Minnesota and the Midwest.



*Autumn 2018 migration trajectory of a red-headed woodpecker captured at the Cedar Creek Ecosystem Science Reserve (Anoka and Isanti counties), in Minnesota.*

---

# Minnesota Trumpeter Swan Migration Ecology and Conservation

**Investigator:** David E. Andersen, John Fieberg (Cooperating Faculty)  
**Student:** David Wolfson, Ph.D. (Conservation Sciences)  
**Duration:** July 2019 to June 2023  
**Funding Source:** Legislative-Citizen Commission on Minnesota Resources  
**Project Location:** Minnesota Cooperative Fish and Wildlife Research Unit

Trumpeter swans (*Cygnus buccinator*) have high intrinsic and economic value in Minnesota as a protected wildlife species. Minnesota citizens enthusiastically invested in the restoration of trumpeter swans through the check-off donation and other funding sources to the Minnesota Department of Natural Resources (MNDNR)

Nongame Program since the mid-1980s. The Interior Population of trumpeter swans (of which Minnesota swans comprise ~63%) has increased dramatically since they were re-established in the 1960s and 1970s and both population size and distribution have expanded significantly in Minnesota since the MNDNR Alaska-egg project began in 1986. The original Minnesota reintroduction goal of 15 breeding pairs and the revised interim goal of 500 individuals by 2001 have been greatly exceeded, with a current estimate of nearly 17,000 swans (an average annual finite rate of increase of ~1.20 since 2000; Figure 1). Better understanding of trumpeter swan ecology will be useful in developing future management strategies for this growing population.

In Minnesota, trumpeter swans currently breed throughout most of the state, but beyond recent



estimates of population size and trend and distribution, relatively little is known about their ecology, hindering conservation decision-making. To address current information needs, we marked a sample of Interior Population trumpeter swans in Minnesota (and in Iowa, Manitoba, Wisconsin, Michigan, and Ohio with project collaborators) with GPS-GSM transmitters. These transmitters record high-resolution, high frequency location and related data and transmit those data through cellular phone networks, and will allow us to:

1. Evaluate year-round swan movements, including determining what proportion of trumpeter swans winter outside of the state, the locations where swans spend the winter, and the timing and duration of their move-



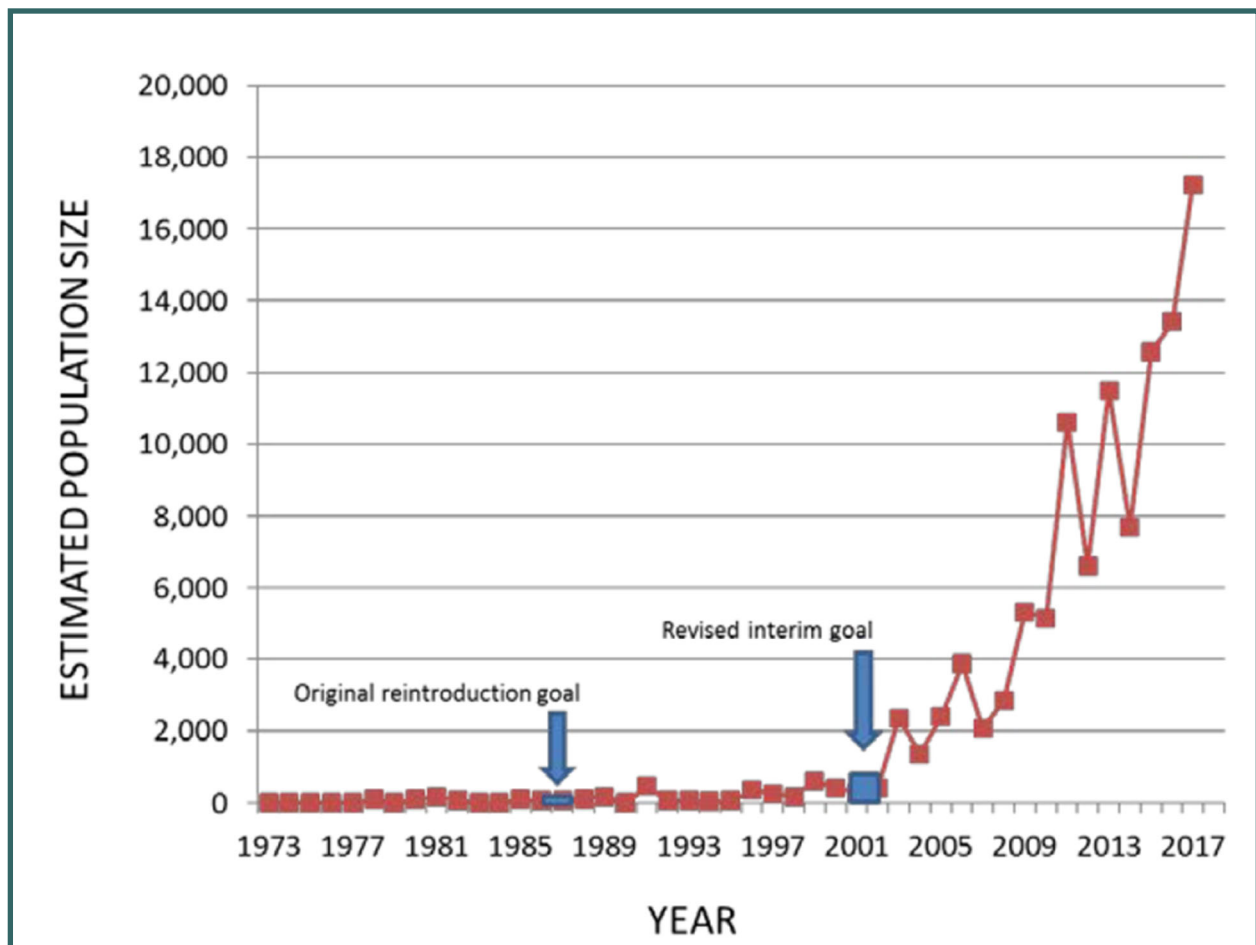
ments.

2. Determine whether and where trumpeter swans make molt migrations.
3. Evaluate year-round habitat use and selection patterns of trumpeter swans.
4. Estimate annual survival rates of trumpeter swans, if sample sizes are adequate and fates (i.e., mortality events) can be determined.

Results of this study will inform current and future trumpeter swan conservation in Minnesota and the Interior Population of trumpeter swans more generally by providing basic information about migra-

tion, year-round movements, mortality risks, and use of agricultural landscapes. Data from the project will be archived with Movebank (<https://www.movebank.org/>) and made available to the public via a website (<https://trumpeterswan.netlify.app/index.html>) that summarizes trumpeter swan movements and habitat use. Thus, the project will also offer the opportunity to actively engage and inform Minnesota citizens about how their past investment in conservation made a positive difference to Minnesota's natural heritage today.

*Figure 1. Minnesota trumpeter swan population size estimated from waterfowl surveys conducted over approximately 39% of the area of the state (MN DNR, unpublished data). The trumpeter swan population in Minnesota has increased substantially, dramatically exceeding original and interim population goals, and is currently growing at an annual rate of ~1.20.*






---

## Ongoing Research



Human Dimensions,  
Management, and Conservation





---

# Assessing Attitudes towards Chronic Wasting Disease

**Investigator:** David C. Fulton  
**Student:** Kyle Smith, Ph.D. (Conservation Sciences)  
**Duration:** August 2019 to June 2021  
**Funding Source:** Minnesota Department of Natural Resources  
**Project Location:** Minnesota Cooperative Fish and Wildlife Research Unit

The emergence of chronic wasting disease (CWD) in wild deer in Minnesota, and declining deer hunter participation, are topics of concern for the Minnesota Department of Natural Resources (MN DNR). Consequently, greater capacity to conduct studies that support decision making associated with white-tailed deer (*Odocoileus virginianus*) management has been identified as an area of need. This proposal supports a Ph.D. student position at the University of Minnesota, housed in the Cooperative Fish and Wildlife Research Unit to conduct human dimensions studies on CWD, deer hunters, and white-tailed deer management.

Chronic wasting disease is an infectious disease of animals belonging to the family cervidae including deer, elk (*Cervus canadensis*), moose (*Alces alces*) and caribou (*Rangifer tandarus*) (Williams et al., 2002). Since 2002, CWD has been found in wild deer populations and captive deer farm facilities throughout the Midwestern United States, including Minnesota. The disease is always fatal and represents a significant threat to the long-term health of wild deer populations and the future of deer hunting opportunity where it is found. Identifying effective avenues for disease management is a concern for the MN DNR. Many of the identified solutions for CWD containment, risk management, and elimination require the voluntary participation of statewide deer stakeholders including hunters, landowners, and the general public (Minnesota Chronic

Wasting Disease Response Plan, 2019). Consequently, understanding the concerns of these stakeholders and the factors that influence the likelihood of participation in behaviors that support disease management will better equip the MN DNR with the knowledge needed to succeed in containing the threat of CWD. Moreover, providing avenues for diverse stakeholders to voice their concerns about the disease and proposed management activities in a scientifically rigorous way will help to foster dialogue and build trust between the MN DNR and the public; priorities identified in the Minnesota White-tailed Deer Management Plan (2018).

Over half a million Minnesotan's participate in deer hunting annually and generate an estimated \$800 million in primary economic impact (Minnesota White-Tailed Deer Management Plan, 2018; U.S. Department of Interior, 2016). Receipts from hunting license sales also support a broad range of wildlife-related activities, including habitat restoration and threatened and endangered species management on state-owned properties. A sizable proportion of hunting license sales are tied to participation in deer hunting. Therefore, the influence of CWD on hunting license sales and hunting participation is a topic of particular concern, with implications beyond white-tailed deer and deer hunting specifically.

This project supports two specific study efforts

including:

1. Statewide Hunter Survey and Survey of the General Public – Conduct a two-strata survey of Minnesota deer hunters' (strata 1) and the general publics' (strata 2) values, beliefs, knowledge, and attitudes toward CWD and CWD management.
2. Lapsed Hunter Survey – Conduct a survey of lapsed deer hunters to determine constraints to participation and effective avenues for hunter reengagement and the potential of CWD to serve as a constraint.

Summary reports of the findings from these studies will be released in Fall 2021.



---

# Chronic Wasting Disease Targeted Outreach to Engage Culturally Diverse Hunting Communities

<b>Investigator:</b>	David C. Fulton and Tiffany Wolf (Cooperating Faculty, University of Minnesota Veterinary Population Medicine)
<b>Student:</b>	Roger Faust, Ph.D. (Conservation Sciences)
<b>Duration:</b>	July 2020 to June 2022
<b>Funding Source:</b>	Environmental Trust Fund as recommended by the Legislative-Citizen Committee on Minnesota Resources
<b>Project Location:</b>	University of Minnesota Veterinary Population Medicine & Minnesota Cooperative Fish and Wildlife Research Unit

Chronic wasting disease (CWD) is a 100% fatal, contagious neurological disease of wild and farmed cervids, such as deer (*Odocoileus* spp.), moose (*Alces alces*), elk (*Cervus canadensis*), and other deer species. It is caused by a prion, which is an infectious, misfolded version of a normal protein that is found in all mammals. Since first discovery in Colorado in 1960, CWD has spread to 26 states, including Minnesota. In heavily affected areas like Wyoming, Colorado, and Wisconsin, more than 40% of free-ranging cervids are infected; and managers and researchers have documented CWD-associated population declines in several cervid species, including white-tailed deer (*Odocoileus virginianus*). Although transmission to humans has never been confirmed, the risks for human infection remain unclear. Thus, the best approach available to protecting wildlife and human health is controlling further spread. The success of Minnesota's efforts to control this disease hinges on the ability of government agencies, researchers, policy makers, and stakeholders to work together, particularly as this issue relates to deer hunting as a CWD management tool. However, in December

2019, our team became aware that culturally-diverse hunting communities had not received critical information regarding CWD biology, management, and potential human health risks. Special outreach efforts are needed to reach diverse stakeholders, such as our Minnesota Tribal Nations and southeast Asian and Amish communities. Additionally, the Grand Portage Band of Lake Superior Chippewa and our team have secured funding from the U.S. Fish and Wildlife Service to support the creation of a Tribal CWD Surveillance Network. A critical, yet unfunded need is simultaneous community engagement on Tribal Lands leading up to and during CWD surveillance in the 2020 hunting season. Our team has connected with these groups through grassroots efforts and is uniquely poised to engage them on CWD. Our goals for this project are to 1) engage in culturally-appropriate CWD outreach and education, and 2) learn more about community-specific hunting behavior and perceptions of CWD management, with an overall goal of achieving more inclusive, community-based CWD management.

---

# Understanding Perceptions of Risk from Chronic Wasting Disease for Tribal Communities in the Midwest

**Investigator:** David C. Fulton  
**Student:** Roger Faust, Ph.D. (Conservation Sciences)  
**Duration:** September 2020 to December 2022  
**Funding Source:** U.S. Fish & Wildlife Service  
**Project Location:** Minnesota Cooperative Fish and Wildlife Research Unit

Chronic wasting disease (CWD) is an always fatal, prion-related spongiform encephalopathy that is transmissible among wild cervids in North America including deer (*Odocoileus* spp.) elk (*Cervus canadensis*) and moose (*Alces alces*) and farmed deer and elk. During the past 10 years, the disease has been spreading across state boundaries and the affected areas are likely to continue to expand. Whereas the overall infection rate in free-ranging deer and elk is low, rates of infection can exceed 10% once established in an area, with higher localized infection rates (25%) in free-ranging animals and very high infection rates (>70%) in some captive herds. (<https://www.cdc.gov/prions/cwd/index.html>).

As CWD continues to spread, concern has increased about the impact of CWD to wild cervids and other wildlife. Recreational hunting and subsistence harvest of cervids is important culturally and economically across most U.S. states with a nearly \$40 billion annual nationwide economic contribution. In response to this threat, there has been broad response from state wildlife management agencies. In addition to affecting recreational hunting on public and private lands, however, increased impacts to ungulate populations could also impact tribes and tribal communities using resources on reservation and ceded territory lands and other lands important to tribal members. Venison is not only a valuable food source to many tribal hunters, it is culturally important to many tribal communities. For this reason, the disease poses both a

risk to food security for many tribal households and a threat to tribal cultural practices if deer and elk populations decline in areas impacted by CWD. In addition, according to the Center for Disease Control and Prevention, the transmission of CWD to humans who consume infected venison (<https://www.cdc.gov/prions/cwd/transmission.html>) cannot be ruled out (Belay et al. 2004; Kong et al. 2005; Czub et al. 2017), and the threat of that possibility could have dramatic negative consequences for the North American Model of Wildlife Management in general. As CWD continues to spread it could lead to decreases in deer and elk hunting on tribally important lands, either through a decline in opportunity or through hunter perceptions of risk from CWD.

The U.S. Fish and Wildlife Service (USFWS) plays a critical role in providing help and support to federally recognized Tribes as they exercise their sovereignty in the management of their wildlife resources on Federal Indian trust land and in treaty reserved lands (<https://www.fws.gov/nativeamerican/index.html>). For this reason, the USFWS has a fundamental stake in addressing CWD on lands significant to the Tribes. National and state experts in public health, wildlife diseases, prion research, and laboratory diagnosis are urgently calling for broad interdisciplinary research to help forge a national strategy to limit the risk of CWD impacts. However, these efforts are primarily focused on state agency response to CWD and not tribal management or impacts.

The proposed research would contribute to national efforts by helping to ensure tribal perspectives and concerns and indigenous knowledge are considered in broader efforts to manage CWD. This exploratory research effort would use interviews and workshops with tribal leaders, wildlife biologists, and managers to identify and prioritize key concerns and actions that need to be addressed to manage CWD on lands important to the Tribes in USFWSA Region 3 (<https://www.fws.gov/midwest/Tribal/tribes.html>). The scope of this study includes: 1) completing a systematic review to determine the state-of-knowledge concerning management activities and human dimensions research related to CWD and the use of Indigenous knowledge for wildlife management; and 2) identifying and prioritizing the key concerns and perspectives of tribes related to CWD in Region 3 USFWS. The outcomes of this study will be used to provide direction for future human dimensions research and management action on CWD relevant to tribal communities.

The objectives of the project are to better understand key concerns and perspectives of tribes in Region 3 USFWS related to CWD management and CWD's potential to impact hunting participation and the food security of tribal members for whom deer and elk are managed for hunting. Addressing CWD and its impacts will be a long-term, nationwide effort. This proposal will serve as a primary step to building essential knowledge about the potential for CWDs to impact the North American Model of Wildlife Management and for addressing CWD on tribal lands. We will use culturally appropriate ethnographic approaches to conduct indepth interviews and nominal group research to better understand tribal perspectives and indigenous knowledge concerning the risks of CWD to hunting opportunities, food security, and cultural practices (Emery et al. 2014, Dockry et al. 2016, Daigle et al. 2019). Such systematic information concerning the perceived threat of CWD will be extremely useful

to the tribes and wildlife management agencies in planning and prioritizing future research and management activities to address CWD and its impacts. Specifically, we will:

1. Complete a systematic review of research and activities addressing the human dimensions of CWD to develop a state-of-the-knowledge summary of the topic;
2. Complete interviews and nominal groups workshops with tribal leadership and members across U.S. Fish and Wildlife Service Region 3 affected or potentially affected by CWD;
3. Identify participants' perceived risks of CWD to hunting, food security, and cultural practices;
4. Identify the Tribes' indigenous knowledge and participants' personal beliefs about research and management activities to address the perceived risks of CWD to hunting, food security, and cultural practices;
5. Identify participants' prioritization for research and management activities to address the perceived risks of CWD to hunting, food security, and cultural practices;
6. Use the study results to help information management plans and programs at the federal, state, and tribal levels design to address the threat of CWD to hunting and food security.

The proposed project is the first step in assessing the key threats posed by CWD for hunting participation, cultural practices, and food security for Tribes in the Midwest. A better understanding of these threats and management actions to address such threats could help in the design of the federal, state, and tribal programs that are resilient to such threats. Results of the group workshops will provide useful information about CWD threats and potential management actions and will be crucial to designing long-term management programs and research efforts.





# Activities









---

# Publications

## Peer-Reviewed

### 2019

Adkins, K., C.L. Roy, **D.E. Andersen**, and R.G. Wright. 2019. Landscape-scale greater prairie-chicken—habitat relations and the Conservation Reserve Program. *Journal of Wildlife Management* 83:1415–1426. DOI:10.1002/jwmg.21724.

Bergh, S.M. and **D.E. Andersen**. 2019. Detection probability and occupancy of American woodcock during Singing-ground Surveys. Pages 200–208 in Krementz, D.G., D. E. Andersen, and T.R. Cooper (eds.). Proceedings of the Eleventh American Woodcock Symposium, University of Minnesota Libraries Publishing, Minneapolis, Minnesota, U.S.A. DOI:10.24926/AWS.0126.

Bergh, S. M. and **D. E. Andersen**. 2019. Estimating density and effective area surveyed for American woodcock. Pages 193–199 in Krementz, D.G., D. E. Andersen, and T.R. Cooper (eds.). Proceedings of the Eleventh American Woodcock Symposium, University of Minnesota Libraries Publishing, Minneapolis, Minnesota, U.S.A. DOI:10.24926/AWS.0125.

Daly, K.O., **D.E. Andersen**, W.L. Brininger, and T.R. Cooper. 2019. Breeding season survival of American woodcock at a Habitat Demonstration Area in Minnesota. Pages 45–63 in Krementz, D.G., D. E. Andersen, and T.R. Cooper (eds.). Proceedings of the Eleventh American Woodcock Symposium, University of Minnesota Libraries Publishing, Minneapolis, Minnesota, U.S.A. DOI:10.24926/AWS.0108.

Daly, K.O., **D.E. Andersen**, W.L. Brininger, and T.R. Cooper. 2019. Evaluating techniques for estimating post-breeding-season age ratios for American woodcock. Pages 35–44 in Krementz, D.G., D. E. Andersen, and T.R. Cooper (eds.). Proceedings of the 11th American Woodcock Symposium, University of Minnesota Libraries Publishing, Minneapolis, Minnesota, U.S.A. DOI:10.24926/AWS.0107.

Kramer, G.R., K.O. Daly, H.M. Streby, and **D.E. Andersen**. 2019. Association between American woodcock seasonal productivity and landscape composition and configuration in Minnesota. Pages 107–121 in Krementz, D.G., D. E. Andersen, and T.R. Cooper (eds.). Proceedings of the Eleventh American Woodcock Symposium, University of Minnesota Libraries Publishing, Minneapolis, Minnesota, U.S.A. DOI:10.24926/AWS.0115.

Kramer, G.R., S.M. Peterson, K.O. Daly, H.M. Streby, and **D.E. Andersen**. 2019. Left out in the rain: comparing productivity of two associated species exposes a leak in the umbrella species concept. *Biological Conservation* 233:276–288. DOI:10.1016/j.biocon.2019.02.039.

Krementz, D.G., **D.E. Andersen**, and T.R. Cooper (eds.). 2019. Proceedings of the Eleventh American Woodcock Symposium. University of Minnesota Libraries Publishing, Minneapolis, Minnesota, U.S.A. ISBN no. 978-1-946135-60-5. eISBN no. 978-1-946135-59-9.

Moore, J., **D.E. Andersen**, T.R. Cooper, J. Duguay, S. Oldenburger, C.A. Stewart, and D.G. Krementz. 2019. Migratory connectivity of American woodcock derived using satellite telemetry. *Journal of Wildlife Management* 83:1617–1627. DOI:10.1002/jwmg.21741.

Moore, J. D., T. R. Cooper, R. Rau, **D. E. Andersen**, J. P. Duguay, C. A. Stewart, and D. G. Krementz. 2019. Assessment of the American Woodcock Singing-Ground Survey zone timing and coverage. Pages 181–192 in Krementz, D.G., D.E. Andersen, and T.R. Cooper (eds.). Proceedings of the Eleventh American Woodcock Symposium, University of Minnesota Libraries Publishing, Minneapolis, Minnesota, U.S.A. DOI:10.24926/AWS.0124.

Schroeder, S., L. Cornicelli, **D.C. Fulton** and Steven S. Merchant. 2019. The influence of motivation versus experience on recreation satisfaction: How appreciative-versus achievement-oriented recreation experience preferences relate to hunter satisfaction. *Journal of Leisure Research* 50: 107–131. DOI: 10.1080/00222216.2018.1557502.

Schroeder, S.A., **D.C. Fulton**, L.J. Cornicelli, S.D. Cordts, and J.S. Lawrence. 2019. Clarifying how hunt-specific experiences affect satisfaction among more avid and less avid waterfowl hunters. *Wildlife Society Bulletin* 43:455–467. DOI:10.1002/wsb.1006.

Tingley, R. W., J.F. Hansen, D.A. Isermann, **D.C. Fulton**, A. Musch and C.P. Paukert. 2019. Characterizing angler preferences for largemouth bass, bluegill, and walleye fisheries in Wisconsin. *North American Journal of Fisheries Management* 39:676–692. DOI:10.1002/nafm.10301.

Wilkins, E.J., N.W. Cole, H.M. Miller, R.M. Schuster, A.A. Dayer, J.N. Duberstein, **D C. Fulton**, H.W. Harshaw and A.H. Raedeke. 2019. Rural-urban differences in hunting and birdwatching attitudes and participation intent. *Human Dimensions of Wildlife* 24:530–547. DOI:10.1080/10871209.2019.

Wolfson, D.W., J.R. Fieberg, and **D.E. Andersen**. 2019. Juvenile sandhill cranes exhibit wider ranging and more exploratory movements than adults during the breeding season. *Ibis* 162:556–562. DOI:10.1111/ibi.12786.

## 2020

Adkins, K., D.L. Roy, **D.E. Andersen**, and R.G. Wright. 2020. Simulating strategic implementation of the CRP to increase greater prairie-chicken abundance. *Journal of Wildlife Management* 85:27–40. DOI:10.1002/jwmg.21960.



Gigliotti, L.M., L.A. Sweikert, L. Cornicelli, and **D.C. Fulton**. 2020. Minnesota landowners' trust in their department of natural resources, salient values similarity, and wildlife value orientations. *Environment Systems and Decisions* 40:577–587. DOI:10.1007/s10669-020-09766-z.

Harshaw, H.W., N.W. Cole, A.A. Dayer, J.D. Rutter, **D.C. Fulton**, A.H. Raedeke, R.M. Schuster, and J.N. Duberstein. Published online November 11, 2020. Testing a continuous measure of recreation specialization among birdwatchers. *Human Dimensions of Wildlife* 27:1-9. DOI:10.1080/10871209.2020.1843741.

Kramer, G.R., R.K. Pagel, K. Maley, C. Ziegler, S.M. Peterson, **D.E. Andersen**, D.A. Buehler, and H.M. Streby. 2020. Say what? Bivalent singing in *Vermivora* warblers. *Ecology* 101:e02881. DOI:10.1002/ecy.2881.

Kramer, G.R., R.K. Pagel, K. Maley, C. Ziegler, S.M. Peterson, **D.E. Andersen**, D.A. Buehler, and H.M. Streby. 2020. Say what? Bivalent singing in *Vermivora* warblers. *Bulletin of the Ecological Society of America* 101:e01627. DOI:10.1002/bes2.1627.

Landon, A. C., **D.C. Fulton**, A. Pradhananga, L. Cornicelli, and M. Davenport. 2020. Community attachment and stewardship identity influence responsibility to manage wildlife. *Society & Natural Resources*. 34:571–584. DOI:10.1080/08941920.2020.1852636.

Manfredo, M.J., T.L. Teel, A.W. Don Carlos, L. Sullivan, A.D. Bright, A.M. Dietsch, J. Bruskotter, and **D.C. Fulton**. 2020. The changing sociocultural context of wildlife conservation. *Conservation Biology* 34:1549–1559. DOI:10.1111/cobi.13493.

Pagel, R.K., **E.H. West**, A.W. Jones, and H.M. Streby. 2020. Variation in individual autumn migration and winter paths of Great Lakes red-headed woodpeckers (*Melanerpes erythrocephalus*). *Animal Migration* 7: 9–18. DOI:10.1515/ami-2020-0002.

Schroeder, S., L. Cornicelli, **D.C. Fulton**, A. Landon, L. McInenly, and S. Cordts. 2020. Explaining support for mandatory versus voluntary conservation actions among waterfowlers. *Human Dimensions of Wildlife* 26: 337-355. DOI: 10.1080/10871209.2020.1830205.

Schroeder, S.A., **D.C. Fulton**, L. Cornicelli, and L. McInenly. 2020. Recreation conflict, coping, and satisfaction: Minnesota grouse hunters' conflicts and coping response related to all-terrain vehicle users, hikers, and other hunters. *Journal of Outdoor Recreation and Tourism* 30:100282. DOI:10.1016/j.jort.2020.100282.

Schroeder, S.A., A. Landon, L. Cornicelli, **D.C. Fulton**, and L. McInenly. 2020. Institutional trust, beliefs and evaluation of regulations, and management of chronic wasting disease (CWD). *Human Dimensions of Wildlife* 26:228–244. DOI:10.1080/10871209.2020.1808915.

Smith, K., S.A. Schroeder, A.C. Landon, L.J. Cornicelli, **D.C. Fulton**, and L.E. McInenly. 2020. A replication of proximity to chronic wasting disease, perceived risk, and social trust in managing between hunters in Minnesota and Illinois. *Human Dimensions of Wildlife* (Published online 12/5/2020 no volume or page numbers yet assigned). DOI:10.1080/10871209.2020.1860270.

Toews, D.P.L., G.R. Kramer, A.W. Jones, C.L. Brennan, B.E. Cloud, **D.E. Andersen**, I.J. Lovette, and H. Streby. 2020. Genomic identification of intergeneric hybrids in New World wood-warblers (Aves: Parulidae). *Biological Journal of the Linnean Society* 131:183–191. DOI:10.1093/biolinnean/blaa085.

## In Press, Review, or Revision

Danehy, R.J., K. Nislow, C.A. Dolloff, **Vondracek, B.**, R.M. Newman, C. Blinn, R. Mackereth, M. Young, J. Walter, D. Martin, and M. Wilzbach. *In Review*. Regional specific interactions of forests and fish: Great Lakes Region. Reflections on forest management, can fish and fiber coexist? R. Danehy and A. Dolloff, Editors. American Fisheries Society, Bethesda, Maryland, U.S.A.

Goebel, K.M., N.M. Davros, **D.E. Andersen**, and P.J. Rice. *Submitted*. Grassland wildlife exposure to insecticide spray drift on public lands in Minnesota's farmland landscape. *Science of the Total Environment*.

Landon, A. **D.C. Fulton**, S.A. Schroeder et al. *In Review*. Chronic wasting disease, the elephant in the room for U.S. wildlife conservation. *Conservation Letters*.

Landon, A.C., S.A. Schroeder, **D.C. Fulton**, L.J. Cornicelli, and L. McInenly. *In Review*. Hunters' adaption to changing social-ecological conditions in a chronic wasting disease management zone. *Human Dimensions of Wildlife*.

Landon, A. C., S.A. Schroeder, **D.C. Fulton**, L. Cornicelli, L. McInenly, and K. Smith. *In Review*. The influence of CWD management on deer hunters' satisfaction. *Human Dimensions of Wildlife*.

LaSharr, K., J.H. Giudice, L.J. Cornicelli, and **D.C. Fulton**. Visitor use on dispersed, state-owned land in Minnesota. *Wildlife Society Bulletin*.

Lasharr, K., **D.C. Fulton**, and L.J. Cornicelli. *In Review*. Experience preferences and place attachment of Minnesota Wildlife Management Area users. *Human Dimensions of Wildlife*.

McCann, N.P., E.M. Walberg, J.D. Forester, M.W. Schrage, **D.C. Fulton**, and M.A. Ditmer. *In Review*. Integrating socio-ecological suitability with human-wildlife conflict risk: case study for translocation of a large ungulate. *Journal of Applied Ecology*.

McInenly, L.E., **D.C. Fulton**, and L. Cornicelli. *In Review*. Beyond the status quo: choice experiments and preference simulation to inform deer season regulations. *Journal of Wildlife Management*.

Moore, J.D., **D.E. Andersen**, T. Cooper, J.P. Duguay, S.L. Oldenburger, C.A. Stewart, and D.G. Krementz. *In Press*. Migratory phenology and patterns of American woodcock in central North America derived using satellite telemetry. *Wildlife Biology* 2021:wlb.00816.

Peterson, S.M., H.M. Streby, G.R. Kramer, and **D.E. Andersen**. *In Revision*. Ecology of brood division in golden-winged warblers. *Ibis*.

Rutter, J.D., A.A., Dayer, H.W. Harshaw, N.W. Cole, J.N. Duberstein, **D.C. Fulton**, A.H. Raedeke, and R.M. Schuster. *In Review*. Racial, ethnic, and social patterns in the recreation specialization of birdwatchers: an analysis of United States eBird registrants. *Journal of Outdoor Recreation and Tourism*.

Schroeder, S.A., **D.C. Fulton**, L.J. Cornicelli, L. McInenly. *In Revision*. How beliefs about regulations, institutional trust, and personal motivations predict attitudes about hunting regulations. *Human Dimensions of Wildlife*.

Schroeder, S.A., **D.C. Fulton**, L. Cornicelli, L. McInenly. *In Review*. Recreation conflict, coping, and satisfaction: interference and coping response among Minnesota grouse hunters. *Leisure Science*.

Schroeder, S.A., A.C. Landon, L.J. Cornicelli, **D.C. Fulton** and L.E. McInenly. *In Press*. Cognitive and behavioral coping in response to wildlife disease: the case of hunters and chronic wasting disease. *Human Dimensions of Wildlife*. DOI: 10.1080/10871209.2021.1919340.

Schroeder, S.A., A.C. Landon, **D.C. Fulton**, L. McInenly. *In Review*. Social identity, values, and trust in government: how stakeholder group, ideology, and wildlife value orientations relate to trust in a state agency for wildlife management. *Biological Conservation*.

Wilkins, E., N. Cole, H. Miller, R. Schuster, A. Dayer, J. Duberstein, **D.C. Fulton**, H. Harshaw, A. Raedeke. *In Revision*. Perceived constraints to participating in wildlife-based recreation. *Wildlife Society Bulletin*.

## Awards and Honors

2019. Cooperative Research Units Program “Excellence in Service Award” (David E. Andersen)

2019. Edited Book Award (short list), The Wildlife Society (David E. Andersen)

2019. Performance Award, U.S. Geological Survey (David E. Andersen)

2019. Professional Award of Merit, North Central Section of The Wildlife Society (David E. Andersen)

2020. Edited Book Award Short List, The Wildlife Society (David G. Krementz, David E. Andersen, and Thomas R. Cooper)

2020. Journal Paper Award (short list), The Wildlife Society (David E. Andersen)

2020. Performance Award, U.S. Geological Survey (David E. Andersen)





# Completed Theses and Dissertations

## 2019

Salcido, E.L. 2019. Private landownership and Walk-In Access program enrollment: motivating factors of landowner attitudes and participatory decision-making. M.S. Thesis, University of Minnesota, St. Paul, Minnesota, U.S.A. 90pp. (Fulton)

### *Landowners' motivations for participation in Minnesota's Walk-In Access program*

Hunter recruitment and retention could be improved by securing public hunting access to private properties, especially for members of the public without means to purchase hunting lands of their own. However, private landowner participation in such "walk-in access" (WIA) programs tends to be limited. To persuade landowners to open their lands and resources to the public, it is first necessary to gain a deeper understanding of what internal factors will most effectively impact their intent to do so. We conducted a self-administered mail-back questionnaire of private landowners in Minnesota with properties eligible for or enrolled in the state's WIA program, and gathered data was assessed through the development of two linear regression models. The first model was based upon Ajzen's Theory of Planned Behavior (TPB), regressing landowners' behavioral intentions towards WIA on their WIA-related attitudes, subjective norms, and perceived behavioral control. The second model incorporated factors demonstrated by previous research to be integral to landowners' conservation decision-making, regressing landowners' WIA-related attitudes on their land ethic agreement, sense of personal responsibility, and prioritization of financial gain, community opinions, and non-human impacts. Our first model found low impact of perceived behavioral control on behavioral intentions, a deviation from previous TPB research. Of the factors included in our second model, only agreement with a land ethic contributed significantly to landowners' WIA-related attitudes. Future studies may consider modifications to and further measurement of subjects' land ethic to further measure its validity as a motivator of attitudes.

### *The influence of place attachment and trust on landowners' attitudes towards Minnesota's Walk-In Access Program*

Government-backed initiatives such as Minnesota's Walk-In Access (WIA) Program rely on the willingness of landowners to relinquish partial control over lands that are often invested with emotional or utilitarian significance. We conducted a self-administered mail-back questionnaire to measure place identity, place dependency, and trust levels among private landowners in Minnesota with properties eligible for or enrolled in the state's WIA program. Hierarchical regression was used to analyze three linear models: Our first model regressed landowners' WIA-related attitudes on their personal place identity and place dependency;

our second model included willingness to trust others as a third variable; and our final model added willingness to engage with others as a fourth variable. Place dependency, willingness to trust, and willingness to engage were significant predictors of landowners' attitudes in all three models, but place identity was not found to be a significant attitudinal predictor in any model. In both models where it was included as a variable, willingness to trust was the most powerful predictor of landowner attitudes. Future studies may consider including trust measurement questions in their data-gathering instruments and contributing further analysis to corroborate whether willingness to trust is truly a powerful, reliable predictor of attitudes.

## Coop Unit Student Awards and Grants

### AWARDS

Katelin Goebel, 2020. Best Student Presentation, Minnesota Chapter of The Wildlife Society.

### FUNDED GRANT APPLICATIONS

David Wolfson, Wally Dayton Fellowship in Wildlife Research (\$2,000)

David Wolfson, Minnesota Chapter of The Wildlife Society research grant (\$500)

David Wolfson, CFANS (College of Food, Agricultural and Natural Resources Sciences, University of Minnesota) Graduate Student Board Research Fellowship (\$1,000)





# Presentations

## Invited Presentations

### 2019

**Fulton, D.C.** H.W. Harshaw, N. Cole, A. Raedeke, and R. Schuster. 2019. Understanding trip preferences of birdwatchers and waterfowl hunters. Pathways: Human Dimensions of Wildlife Conference. Estes Park, Colorado, U.S.A.

**Fulton, D.C.**, M.J. Manfredo, and T.L. Teel 2019. America's shifting wildlife values, attitudes, and wildlife management in the U.S. North American Duck Symposium. Winnipeg, Manitoba, Canada. (Invited presentation in opening plenary session)

Harshaw, H., **D.C. Fulton**, A. Dayer, A. Raedeke, and J. Duberstein. 2019. North American waterfowl hunters' and birdwatchers' involvement in conservation. Pathways: Human Dimensions of Wildlife Conference. Estes Park, Colorado, U.S.A.

Landon, A., L. Cornicelli, **D.C. Fulton**, L. McInenly, and S. Schroeder. 2019. Assessing landowner preferences for CWD management in southeast Minnesota: a discrete choice experiment. Pathways: Human Dimensions of Wildlife Conference. Estes Park, Colorado, U.S.A.

Raedeke, A., **D.C. Fulton**, H. Harshaw, R.M. Schuster, J. Duberstein. 2019. Adaptively applying human dimensions at multiple scales. Pathways: Human Dimensions of Wildlife Conference. Estes Park, Colorado, U.S.A.

Rutter, J., A. Dayer, H. Harshaw, J. Duberstein, and **D.C. Fulton**. 2019. Ethno-racial and social predictors of birdwatcher specialization. Pathways: Human Dimensions of Wildlife Conference. Estes Park, Colorado, U.S.A.

Schroeder, S., L. Cornicelli, **D.C. Fulton**, A. Landon, and L. McInenly. 2019. Factors influencing acceptance of CWD management in Minnesota. Pathways: Human Dimensions of Wildlife Conference. Estes Park, Colorado, U.S.A.

Smith, E., H. Harshaw, **D.C. Fulton**, A. Raedeke, R.M. Schuster. 2019. The few but satisfied: Alberta water-



fowl hunter satisfaction. Pathways: Human Dimensions of Wildlife Conference. Estes Park, Colorado, U.S.A.

Wolfson, D. W., T. Cooper, S. Cordts, J. Fieberg, C. Henderson, C. Herwig, J. Moriarty, M. Smith, and **D. E. Andersen**. 2019. Interior Population trumpeter swan migration ecology and conservation. 25<sup>th</sup> Trumpeter Swan Society Conference. Alton, Illinois, U.S.A.

## Contributed Presentations

### 2019

**Fulton, D.C.**, E.M. Walberg, M.W. Schrage, J.D. Forester, and N. McCann. 2019. Restoring elk to northeast Minnesota: landowner and general public attitudes. Western Association of Fish and Wildlife Agencies, Deer and Elk Workshop, Marfa, Texas, U.S.A.

Goebel, K., N. Davros, **D.E. Andersen**, and P. Rice. 2019. Grassland wildlife exposure to insecticides on public land in Minnesota. Natural Resources Association of Graduate Students Symposium. St. Paul, Minnesota, U.S.A.

Goebel, K., N. Davros, **D.E. Andersen**, and P. Rice. 2019. Grassland wildlife exposure to insecticides on public land in Minnesota. 2019 Annual Meeting of the Minnesota Chapter of The Wildlife Society. Duluth, Minnesota, U.S.A.

McCann, N., J. Forester, M. Schrage, **D.C. Fulton**, and E. Walberg. 2019. Integrating forage estimates and public opinion into elk habitat suitability index maps. Western Association of Fish and Wildlife Agencies, Deer and Elk Workshop, Marfa, Texas, U.S.A.

McInenly, L. **D.C. Fulton**, L. Cornicelli. 2019. Trophy hunting and other motivations in regulatory design. Pathways: Human Dimensions of Wildlife Conference. Estes Park, Colorado, U.S.A.

Salcido, E. and **D.C. Fulton**. 2019. Place attachment and trust as predictors of landowner attitudes. Pathways: Human Dimensions of Wildlife Conference. Estes Park, Colorado, U.S.A.

Slagle, K. A. Dietsch, **D.C. Fulton**, R. Wilson, and J. Bruskotter. 2019. Social identity and trust in wildlife conservation. Pathways: Human Dimensions of Wildlife Conference. Estes Park, Colorado, U.S.A.

Wolfson, D., J. Fieberg, and **D.E. Andersen**. 2019. Juvenile sandhill cranes exhibit wider ranging and more exploratory movements than adults during the breeding season. Joint Annual Conference of the American Fisheries Society and The Wildlife Society. Reno, Nevada, U.S.A.

### 2020

Goebel, K.M., N.M. Davros, **D.E. Andersen**, and P.J. Rice. 2020. Impacts of insecticide spray drift on insect prey resources of birds in public grasslands in Minnesota. 2020 Annual Meeting of the Minnesota Chapter of The Wildlife Society, Willmar, Minnesota, U.S.A.

Goebel, K.M., N.M. Davros, **D.E. Andersen**, and P.J. Rice. 2020. Insecticide drift and impacts on insect prey resources of birds on public grasslands in Minnesota. Midwest Fish and Wildlife Conference, Springfield, Illinois, U.S.A.

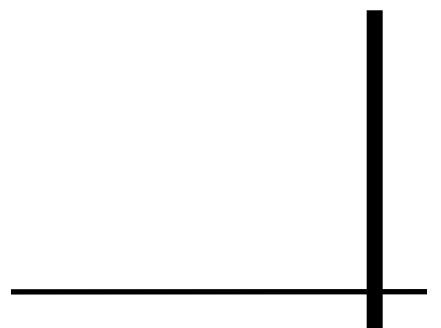
Kramer, G.R., **D.E. Andersen**, D.A. Buehler, P.B. Wood, S.M. Peterson, J.A. Lehman, K.R. Aldinger, L.P. Bullock, S. Harding, J.A. Jones, J.P. Loegering, C. Smalling, R. Vallender, and H.M. Streby. 2020. Limited evidence that variation in space use and exposure to potential risk factors during migration are associated with variation in *Vermivora* warbler population trends. North American Ornithological Conference. *Virtual meeting*.

Schrage, M., **D.C. Fulton**, E. Walberg, J. Forester, N. McCann. 2020. Restoring elk to northeast Minnesota: landowner and general public attitudes. Annual Meeting of the Minnesota Chapter of the Society of American Foresters, Nisswa, Minnesota, U.S.A.

Wolfson, D., **D.E. Andersen**, T. Cooper, S. Cordts, J. Fieberg, C. Henderson, C. Herwig, J. Moriarty, M. Smith, D.M. Arsnøe, B.A. Avers, A.G. Duffiney, R.T. Knapik, and D.R. Luukkonen. 2020. Interior Population trumpeter swan migration ecology and conservation. Midwest Fish and Wildlife Conference, Springfield, Illinois, U.S.A.

Wolfson, D., R. Knapik, J. Fieberg, T. Cooper, and **D.E. Andersen**. 2020. Interior Population trumpeter swans: where are they going next? 2020 Annual Meeting of the Minnesota Chapter of The Wildlife Society, Willmar, Minnesota, U.S.A.

Wolfson, D., R. Knapik, J. Fieberg, and **D.E. Andersen**. 2020. Interior Population trumpeter swan migration ecology and conservation. Annual Conference of The Wildlife Society. *Virtual meeting*.



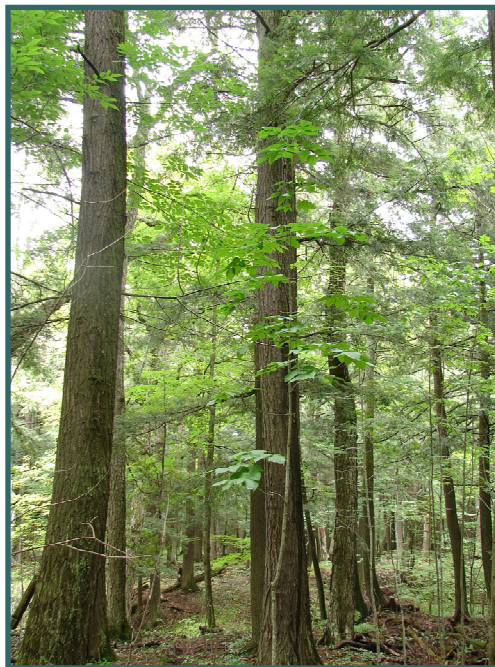


---

# Unit News

During the last two years (2019–2020), the Minnesota Cooperative Fish and Wildlife Research Unit operated at reduced capacity, in that we were unable to fill the vacancy left when Dr. Bruce Vondracek (Assistant Leader – Fisheries) retired in May 2015. Increasing Cooperative Research Units (CRU) Program funding has been a priority of the National Cooperators Coalition, the Wildlife Management Institute, and other CRU supporters for some time, as flat budgets and other constraints had resulted in a substantive reduction in CRU capacity (e.g., there were almost 40 CRU scientist vacancies in Fiscal Year 2019). In 2019, with critical support from the University of Minnesota, CRU received a substantial increase in federal funding that allowed filling all vacancies and upgrading and acquisition of federal property (e.g., vehicles, boats, etc.). Following that increase in funding for CRU beginning in Fiscal Year 2020, we finally received authorization to fill our vacancy. The Minnesota Coop Unit, after carrying a vacancy for almost 6 years, was able to fill the position of Assistant Leader – Fisheries. Dr. Lynn Waterhouse was selected for and accepted that position, and will start as the second Assistant Leader – Fisheries at the Minnesota Coop Unit in June 2021. Dr. Waterhouse has strong quantitative skills and experience working with fish stocks in both marine and freshwater systems, and is poised to build a strong research program in quantitative fisheries in collabora-

tion with the Minnesota Department of Natural Resources. We thank the search committee (John Fieberg, Gretchen Hansen, Ted Treska, Patrick Schmalz, David Fulton, Margaret McEachran, Hattie Saloka, and David Andersen) for all of their efforts to help fill this position.



Over the last several years, the Minnesota Coop Unit has continued to advance our mission of research, teaching, and technical assistance, although as has been the case for a while, we have operated in a setting of increased costs and reduced support. Prior to an increase in our federal budget in Fiscal Year 2020, the Minnesota Coop Unit had relied heavily on our base contributions from the Minnesota Department of Natural Resources to support day-to-day operations. That changed in Fiscal Year 2020, with the availability of federal funds, which allowed us to acquire federal equipment and have access to federal funds to support general operations. At the same time, the University of Minnesota reduced space allocated to the Minnesota Coop Unit and requested that our Cooperative Agreement be renegotiated such that indirect cost recovery (ICR) that formerly was retained by the Minnesota Coop Unit will, in the future, be wholly retained by the University of Minnesota. That change, which will become effective in 2021, effectively removed our ability to generate funds to offset University costs (e.g., fees imposed

by Fleet Services, unanticipated research project costs, and unfunded University mandates, such as those associated with an early retirement incentive in 2020). We have used those funds to support graduate students, pay page charges, cover travel expenses to professional meetings, and leverage other funding to support research—in the long run, it's not clear how those funds will be replaced. As federal research scientists and members of an academic department, we also struggle with maintaining a seamless partnership that has historically served our cooperators and partners well. Beginning in the early 2000s, the University of Minnesota; the College of Food, Agricultural and Natural Resources Sciences; and the Department of Fisheries, Wildlife, and Conservation Biology have incrementally changed our relationship with our host university. For example, Coop Unit scientists have been largely excluded from discussions about academic promotion, limited in our ability to serve in leadership roles in graduate programs, and reduction in staff support has been threatened on several occasions. We continue to work to keep those relationships strong, but we are concerned that over time, the faculty role of Coop Unit scientists seems to have been diminished through incremental reduction in rights and privileges afforded Coop Unit scientists and codified in our Cooperative Agreement. In spite of those challenges, and with the continued support of our cooperators, both David Fulton (Assistant Leader- Wildlife) and David Andersen (Leader) continue to have active research programs that address priority research needs and support M.S. and Ph.D. graduate students and postdoctoral research associates.

In addition, of course, the influence of Covid-19 on the Minnesota Coop Unit has been substantive. Both the U.S. Geological Survey and the University of Minnesota took unprecedented steps to minimize risk associated with the pandemic. In March 2020, the University of Minnesota entered reduced operations status, mandating working remotely, including converting instruction to remote-learning platforms. At the same time, the U.S. Geological Survey entered “maximum telework” status and essentially prohibited almost all travel and required

working from home. Those conditions remained largely in place through the end of 2020 and into 2021. We are all grateful that we could continue working, but obviously these conditions posed significant impediments to conducting research, interacting with graduate students, and day-to-day operation of the Minnesota Coop Unit. On the University of Minnesota side, higher levels of administration, especially at the collegiate level, developed protocols and procedures that allowed us to continue most aspects of our research program, albeit with sometimes-onerous-but-necessary safety procedures. Working under those protocols and procedures, we were able to continue most of our research efforts, including all those involving graduate students and postdoctoral research associates. In many cases, that required safety protocols that increased project costs (e.g., single-occupancy vehicle requirements that increased the number of vehicles required to conduct field work)—costs that we covered with discretionary funds, including funds accumulated through return of ICR to the Minnesota Coop Unit.

We completed a number of research projects during 2019–2020, and initiated several new projects. As you can see in this report, our students continue to present their research results at professional conferences (although recently, primarily remotely) and in the peer-reviewed literature at an impressive rate. During the last two-year period, we are also happy to report that we have continued to have a strong relationship and work collaboratively with the Minnesota Department of Natural Resources and our federal partners, even amidst the ongoing pandemic.

There are some other challenges, both ongoing and in the future for the Minnesota Coop Unit. On the federal side, any change in administration always results in some confusion as priorities and funding allocation changes. We are guardedly optimistic that the current administration will continue to support CRU and increase funding allocated to natural resources research, and that we won't face future government shutdowns (as happened in early 2019) anytime soon. On the state side, budgets in both

fisheries and wildlife have shrunk, and the Minnesota Department of Natural Resources is facing financial challenges in the absence of increases in revenue, which makes research collaboration more challenging. However, the Minnesota Department of Natural Resources has ongoing need of expertise in stock assessment and other fisheries issues, and we foresee building back a strong relationship with the Minnesota Department of Natural Resources in fisheries with the addition of Dr. Waterhouse as Assistant Leader – Fisheries beginning in 2021. Finally, the University of Minnesota, like many institutions of higher education, faces ongoing financial challenges, compounded by the Covid-19 pandemic, that affect availability of resources to support departmental and graduate program operations. Over the more than 30 years the Minnesota Coop Unit has been in existence, the last 10 or more years have seen constant downward pressure of department budgets, which influences institutional support for our program. Within the University system, the Minnesota Coop Unit needs a strong advocate to higher administration from the level of the Department of Fisheries, Wildlife, and Conservation Biology, especially from a new Department Head, scheduled to take over at the beginning of 2021 in the midst of a review of collegiate structure and function. So, perhaps as much as ever, we need support from our cooperators, collaborators, former students, colleagues, and friends to champion what we do and the contributions we have made and will make. If you have the opportunity, please put in a good word on our behalf!

Finally, a quick update on some of the activities of Minnesota Coop Unit scientists and staff. David Fulton continues to work closely with the Minnesota Department of Natural Resources to address their information needs. Sue Schroeder, who worked closely with David for over 20 years to address Minnesota Department of Natural Resources information needs took advantage of a University early retirement incentive program in 2020, and resigned her position—we are pretty sure that Sue is keeping busy skiing, cycling, and climbing in special places across the country. David is currently working on a variety of projects within the State of Minnesota,

and is working with collaborators across the country on issues of national and international importance. Summaries of those activities are provided in this report. David Andersen has wound down field portions of projects focused on marshbirds and exposure risk of grassland wildlife to agricultural insecticides, and is continuing projects on movement ecology of Interior Population trumpeter swans and red-headed woodpeckers in the Upper Midwest. Finally, Hattie Saloka, who as everyone familiar with the Minnesota Coop Unit knows, continues to keep everything humming along, albeit mostly remotely. As a busy mother of two growing boys, she has had the additional job of overseeing their remote education at home during the pandemic, in addition to keeping all of us in line. As has most everyone else, we are all much more adept working via Zoom, but are looking forward to spending at least some time in our offices relatively soon, as the University is anticipating opening back up this fall.

