Nebraska Cooperative Fish and Wildlife Research Unit

ANNUAL REPORT
October 2014 – September 2015

Cooperating Agencies

Nebraska Game and Parks Commission
University of Nebraska–Lincoln
Wildlife Management Institute
U.S. Fish and Wildlife Service
U.S. Geological Survey (USGS) – Ecosystems Division

Report of Activities
October 2014 – September 2015

Nebraska Cooperative Fish and Wildlife Research Unit—USGS
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TABLE OF CONTENTS

TABLE OF CONTENTS v

INTRODUCTION 1

PERSONNEL AND COOPERATORS 2

Unit Personnel 2
Coordinating Committee Members 4
Cooperating Organizations 5

MILESTONES AND HIGHLIGHTS 6

THESES AND DISSERTATIONS 8

ALUMNI: WHERE ARE THEY NOW? 9

AWARDS AND RECOGNITIONS 9

OUTREACH ACTIVITIES 11

RESEARCH PROJECTS 12

Amphibian Occupancy, Functional Connectivity, and Resilience of Rainwater Basin Wetlands 13
Angler Behavior in Response to Management Actions on Nebraska Reservoirs – Part II 14
Aquatic Invasive Species (AIS) Prevention Program 16
Bat Movements across Transforming Landscapes 17
Better Soils for Birds 18
Bioenergetics and Habitat Suitability Models for the Chinese Mystery Snail (*Bellamya chinensis*) 19
Canid Distribution and the Potential Impacts of Energy Development in Nebraska 20
Climatic Constraints on Bobwhite Quail Populations along Their Northern Extent 21
Developing a Network for Invasive Species Outreach and Monitoring in Nebraska 22
Dynamics of Resilience in Complex Adaptive Systems 23
Ecological Applications of Time-Lapse Photography 24
Ecological Models and Biodiversity Conservation in Nebraska Landscapes 25
Evaluating the Benefits of Higher Diversity CRP Plantings for At-risk Species 26
Evaluating the Value and Efficacy of Agricultural Conservation Programs for Landowners and Conservation Practitioners 27
Fremont State Lakes Renovation Study: Effects of Alum Application and Fishery Renovation on Water Quality 28
Generation of Novelty in Complex Systems 29
Geographic Distribution and Occupancy of Otters in Nebraska 30
Global Change, Vulnerability and Resilience: Management Options for an Uncertain Future 31
Implications of Hunter Harvest and Wildlife-friendly Agricultural Practices on Pheasant Behavior and Population Dynamics 32
Incorporating Soil Ecological Knowledge into Management of CRP Lands 33
Local and Landscape Constraints on Habitat Management for Upland Birds 34
Making Adaptive Management Meaningful: Translating Science Learning into Policy Decision-making 35
Management Induced Shifts in Pheasant Reproductive Strategies 36
Merging Social and Ecological Network Models 37
Monitoring, Mapping, Risk Assessment, and Management of Invasive Species in Nebraska 38
Pollinator Assemblages in Southeast Prairies and Sandstone Prairies Biologically Unique Landscapes 39
Population Assessments of Temperate Basses in Nebraska Reservoirs 40
Rainwater Basin Joint Venture Science 41
Range and Habitat Preferences of Northern Long-eared Bats in Nebraska 42
Resilience Thinking and Structured Decision Making in Social-ecological Systems 43
Stopover Decisions of Migratory Shorebirds: An Assessment of Habitat, Food, Behavior and Phenology 44
Testing for the Presence of the Chytrid Fungus (*Batrachochytrium dendrobatidis*) in Amphibian Populations across Nebraska 45

Testing the Functional Resilience of High and Low-diversity Prairie Communities to Paired Disturbance.....46
Understanding and Managing for Resilience in the Face of Global Change 47
Use and Satisfaction of Public Hunting Opportunities.....48
Wetland Condition Assessment.....49
Wind and Wildlife Project.....50
Woody Plant Management in the Niobrara River Valley.....51

PROFESSIONAL ACTIVITIES 52

Teaching 52
Graduate Committee Service.....53
Professional and Faculty Service.....53
Other Professional Service.....54
Training Assistance, Workshops and Outreach Activities.....55
Peer-Reviewed Publications 56
Presentations.....58

INTRODUCTION

The U.S. Geological Survey (USGS) Cooperative Research Units Program has been in existence for over 70 years as a partnership among USGS, state natural resource agencies, host universities, the Wildlife Management Institute, and the U.S. Fish and Wildlife Service. The first unit was founded at Iowa State University in Ames, Iowa. The program currently has 40 units in 38 states.

In 1960, the U.S. Congress gave statutory recognition to the program when they enacted Public Law 86–686, the Cooperative Research Units Act. The intent of the act was to "facilitate cooperation among the Federal Government, colleges, and universities, the States, and private organizations for . . . research and education relating to fish and wildlife, and for other purposes [by developing] coordinated, cooperative research and training programs for fish and wildlife resources. . . ."

The three-part mission of the Cooperative Research Units Program is focused on education, research and technical assistance.

- *Education*. Unit scientists teach graduate-level university courses and provide graduate students academic guidance, linking the research mission with student training.
- *Research*. Unit scientists conduct research that supports the needs of local cooperators and partners. Research can be of local, regional or national interests.
- *Technical Assistance*. Units provide technical assistance and training to state and federal natural resource managers, and to other natural resource managers as needed. Cooperators benefit from the expertise of unit scientists, cooperating university faculty, and biologists at state natural resource agencies.

In 2004, the Nebraska Cooperative Fish and Wildlife Research Unit became the newest state Cooperative Research Unit through a Cooperative Agreement signed by the U.S. Geological Survey, the University of Nebraska–Lincoln, the Nebraska Game and Parks Commission, the U.S. Fish and Wildlife Service and the Wildlife Management Institute.

PERSONNEL AND COOPERATORS

UNIT PERSONNEL

STAFF – U.S. GEOLOGICAL SURVEY, COOPERATIVE RESEARCH UNITS PROGRAM

Craig R. Allen, Unit Leader
Joseph J. Fontaine, Assistant Unit Leader – Ecology
Kevin L. Pope, Assistant Unit Leader – Fisheries

STAFF – UNIVERSITY OF NEBRASKA–LINCOLN

Caryl Cashmere, Unit Staff Assistant
Valerie Egger, Unit Administrative Assistant

Adela Annis, Project Manager
Christopher Chizinski, Research Assistant Professor and Coordinator, Angler Survey Project
Caitlyn Gillespie, Research Communication Specialist
Caroline Jezierski, Coordinator, Nebraska Wind Energy and Wildlife Project
Lindsey Messinger, Research Specialist, Wildlife Ecologist
Erica Stuber, Post-doctoral Associate, Wildlife Ecologist
Michael Winkler, Project Manager
Dana Varner, Science Coordinator, Rainwater Basin Joint Venture
Allison Zach, Coordinator, Nebraska Invasive Species Program

RESEARCH TECHNICIANS AND OTHER STAFF

Rory Anderson
Jacalyn Beck
Brandon Bernhardt
Emila Breitenbach
Jason Clark
JoLeisa Cramer
Tanner Doescher
Cody Dreier
Hugh Ellerman
Alex Engel
Baili Foster
Megan Gallagher
Steven Granroth
Cory Grober
Alan Harrington
Jonathan Howell
Lauren Kiser
Abram Lollar
Sean McHugh
Nathan Meadows
Vincent Meyer
Brian Meyers
Cameron Oden
Lisa Pipino
Emily Prosser
Samuel Reibman
Nicholas Salick
Kimberly Tri
Tyler Trump
Ashlee Wright
Ashley VanderHam
Garrett Zimmer

CREEL AND HUNTER SURVEY CLERKS

Katherine Allen
Maria Baglieri
Brandon Boehm
Don Bohnenkamp
Daniel Brundrett
Matthew Brym
Brittaney Buchanan
Peyton Burt
Ryan Conat
Katherine Crawley
Derek Danner
Greg Detweiler
Jonathan Ewanyk
Bennett Grooms
Debbie Hafer
Christine Helseth
Kathy Hixson
Jacob Klooster
Rhonda Lawing
Brian McCue
Sarah Moodie
Stephanie Nefas
Carly Otto
Chris Pool
Jennifer Proescholdt
Gerald Ryschon
Luke Schalekamp
Dennis Thompson
Jonathon Yates
Kristie Vanderlinde
Rayma Volkmer

UNL UCARE STUDENTS

Sarah Spier

Student Workers

Mellisa Allen
Catherine Berrick
Lindsay Brown
Thane Carstens
Evan Carroll
Kyle Copple
Jacob Drozda
Nick Giger
Phoebe Haney
Garrett Hanquist
Samantha Lange
Nathan Liscom
Baillie Luff
Derek Mettenbrink
Victoria Simonsen
Chelsey Sims
Tyler Trump
Emalee Warner
Brooke Welsh

Current Graduate Degree Candidates – University of Nebraska–Lincoln

Master of Science

Rebecca Bevans, School of Natural Resources, May 2015 – present

Nathan Bieber, School of Natural Resources, May 2014 – present

Emma Brinley Buckley, School of Natural Resources, November 2012 – present

Alexis Fedele, School of Natural Resources, August 2014 – present

Brian Harmon, School of Natural Resources, October 2014 – present

Victoria Simonsen, School of Natural Resources, August 2015 – present

Zachary Warren, School of Natural Resources, May 2015 – present

Lyndsie Wszola, School of Natural Resources, August 2014– present

Doctorate

Hannah Birgé, School of Natural Resources, January 2013 – present

Jessica Burnett, School of Natural Resources, August 2015 – present

Nicholas Cole, School of Natural Resources, August 2014 – present

Lucía Corral, School of Natural Resources, June 2012 – present

Kent Fricke, School of Natural Resources, June 2011 – present

Michelle Hellman, School of Natural Resources, May 2013 – present

Amanda Lipinski, School of Natural Resources, August 2014 – present

Nicholas Smeenk, School of Natural Resources, August 2010 – present

Chad Smith, School of Natural Resources, August 2007 – present

Shana Sundstrom, School of Natural Resources, August 2011 – present

Bethany Teeters, School of Natural Resources, August 2012 – present

Daniel Uden, School of Natural Resources, August 2012 – present

Michael Whitby, School of Natural Resources, January 2014 – present

Graduates, 2014–15

Caitlyn Gillespie, M.S., School of Natural Resources, UNL, May 2015

Danielle Haak, Ph.D., School of Natural Resources, UNL, May 2015

Noelle Hart, Ph.D., School of Natural Resources, UNL, August 2015

Lindsey Messinger, M.S., School of Natural Resources, UNL May 2015

Donald Pan, Ph.D., School of Biological Sciences, UNL, May 2015

Nathan Stewart, M.S., School of Natural Resources, UNL, May 2015

Coordinating Committee Members

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U.S. Fish and Wildlife Service

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134 Union Blvd, PO Box 25486
Denver, CO 80225
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Cooperating Organizations

Bard College, New York
Central Nebraska Public Power and Irrigation District
Chadron State College, Nebraska
Emory University, Georgia
Michael Forsberg Photography
International Institute for Applied Systems Analysis, Austria
National Socio-Environmental Synthesis Center
The Nature Conservancy
Nebraska Association of Resource Districts
Nebraska Department of Agriculture
Nebraska Department of Environmental Quality
Nebraska Department of Roads
Nebraska Educational Television
Nebraska Environmental Trust
Nebraska Forest Service
Nebraska Game and Parks Commission
Nebraska Natural Resources Districts
Nebraska Public Power District
Nebraska Weed Control Association
Swedish University of Agricultural Sciences, Sweden
Towson University, Maryland
University of Minnesota
University of Nebraska at Kearney
University of Nebraska–Lincoln
- Daugherty Water for Food Institute
- Department of Agricultural Economics
- Department of Agronomy and Horticulture
- Department of Computer Science / Engineering
- Department of Earth and Atmospheric Sciences
- Department of Plant Pathology
- Nebraska Water Center
- School of Biological Sciences
- School of Natural Resources

University of Nebraska Omaha
University of New Mexico
U.S. Army Corps of Engineers
U.S. Department of Agriculture
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Geological Survey
U.S. National Park Service
Wyoming Game and Fish Department

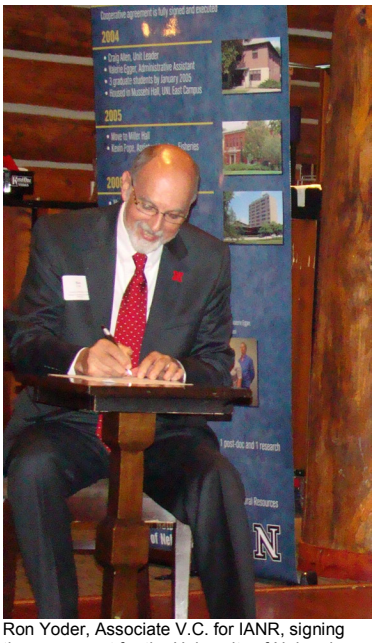
MILESTONES AND HIGHLIGHTS

REMARKABLE RESEARCH, EXCEPTIONAL EDUCATION

Our last annual Coordinating Committee Meeting was held at Wilderness Lodge in Lincoln on September 30, 2014. This meeting was extra special because it included a 10th anniversary celebration of the Nebraska Cooperative Fish and Wildlife Research Unit. The Unit officially opened its doors in July 2004 with Unit Leader Craig R. Allen and Administrative Assistant Valerie Egger. Torrential rains did not dampen our spirits, nor did they keep people away. About 70 guests celebrated with us, including eight former graduates who are now working in Nebraska, Illinois and Missouri.

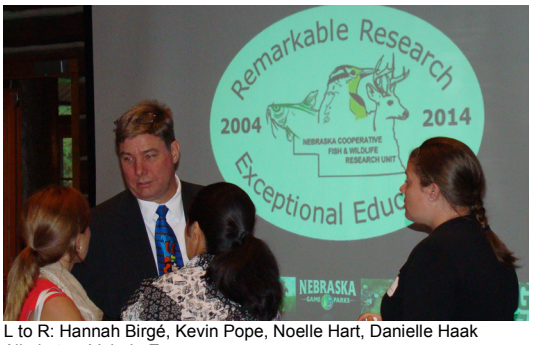
Following the business meeting, representatives of Nebraska's Coordinating Committee signed a renewal of the Cooperative Agreement that established the Unit. Committee members represented U.S. Geological Survey, the University of Nebraska–Lincoln, the Nebraska Game and Parks Commission, U.S. Fish and Wildlife Service, and the Wildlife Management Institute. Current graduate students gave research presentations, always a highlight of the meeting, which were followed by a delicious buffet dinner and time for informal networking.

Coordinating Committee members and the organizations they represent. L to R: Ron Yoder (IANR, UNL), Steve Torbit (USFWS), Pat Ruble (WMI), Jim Douglas (NGPC), Joe Margraf (USGS)



Ron Yoder, Associate V.C. for IANR, signing the agreement for the University of Nebraska

L to R: Dan Uden, Jason DeBoer (M.S. 2013), Kody Unstad (M.S. 2012), Kent Fricke, Nathan Bieber



L to R: Hannah Birgé, Kevin Pope, Noelle Hart, Danielle Haak
All photos: Valerie Egger

Peccei Award

Danielle Haak received the 2014 Peccei Award for her paper *Coupling ecological and social network models to assess "transmission" and "contagion" of an aquatic invasive species*. The paper was a product of Danielle's three month participation in IIASA's Advanced Systems Analysis Program in Laxenburg, Austria. IIASA is the International Institute for Applied Systems Analysis. The awards are given annually for outstanding work by participants in IIASA's Young Scientists Summer Program and provide financial support for the winners to return to IIASA for an additional three to six month period of research. Supervisor is Brian Fath.

Aquatic Invasive Species Legislation

Nebraska Legislative Bill 142 was introduced by the Nebraska Natural Resources Committee in January 2015 to provide funding for aquatic invasive species management and prevention efforts across the state. In early March, Governor Ricketts signed LB 142 into law creating the Nebraska Aquatic Invasive Species Prevention Program. Funding will come from a $5 aquatic invasive species (AIS) fee on resident boat registrations (every 3 years) and an annual $10 AIS stamp for nonresident boaters. The law can be accessed here: http://nebraskalegislature.gov/FloorDocs/104/PDF/Slip/LB142.pdf.

The fee goes into effect in 2016 and will be administered by the Nebraska Game and Parks Fisheries Division. Since 2011, the Nebraska Invasive Species Program, a grant-funded program within the Nebraska Fish and Wildlife Cooperative Unit, has conducted boater education programs and public surveys to provide the public with prevention information. Once the new program goes into effect in 2016, the Nebraska Invasive Species Program will continue outreach, education and prevention efforts for aquatic and terrestrial invasive species.

Highly Cited Paper

Nash, K.L., C.R. Allen, D. Angeler, C. Barichievy, A.S. Garmestani, N.A.J. Graham, D. Granholm, M. Knutson, J. Nelson, M. Nyström, S. Riley, C.A. Stow, and S.M. Sundstrom. 2014. Discontinuities, cross-scale patterns and the organization of ecosystems. *Ecology* 95: 654-667.
ISI recognized this paper as a highly cited paper for 2014. Citations place the manuscript in the top 1% of the academic field of environment/ecology based on a highly cited threshold for the field and publication year:

Workshop Awards

Telling Stories about Science: Science Communication in the Digital Age – Workshop
In July 2015, Caitlyn Gillespie participated in a workshop put on by the Organization for Tropical Studies designed to provide scientists with the necessary skills to communicate to diverse non-science audiences. With support from the Great Plains Landscape Conservation Cooperative and the Nebraska Game and Parks Commission, Caitlyn spent two weeks working with expert science storytellers in every medium: writing, radio, photography, and film. By the end of the program, she had produced a science communication mini-portfolio focused on her research on shorebird migration. This fall Caitlyn will lead a workshop to share some of what she learned with students and other science professionals at the University of Nebraska.

Socio-Environmental Synthesis Research Proposal Writing – SESYNC Workshop
Nicholas Cole participated in SESYNC's Socio-Environmental Synthesis Research Proposal Writing Workshop in September 2015. Nick received travel funding from the National Socio-Environmental Synthesis Center (SESYNC) to cover airfare, accommodations, and food expenses for the workshop. The training program supports Ph.D. students in the natural, social, and computational sciences; humanities; communications; and business studies in their pursuit of socio-ecological synthesis research at the SESYNC center in Annapolis, Maryland. The workshop provides graduate students with introductions to SESYNC, socio-environmental synthesis research, team science, bridging natural and social sciences, and actionable science; networking opportunities with other students; and training sessions on the methods, challenges, and strategies associated with writing successful proposals.

Enhancing Linkages between Mathematics and Ecology – Workshop
In June 2015, Lyndsie Wszola was awarded a scholarship by the National Science Foundation and Michigan State University to attend a three week workshop: *Enhancing Linkages between Mathematics and Ecology*. The course was taught by statisticians and ecologists from Yale University, University of Hawaii, and Rice University and included top students from around the United States. The workshop focused on training students in the theoretical underpinnings and practical applications in R (e.g., maximum likelihood analysis, modern regression, and Bayesian statistics). Lyndsie was able to use her own data to analyze the environmental variables that determine hunter and pheasant habitat selection, and was fortunate enough to make connections with other ecology grad students. These connections continue to yield valuable scientific discussions.

THESES AND DISSERTATIONS

Caitlyn Gillespie, M.S., May 2015

Shorebird Migratory Stopover Responses to Local and Regional Change: Habitat Decisions in a Vanishing Landscape
University of Nebraska–Lincoln, Natural Resources. Advisor, Joseph J. Fontaine

Danielle Haak, Ph.D., May 2015

Bioenergetics and Habitat Suitability Models for the Chinese Mystery Snail (Bellamya chinesis)
University of Nebraska–Lincoln, Natural Resources. Advisor, Kevin L. Pope

Noelle Hart, Ph.D., August 2015

Resilience Thinking and Structured Decision Making in Social-ecological Systems.
University of Nebraska–Lincoln, Natural Resources. Advisor, Craig R. Allen

Lindsey Messinger, M.S., May 2015

Habitat and Site Selection of Pheasants and Their Hunters during the Hunting Season
University of Nebraska–Lincoln, Natural Resources. Advisor, Joseph J. Fontaine

Donald Pan, Ph.D., May 2015

Role of Viruses Infecting Bacteria in Subsurface Sediments and Groundwater
University of Nebraska–Lincoln, Biological Sciences. Co-advisor, Craig R. Allen

Nathan Stewart, M.S., May 2015

Ecology and Management of Superabundant Fish Populations
University of Nebraska–Lincoln, Natural Resources. Advisor, Kevin L. Pope

ALUMNI: WHERE ARE THEY NOW?

Christopher Jorgensen (M.S., 2012)

Chris completed his master's degree from UNL in December 2012. Prior to graduation, he accepted a job with the Rainwater Basin Joint Venture where he worked with state and federal agencies to develop decision support tools to help facilitate and target conservation efforts throughout Nebraska. In August 2014, Chris was hired by Olsson Associates, an engineering and environmental firm in Lincoln, Nebraska. Since joining the Olsson team, he has participated in environmental compliance projects, coordinated field surveys, and analyzed a number of datasets for the firm. He works closely with the renewable energy industry, as well as state and federal government agencies. He spends his free time in the outdoors, camping and fishing with his wife, Jennifer, and their dog. They celebrated their one-year anniversary this past July.

Ryan Stutzman (M.S., 2012)

Ryan completed his degree in December 2012 after having already left Lincoln for a job with Washington Department of Fish and Wildlife in April 2012. Ryan serves as a private lands biologist where he gets to work with farmers and ranchers to improve habitat and recreational opportunities. Using primarily Farm Bill programs, Ryan oversees habitat projects and conservation agreements aimed at both non-game species like Sage Grouse and Ferruginous Hawks as well as traditional game species like mule deer and pheasants. Conservation in the increasingly scarce shrub-steppe can be a challenge, but Ryan enjoys finding solutions that work for both landowners and wildlife. He also manages the area's hunter access properties, providing public hunting access to thousands of acres of private land. Ryan lives in Washington's Yakima Valley with his girlfriend Naomi and their two dogs. Living in the heart of Washington's wine country has its perks and when not sampling the local product or tending to their garden, Ryan and Naomi spend their time pursuing upland game birds, various salmonid species, and huckleberry patches with good views of Mount Rainier.

AWARDS AND RECOGNITIONS

Outstanding Faculty, Staff and Students

Lindsey Messinger received the 2015 School of Natural Resources *Meritorious Graduate Student Award*. The award is presented by the SNR Graduate Committee to one master's and one Ph.D. student annually. "Being nominated and selected for the School of Natural Resources Masters Meritorious Graduate Student Award by my peers and the SNR community, many of whom shaped me both as a student and a professional, has particular meaning for me," Messinger said. "Knowing that my research and professional contributions are valued inspires me to continue to strive for excellence both in my ongoing work here in SNR with the Nebraska Cooperative Fish and Wildlife Research Unit and in the future as my career develops." [Quote used with permission, Mekita Rivas, SNR.]

Lindsey Messinger conducting a hunter survey

Lindsey was selected as a member of the 2015 Leadership Institute with The Wildlife Society. The Leadership Institute is an annual program which accepts 10 early-career members of The Wildlife Society to participate in intensive leadership training and mentoring activities that prepare participants for leadership positions, both in their workplace and within The Wildlife Society. Messinger received a $1,800 travel grant and a registration waiver to attend the October 2015 annual meeting of The Wildlife Society in Winnipeg, Canada as part of the program. In July, Lindsey was also elected to the board of the Central Mountains and Plains Section of The Wildlife Society

Fellowships and Assistantships

Danielle Haak was one of seven recipients of the University of Nebraska Presidential Graduate Fellowships for the 2014–15 academic year. The fellowships are awarded to graduate students across the University of Nebraska's four campuses and are based upon high scholastic performance and personal accomplishments.

2014–15 Othmer Fellowships from the University of Nebraska–Lincoln were awarded to Amanda Lipinski and Dan Uden. Dan also received two other awards for 2014–2015: the University of Nebraska–Lincoln Center for Great Plains Studies Fellowship, and a National Science Foundation IGERT assistantship.

Lindsey Messinger received a 2014 Pheasants Forever Wildlife Scholarship.

Other Professional Honors

Hannah Birgé was inducted into the University of Nebraska–Lincoln Center for Great Plains Studies as a Great Plains Graduate Fellow.

As an August T. Larsson Visiting Fellow, Hannah Birgé traveled to the Swedish University of Agricultural Sciences in Uppsala, Sweden in May 2015 where she collaborated with international scientists to write a paper on cross-scale dynamics and resilience in soil ecosystems.

Presentations and Posters

Emma Brinley Buckley received two awards for her poster highlighting the Platte River Basin Time Lapse project at the October 2014 Global Water for Food Conference in Seattle, WA. She won first place in the Viewers' Choice Competition as well as third place in the On-line Competition.

L to R: Roberto Lenton, Emma Brinkley Buckley

Caitlyn Gillespie received a Conference Presentation Award at the 2015 Nebraska Chapter Wildlife Society Meeting.

Best Paper was awarded to Nathan Stewart for *Effectiveness of low-dose-rotenone application for controlling White Perch and Gizzard* Shad presented at the February 2015 meeting of the Nebraska Chapter of the American Fisheries Society.

Elevator Speech Contest

In March 2015, the School of Natural Resources hosted their 2nd annual Elevator Speech Contest and Graduate Student Association Poster Symposium. Undergraduate and graduate students were challenged to give a three to four minute speech about their research project without props or special effects. Enthusiasm was high and our students performed well!

- Lyndsie Wszola, fourth place, master's category
- Amanda Lipinski, second place, doctorate category
- Alexis Fedele, popular vote, poster symposium

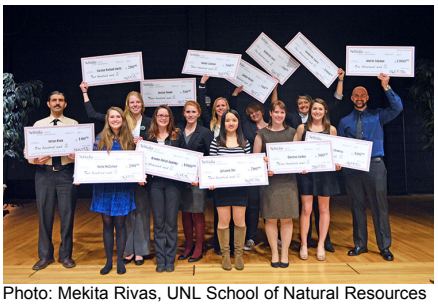


Photo: Mekita Rivas, UNL School of Natural Resources

Travel Awards

Lucía Corral received a 2015 SNR Graduate Student Travel Grant. Lindsey Messinger was awarded a $1600 travel grant from The Wildlife Society for travel expenses to attend their October 2015 meeting in Winnipeg, Canada.

OUTREACH ACTIVITIES

The following are a *sample* of the outreach activities that Unit staff and students participated in during the past year.

EnvironMentors

October 2014 through April 2015, Kent Fricke and Dan Uden mentored a high school student in the UNL Chapter of Upward Bound EnvironMentors program. The student's project focused on the reduction of static electricity.

Media Coverage

Local media coverage highlighted several research projects.

- *Swift fox study underway in Western Nebraska*. Nebraska Public Radio. January, 2015.
- *Game and Parks plans changes in managing pheasant habitat areas*. Omaha World-Herald. January, 2015.
- *Children's book about swift fox has ties to Chadron State College*. CSC in the News. September, 2014.
- *Chadron State College doing leg work for swift fox study*. Panhandle Post. April, 2014.

Nebraska Invasive species program

The Nebraska Invasive Species Program participated in several expos and public events, and had booths with invasive species information. The program's website (neinvasives.com) has a calendar listing events that program staff attend or presentations they conduct at events. Technicians interviewed boaters at high risk Nebraska waterbodies between May and August educating the public on how to prevent the spread of aquatic invasive species. The program has two billboards at Lake McConaughy promoting the Clean, Drain and Dry practice.

Science fair booth
Photo by: JoLeisa Cramer

Water Safety Training

NE Coop staff organized and provided water safety training followed by American Red Cross certification for Adult First Aid/CPR/AED for about 20 staff in the NGPC fisheries division (at their request) in August 2015 in Lincoln, NE. This training meets the Unit's mission to provide technical assistance to a cooperator. Water safety instructors were Kevin Pope (lead), TJ Fontaine, Chris Chizinski and Craig Allen.

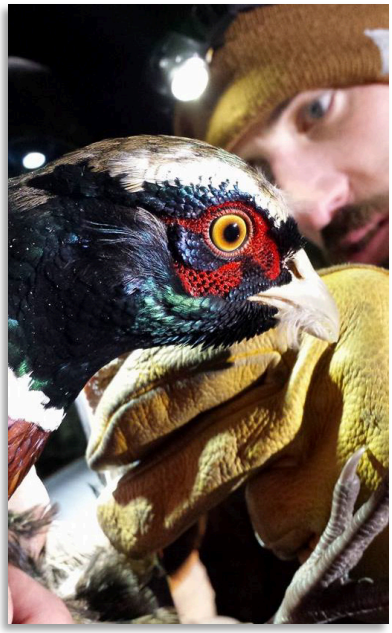
Wind and Wildlife

Caroline Jezierski planned and executed the March 2015 Spring Migration Event for wind energy stakeholders to help them learn why some areas in Nebraska are more important to wildlife and less suited to wind energy development. The event took place in the Rainwater Basin along the Central Platte River in Nebraska, and at the Crane Trust. Guest presenters included Dana Varner (NE Coop and Rainwater Basin Joint Venture) and Mark Vrtiska (NGPC). Caroline also had outreach booths at several events throughout the state and interacted with undergraduate and graduate students in several University of Nebraska–Lincoln courses. Every two weeks, she compiles a newsletter with news stories and peer-reviewed journal articles about wind energy and wildlife in Nebraska and throughout the world. The newsletter is sent out to over 100 people and is posted online. http://snr.unl.edu/renewableenergy/wind/moreinformation.asp.

Workshop

Lucía Corral conducted a workshop on using camera traps to survey for swift fox. Held at Chadron State College, the workshop included participates from Chadron State College as well as several Nebraska Game and Parks staff. The workshop offered training in camera trapping and in swift fox survey protocol. Chadron students have been assisting with the Nebraska Canid Project by conducting swift fox surveys during the school year.

RESEARCH PROJECTS



Amphibian Occupancy, Functional Connectivity, and Resilience of Rainwater Basin Wetlands

Principal Investigator(s):	Dan Snow, Craig R. Allen
Graduate Student(s):	Michelle Hellman, Ph.D.
Project Duration:	April 2013 – May 2017
Funding:	National Science Foundation IGERT Program, Grant 0903469 U.S. Environmental Protection Agency
Project Location:	Rainwater Basin, Nebraska

This project will seek to assess how agricultural land-use may affect resilience of a large wetland complex. Both the quantity and overall quality of wetlands have severely declined globally. Many remaining wetlands exist in landscapes dominated by agricultural production. The Rainwater Basin is a region of Nebraska characterized by shallow wetlands located in an agricultural matrix. Following European settlement in the mid-to-late 19th century, more than 90% of historic wetlands in the Rainwater Basin were filled or farmed through. The remaining wetlands exist in an intensive agricultural matrix that has further isolated wetlands and may affect their function, and reduce the resilience of the Rainwater Basin.

For the Nebraska Rainwater Basin, we are interested in the resilience of the functional connectivity among wetlands for amphibian species. Amphibians are an important taxonomic group that provide services by controlling insects, serving as food for migratory birds and other species, and integrating terrestrial and aquatic systems. Amphibians are sensitive to environmental contaminants and can be used as an indicator of water quality, system health, and resilience. Occupancy of amphibians, functional connectivity of remaining wetlands, and acute and chronic effects to amphibians from commonly applied agrichemicals will be investigated. Volunteers from the Unit, the University of Nebraska, the Nebraska Game and Parks Commission, and various other organizations performed roadside amphibian call surveys at 125 wetlands in the Rainwater Basin. Additionally, water contaminant samples continue to be collected and analyzed for a suite of agricultural contaminants. Concentrations of contaminants found in the Rainwater Basin will be replicated in laboratory conditions to assess toxicity to larval amphibians.

Private wetland in an agricultural field in the Rainwater Basin in May 2014 (flooded with rainfall)
Photo: Michelle Hellman

The same wetland in July 2014. Wetland has contracted and surrounding land has been planted.
Photo: Michelle Hellman

Angler Behavior in Response to Management Actions on Nebraska Reservoirs – Part II

Principal Investigator(s):	Kevin L. Pope, Christopher J. Chizinski
Graduate Student(s):	Nicholas Cole, Ph.D. Alexis Fedele, M. S. Brian Harmon, M.S.
Project Duration:	January 2014 – December 2018
Funding:	Nebraska Game and Parks Commission
Project Location:	Statewide Nebraska
Website:	FishHunt.unl.edu

Recreational angling, a billion-dollar industry, is the most influential factor structuring fish populations in inland systems. Given its importance and the reliance in North America on sportspersons to fund conservation activities (i.e., the North American Model of Wildlife Conservation), natural resource agencies invest substantial resources to recruit and retain anglers. However, there is little understanding of the motivations to participate in angling activities or the influence of management actions on that angler participation. Scientists know little about the spatial and temporal patterns of participation by anglers. Further, little is known about the non-consumptive responses of fish populations to angling such as changes in behavior that affect vulnerability to angling. A greater understanding of the positive and negative feedbacks between angling participation and responses of fish populations to angling are needed to understand and properly manage recreational angling.

Project goals are to understand 1) the participation patterns of anglers on multiple spatial and temporal scales; 2) how participation patterns of anglers influence fish populations and associated communities; 3) how management actions influence angler participation patterns and, in turn, fish communities; and 4) interactions and feedback mechanisms between and among angler groups and fish communities.

The project currently has six study components.

1. *Statewide Angler Survey.* Anglers are being interviewed at Branched Oak Lake, Calamus Reservoir, Harlan County Reservoir, Lake McConaughy, Merritt Reservoir, Pawnee Reservoir, and Sherman Reservoir from April through October, 2014–2018. These interviews add to long-term (>10–20 years) data sets that are valuable for assessment of temporal changes in angler participation. In particular, these extended data sets will allow for relational assessments of changes in angling participation with environmental conditions and management actions on large-scales.

2. *Individual-Based Model Describes Behavioral Feedbacks between Anglers and Sportfish.* Behavioral feedbacks between anglers and sportfish are widely recognized to be important in the management of sustainable and economically viable recreational fisheries. Quantifying these feedbacks empirically is difficult. Individual-based modeling has proven to be a powerful tool for assessing ecological processes that are difficult to quantify empirically. We used this computational-modeling form to simulate various assumptions associated with fishery-induced behavioral changes within an exploited fish population. We parameterized the angler agents using creel survey data from a new reservoir in Eastern Nebraska. These simulations result in robust-emergent relationships, over many model iterations, between empirically represented anglers and hypothetical sportfish. This provides a theoretical framework for in situ assessments of behavioral feedbacks between anglers and sportfish.

3. *Using Naïve Systems to Identify How Angling Influences Fish Populations.* Catchability of sportfish can be negatively affected by repeated capture with catch-and-release angling, which is potentially a result of learned hook

avoidance. The opening of two new reservoirs in eastern Nebraska to angling provided a unique opportunity to assess this relationship. Lake Wanahoo and Prairie Queen Lake were stocked and allowed to develop without angling for several years prior to opening. Thus, we assumed that fish were naïve to angling. We hypothesized that learned hook avoidance would be more prevalent in release-oriented than harvest-oriented fish populations, resulting in a more rapid decline of angler catch per unit effort (CPUE) for release-oriented species. Creel surveys were employed through the first 30 days of angling at each location, and were used to estimate angler catch, harvest, and effort. We observed a marked decrease in the CPUE of release-oriented species, but we did not observe declines in CPUE for harvest-oriented fish. This may suggest that individuals developed learned behavior to avoid recapture and has strong implications for efficacy of management regulations and angler satisfaction.

4. *Quantifying the Effect of Fish Personality on Fishing-induced Learning.* Fish populations display reduced catchability over time in catch-and-release fisheries, suggesting that individual fish have the ability to learn to avoid capture. We will investigate whether learning occurs and the potential influence an individual fish's personality has on its ability to learn. Behavioral tests will be conducted in a laboratory to determine where an individual falls along a boldness continuum, and repeated fishing trials will determine if certain fish personality types are better able to learn to avoid a lure. If personality dictates learning, angling may select for a particular type of individual, leading to homogenous populations of fish that become "informed" about angling and develop low vulnerability to capture.

5. *Spatial Distribution of Angler Parties.* The outcomes of interactions between anglers and fish are a function of decisions made by the predator (anglers) and the prey (fish). Anglers must decide where to fish within a waterbody, yet most assessments of fisheries via angler surveys provide only whole-waterbody estimates of angler pressure. Angler distribution within a waterbody is not uniform, and if anglers are not randomly distributed, then anglers are selecting for factors within a waterbody. We will describe the distribution of anglers within six Salt Valley reservoirs across an open-water season and elucidate the physical landscape features that predict their distribution. Anglers of different typologies may select for different landscape features, but these typologies of anglers and their preferences for landscape features are unknown. We seek to describe these typologies through online surveys and predict the intra-waterbody distribution of anglers with different typologies. We are also developing alternative techniques to assess the spatial distribution of anglers with stationary cameras and image analysis software. Use of stationary cameras and associated image processing may allow for an increase in the number of reservoirs surveyed. Information gained by this research should improve precision for estimates of angling effort and catch in spatially complex fisheries and provide managers with information on how changes in infrastructure will alter angler distribution.

6. *Length-based Economic Assessment of Sportfish.* Recreational fisheries are a unique industrial component to Nebraska's economy. Though they do not produce a directly valued product of traditional economics, they do provide utility to recreational anglers through social capital or enjoyment. In seeking this social capital, anglers create demand for secondary industries (e.g., tackle, media, and travel accommodations). Thus, these secondary industries are a direct result of the quality of Nebraska's aquatic resources. As such, accounting for these economic gains within any resource assessment provides a more accurate value of the resource itself.

   Quantifying this valuation requires assessment of individual angler willingness-to-pay to capture a fish and for each successive capture. Willingness-to-pay is most commonly quantified through classic cost-benefit analyses. We will use contingent valuation methods to quantify anglers' stated willingness-to-pay values. This willingness-to-pay variable can then be used to set a monetary value for the capture of a fish.

   We recognize that anglers derive social capital differently from the captures of trophy and non-trophy fish. Thus, we should expect that an angler's willingness-to-pay for a large fish is substantially greater than the willingness-to-pay for a small fish. To properly include this in our assessment, we will use a length-based framework. Thus, this assessment will provide a length-specific estimate of the value of captured sportfish in Nebraska. Additionally, it will develop an improved census of the typologies and goals associated with Nebraska's modern angling population.

AQUATIC INVASIVE SPECIES (AIS) PREVENTION PROGRAM

Principal Investigator(s):	Craig R. Allen
Project Coordinator(s):	Karie Decker (7/2009 – 11/2012) Rodney Verhoeff (4/2013 – 7/2013) Allison Zach (9/2013 – present)
Project Duration:	April 2011 – December 2016
Funding:	Nebraska Environmental Trust USFWS Aquatic Nuisance Species Taskforce Central Nebraska Public Power and Irrigation District
Project Location:	Statewide Nebraska

The Nebraska Invasive Species Program (NISP) continues to administer a multi-institutional Aquatic Invasive Species Prevention Program funded with grant funding from the Nebraska Environmental Trust and the U.S. Fish and Wildlife Service (USFWS).

Goals are to:

1. *Decrease* the risk of aquatic invasive species introduction into Nebraska by implementing a boat inspection and decontamination program;
2. *Increase* public awareness of aquatic invasive species through an integrated outreach/education program;
3. *Continue* aquatic invasive species monitoring to help focus prevention efforts; and
4. *Increase* local and regional collaboration in the prevention of aquatic invasive species.

The NISP has conducted boater surveys each summer since 2012 at high-risk waterbodies throughout Nebraska to gauge public awareness of invasive species, track where boaters are coming from and going to, and to educate boaters on aquatic invasive species prevention. In 2014, surveys were collected using new survey software, and tablets were used by technicians administering the boater surveys. The new software allows technicians to collect boater surveys when outside of Wi-Fi range. Then once back in Wi-Fi range, the technicians sync the tablets, and the survey data is uploaded to a remote server. The program coordinator had access to the remote server and could analyze data on a daily basis to view trends, and to make adjustments to survey schedules if necessary. In the past, surveys were conducted using paper; data was later entered into an Access database during the fall. This didn't allow data analysis to be conducted until the winter following the field season. The new survey software has proven valuable for providing real time results and for looking at specific trends in boater surveys. In the fall of 2015, results of the 2012–2014 boater surveys will be presented at regional and national meetings. Results show that outreach efforts have been successful in educating people to Clean, Drain and Dry watercrafts to prevent the spread of invasive species.

Conducting a boater survey
Photo: Allison Zach

Below is a comparison of survey results collected between 2012-2014 boater surveys.

Topic	2012	2013	2014
Total boater surveys completed	2,600	2,351	1,912
Boaters that inspected their watercraft	48%	77%	95%
Removed vegetation from watercraft	39%	42%	96%

BAT MOVEMENTS ACROSS TRANSFORMING LANDSCAPES

Principal Investigator(s):	Craig R. Allen, Caroline Jezierski
Graduate Student(s):	Michael Whitby, Ph.D.
Project Duration:	May 1, 2013 – April 30, 2016
Funding:	Nebraska Environmental Trust Nebraska Game and Parks Commission
Project Location:	Platte River, Nebraska
Website:	http://snr.unl.edu/renewableenergy/wind/researchbat.asp

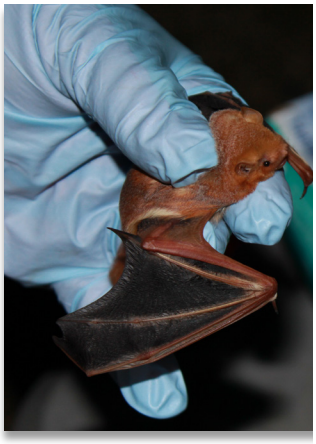
Bats provide critical ecosystem services across the globe. In the U.S. Midwest, these services are primarily in the form of insect consumption. Decreased bat populations could result in the need for additional pesticides and other insect control measures in states dominated by agriculture, such as Nebraska. These additional pest control costs are estimated to be about $2.9 billion, or $74 per acre. Preserving bat populations is important for both the ecosystem and the humans who rely on the services they provide.

Unfortunately, the cumulative impacts of opportunistic wind energy development could have unanticipated, negative consequences in Nebraska and around the nation. Already, wind turbines kill an estimated 800,000 bats every year. As the energy sector positions itself to harness Nebraska's vast wind resources, we must consider and minimize the unintended consequences to Nebraska agriculture. Potential negative impacts of wind energy development on bats can be minimized through siting and operations that consider bat presence, activity, and movement. By studying bat migratory patterns in Nebraska we will help utility companies, wind energy developers, and facility owners avoid, manage, and mitigate the effects of new and existing wind energy facilities.

We will use bat detectors to identify when and where bats are moving in eastern Nebraska throughout the year. These detectors record the ultrasonic acoustic signals bats use to navigate and allow us to determine the species present and activity levels at recording locations. Currently, 20 bat detectors are placed approximately every 10 miles from Leigh east to Blair and south to Seward and Nebraska City, primarily on silos and grain bins graciously opened to us by private citizens. We have collected more than 234,000 bat calls during 336 days of sampling. This data will help us identify the when and where bats migrate and provide insight into why/how bats choose their migration routes.

Information gathered will be used to further promote sound resource management practices, especially by informing new wind energy facilities of high risk areas and help all facilities identify times of greatest threats to bats. Partners on this project include the Nebraska Wind Energy and Wildlife Project, the U.S. Fish and Wildlife Service, the Nebraska Game and Parks Commission, and the University of Nebraska–Lincoln.

Michael Whitby with bat
Photo: Mandy Lipinski



Bat caught by a mist net
Photo: Mandy Lipinski

BETTER SOILS FOR BIRDS

Principal Investigator(s):	Craig R. Allen
Graduate Student(s):	Hannah Birgé, Ph.D.
Project Duration:	June 2013 – May 2016
Funding:	National Science Foundation IGERT Program, Grant 0903469 Nebraska Game and Parks Commission
Project Location:	North Central Nebraska

This project investigates how disturbance is used as a tool by managers to improve the quality of grasslands enrolled in the Conservation Reserve Program. To achieve this aim, we are tracking 1) soil, 2) plant, 3) pollinator, and 4) ground-dwelling macroinvertebrates response to the disturbances used by managers that serve as stand-ins for historical disturbance. These manager-applied disturbances are part of Conservation Reserve Program mid-contract management (MCM) and typically include burning, disking, interseeding, herbicide, or some combination thereof.

The decision to use one or many of these approaches to fulfill MCM obligations requires landowners to weigh various economic, ecological, and social tradeoffs. By combining the ecological knowledge gained from our field investigation with knowledge generated from a statewide landowner survey, this work seeks to provide valuable information to private landowners, agency personnel and scientists interested in supporting smart land management decision-making.

The two chief goals of this work are to create:

1. An understanding of how the ecosystem responds to four common MCM strategies, including soil, plant, insect, and bird attributes; and
2. Relevant information to provide to private landowners, land managers, and federal and state personnel in an effort to promote informed management decisions by:
   a. Balancing various management objectives and costs, and
   b. Providing a structured, iterative learning process to inform future management activities.

Upland sandpiper in the Lynch area
Photo: Hannah Birgé

BIOENERGETICS AND HABITAT SUITABILITY MODELS FOR THE CHINESE MYSTERY SNAIL (*BELLAMYA CHINENSIS*)

Principal Investigator(s):	Kevin L. Pope, Valery Forbes
Graduate Student(s):	Danielle Haak, Ph.D. (2015)
Project Duration:	August 2011 – May 2015
Funding:	National Science Foundation IGERT Program, Grant 0903469 University of Nebraska Presidential Fellowship University of Nebraska–Lincoln
Project Location:	Southeast Nebraska

Aquatic invasive species continue to spread throughout the United States at an alarming rate and Nebraska is no exception. Maintaining ecosystem functions is a key component to preserving system resilience, but more information on how these functions are altered by specific invasive species is necessary.

The Chinese mystery snail (*Bellamya chinensis*) is an invasive freshwater snail already established in Nebraska, yet little is known about this species life-history traits and ecology or how it influences an ecosystem after invasion. Similar to other mollusk species, Chinese mystery snail populations commonly reach high densities shortly after establishment. We developed a bioenergetics model for the species by quantifying and comparing consumption, egestion, respiration, and production of the Chinese mystery snail at different water temperatures. As expected, temperature affects growth and reproductive strategies of this species. We also analyzed a specific case study to identify physical, chemical, and biological lake characteristics that help predict where the Chinese mystery snail is found. The presence of Chinese mystery snail is correlated with water clarity, latitude, and the presence of other aquatic invasive species.

This research attempted to help clarify some of the mystery for the Chinese mystery snail, a species we knew very little about at the onset of the study. We investigated the specie's ecology in laboratory experiments and assessed variables in the field that may be used to predict the species' distribution.

Chinese Mystery Snails
Photo: Danielle Haak

Canid Distribution and the Potential Impacts of Energy Development in Nebraska

Principal Investigator(s):	Joseph J. Fontaine, Larkin Powell, Teresa Frink (Chadron State College)
Graduate Student(s):	Lucía Corral, Ph.D.
Project Duration:	January 2013 – January 2018
Funding:	Nebraska Game and Parks Commission Nebraska Department of Roads
Project Location:	Western Nebraska
Website:	http://snr.unl.edu/nebraskacanidproject/

Increasing conversion of grasslands throughout the Great Plains has led to significant declines in the distribution and abundance of a variety of grassland obligate species and associated increases in habitat generalists. For example, the distribution and likely densities of generalist carnivores, including coyote (*Canis latrans*) and red fox (*Vulpes vulpes*) have increased throughout much of North America, while the closely related grassland obligate, swift fox (*V. velox*) has and continues to undergo significant declines. In Nebraska, swift fox currently occupy only 21% of their historical range, while coyotes have increased both in numbers and range throughout the state. Clearly generalists such as coyotes are capable of thriving in highly altered human landscapes, thus it is not surprising that their distribution has increased. What is less clear is why swift fox fail to occupy the 42% of Nebraska that continues to contain seemingly high quality swift fox habitat.

As the largest canid in Nebraska, coyotes are dominant to swift fox and are often cited as an important source of mortality for swift fox populations. As such, increases in the abundance and distribution of coyotes following the development of the Great Plains may have inadvertently restricted the range of swift fox despite the availability of suitable habitats. With increasing interest in developing infrastructure in the shortgrass prairie for gas, oil and wind energy resources, there is a clear need to identify the mechanism limiting the distribution of grassland obligate species such as swift fox, and how anthropogenic change is likely to alter important ecological relationships.

We are working to identify the ecological mechanisms shaping the distribution of canid communities across Nebraska by developing and testing a series of species distribution models based on the habitat requirements and intraguild interactions between coyote and swift fox. The project goal is to understand how habitat structure, landscape attributes, and behavioral intraguild interactions, across multiple spatial and temporal scales, affect habitat use and geographic distribution of Nebraska's canids species and how energy development may alter these relationships.

Starting in the spring of 2014, we began surveying for canids across 26,000 square miles of western Nebraska using baited camera traps. With the help of 129 private landowners, we were able to deploy cameras at 908 survey sites, for over 16,650 trap nights resulting in nearly 4.5 million photos. Over the next several years, we will continue surveying for canids in the spring and fall, working to develop a baseline model for canid species distribution in Nebraska.

Lucía Corral setting a camera trap
Photo: Adela Annis

Lisa Pipino and Baili Foster preparing trail cameras
Photo: Lucía Corral

Lucía and Lindsay Brown setting a camera trap station Photo: Adela Annis

Swift fox caught on a trail camera in Western Nebraska

CLIMATIC CONSTRAINTS ON BOBWHITE QUAIL POPULATIONS ALONG THEIR NORTHERN EXTENT

Principal Investigator(s):	Joseph J. Fontaine, Gwen Bachman
Graduate Student(s):	Amanda (Mandy) Lipinski, Ph.D. Victoria Simonsen, M.S.
Project Duration:	June 2014 – December 2020
Funding:	Nebraska Game and Parks Commission
Project Location:	South Central Nebraska
Website:	http://snr.unl.edu/prairiebirds/

Northern bobwhite quail (*Colinus virginianus*) are among the most popular game birds in North America; however, the loss of suitable habitat has led to precipitous population declines throughout their range. With significant grassland and farmland habitats, Nebraska has the potential to maintain viable quail populations, but due to the climatic conditions imposed by harsh winters and periodic wet springs, quail populations in Nebraska tend to be highly variable from year to year. Local habitat management may be capable of overcoming some environmental constraints, but effective management strategies necessitate a comprehensive understanding of the impacts of large scale climatic conditions on Nebraska's quail resources.

Although there are numerous studies focused on water constraints for quail populations in arid environments, the role of climatic conditions in driving quail populations in traditional temperate environments remains limited with much of the research conducted when the landscape was more conducive to facilitating population rebounds after severe weather events. Given the current agricultural paradigm, and predicted changes in climatic conditions, it remains unknown whether effective management implementation can lead to reliable quail populations and facilitate long-term stability in hunter engagement, satisfaction, and participation. In a first step to addressing this issue, we propose to identify the mechanism by which climatic conditions impact quail and the means by which management may overcome climatic constraints.

The purpose of this project is to improve our understanding of how severe climatic events (e.g., snow storms, spring rains) alter quail physiology and behavioral decisions to impact population stability in Nebraska and to further develop management strategies aimed at offsetting these costs. Utilizing an individualistic approach that considers the inherent trade-offs in life history, physiological, and behavioral expression, we hope to identify key constrains in population growth and management strategies that many ameliorate population cycles.

Bobwhite quail
Photo: Dave Menke, USFWS

Developing a Network for Invasive Species Outreach and Monitoring in Nebraska

Principal Investigator(s):	Craig R. Allen
Coordinators:	Rodney Verhoeff (4/2013 – 7/2013) Allison Zach (9/2013 – present)
Project Duration:	April 2013 – June 2016
Funding:	Nebraska Environmental Trust U.S. Fish and Wildlife Service
Project Location:	Statewide Nebraska

The Nebraska Invasive Species Program (NISP) administers a multi-institutional Aquatic Invasive Species Prevention Program with grant funding from the USFWS and Nebraska Environmental Trust.

Goals are to:

- Decrease the risk of invasive species introduction and spread through volunteer training workshops, and by targeted messaging across multiple user groups;
- Develop and implement a "next generation" invasive species education strategy;
- Evaluate the effectiveness of outreach in invasive species prevention through focused inventory and monitoring as well as through surveys designed to assess awareness;
- Increase local and regional collaboration in the prevention and control of invasive species.

Brochures were created and distributed to public and agency staff to promote the Nebraska Invasive Species Program and to educate people on invasive species in Nebraska. Advertisements for Clean, Drain and Dry and don't move firewood were included in Nebraska Game and Parks (NGPC) fishing and hunting guides. Advertisements were placed in community news journals and other NGPC publications in 2015. The program's website was further developed and will now include educational materials for teachers and outdoor educators (neinvasives.com).

Youth created masks of invasive insects
Photo by: Baillie Luff

Technicians located throughout Nebraska in 2014 and 2015 conducted boater surveys and participated in outreach events. The technicians also gave presentations at outreach events and to agency staff.

Curriculum for 9–12 grades was developed in 2015, and will be advertised and made available to teachers in Nebraska. A collection of hands-on materials and teaching materials on invasive species is in development and will be made available to teachers upon request.

The NISP coordinator organizes monthly meetings of the Nebraska Invasive Species Advisory Council (NISC). Members of the Council taught invasive species identification workshops in 2014 and 2015 to Master Naturalist program trainees. New invasive species identification guides were developed and disseminated at identification workshops and to agency staff.

Dynamics of Resilience in Complex Adaptive Systems

Principal Investigator(s):	Craig R. Allen
Graduate Student(s):	Shana Sundstrom, Ph.D.
Project Duration:	August 2012 – December 2015
Funding:	U.S. Geological Survey, Powell Center for Analysis and Synthesis (RWO 16)
Project Location:	Northwest United States and British Columbia, Canada

Ecosystems are a type of complex system, and as such share general rules of behavior with other types of complex adaptive systems. Research across a wide variety of disciplines has uncovered rules of system dynamics that address features of self-organization and emergence. Work in the field of ecology has proposed that resilience may be an emergent phenomenon of complex adaptive systems, and in particular, social-ecological systems. Resilience is the amount of disturbance a system can absorb or buffer while staying organized around the same key structures, processes, and functions. As our understanding of non-linear dynamics and complex systems has grown in recent years, the concept of resilience has exploded, and a great deal of work has been done to understand how resilience emerges and what system components and interactions comprise resilience.

One of the key findings is summarized in the cross-scale resilience model, which proposes that the distribution of species and the functions they represent within and across the scales of an ecosystem plays a key role in system resilience. While most previous work has been explicitly focused on social-ecological systems, there is some tantalizing evidence to suggest that resilience and the cross-scale model may also be applicable to other types of complex adaptive systems, such as economics.

In a more applied exploration of these ideas, the role of species abundance, coupled with their distribution of function, is an element of the cross-scale model that remains unexplored.

This project has two objectives.

1. Explore the discontinuity hypothesis and cross-scale model in greater detail at both ends of the research spectrum, building the theoretical foundations of the cross-scale model and thus its applicability to other complex adaptive systems, in order to expand our understanding of the cross-scale model to incorporate species' abundances and potentially use it as a tool for resource managers to use for identifying impending regime shifts.
2. Focus on improving our understanding of the relationship between cross-scale distributions, species abundance, and regime shifts at a system level.

Ecological Applications of Time-Lapse Photography

Principal Investigator(s):	Craig Allen, Michael Farrell, Michael Forsberg
Graduate Student(s):	Emma Brinley Buckley, M.S.
Project Duration:	January 2013 – December 2015
Funding:	Institute for Agriculture and Natural Resources, UNL
Project Location:	Central Platte River Basin, Nebraska

The Platte River Basin is one of the most significant river systems in the Great Plains and an internationally important wildlife resource. It demonstrates the complexity, over-appropriation, and importance of a human-dominated ecosystem that sustains many services including water supply for municipalities, agricultural irrigation, recreation, and fish and wildlife habitat. The objective of this project is to connect environmental changes, documented by time-lapse imagery, with bioacoustic data and water quality measurements to further our understanding of ecological variability and communicate complex system changes to a public audience.

Phenology, the timing of biological events and the causes of their timing, is an increasingly valuable component in understanding ecosystems. Our goal is to identify what environmental factors influence wildlife activity and other biological phenomena. We are utilizing bioacoustic recordings to determine the relative activity of bat, bird and frog species, and time-lapse imagery to quantitatively assess vegetation phenophase, a proxy for primary productivity and, therefore, resource availability. Preliminary findings suggest vegetation is an influential cue for migratory bat species.

Freshwater systems are inherently complex, functioning at varying temporal and spatial scales. We installed passive sensors and collected water samples in the Platte River Basin to measure water quality variables, including nutrients and pesticides. Time-lapse image analysis was used to estimate water-inundation where hydrological information was not available. We assessed variables using a multivariate time-series modeling approach. Models captured temporal dynamics of water quality and revealed the difference in patterns between wetland and river channels.

We are also developing educational tools through the synthesis of time-lapse imagery and data visualization. Videos, stories, and interactive graphics in a new media format will communicate the phenology, water quality dynamics, and importance of the Platte River Basin and our freshwater ecosystems.

Time-lapse, Platte River, 2014

Ecological Models and Biodiversity Conservation in Nebraska Landscapes

Principal Investigator(s):	Craig R. Allen
Graduate Student(s):	Daniel Uden, Ph.D.
Project Duration:	August 2012 – January 2016
Funding:	Nebraska Game and Parks Commission National Science Foundation IGERT Program, Grant 0903469
Project Location:	Nebraska

Biodiversity is increasingly threatened by an array of stressors; therefore, sustainable means of satisfying growing human resource demands while protecting the environment and at-risk species must continue to be explored and implemented. The consideration of alternative, plausible futures for, and adaptive management of, social-ecological systems have been promoted for addressing present societal, environmental and ecological challenges; however, the application of these approaches has been met with varying degrees of success at different spatial and temporal scales. Learning from the past, adjusting current strategies according to new findings, and considering alternative plausible scenarios of the future could increase preparedness and improve management outcomes, despite uncertainties.

The Nebraska Natural Legacy Project is a state wildlife action plan that aims at accomplishing the following objectives:

1. Reverse declines of at-risk species;
2. Recover species currently listed as state or federally threatened or endangered;
3. Keep common species common, and conserve natural communities.

The plan identifies 39 Biologically Unique Landscape(s) (BUL) within Nebraska where conservation actions will be specifically targeted. A coarse filter/fine filter approach to conservation has been adopted in the plan, with the goal of benefiting the majority of species by managing at the community (coarse filter) level. Threatened species not encompassed by community-level management are then addressed specifically (fine filter).

This project will develop distribution models for species and/or communities identified as conservation targets within Nebraska BULs, with the goal of integrating modeling into an adaptive management conservation framework for BUL management.

Expected products for BULs include habitat suitability ranks, assessments of functional connectivity for suitable habitat patches, baseline community area and species abundance estimates, identification of locations for focusing additional sampling and monitoring efforts, predicted community distributions and species abundances under an array of plausible management-based scenarios, evaluation of progress toward accomplishing established conservation objectives, and identification of suitable locations for the reintroduction of extirpated target species. Modeling techniques will be utilized according to data availability and their propriety for addressing specific research questions. Within an iterative framework, conservation objectives, management actions, and modeling techniques may be altered as additional information supporting adjustments is obtained.

EVALUATING THE BENEFITS OF HIGHER DIVERSITY CRP PLANTINGS FOR AT-RISK SPECIES

Principal Investigator(s):	Craig R. Allen
Graduate Student(s):	Hannah Birgé, Ph. D. Bethany Teeters, Ph.D.
Project Duration:	April 2011 – January 2017
Funding:	National Science Foundation IGERT Program, Grant 0903469 Nebraska Game and Parks Commission
Project Location:	Statewide Nebraska

The Nebraska Legacy Plan lists grassland loss as one of the primary conservation threats in the state. The USDA Conservation Reserve Program (CRP) provides incentives for farmers to take marginal lands out of crop production for a 10–15 year period, during which it is frequently planted to grasslands. Land enrolled in CRP covers more than a million acres in Nebraska, but it is planted to a wide range of seed mixes and little is known about how differences in plant diversity and composition may impact faunal biodiversity and conservation threats. This project compared high and low diversity CRP plantings to evaluate potential benefits for at-risk species, including habitat for butterflies, bees and birds, the exclusion of non-native species, and water infiltration. The data from this project may be useful for monitoring succession and the impacts of management techniques in future research. Overall, the effect of higher diversity CRP was either neutral or positive, with a few exceptions. The objectives and primary findings were as follows.

1. *Determine if higher diversity CRP plantings provide habitat and forage for at-risk grassland butterfly species.* Higher diversity CRP planting mixes more often contained forage species for at-risk butterflies. CP38 was typically best suited for all species. The exception in all cases was the regal fritillary (*Speyeria idalia*) since no planting lists contained the larval forage (violets).

2. *Determine benefits of planting diversity for native bees and at-risk grassland birds.* Bumble bees (*Bombus* spp.) responded positively to forbs that were found only in pollinator CRP, but the effect of forb diversity on wild bees is likely to change over time as the pollinator plantings become better established. This may also influence at-risk bird species by enhancing nesting suitability and invertebrate forage in high diversity plantings. The eastern meadowlark (*Sturnella magna*), was only counted in pollinator plots, for example.

3. *Determine if higher diversity plantings drive changes in soil health and impact the colonization of non-native species.* Better infiltration rates were observed in the higher diversity pollinator plantings but may be an effect of disking, the weedy species on the plots, or both. Regardless, sufficient bulk density for desirable plant growth may only be maintained on these sandy soils with disking until the plots are better established. Similarly, although the pollinator plantings had a greater number of non-native species, this may be due to the stage of succession at which the study was done, with weedy species coming in before deeper-rooted native species. Limited spread of invasive species and non-native species may be more strongly linked to planting diversity as the pollinator plots become better established.

Grass seed planting mix
Photo: Bethany Teeters

Forb seed planting mix
Photo: Bethany Teeters

Evaluating the Value and Efficacy of Agricultural Conservation Programs for Landowners and Conservation Practitioners

Principal Investigator(s):	Joseph J. Fontaine
Project Coordinator:	Caitlyn Gillespie (2015)
Post-Doctoral Associate:	Dustin Martin (2014)
Project Duration:	July 2013 – June 2015
Funding:	Nebraska Environmental Trust Nebraska Game and Parks Commission
Project Location:	Nebraska

In Nebraska, Conservation Reserve Program (CRP) enrollment peaked in 2007 at 1.3 million acres and by 2012 had declined by roughly 30% to 900,000 acres. At the current rate of loss, CRP could disappear from the Nebraska landscape by 2025. Although the complete loss of CRP is unlikely, dramatic reductions in the availability of CRP and changes in the distribution and land types covered in CRP are likely to have corresponding implications for the soil, water, and wildlife resources of Nebraska. While much of the decline in CRP enrollment is attributed to higher commodity prices—as corn acres over the same time period increased from 9.4 million to 9.9 million acres—the complexity of the CRP program and the associated changes in farm demographics and agricultural practices brings into question whether factors beyond economics may drive conservation attitudes in Nebraska's farmers.

Moreover, while conservation efforts have largely focused on reducing impacts through habitat restoration, it is becoming increasingly apparent that protectionist efforts are insufficient to ensure long-term socio-ecological resilience. Conservation approaches which are inclusive of human demands on ecosystem services and consider the potential for human dominated landscapes to provide for and maintain biodiversity while simultaneously providing for the food and fiber needs of society may provide an opportunity to strike a balance between socio-economic needs and socio-ecological impacts. However, this shift in paradigm necessitates innovative approaches that move beyond traditional conservation strategies. In either case, whether we are attempting to ensure the future of CRP or develop novel agricultural conservation programs, it is imperative that we understand the perceptions and values of the stakeholders involved.

This project will work with conservation practitioners and landowners throughout the state of Nebraska to evaluate the perceptions and values of landowners, specifically:

1. What are the perceptions and perceived values of the CRP program?
2. What are the perceptions and perceived values of the alternative CRP practices and the associated management requirements and approaches?
3. What are the limitations to participation in CRP by landowners?
4. What are the limitations in the ability of conservation practitioners and natural resource agencies to promote CRP?
5. What are alternative conservation strategies to CRP and the perceptions and perceived values surrounding the implementation of these alternatives?

Fremont State Lakes Renovation Study: Effects of Alum Application and Fishery Renovation on Water Quality

Principal Investigator(s):	Amy Burgin, Steve Thomas, Mark Pegg, Kevin L. Pope
Graduate Student(s):	Meg Trowbridge, M.S. Christa Webber, M.S. (2014)
Project Duration:	April 2012 – September 2015
Funding:	Nebraska Department of Environmental Quality Nebraska Game and Parks Commission
Project Location:	Fremont State Recreation Area, Douglas County, Nebraska

The Fremont State Lake System (FLS) is made up of 20 sandpit lakes adjacent to the Platte River near Fremont, Nebraska and is used by 800,000 visitors annually. These lakes were created as early as the 1940s and many are now experiencing water quality problems related to eutrophication. High nutrient concentrations in the water column are driven primarily by internal loading from nutrient-rich sediments accumulated through deposition of leaves fallen from trees, shoreline vegetation, fish excrement, and decaying remains of fish and aquatic vegetation. Eight of the lakes in the Fremont State Lakes are on Nebraska's 2012 section 303(d) list of impaired waters with 30 different impairments. In the fall of 2012, 16 lakes were chemically treated (with aluminum sulfate, alum) to reduce nutrients available for phytoplankton growth. In addition, four lakes were also treated with rotenone for a fishery renovation, which subsequently included removing bottom-feeding species and restocking with a more desirable assemblage.

Given the alterations to the chemical and biological structure of the lakes, the goal of this study is to understand how physical drivers (e.g., lake-basin structure) and biological drivers (e.g., fish community composition) interact to affect the longevity and effectiveness of alum additions for improving water quality. This will be addressed through three major tasks:

1. *Monitoring* physical and chemical water quality;
2. *Analyzing* the internal and external phosphorous (P) budgets, and
3. *Discerning* how altered fish communities indirectly affect water-quality dynamics.

Alum additions improved water quality by decreasing TP and chlorophyll a. Combining alum and biomanipulation (fish renovation) together had the added benefit of decreasing phytoplankton and cyanobacteria densities. Restoration treatments, however, were ineffective for shifting the phytoplankton community away from cyanobacteria dominance. Furthermore, microcystin toxin, produced by cyanobacteria and a key target of many water quality restoration efforts, varied more year-to-year than by restoration technique. We conclude that if water quality restoration goals are focused on biological improvements, as opposed to solely chemical improvement, then adding biomanipulation in a dual treatment may enhance restoration success. The information collected during this project will be useful in designing future lake renovation projects and developing long-term management plans for renovated lakes.

Private contractor applying alum treatment to Fremont Lakes
Photo: Brian Hammond

GENERATION OF NOVELTY IN COMPLEX SYSTEMS

Principal Investigator(s):	Craig R. Allen
Project Duration:	January 2013 – December 2015
Funding:	James S. McDonnell Foundation
Project Location:	Global

Novelty and innovation are essential attributes for the continued success of ecological, social and other complex systems, both natural and anthropogenic. Without them, dynamic, adaptive change in response to disturbance is not possible. Novelty and innovation are required to keep existing complex systems resilient and adaptable, and to create new structures and interactions following catastrophic ecological or social failures. The importance of novelty is recognized in the management and business world, but is less explicitly recognized and appreciated in the scientific world.

Novelty refers to new "products," things or ideas which are generated through innovation, the process whereby novelty is created. Novelty and innovation are characteristic of dynamic systems—systems that are alive and changing—and are generated at multiple levels. For example, in biological systems, novelty is generated at the genetic level through random processes of mutation, at the species level through evolution and natural selection, at the community level as a result of regrouping of species combinations, and at the ecosystem level as a result of changes in key processes and interactions. Novelty is being constantly created, and extinguished. By generating potential solutions in advance of need, solutions may be readily available when problems arise.

Novelty can be either local or global. Locally novel additions are unique to that particular system, but may exist and originate from elsewhere. For example, when a species invades an ecosystem, novelty is added to that system. The invasive species is new to that system, but the species itself is not a novel or new life-form. On the other hand, globally novel additions had no prior existence. They are new not only to the particular system within which they are generated or added, but are globally unique. Speciation in an ecological system represents the addition of global novelty.

Without innovation and novelty, systems may become stagnant. Having a constant source of innovation and novelty is clearly important for systems, both following transformations and during their normal dynamics. However, novelty may be a destructive force as well. Invasive species, for example, can alter basic process and structure in ecosystems and be a source for decline or collapse. Cellular mutations can have obviously destructive consequences upon individuals and lineages—cancer is a prime example. Thus, innovation and novelty can be a double-edged sword. In ecosystems, for example, novelty in the form of new species has been a cause of major extinctions, but is also the prime source for recovery.

To explore the causes and consequences of the generation of novelty and innovation for humans, for social systems and for ecological systems, we will convene a small diverse group of researchers from diverse disciplines, with a variety of approaches and backgrounds, where we believe a deliberate focus on the concept of novelty could be fruitful. Our overall intent is to identify commonalities across disciplines. What attributes of a system are necessary if novelty is to arise? What might be the consequences, both positive and negative, of systems structured to permit novelty and innovation?

GEOGRAPHIC DISTRIBUTION AND OCCUPANCY OF OTTERS IN NEBRASKA

Principal Investigator(s):	Craig R. Allen
Graduate Student(s):	Nathan Bieber, M.S.
Project Duration:	June 2014 – June 2016
Funding:	Nebraska Game and Parks Commission
Project Location:	Nebraska

After nearly a century of absence from Nebraskan waters, otter reintroduction efforts began in the state in 1986, and the otter was listed as an at-risk species in the state at that time. By 1991, 159 release otters were obtained from around North America (primarily from Alaska and Louisiana) and released at seven sites on the Platte, Niobrara, South Loup, Elkhorn, Calamus, and Cedar rivers. Early indications from citizen reports, bridge surveys, and radio-telemetry of marked otters in the Central Platte River region suggest that these iconic predators have recolonized much of their lost historic range. With the apparent success of the reintroductions, Nebraska's wildlife managers are anticipating removing this species from the at-risk species list, and developing an active management plan for the species.

Our goal is to provide state furbearer managers with a more complete picture of North American river otter (*Lontra canadensis*) distribution in the state of Nebraska, to help aid the development of an otter management plan.

Our specific research objectives are to:

1. Determine current distribution of river otters in the state; and
2. Identify patterns of otter occupancy in order to provide managers with a framework around which to base decisions on possible controlled otter harvests and otter conservation status changes.

Two field seasons will be dedicated to paddling Nebraska's rivers in order to document otter sign—primarily tracks and scats on river banks. The location data obtained will be used to build models of otter occupancy across the state's major watersheds. We will also deploy remote cameras in order to bolster our likelihood of detection and to draw comparisons between active sign surveying by boat and passive surveying with cameras.

During the summer of 2014, more than 600 river miles were paddled or walked by the surveys team. Otter sign was found in abundance on the Platte and Niobrara Rivers, and sign was also located on the Elkhorn, Loup, and Cedar Rivers.

Kayaking Nebraska rivers looking for signs of otters
Photo: Nathan Bieber

Otter tracks found beneath a bridge
Photo: Nathan Bieber

GLOBAL CHANGE, VULNERABILITY AND RESILIENCE: MANAGEMENT OPTIONS FOR AN UNCERTAIN FUTURE

Principal Investigator(s):	Craig R. Allen, Dirac Twidwell, David G. Angeler (Swedish University of Agricultural Sciences)
Graduate Student(s):	Jessica Burnett, Ph.D. Caleb Roberts, Ph.D.
Project Duration:	May 2015 – January 2019
Funding:	U.S. Department of Defense
Project Location:	Nebraska

Our objectives for this new project are to develop models to detect and assess ecological regime shifts in space and time, to identify components of adaptive capacity, and to identify species and techniques that may serve as leading indicators of thresholds of changing ecological regimes. We will utilize monitoring and survey data that is currently available in North America (e.g., Breeding Bird Surveys) with developing and novel statistical tools and theory to assess long-term trends in resilience of landscapes, changes in ecological regimes in both space and time, and species vulnerable to decline and extinction, with a focus on the management of ecosystems in the Great Plains of the USA.

We will accomplish these goals using advanced spatial and time series modeling, and discontinuity analysis to quantify how core attributes of resilience (within-scale and cross-scale distributions of species and their functional traits) change over time in ecosystems and landscapes. Additionally, we will evaluate the significance of individual species to adaptive capacity, and thus the resilience of ecosystems and landscapes. We will conduct these analyses with data from the central United States with focal areas on Department of Defense managed properties, in particular Eglin Air Force Base, Florida, and Fort Riley, Kansas.

Implications of Hunter Harvest and Wildlife-friendly Agricultural Practices on Pheasant Behavior and Population Dynamics

Principal Investigator(s):	Joseph J. Fontaine, Larkin Powell
Project Manager:	Adela Annis
Graduate Student(s):	Lindsey Messinger, M.S. (2015)
Project Duration:	January 2012 – May 2019
Funding:	Nebraska Game and Parks Commission
Project Location:	Southwestern Nebraska
Website:	http://snr.unl.edu/fishhunt/index.asp

Ring-necked pheasants (*Phasianus clochicus*) are a culturally and economically important game species in Nebraska. Unfortunately populations have been declining since the 1950s due to habitat loss and land use change. Managers are interested in developing programs that will continue to support and increase existing pheasant populations. While lands enrolled in the Conservation Reserve Program (CRP) are vital in supporting pheasant populations, participation in the program is expected to decline. Land managers in Nebraska are offering incentives to private landowners for employing wildlife friendly agricultural practices (e.g., grazing deferment, tall stubble height, and prescribed burning) and access to private lands through public access signup programs.

Our goal is to provide a better understanding of how pheasants use agriculturally-dominated landscapes and to identify the impacts of recreational hunting on pheasant behavior and population dynamics as well as evaluate the effectiveness and potential benefits of wildlife friendly agricultural practices within the Southwest Focus on Pheasants area in southwestern Nebraska.

Over the course of the project we captured and radio collared over 300 pheasants, including equipping several birds with GPS collars programmed to take locations every four hours. We recorded over 4,000 locations and collected vegetation and microclimatic conditions at nearly 500 sites. In addition, we collected data on hunter movements and interests. Using advanced time-lapse photography, we took over 100,000 photos which we are using to estimate hunting pressure on private lands enrolled in the Nebraska Open-Fields and Waters programs. We also conducted interviews of 150 parties hunting the open access fields for pheasants. This project is expected to be completed is ongoing.

Pheasant hunting, southwest Nebraska
Photo: Jessica Laskowski

Radio collared hen pheasant
Photo: Lyndsie Wszola

INCORPORATING SOIL ECOLOGICAL KNOWLEDGE INTO MANAGEMENT OF CRP LANDS

Principal Investigator(s):	Craig Allen, Hannah Birgé
Graduate Student(s):	Hannah Birgé, Ph.D.
Project Duration:	May 2013 – August 2016
Funding:	National Science Foundation IGERT Program, Grant 0903469 United States Department of Agriculture
Project Location:	North Central Nebraska

Mid-contract management on land enrolled in the Conservation Reserve Program (CRP) seeks to mimic the natural disturbance regimes (e.g., fires) that were once common in the Great Plains, but are now largely repressed by humans. The goal of mid-contract management is to increase the abundance of ground-dwelling macro-invertebrates, increase forbs, increase overall plant diversity, and increase bare ground—all of which are essential to quality upland game bird habitat. However, these different types of disturbances often have unintended consequences beyond enhancing bird habitat. This project focuses on evaluating how different mid-contract management strategies address the goal of improving upland gamebird habitat, and also seeks to quantify the effects of mid-contract management on soil, plants, and insects.

Disentangling and quantifying the tradeoffs in different mid-contract management strategies will allow private landowners and federal and state personnel to better navigate the delicate task of balancing management goals (e.g., cost of implementation, bird production and/or soil quality). For example, if a mid-contract management strategy imparts concurrent benefits to bird populations, soil quality, plant communities and invertebrates, its true value to management may be underestimated. Conversely, if immediate benefits to bird production actually undermine soil quality and its long-term ability to support key macro-invertebrate populations, the benefit of mid-contract management to upland bird production could be limited.

We believe that our work addresses a substantial gap in current understanding of agroecosystems enrolled in the Conservation Reserve Program. We will in particular investigate the response to four common mid-contract management activities, disking, burning, selective plantings, and herbicides. Although the impact of the CRP and management activities on soil health is well-documented, there are no known studies investigating the impacts of four common mid-contract management activities on various attributes of ecosystem health within the scope of an individual study.

Local and Landscape Constraints on Habitat Management for Upland Birds

Principal Investigator(s):	Joseph J. Fontaine, Larkin Powell
Post-Doctoral Associate:	Erica Stuber
Graduate Student(s):	Christopher F. Jorgensen, M.S. (2012)
Undergraduate Student:	Victoria Simonsen, UCARE Student (2015)
Project Duration:	January 2010 – May 2018
Funding:	Nebraska Game and Parks Commission University of Nebraska–Lincoln UCARE Program
Project Location:	Statewide Nebraska
Website:	http://snr.unl.edu/prairiebirds/

Throughout the Great Plains, changing land-use practices are resulting in large scale biodiversity loss and an ever increasing dependence on effective conservation and restoration efforts provided by private, state, and federal agencies. Yet, far too often local management efforts fail to demonstrate the desired outcome for wildlife populations. Understanding why management actions are unsuccessful is paramount, but past studies often fail to consider the importance of ecological mechanisms that act across multiple spatial and temporal scales. By exploring how grassland bird communities select habitat based on local vegetative composition as well as landscape attributes, we can gain perspective on why populations and communities fail to react to apparently suitable habitat improvements.

Using geographic information system spatial analysis tools, we are analyzing data from avian point count surveys and local vegetation assessments within a larger land cover layer of Nebraska. The resulting outputs are being employed to create species specific spatial models for Nebraska, which identify key focus areas to implement management efforts with the goal of maximizing management benefits to grassland bird communities.

Over the 2010, 2011, and 2012 field seasons, roughly 3,000 avian point count surveys were conducted on State Wildlife Management Areas, private properties enrolled in the Open Fields and Waters program, road transects, and other private properties enrolled in Conservation Reserve Program throughout much of Nebraska. In order to validate our spatially explicit species distribution models, this past field season we added ten transects located in the panhandle, north-central, and north-eastern portions of the state. Analysis of habitat factors influencing upland species and other obligate grassland birds indicates that the surrounding landscape strongly affects local habitat suitability. Thus, the success or failure of conservation efforts on the ground may be determined by the landscape context.

Vicki Simonsen, as an undergraduate UCARE student, tested one of the mechanisms that may explain how landscapes influence pheasant populations. In the summer of 2013, we used artificial nests to test if the presence of suitable nesting habitat in the surrounding landscape reduced nest predation. Over the course of two months we put out more than 100 nests, some of which were monitored by trail cameras.

Badger depredating an artificial nest
Photo: Victoria Simonsen

MAKING ADAPTIVE MANAGEMENT MEANINGFUL: TRANSLATING SCIENCE LEARNING INTO POLICY DECISION-MAKING

Principal Investigator(s):	Craig R. Allen, Kyle Hoagland
Graduate Student(s):	Chad Smith, Ph.D.
Project Duration:	July 2007 –
Funding:	No external funding
Project Location:	Great Plains and Western U.S.

Chad Smith continues his research into the application of adaptive management at large scales and the link between governance structure and the successful implementation of adaptive management.

Smith is investigating major Bureau of Reclamation river recovery programs and his research includes: 1) literature review of adaptive management and adaptive governance; 2) how the river recovery programs define and implement adaptive management; 3) a comparison of different program governance structures; and 4) the aspects of governance and program management that relate to and predict successful implementation of adaptive management. Smith is applying learning from his research in the real world, serving as Adaptive Management Plan implementation coordinator for the Platte River Recovery Implementation Program. He was also co-lead of a small team that wrote an Adaptive Management Plan for the Middle Rio Grande Endangered Species Collaborative Program and has provided expert advice on adaptive management to programs on the Trinity River, Missouri River, and the Everglades.

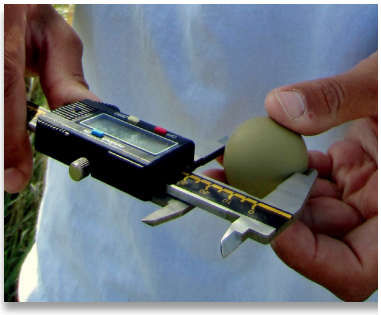
Management Induced Shifts in Pheasant Reproductive Strategies

Principal Investigator(s):	Joseph J. Fontaine
Project Manager:	Adela Annis
Graduate Student(s):	Jessica Laskowski, M.S. (2014)
Project Duration:	September 2011 – August 2018
Funding:	Nebraska Game and Parks Commission
Project Location:	Southwestern Nebraska
Websites:	http://snr.unl.edu/prairiebirds/

The native grasslands of the Great Plains serve as habitat for numerous wildlife species, but the intensification of agricultural practices and the subsequent alteration of the landscape has drastically reduced and fragmented remaining grasslands. The Conservation Reserve Program (CRP) has helped to mitigate habitat loss and slow the rate of population decline of grassland dependent species, but funding for, and subsequent enrollment in, CRP is declining. Pheasants are an economically important species that responds well to CRP, but as acres of CRP decline, it is becoming increasingly important to develop new approaches to improve and stabilize pheasant populations.

Because pheasants are relatively short-lived, successful reproduction is paramount to population growth. The goal of this project is to better understand how management actions (e.g., habitat enhancement programs, harvest management) influence pheasant reproduction and subsequently pheasant population growth. We employed an individualistic approach that considers behavioral and life history responses to management actions as a means of understanding pheasant population dynamics.

Radio-telemetry was used to track hen pheasants in the breeding seasons of 2012 to 2014 within Nebraska's Southwestern Focus on Pheasant Area, a site intensely managed to boost pheasant populations. Hen nesting site preferences and reproductive strategies (e.g., clutch size, egg size, and incubation patterns) were assessed in response to variable land-cover, hunting regimes and habitat enhancement. Over three years we captured nearly 100 hen pheasants on more than ten study sites. We measured many aspects of reproductive conditions, including collecting blood from roughly 60 hens to assess baseline and elevated cortecosterone levels, an indicator of stress. We found and monitored almost 70 nests, and collected nearly 300 samples of invertebrate food resources in brood rearing habitats. Work on this project is on-going.



Measuring pheasant eggs
Photo: Lindsey Messinger

MERGING SOCIAL AND ECOLOGICAL NETWORK MODELS

Principal Investigator(s):	Brian D. Fath (Towson University), Kevin L. Pope, Valery Forbes
Graduate Student(s):	Danielle Haak, Ph.D.
Project Duration:	June 2014 – November 2015
Funding:	International Institute of Applied Systems Analysis (IIASA) Young Scientists Summer Program National Science Foundation IGERT Program, Grant 0903469 University of Nebraska Presidential Fellowship
Project Location:	Laxenburg, Austria and Southeast Nebraska

The field of ecology is shifting from population and community-based research to social-ecological research at a systems scale. Humans are often excluded from analysis, nullifying the social-ecological approach proposed by the sub-fields of resilience and adaptive management. Successful natural resource management relies on understanding how the components within a system fit together, allowing actions to be more proactive than reactive.

To apply this shift in thinking to aquatic invasive species management, there are two main research objectives.

1. Identify how the social component of ecosystems can be integrated into ecological network analysis (or vice versa); and
2. Apply and adapt the current ecological network analysis approach to predict movement, likelihood of introduction, and establishment of aquatic invasive species.

This will allow us to assess how disturbances, such as the introduction of an invasive species, alter energy flows both within an individual lake and across the regional landscape.

We adapted the framework of infectious disease network modeling to couple a social-network model depicting angler movement with ecological models depicting aquatic food webs to develop a dual-aspect (i.e., "coupled") model. We used this coupled model to simulate the invasion process for Chinese mystery snail in the Salt Valley reservoirs in southeastern Nebraska over the next 25 years. In the simulation, five reservoirs started with source populations of mystery snail, seven additional reservoirs were invaded and became "contagious," and two had snail populations introduced but were still below the contagion threshold.

This case study demonstrates the utility of combining both social and ecological models to address the interdisciplinary problem of spreading invasive species within a complex, social-ecological system. This method may allow us to take a true "regional fishery" approach to sportfish management.

MONITORING, MAPPING, RISK ASSESSMENT, AND MANAGEMENT OF INVASIVE SPECIES IN NEBRASKA

Principal Investigator(s):	Craig R. Allen
Coordinators:	Karie Decker (7/2009 – 11/2012) Rodney Verhoeff (4/2013 – 7/2013) Allison Zach (9/2013 – present)
Project Duration:	January 2010 – December 2019
Funding:	Nebraska Game and Parks Commission
Project Location:	Statewide Nebraska
Website:	http://neinvasives.com/

Funding was provided through a federal-aid grant from the Nebraska Game and Parks Commission to:

- Provide outreach to, and facilitate communication among, stakeholders regarding biological invasions, coordinate the Nebraska Invasive Species Council, and assist with any additional legislation regarding invasive species as needed;
- Develop management tools including an invasive species adaptive management plan, a risk analysis for high-risk invasive species in Nebraska, a multi-agency prevention protocol for preventing the spread of invasive species (terrestrial and aquatic), and identification of invasive species introduction pathways.

The Nebraska Invasive Species Program continues to coordinate monthly meetings for the Nebraska Invasive Species Advisory Council, which was formalized as a state council through legislation in April 2012. This seventeen-member advisory council discusses topical invasive species issues, develops management plans and Early Detection-Rapid Response (EDRR) plans, builds collaborative partnerships to address priority issues, and informs the Nebraska Legislature of the status of invasive species in the state. An adaptive management plan was written by the Council in 2015 and provided to the Governor and legislative agricultural committee.

In early 2015, the council supported Legislative Bill 142 which was passed into law in March. Several council members testified at the senate hearing and wrote letters in support. The law will help provide funding for an aquatic invasive species prevention program within the Nebraska Game and Parks Commission. The council supported this bill because similar programs have shown to be successful in other states.

Council members participated in a variety of outreach events in order to provide information regarding identification, prevention, and management of invasive species. The council's page of the website was further expanded to provide the public with information on the group. EDRR efforts were expanded through identification courses council members provided their own staff and other groups. The council updated the Nebraska weed watch list to identify key species of concern for management efforts. Nebraska Invasive Species identification guides were developed and distributed to the public at outreach events to assist in identifying invasive species and report them via the invasive species website.

2015 lakeside outreach event
Photo: Allison Zach

Pollinator Assemblages in Southeast Prairies and Sandstone Prairies Biologically Unique Landscapes

Principal Investigator(s):	Craig R. Allen, Chris Helzer (The Nature Conservancy)
Graduate Student(s):	Bethany Teeters, Ph.D.
Project Duration:	June 2009 – December 2015
Funding:	Nebraska Game and Parks Commission National Science Foundation IGERT Program, Grant 0903469
Project Location:	Southeast Nebraska (Pawnee, Johnson, and Richardson Counties)

Grasslands are among the most highly altered ecosystems in North America, and most tallgrass prairie, for example, has been converted to agricultural land uses. The surviving fragments provide critical habitat for sustaining the wildlife and functions of grasslands. Pollination, especially for forbs, is largely mediated by wild bees, and therefore pollination plays a key role in maintaining the diversity and structure of the tallgrass prairie community. This project documents the diversity of the wild bee communities and the relationship between bee and forb communities in different grasslands of the Southeast Prairies Biologically Unique Landscape in southeast Nebraska. Natural and semi-natural grasslands vary greatly in the availability of floral resources that bees require, but in a fragmented landscape other factors, such as the connectivity of suitable habitat patches, may be just as influential on bee species diversity and abundance as floral resources. This project examines the role of such factors in shaping bee community assemblages. The primary objectives are to:

1. Characterize the bee fauna from natural and semi-natural grasslands,
2. Determine how floral resource availability is linked to bee species diversity,
3. Examine the response of the wild bee community to local and landscape factors.

An analysis of bees' pollen profiles was added to the project with the help of the palynology lab at UNL to indicate resource use within a patch and the exportation or restriction of pollination services. Also, since bees are expected to respond differently to local and landscape factors according to functional traits, documenting these differences is important for monitoring species distributions and predicting changes in those distributions over time, especially because different functional groups may respond more strongly to certain types of land use or management than others. Analyses for this project should be completed by the end of 2015.

A native bee (*Melissodes sp.*) on poppy mallow (*Callirhoe involucrata*).
Photo: Bethany Teeters

Population Assessments of Temperate Basses in Nebraska Reservoirs

Principal Investigator(s):	Kevin L. Pope, Christopher J. Chizinski
Graduate Student(s):	Lucas Kowalewski, M.S. (2014) Nathan Stewart, M.S. (2015)
Project Duration:	July 2012 – June 2015
Funding:	Nebraska Game and Parks Commission
Project Location:	Southeastern Nebraska

Branched Oak Lake and Pawnee Reservoir are flood-control reservoirs located in the Salt Creek watershed of southeastern Nebraska, and are popular sites for water-based recreation. Angler use of these reservoirs has declined in recent years and the Nebraska Game and Parks Commission is interested in restoring angler use to historic levels. The observed declines in angler use in both reservoirs have been associated with shifts in the fish communities and declines in the quality of the sport fisheries.

White perch comprised a large portion of the fish biomass in both reservoirs following their unintentional introduction. An important step towards the improvement of the sport fisheries in these reservoirs was reduction of white perch population sizes and their maintenance at low abundances. Previous attempts to reduce white perch population sizes by stocking predatory fish were unsuccessful, likely because gizzard shad present in both reservoirs provided predatory fish with preferred, alternative prey. Physical reductions (removal of large portions of the populations) were needed in the white perch and gizzard shad populations for predators to have any chance of controlling and maintaining white perch abundances at low levels.

Managers needed baseline information on the abundances and spatial distributions of white perch and gizzard shad to assist in implementing effective actions for removing large proportions of these populations. Also, the effects of management actions need to be described to improve future management actions. The goals of this project were to provide this baseline information and to describe the effects of a control effort. The three specific objectives were:

1. Quantify white perch and gizzard shad abundances;
2. Describe the seasonal spatial distributions of white perch and gizzard shad;
3. Describe the effects of the 2013 low-dose rotenone application on white perch and gizzard shad populations in Pawnee Reservoir.

In Branched Oak Lake, we estimated that there were 1.14-1.26 million white perch along with 0.77-1.04 million gizzard shad. In Pawnee Reservoir, we estimated that there were 1.49-1.69 million white perch along with 0.59-0.68 million gizzard shad. White perch exhibited seasonal movements, particularly in Branched Oak Lake. During spring, white perch abundance was greatest in the lower portions of the reservoir. During summer, white perch dispersed into the upper reaches of the reservoir. In the fall, white perch shifted back to the lower reaches of the reservoir. We did not detect a consistent pattern in gizzard shad spatial distributions.

In an attempt to reduce white perch and gizzard shad abundances in Pawnee Reservoir, managers applied a low-dose of rotenone (9 µg/L target concentration) during November 2013. This application nearly extirpated gizzard shad from Pawnee Reservoir and reduced white perch abundance by 83%. This reduction in white perch abundance was accompanied by a 47% increase in white perch mean length from September 2013 to September 2014.

RAINWATER BASIN JOINT VENTURE SCIENCE

Principal Investigator(s):	Craig R. Allen, Andy Bishop (Rainwater Basin Joint Venture Partnership)
Science Coordinator:	Dana Varner
Project Duration:	October 2014 – June 2016
Funding:	Rainwater Basin Joint Venture
Project Location:	Nebraska

The Rainwater Basin Joint Venture's (RWBJV) mission includes science-based conservation efforts for all priority bird habitats throughout Nebraska's mixed-grass prairie region. The Management Board of the RWBJV is committed to implementing the U.S. Fish and Wildlife Service's Strategic Habitat Conservation model. This science-based model requires a commitment of resources and time to develop a strong biological foundation for delivering conservation planning and designing research and monitoring efforts. To fulfill this commitment, the University of Nebraska–Lincoln hired Dana Varner as the RWBJV Science Coordinator in October 2014. This position is the product of a partnership between the RWBJV, the Nebraska Cooperative Fish and Wildlife Unit, and the University of Nebraska–Lincoln School of Natural Resources, which provides office space and support in Lincoln. Funding for the position is provided by the RWBJV.

As science coordinator, Dana is working with RWBJV science staff to develop models and decision support tools that help identify areas where conservation is most likely to benefit migratory birds and wildlife. She works with partner researchers and scientists to expand the knowledge of the region's conservation needs and to monitor and evaluate the success of completed habitat projects. In addition, Dana helps monitor and evaluate the success of ongoing and past conservation projects and collaborates with researchers from various federal, regional, and state conservation organizations. Dana recently worked with the RWBJV's Conservation Planning Workgroup to complete an updated *Research, Inventory, and Monitoring Plan* which outlines science questions, concerns, and needs within the administrative area. Several projects are currently in progress including an assessment of National Wetland Inventory data, an evaluation of several years of wetland vegetation and management data, and a conservation acquisition prioritization model.

Range and Habitat Preferences of Northern Long-eared Bats in Nebraska

Principal Investigator(s):	Craig R. Allen
Coordinator:	Zachary Warren, M.S.
Project Duration:	May 2015 – May 2017
Funding:	Nebraska Department of Roads; RHE-06
Project Location:	State-wide Nebraska

The listing of the Northern long-eared bat (NLEB) as threatened under the U.S. Endangered Species Act in spring of 2015 highlighted the need to better understand this species ecology within Nebraska. This project aims to evaluate geographic distribution and potential habitat of the Northern long-eared bat throughout the state, in order to identify areas of high and low probability of occurrence. This critical information will allow managers and biologists to focus future conservation efforts on areas that will have the greatest positive impact. If federal restrictions are increased in the future, this work will also potentially limit intensive and costly consultations with the U.S. Fish and Wildlife Service to only areas where NLEB is likely to occur. To achieve our objective, this project will use a two-step process over the course of two field seasons.

The first step of the project, implemented during the summer of 2015, is to better define the actual geographic distribution of the Northern long-eared bat within Nebraska by conducting statewide surveys. Acoustic detectors that record the echolocations of bats have been deployed for six nights at a time in preselected 10km x 10km grids. Because each species of bat emits a unique echolocation in the same way that bird species have unique songs, the collected recordings can be analyzed for NLEB presence. The acoustic detectors allow for simultaneous large-scale surveying in a variety of habitat types while requiring fewer man-hours compared to the physical trapping of bats. The results from this acoustic survey will provide a better idea of NLEB distribution throughout the state and will focus efforts for the project's second step.

In part two of the project, regions where NLEB was detected will be intensely acoustically surveyed in a variety to habitat types in 2016 to better define habitat preferences of the species. The data gathered from this stage of the project will be used to create a model that can predict NLEB presence in the state and evaluate influential landscape features (e.g., forest cover, water availability, vegetation types, etc.). The final product will be a map showing the probability of NLEB presence throughout Nebraska. This map can be used by federal and state managers to focus conservation efforts and mitigation actions to areas where the species is likely to be present and will have the greatest effect.

An increased understanding of at-risk bat populations is critical for their conservation. Until technology such as acoustic bat detectors became available, landscape-level bat research required trapping, which is time consuming and often yields biased and incomplete results. Now that bat researchers have the tools to conduct large-scale surveys with relatively small field crews, we can better begin to answer larger-scale questions and improve conservation measures for at-risk bat species. This research is a step in that direction for the state of Nebraska.

Resilience Thinking and Structured Decision Making in Social-ecological Systems

Principal Investigator(s):	Craig R. Allen, Melinda Harm Benson (University of New Mexico)
Graduate Student(s):	Noelle Hart, Ph.D. (2015)
Project Duration:	August 2011 – August 2015
Funding:	National Science Foundation IGERT Program, Grant 0903469 Nebraska Natural Legacy Project
Project Location:	Statewide Nebraska

The natural resource management paradigm has been shifting from traditional command-and-control to a focus on complex social-ecological systems and explicit recognition of uncertainty. Implementation of the new paradigm requires methods for making wise, defensible decisions in the face of the challenges and risks presented by managing natural resources in complex social-ecological systems. This research project presents an approach to natural resource management planning in complex social-ecological systems that combines the benefits of structured decision making (including adaptive management) and resilience thinking. Oak forest conservation in southeastern Nebraska is used as a case study throughout.

Structured decision making is a process for developing management plans that are built upon a thorough understanding of the problem, values, options, and potential consequences. Adaptive management is a form of structured decision making in which uncertainty is reduced through designed monitoring and review. Resilience thinking offers ways of conceptualizing complex systems, acknowledging the presence of multiple stable states in nature and considering the extent to which a given system can absorb perturbation before shifting into a different organization of functions and processes.

Research conducted as part of this project involved:

1. Linking recommendations for resilience thinking and structured decision making;
2. Investigating how optimization can be used to address resilience objectives;
3. Exploring the potential for adaptive management under State Wildlife Grants, focusing on the Nebraska Natural Legacy; and
4. Reducing uncertainty about the environmental and management drivers of oak seedling abundance at Indian Cave State Park.

Full results can be found in Noelle Hart's dissertation.

Stopover Decisions of Migratory Shorebirds: An Assessment of Habitat, Food, Behavior and Phenology

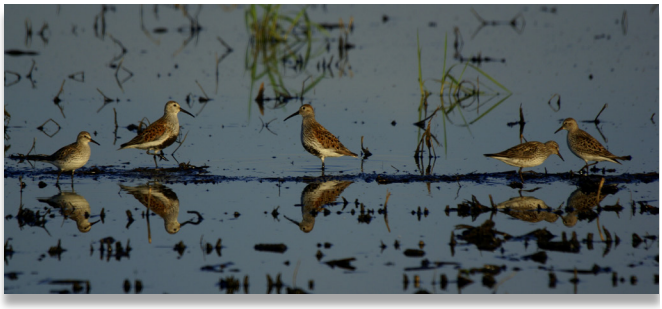
Principal Investigator(s):	Joseph J. Fontaine, Susan Skagen (USGS Fort Collins Science Center), Ted LaGrange (NGPC), Lisa Webb (Missouri Cooperative Fish and Wildlife Unit), Andy Bishop (Rainwater Basin Joint Venture)
Graduate Student(s):	Ryan Stutzman, M.S. (2012) Caitlyn Gillespie, M.S. (2015)
Project Duration:	January 2010 – December 2015
Funding:	U.S. Geological Survey, National Climate Change and Wildlife Science Center (RWO 12) Rainwater Basin Joint Venture Great Plains Landscape Cooperative
Project Location:	Nebraska, North Dakota, South Dakota

The wetlands of the Great Plains are increasingly altered by anthropogenic change, but remain important stopover habitats for a variety of migratory birds, including 37 species of shorebirds. Although shorebirds use highly altered wetlands, the extent to which these habitat decisions represent true preference and are adaptive remains unclear.

To identify the influence of anthropogenic change on avian habitat preferences, surveys were conducted for migrating shorebirds from April to June of 2010 and 2011 in north-central South Dakota. Our results show that shorebirds prefer highly-altered, agricultural wetlands, which have lower invertebrate (food) abundance than do grassland wetlands. However, by examining migrant behavior, we were able to determine that individuals have a higher foraging rate and search effort at preferred habitats, indicating that foraging efficiency, rather than food availability, is the limiting factor in this system.

We also examined the influence of local phenology on shorebird migration to identify the potential sensitivity of migratory timing to climate change. We found that shorebird migration coincides with invertebrate food resources, indicating that migrants may be sensitive to climate-driven changes in food resource phenology.

Based on the findings from this initial study, which concluded with Ryan Stutzman receiving his M.S. in December 2012, we have now begun to assess how larger landscape attributes affect stopover decision processes and the corresponding physiological implications. In the spring of 2013, Caitlyn Gillespie began monitoring shorebird migratory patterns through the Rainwater Basin of south-central Nebraska as well as the southern Prairie Pothole Region of South Dakota, a study that is currently on-going.



Shore birds
Photo: Joseph J. Fontaine

TESTING FOR THE PRESENCE OF THE CHYTRID FUNGUS (*BATRACHOCHYTRIUM DENDROBATIDIS*) IN AMPHIBIAN POPULATIONS ACROSS NEBRASKA

Principal Investigator(s):	Craig R. Allen, Ted LaGrange (NGPC)
Graduate Student(s):	Nick Smeenk, Ph.D.
Project Duration:	August 2010 – May 2015
Funding:	Nebraska Game and Parks Commission U.S. Environmental Protection Agency (EPA)
Project Location:	Statewide Nebraska

Many worldwide amphibian population declines and mass mortality events have been attributed to a fungal infection, chytridiomycosis (chytrid), caused by the fungal zoospore *Batrachochytrium dendrobatidis* (Bd). Although the exact mechanism by which mass mortalities occur from chytrid is unknown, it is hypothesized that the chytrid fungus infects keratinized epidermal cells of post-metamorphic frogs with death caused by: 1) disruption of osmoregulation, 2) the absorption of a fungal toxin, 3) or a combination of these factors. Concern over the potential ecological consequences of such rapid and drastic extinctions has led to an increase in effort studying the potential effects of emerging infectious disease on amphibian populations. Furthermore, scientific and technological advances in non-invasive techniques to detect the chytrid fungus have changed the ability of researchers and managers to track the distribution of and measure the population fluctuations and declines caused by infectious disease such as chytrid.

The chytrid fungus is known to occur in Nebraska and has been found in amphibian populations located in eastern Nebraska as well as along the Central Platte River. Although sporadic testing for the chytrid fungus in populations of native amphibians has occurred in Nebraska, a statewide survey has never been conducted. This gap in our knowledge pertaining to the current distribution of chytrid complicates management and conservation of amphibians. Filling this gap will allow researchers to know where chytrid is currently found in the state, and will aid in the development of predictive models and help in the understanding of factors that may help or mitigate the further spread of chytrid.

The primary goal of this study was to determine the current extent of chytrid in Nebraska by swabbing larval amphibian populations statewide. Using PCR, the samples were tested for the presence of Bd zoospores. The presence/absence of chytrid in amphibian populations were used to model the distribution of chytrid based on environmental covariates associated with wetland condition and amphibian call surveys. The modelling results will be used to develop predictive maps of the potential spread of chytrid based on important environmental and anthropogenic variables.

During the spring and summer of 2011 and 2012, researchers visited wetlands in eastern and central Nebraska. During site visits, tadpoles were captured using dip nets. At those sites where tadpoles were captured, each individual was swabbed using a sterile swab. In 2011 and 2012, 168 swabs were collected from five frog species at 21 sites. Preliminary PCR results detected chytrid in 62% of the sites. Additionally, chytrid was detected in at least one swab from each species. The detection rate (d) was highest in bullfrogs ($n = 9$; $d = 1.00$) and lowest in plains leopard frogs ($n = 78$; $d = 0.10$). The detection rate did not appear to vary between months (May – $n = 56$, $d = 0.125$; June – $n = 112$ $d = 0.17$). An additional ten samples were collected during 2013 and 23 samples were collected during 2014.

Testing the Functional Resilience of High and Low-diversity Prairie Communities to Paired Disturbance

Principal Investigator(s):	Craig R. Allen
Graduate Student(s):	Rebecca Bevans, M.S.
Project Duration:	May 2015 – May 2017
Funding:	Institute for Agriculture and Natural Resources, UNL
Project Location:	Platte River Prairies (Nature Conservancy Restoration Site)

As climate change and human intervention continue to affect long-term weather patterns, increase the likelihood of extreme weather, and introduce novel stressors into native ecosystems, managing for resilience has become a key concern for land managers and policy makers seeking to prepare for the consequences of these changes. Resilience, defined as the ability of a system to maintain its essential functions and identity in the face of disturbance, may work both for and against sustainability efforts, as degraded ecosystems may develop "negative" resilience that makes restoration of essential ecosystem functions difficult or impossible. Identifying and reinforcing the factors that support the resilience of healthy ecosystems to disturbance is, therefore, key to the long-term goals of both conservationists and policy makers hoping to improve the long-term sustainability of their regions.

Biodiversity, by maintaining biomass production under a wide range of conditions, protecting against biological invasion, and providing functional redundancy for essential ecosystem processes, is frequently noted as one of the most important factors in developing ecosystem resilience. However, studies of biodiversity and resilience are often undertaken at very small scales, under laboratory conditions, and frequently test only one disturbance. To improve our understanding of the cumulative impact of multiple disturbances on ecosystem resilience and stability, we have developed a two-year study focusing on the resilience of prairie ecosystem functions to paired disturbances. By imposing paired disturbances to experimental subplots within larger restoration plots, this study will address the cumulative impact of multiple disturbances on grassland community functions at both high and low diversity.

Our study, set in the Nature Conservancy's Platte River Prairies restoration area, will impose paired disturbances in an experimental restoration seeded in 2010 with twelve 0.5 acre blocks of either low-, mid- or high- diversity communities of native prairie plants. Passive rainout shelters will be in place from mid-May 2015 through 2017 on the low- and high-diversity plots to simulate long-term drought conditions, and subplots within each of these shelters will receive a secondary disturbance of either nitrogen additions (mimicking runoff from large-scale conventional farms), biomass removal (mimicking typical haying patterns on grasslands statewide), or invasive species plantings (to simulate biological invasion). One drought subplot and one subplot with no disturbances will also be established as controls. Experimental plots will be monitored for water stress, changes in community composition and nutrient cycling, and other functional characteristics over the course of the study to establish whether responses differ between low and high diversity plantings. This study, by imposing relatively large disturbances within large restoration blocks allows for the in-situ evaluation of disturbance effects that has been lacking in previous research and ensures that our results are due to our manipulations and not to edge effects typically present in smaller designs.

A rainout shelter in the field (May 2015)
Photo: Becca Bevans

Inside view of a rainout shelter in the field (May 2015)
Photo: Becca Bevans

UNDERSTANDING AND MANAGING FOR RESILIENCE IN THE FACE OF GLOBAL CHANGE

Principal Investigator(s):	Craig R. Allen, Shana Sundstrom, Kirsty Nash (James Cook University, Australia)
Graduate Student(s):	Kirsty Nash, Ph.D. Shana Sundstrom, Ph.D.
Project Duration:	August 2012 – December 2015
Funding:	U.S. Geological Survey, Powell Center for Analysis and Synthesis (RWO 16)
Project Location:	Global

Resilience science provides a conceptual framework and methodology for quantitatively assessing the ability of a system to remain in a particular state. Probable non-linear ecological responses to global change, including climate change, require a clear framework for understanding and managing resilience. However, much of the resilience research to date has been qualitative in nature, and frameworks developed for the implementation of resilience science have been either vague or focused on the social component of social-ecological systems. Attempts to quantify resilience and operationalize the concept include the cross-scale resilience model, discontinuity theory and the early detection of leading indicators of regime shifts. More work is needed to support the effective use of resilience theory for managing ecological systems. We propose to address gaps in the science of ecological resilience in order to develop a usable framework for the implementation of resilience science by natural resource managers. We will do this by accomplishing a series of related but discrete tasks.

1. *Synthesize* the current state of discontinuity research, the language barriers to communicating complex systems science and discontinuities, and the key criticisms of discontinuity theory in order to present a defined direction for how these criticisms could be addressed and/or tested.
2. *Determine* whether changes in species abundance can be a leading indicator of system-level regime shifts and an indication of the location of scale breaks within the scales of a system, and test the hypothesis that the location of species with the highest variance in abundance will be non-random.
3. *Develop* a new conceptual model of the relationship between biodiversity, scale and resilience that accounts for abundance and functional response diversity.
4. *Develop* a resilience framework for managers from a synthesis of our discussions and basic research.

To accomplish these goals we will convene a working group of international team of scientists working in a broad range of social-ecological systems. Working group meetings will be arranged to collaboratively address these tasks.

We successfully completed all three working group meetings in Fort Collins, Colorado, at the USGS John Wesley Powell Center for Analysis and Synthesis. Numerous publications are being developed as a result of the analytical, data-driven focus of our meetings. One is nearing completion, and three others are in varying stages of development.

USE AND SATISFACTION OF PUBLIC HUNTING OPPORTUNITIES

Principal Investigator(s):	Joseph J. Fontaine, Lindsey Messinger
Project Manager:	TBD
Graduate Student(s):	Lyndsie Wszola, M.S.
Project Duration:	January 2010 – December 2015
Funding:	Nebraska Game and Parks Commission
Project Location:	Statewide Nebraska
Website:	FishHunt.unl.edu

The retention and recruitment of hunters is of increasing concern to wildlife management agencies nationwide. A lack of access to quality hunting opportunities is often deemed as the primary reason why people quit hunting. In an effort to provide hunting opportunities for their constituency, the Nebraska Game and Parks Commission (NGPC) invests considerable time and resources into the development and management of public Wildlife Management Areas and private lands open to public access through the Open Fields and Waters Program. Although investment in these programs is assumed to fulfill the needs of the hunting community, evaluating the use of public or private land by hunters, and their overall satisfaction with the hunting experience is challenging. Currently, the majority of hunter participation, satisfaction, and harvest data are collected at coarse spatial and temporal scales, through post season surveys. Unfortunately, this data does not provide the preferred resolution needed to appropriately manage individual Wildlife Management Areas or Open Fields and Waters sites. Moreover, it does not allow managers to assess the value of their investment in particular lands. Given the limited resources available for wildlife management, managers need a better understanding of hunter participation at the scales for which management actions occur if they are expected to manage lands appropriately. The integration of research methods from fisheries and human dimensions will allow for fine-scale spatial and temporal data to be collected using proven methodology. Incorporation of fine-scale spatial and temporal patterns in hunter participation will help managers better determine appropriate site-specific management objectives given the dynamic nature of hunter participation.

Further, fine-scale spatial and temporal patterns in hunter participation can be used to develop regional management approaches that consider the dynamic nature of hunter participation. Hunters often move among multiple sites within a region. The geographic distribution of alternative hunting locations, the respective availability of game, and the overall quality of the hunting experience plays a critical role in how people perceive and participate in outdoor recreation. Thus the effect of hunting and hunter participation on wildlife populations, hunter recruitment and retention, and local economies is likely acting at multiple scales that are currently not considered when managing wildlife resources. This regional understanding of hunter participation and satisfaction could be a considerable aid in guiding NGPC investments in public land acquisition and private land initiatives such as the Open Fields and Waters Program.

Lindsey Messinger interviewing pheasant hunters in southwest Nebraska
Photo: Joseph J. Fontaine

WETLAND CONDITION ASSESSMENT

Principal Investigator(s):	Craig R. Allen, Ted LaGrange (NGPC)
Graduate Student(s):	Nick Smeenk, Ph.D.
Project Duration:	August 2010 – May 2015
Funding:	Nebraska Game and Parks Commission U.S. Environmental Protection Agency (EPA)
Project Location:	Statewide Nebraska

Since 1867, Nebraska has lost nearly 35% of its wetland resources, which equates to a loss of over one million acres of wetlands across the state. As of 2005, only 3% of remaining wetlands in Nebraska were owned by state, federal, or other conservation and management organizations. Although the quantity of these wetlands is known, the quality of the remaining, privately owned wetlands is less well understood.

As an extension of the U.S. Environmental Protection Agency's (EPA) National Wetland Condition Assessment (NWCA), eleven wetland complexes were visited, many in recognized Biologically Unique Landscapes, and wetland condition measured in ten individual wetlands in each complex. One wetland in each complex is considered the "reference standard" in terms of condition for wetlands in each complex, which provides a reference point to which other wetlands in that complex are compared. The data collection methods conform to those developed by the EPA, in which three levels of assessment are used to quantify wetland condition including landscape assessment, intensive on-site assessment focusing on vegetative, soil, and hydrologic characteristics and amphibian presence, and a rapid assessment method (USA-RAM) developed by the EPA.

The primary goal of this wetland condition assessment project is to quantify the condition of important wetland resources in Nebraska and aid in the development of wetland-specific, rapid assessment methods and state-wide wetland management strategies. The knowledge gained will be important to the management of our wetland resources in Nebraska, and nationally.

Data collection began in April 2011. In the spring of 2011 and 2012, anuran call surveys were conducted to determine amphibian presence in 50 wetlands located in six wetland complexes (Eastern saline, Missouri River, Central Platte River, Cherry County, Elkhorn River headwaters, and Rainwater Basins). During the summer of 2011, researchers conducted assessments at 12 wetland sites associated with the EPA's National Wetland Condition Assessment. In addition, during the summers of 2011–2013 researchers conducted wetland condition assessments at 109 wetland sites located across Nebraska. Using data collected in 2011–2012, a Nebraska specific wetland rapid assessment method (NeWRAM) was developed and tested at 40 sites during 2013. Initial results indicate that NeWRAM is an effective method for measuring wetland condition. Our analyses of data, and final report to the U.S. EPA are nearing completion.

Walking to a remote sampling site
Photo: Craig Allen

Establishing survey plots in the Sandhills
Photo: Craig Allen

Wind and Wildlife Project

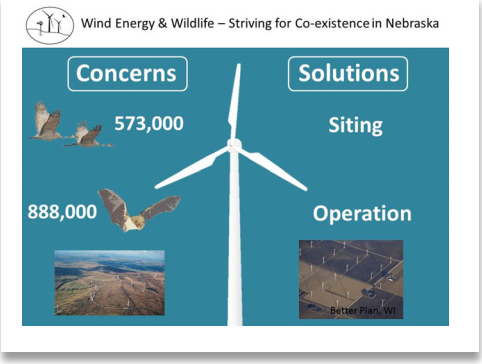
Principal Investigator(s):	Craig R. Allen, Joseph J. Fontaine
Coordinator:	Caroline Jezierski
Project Duration:	March 2011 – July 2016
Funding:	Nebraska Game and Parks Commission
Project Location:	Statewide Nebraska
Website:	http://snr.unl.edu/renewableenergy/wind/

This project helps to avoid, minimize, and mitigate negative impacts of wind energy development and operation on local flora and fauna by facilitating communication among stakeholders regarding wind power development and operation, identifying and implementing priority research and monitoring efforts, and developing management tools and technical guidance materials.

A number of tools have been developed to educate stakeholders about wind energy and wildlife issues. The Nebraska Wind Energy and Wildlife Project website was developed in 2011 and is frequently updated to assist in informing wind energy developers and environmental consultants on policies and resources for Nebraska. More than 100 individuals from a diverse array of stakeholders have subscribed to the listserv used to disseminate wind energy and wildlife information. Emails sent out via the listserv approximately every two weeks contain Nebraska-specific information and nation-wide wind and wildlife news. Several informational handouts and brochures were developed including: *Mitigation Guidelines for Wind Energy Development in Nebraska*, *Nebraska Bat Migration Project*, and *Nebraska Wind Conference: Wind–Wildlife Session Presenters 2014*.

A number of guidance documents have been or are currently being updated and/or developed. The *Whooping Crane Operational Contingency Plan* was developed for wind energy companies to use as a template. Due to more frequent sightings of whooping cranes outside of the historic migration corridor, an operational contingency is recommended for all wind energy facilities in Nebraska. The template was developed with input from the Nebraska Game and Parks Commission and U.S. Fish and Wildlife Service and is freely available on-line. A sub-group of the Nebraska Wind and Wildlife Working Group developed a mitigation document including recommendations and a map for forthcoming wind energy developments. The document was open for review for six months. Comments were received from a wide-range of stakeholders. Based on comments, the map developed by the group was updated to include not only levels of mitigation in areas, but also the relative sensitivity of areas to wind energy development (siting information). The *Guidelines for Wind Energy and Wildlife Resource Management* and the *Mitigation Guidelines for Wind Energy Development in Nebraska* documents were merged into one comprehensive document that is currently under review. All of these documents have been developed with input from a variety of stakeholders.

A number of research projects related to wind energy and wildlife are currently being developed with stakeholders across Nebraska and beyond.



WOODY PLANT MANAGEMENT IN THE NIOBRARA RIVER VALLEY

Principal Investigator(s):	Craig R. Allen, Joseph J. Fontaine
Graduate Student(s):	Kent Fricke, Ph.D.
Project Duration:	June 2010 – January 2016
Funding:	Nebraska Game and Parks Commission
Project Location:	Northeastern Nebraska

The Nebraska Natural Legacy Plan (NNLP) is a conservation strategy that identifies conservation targets (such as wildlife species and plant communities) and management approaches to decrease threats to Nebraska's biodiversity. In cooperation with the Nebraska Game and Parks Commission, an adaptive management framework will be developed for the NNLP to:

1. Evaluate the effects of conservation activities;
2. Prioritize research and monitoring activities;
3. Develop innovative programs to improve the ability to inventory and monitor at-risk species;
4. Develop theoretical and empirical techniques that facilitate the integration of research and monitoring into the management programs of at-risk, non-game species, including consideration of the complex trade-offs between social, economic, and biological factors that may facilitate and constrain effective wildlife management.

This project specifically investigates aspects of invasive woody plant management in the Niobrara River Valley in northern Nebraska. Species of interest include eastern red cedar, which has expanded its range in Nebraska by an average of 38,000 acres each of the last five years. Landowner perceptions of cedar encroachment and attitudes toward management techniques will be surveyed to determine the effectiveness of landscape management options. The effects of woody plant removal on vegetation will be quantified to determine the effectiveness of removal techniques to improve ecosystem health and function. To this end, more than 45 acres of cedar were removed from private properties in 2012 and 2013, and 25,650 meters of vegetation surveys were completed. Additionally, 600 bur oak seedlings were hand planted in herbivore exclosures to determine survival and herbivory rates for the recovering plots where cedar were removed. Finally, an economic analysis of cedar timber harvest and markets will determine the efficacy of cedar harvest as a viable tool for reducing management costs.

The results of this study will be used to develop an adaptive plan for management of invasive woody plants in the Niobrara River Valley. The majority of fieldwork began in spring 2012 and ended in fall 2014. Oak seedlings are being monitored through the fall 2015. A manuscript on adaptive management of invasive species for ecosystem services is being developed, landowner surveys will be distributed in fall 2015, and analysis of vegetation data is being conducted.

Kent Fricke measuring the diameter of a burned eastern red cedar following a 2012 wildfire in Boyd County, NE. Photo: Kent Fricke

Before and after cedar tree removal. Photo: Kent Fricke

PROFESSIONAL ACTIVITIES

TEACHING

CRAIG ALLEN, HANNAH BIRGÉ AND DANIEL UDEN

Spring 2015: Landscape Ecology

Landscape ecology is a bridge between applied and basic ecology, which investigates the influence of spatial heterogeneity and pattern: how to characterize patterns, how they develop and change through time, and the implications for populations, communities, and ecosystem processes. Landscape ecology explicitly considers spatial (as well as temporal) relationships among diverse ecological phenomena. Topics for this graduate level class include GIS applications in landscape ecology, spatial heterogeneity and scale, invasions, connectivity, quantitative analysis of patterns, resilience, alternative states, and applications to conservation. This course was team-taught.

CHRISTOPHER CHIZINSKI

Fall 2014 and Summer 2015 Analytics in R

This course—for graduate students, faculty, and staff at Nebraska Game and Park Commission—introduces the open source statistical program R. Topics include understanding R's data structures, writing functions, data wrangling and summarization, creating publication-level graphics, loops, applied multivariate analyses, applied regression analysis, and document creation with RMarkdown.

CHRISTOPHER CHIZINSKI AND JOSEPH FONTAINE

Fall 2014 and Spring 2015: Readings in Ecology

Co-taught by Chris Chizinski and Joseph Fontaine, the focus of this course is to identify and discuss the classic and emerging papers in ecology as directed by the interest of the graduate student body. Through this course students identify concepts in ecology of interest to them, presenting 2–3 classic papers and 2–3 emerging papers on the topic.

JOSEPH FONTAINE

Fall 2014 and Spring 2015: Trends in Ecological Applications

This course focuses on current research in applied ecology by exploring and developing the current research programs of participating students. Through this course students learn to develop and communicate their research by placing their questions within the scope of current ecological research.

CAROLINE JEZIERSKI

Fall 2014: Employment Seminar

This undergraduate employment seminar intends to prepare new graduates to be successful applicants. Topics covered include efficient job-hunting, resumes, cover letters, mock interviews, and dining etiquette. The class is group taught. Instruction included facilitating small group discussions, serving as a resource person, grading assignments, and providing feedback to students on subjects that include job market research, resume preparation, and interviewing skills.

KEVIN POPE

Spring 2015: Managed Aquatic Systems

This course provided theoretical aspects of structure and function in aquatic systems managed for human needs, ecological processes, river-reservoir interface, energy flow (including fate and transport), population dynamics, and multiple-use systems. Team-taught with Mark Pegg (UNL SNR), the course was designed to increase students' understanding of ecological processes that occur in regulated river basins and associated problems or opportunities that arise with fishery management. The focus was primarily on fishes and understanding how structure, process and function of aquatic systems are influenced by human activities. A unique aspect of this course is the presence of both professors in the classroom; that is, this course is truly team-taught, providing students the formal opportunity to interact with two faculty members that have differing experiences and sometimes differing opinions.

Graduate Committee Service

Craig Allen

- Didier Baho (Ph.D., Aquatic Sciences and Assessment, Swedish University of Agricultural Sciences, Uppsala, graduated June 2015)
- Anil Giri (Ph.D., Agricultural Economics, UNL, graduated August 2015)
- Jeff Hartman (Ph.D., School of Natural Resources, UNL)
- Julianne Matczyszyn (Ph.D., Department of Plant Pathology, UNL)
- Wayne Ohnesorg (Ph.D., Entomology, UNL)
- Katilyn Price (M.S., School of Natural Resources, UNL, graduated June 2015)
- P. Shrestha (Ph.D., Agricultural Economics, UNL, graduated August 2015)
- Trisha Spanbauer (Ph.D., Earth and Atmospheric Sciences, UNL, graduated August 2015)
- Bruce Stephen (Ph.D., School of Natural Resources, UNL)

Christopher Chizinski

- Nathan Bieber (M.S. School of Natural Resources, UNL)
- Brian Harmon (M.S. School of Natural Resources, UNL)
- Nicholas Cole (Ph.D. School of Natural Resources, UNL)
- Amanda Lipinski (Ph.D. School of Natural Resources, UNL)
- Lindsey Messinger (M.S. School of Natural Resources, UNL, graduated May 2015)
- Christa Webber (M.S., School of Natural Resources, UNL, graduated December 2014)

Joseph Fontaine

- Teresa Ely (M.S., School of Biological Science, UNL)
- Alexis Fedele (M.S., School of Natural Resources, UNL)
- Brian Harmon (M.S., School of Natural Resources, UNL)
- Abigail Neyer (Ph.D., School of Biological Science, UNL)

Kevin Pope

- Christina Edholm (Ph.D., Department of Mathematics, UNL)
- Alexis Fedele (M.S., School of Natural Resources, UNL)
- Jeremy Hammen (Ph.D., School of Natural Resources, UNL)
- Lindsey Messinger (M.S., School of Natural Resources, UNL, graduated May 2015)
- Ryan Ruskamp (M.S., School of Natural Resources, UNL)
- Stephen Siddons (M.S., School of Natural Resources, UNL)
- Jonathan Spurgeon (Ph.D., School of Natural Resources, UNL)
- Shana Sundstrom (Ph.D., School of Natural Resources, UNL)

Professional and Faculty Service

Craig Allen

- Member. Predicting high impact insect invasions, USGS Powell Center for Analysis and Synthesis
- Member. James S. McDonnell Foundation Advisory Panel for Studying Complex Systems
- Core Team member. National Socio-Environmental Synthesis Center, Social-Ecological System Resilience, Climate Change and Adaptive Water Governance [The Resilience and Law Project]
- Guest editor. *Ecological Applications.* Contribution of reserves to regional resilience
- Member. Core Advisory Group, Collaborative Adaptive Management Network
- Guest Researcher. August T. Larsson Programme, Swedish University of Agricultural Sciences, Uppsala, Sweden
- Associate editor. *Ecology and Society*
- Board of Trustees. The Nature Conservancy Nebraska
- Nebraska Conservation Roundtable

Kevin Pope

- Book Editorial Advisory Board. American Fisheries Society
- Member. Graduate Committee. UNL School of Natural Resources

Joseph Fontaine

- Assistant secretary. Cooper Ornithological Society
- At large representative. Editorial Advisory Board, The Wildlife Professional, The Wildlife Society

Other Professional Service

Hannah Birgé

- Treasurer. School of Natural Resources Graduate Student Association Treasurer, 2013–2015
- Organizer. special session for the fall 2014 Soil and Water Conservation Society annual meeting: *Adaptive management for ecosystems*
- Guest editor and manuscript coordinator. *Journal of Environmental Management* Special Feature

Caryl Cashmere

- Member. School of Natural Resources Social Committee, 2015–2017

Kent Fricke

- Graduate Fellow captain. Center for Great Plains Studies
- Newsletter editor. Graduate Fellows Program, Center for Great Plains Studies
- Treasurer. Nebraska Chapter of The Wildlife Society
- Journal reviewer. *Ecology and Society* and *Southeastern Naturalist*
- Undergraduate environmental science thesis advisor. For Elise Jarrett, *Assessing the effects of Juniperus virginiana removal on cattle forage*, Environmental Studies Program, School of Natural Resources, University of Nebraska–Lincoln, May 2014–May 2015

Valerie Egger

- Editor. USGS *Coop Catch-up* newsletter

Caroline Jezierski

- Planning Committee and abstract reviewer. National Wind Coordinating Collaborative Wind Wildlife Research Meeting X, 2014
- Planning assistance. Nebraska Wind Conference 2014, 2015
- Member. Staff Advisory and Professional Development Committee, Fall 2015

Amanda Lipinski

- Co-chair Education Committee. Nebraska chapter of The Wildlife Society

Lindsey Messinger

- Secretary. Early Career Professional working group for The Wildlife Society
- Co-chair Education Committee. Nebraska Chapter of The Wildlife Society
- Central Mountains and Plains Section representative. Editorial Advisory Board, The Wildlife Professional, The Wildlife Society

Michael Whitby

- Chair. Southeastern Bat Diversity Network Bat Blitz Committee
- Organizer. National Bat Blitz
- Reviewer. *Indiana Academy of Science* journal
- Reviewer. North American Bat Monitoring Program Technical Report
- Founding member. Nebraska bat working group

Allison Zach

- Nebraska representative. Mississippi River Basin Panel on Aquatic Nuisance Species
- Nebraska representative. Western Regional Panel on Aquatic Nuisance Species
- Coordinator. Nebraska Invasive Species Council

Training Assistance, Workshops and Outreach Activities

Craig Allen

- Co-instructor. Over-the-water training, July 2015, Lincoln, NE

Nathan Bieber

- Co-instructor. Over-the-water training, July 2015, Lincoln, NE

Hannah Birge

- Mentored an undergraduate School of Natural Resources thesis project titled *Ecosystem services and carbon storage in Lincoln City Parks*, fall 2014-spring 2015
- Helped design the *Soil is Awesome*! booth for the Fall 2014 UNL School of Natural Resources Naturepalooza outreach event, Lincoln, NE
- Created and led a professional development series seminar for SNR Graduate Students titled *How to craft a winning elevator speech*, spring 2015, Lincoln, NE

Caryl Cashmere

- Presenter. UNL Forms and Processes, Statewide Creel Clerk Workshop, March 2015, Lincoln, NE
- Presenter. UNL Forms and Processes, Hunter Survey Clerk Workshop, August 2015, Lincoln, NE

Christopher Chizinski

- Planning coordinator. Statewide Creel Clerk Workshop, March 2015, Lincoln, NE
- Co-instructor. Over-the-water training, March 2015, Lincoln, NE

Lucía Corral

- Workshop presenter. Camera trapping at Chadron State College, October 27, 2014 (part of Wildlife Research and Management Techniques course)

Kent Fricke

- Co-mentor. EnvironMentors/Upward Bound, University of Nebraska–Lincoln

Caroline Jezierski

- Invited presenter. Nebraska Master Naturalist Reunion, August 2015, Norden, NE
- Outreach event. Bat Educators Workshop, July 2015, Beatrice, NE
- Guest lecturer. Iowa State University NSF Wind Energy Research Experience for Undergraduates, July 2015, Ames, IA
- Outreach/Education booth. Lincoln Earth Day, April 2015, Lincoln, NE
- Organizer and host. Wind Energy Spring Migration Informational Field Trip, March 2015, Nebraska Rainwater Basin area and Wood River, NE
- Federal Work Study Program student advisor. Fall 2014–spring 2015, University of Nebraska–Lincoln.
- Outreach/Education booth. 2015 Nebraska Chapter of The Wildlife Society Annual Meeting, February 2015, Ogallala, NE
- Invited presenter. Saline County Wind Association Annual Meeting, February 2015, Saline Center, NE
- Invited presenter. Hallam Wind Farm Informational Meeting, January 2015, Cortland, NE
- Session planner. Outreach/Education Booth. The Nebraska Wind and Solar Conference, November 2014, LaVista, NE
- Guest lecturer. Wind Energy Development & Wildlife—Striving for Co-existence. University of Nebraska–Lincoln Environmental Planning and Policy class, November 2014, Lincoln, NE
- Professional panel member. University of Nebraska–Lincoln Natural Resources Course, November 2014, Lincoln, NE

Kevin Pope

- Co-instructor. Over-the-water training, March 2015, Lincoln, NE

Dan Uden

- Co-mentor. EnvironMentors Program, 2012–2015. Conduct a science experiment with a local high school student

Dana Varner

- Invited presenter. The Rainwater Basin Region of Nebraska. Wind Energy Spring Migration Informational Field Trip, March 2015, Wood River, NE

Michael Whitby

- Bats of Nebraska: An introduction to bats, research methods, and conservation efforts, March 28, 2015, Rowe Sanctuary
- Organize, promote, and conduct a Nebraska bat blitz as part of the National bat blitz, September 2014. Invited local conservationists from NET, NGPC, and Audubon

Allison Zach

- Invasive species identification workshop, Master Naturalists, July 2015
- Statewide invasive species technician training, May 2015, Lincoln, NE
- Aquatic invasive species identification workshop, Creel Clerk Training, April 2015, Lincoln, NE
- Booth at Carp-O-Rama, various locations throughout Nebraska during summer 2015
- Booth at Family Fishing Nights throughout Nebraska during summer 2015
- Booth at Nebraska Game and Parks Outdoor Expos in Kearney and Ponca, summer 2015
- Booth at fishing tournaments throughout Nebraska, summer 2015
- Booth at NESCIFEST, April 2015
- Booth at Platte River Prairies Field Day, August 2015

Peer-Reviewed Publications

Allen, C.R., D.G. Angeler, M.P. Moulton, and C.S. Holling. 2015. The importance of scaling for detecting community patterns: Success and failure in assemblages of introduced species. *Diversity* 7:229–241.

Allen, C.R., and A. Garmestani. 2015. *Adaptive Management of Social-ecological Systems*. Springer, Dordrecht, the Netherlands.

Allen, C.R., and A.S. Garmestani. 2015. Adaptive management. Pages 110 in Allen, C.R., and A.S. Garmestani (Eds.). *Adaptive Management of Social-ecological Systems*. Springer, Dordrecht, the Netherlands.

Allen, C.R., D.R. Uden, A.R. Johnson, and D.G. Angeler. 2015. Spatial modeling approaches for understanding and predicting the impacts of invasive alien species on native species and ecosystems. Pages 162–1 70 in R.C. Vennette (Ed.), *Pest risk modelling and mapping for invasive alien species*. CAB International, Wallingford, U.K.

Angeler, D., C.R. Allen, D.G. Angeler, C. Barichievy, T. Eason, A. Garmestani, N.A.J. Graham, D. Granholm, M. Knutson, K. Nash, R.J. Nelson, M. Nystrom, T. Spanbauer, C. Stow, S.M. Sundstrom. In press. Management applications of discontinuity theory. *Journal of Applied Ecology*.

Angeler, D.G., C.R. Allen, H.E. Birge, B.G. McKie, and R.K. Johnson. 2014. Assessing and managing freshwater ecosystems vulnerable to global change. *Ambio* 43(1):113–125. DOI 10.1007/s13280-014-0566-z

Angeler, D.G., C.R. Allen, D.R. Uden and R.K. Johnson. 2015. Spatial scaling patterns and functional redundancies in a changing boreal lake landscape. *Ecosystems* 18:889–902.

Angeler, D.G., C.R. Allen, A. Vila-Gispert, and D. Almeida. 2014. Fitness in animals correlates with proximity to discontinuities in body mass distributions. *Ecological Complexity* 20:213–218. DOI:10.1016/j.ecocom.2014.08.001

Angeler, D.G., D.L. Baho, C.R. Allen, and R.K. Johnson. 2015. Linking degradation status with ecosystem vulnerability to environmental change. *Oecologia* 178:899–913.

Bajer, P.G., T.K. Cross, C.J. Chizinski, M.J. Weber, and P.W. Sorensen. 2015. Lake productivity and predation modulating the recruitment of a highly invasive fish. *Diversity and Distributions* 21:500–510.

Birge, H.E., C.R. Allen, R.K., Craig, A.S. Garmestani, J.A. Hamm, C. Babbitt, K. Nemec, and E. Schlager. 2014. Social-ecological resilience and law in the Platte River basin. *Idaho Law Review* 51(1):229–256. http://www.uidaho.edu/law/law-review/articles

Birge, H.E., R.T. Conant, R.F. Follett, M.L. Haddix, S.J. Morris, S.S. Snapp, M.D. Wallenstein, and E.A. Paul. 2015. Soil respiration is not limited by reductions in microbial biomass during long-term soil incubations. *Soil Biology and Biochemistry* 81:304–310. DOI:10.1016/j.soilbio.2014.11.028

Chizinski, C.J., D.R. Martin, and K.L. Pope. 2014. Self-confidence of anglers in identification of freshwater sport fish. *Fisheries Management and Ecology* 21:448–453. DOI: 10.1111/fme.12094

Chizinski, C.J., D.R. Martin, C.G. Huber, and K.L. Pope. 2014. The influence of a rapid drawdown and prolonged dewatering on angling pressure, catch, and harvest in a Nebraska reservoir. *Great Plains Research* 24:145–152.

Cumming, G.S., C.R. Allen, N.C. Ban, D. Biggs, H.C. Biggs, D.H.M. Cumming, A. de Vos, G. Epstein, M. Etienne, K. Maciejewski, R. Mathevet, C. Moore, M. Nenadovic, and M. Schoon. 2015. Understanding protected area resilience: A multi-scale, social-ecological approach. *Ecological Applications* 25:299–319. http://dx.doi.org/10.1890/13-2113.1

DeBoer, J.A., K.L. Pope, J.J. Fontaine, C.J. Chizinski. 2015. Masked expression of life-history traits in a highly variable environment. *Great Plains Research* 25:25–38.

Fontaine, J.J., R.J. Stutzman, and L.Z. Gannes. 2015. Leaps, chains, and climate change for western migratory songbirds. Pages 3–15 in E.M. Wood and J.L. Kellermann (Eds.), *Phenological synchrony and bird migration: changing climate and seasonal resources in North America*. Studies in Avian Biology Series (no. 47). CRC Press, Boca Raton, FL. ISBN: 978-1-4822-4030-6

Fricke, K.A. 2015. Review of the book *Wild again: The struggle to save the black-footed ferret* by D.S. Jachowski. *Great Plains Research*. Fall 2015.

Garmestani, A.S., and C.R. Allen. 2015. Adaptive management of social-ecological systems: The path forward. Pages 255–262 in Allen, C.R., and A.S. Garmestani (Eds.). *Adaptive Management of Social-ecological Systems*. Springer, Dordrecht, the Netherlands.

Gordon, N.M., and M.L. Hellman. Accepted. Dispersal distance, gonadal steroid levels and body condition in Gray Treefrogs (*Hyla versicolor*): Seasonal and breeding night variation in females. *Journal of Herpetology*.

Göthe, E., L. Sandin, C.R. Allen, and D.G. Angeler. 2014. Quantifying spatial scaling patterns and their local and regional correlates in headwater streams: Implications for resilience. *Ecology and Society* 19(3):15. http://dx.doi.org/10.5751/ES-06750-190315

Green, O.O., A.S. Garmestani, L.H. Gunderson, C.R. Allen, J.B. Ruhl, C.A. Arnold, N.A.J. Graham, B. Cosens, D.G. Angeler, B. Chaffin and C.S. Holling. 2015. Barriers and bridges to the integration of social-ecological resilience and law. *Frontiers in Ecology and the Environment* 13:332–337.

Haak, D.M., B.J. Stephen, R.A. Kill, N.A. Smeenk, C.R. Allen, and K.L. Pope. 2014. Toxicity of copper sulfate and rotenone to Chinese mystery snail (*Bellamya chinensis*). *Management of Biological Invasions* 5:371–375. DOI: http://dx.doi.org/10.3391/mbi.2014.5.4.08

Haugen, M.T., L.A. Powell, M.P. Vrtiska, and K.L. Pope. 2015. The effects of harvest regulations on behaviors of duck hunters. *Human Dimensions of Wildlife* 20:15–29. DOI: 10.1080/10871209.2014.950437

Huser, B.J., P.G. Bajer, C.J. Chizinski, and P.W. Sorensen. In Press. Effects of common carp (*Cyprinus carpio*) on sediment mixing depth and mobile phosphorus mass in the active sediment layer of a shallow lake. *Hydrobiologia*.

Martin, D.R., C.J. Chizinski, and K.L. Pope. 2015. Reservoir area of influence and implications for fisheries management. *North American Journal of Fisheries Management* 35:185–190.

Myers, P.E., C.R. Allen, and H.E. Birgé. 2014. Consuming fire ants reduces northern bobwhite survival and weight gain. *Journal of Agricultural and Urban Entomology* 30(1):49–58. DOI: http://dx.doi.org/10.3954/JAUE12-08.1

Spanbauer, T.L., C.R. Allen, D.G. Angeler, T. Eason, S.C. Fritz, A.S. Garmestani, K.L. Nash, and J.R. Stone. 2014. Prolonged instability prior to a regime shift. *PLoS ONE* 9(10): e108936. DOI:10.1371/journal.pone.0108936

Stutzman, R.J., and J.J. Fontaine. 2015. Shorebird migration in the face of climate change: Potential shifts in migration phenology and resource availability. Pages 145–159 in E.M. Wood and J.L. Kellermann (Eds.), *Phenological synchrony and bird migration: changing climate and seasonal resources in North America*. Studies in Avian Biology Series (no. 47). CRC Press, Boca Raton, FL. ISBN: 978-1-4822-4030-6

Sundstrom S.M., D.G. Angeler, A.S. Garmestani, J.H. García, and C.R. Allen. 2014. Transdisciplinary application of cross-scale resilience. *Sustainability* 6(10):6925–6948. DOI:10.3390/su6106925

Uden, D.R. 2015. Book review on *This far-off wild land: The upper Missouri letters of Andrew Dawson*, by L. Wischmann, and A.E. Dawson. *Great Plains Quarterly* 35(2):225. DOI: 10.1353/gpq.2015.0029

Uden, D.R., C.R. Allen, D.G. Angeler, L. Corral, and K.A. Fricke. 2015. Adaptive invasive species distribution models: A framework for modeling incipient invasions. *Biological Invasions*. Published online. DOI 10.1007/s10530-015-0914-3.

Uden, D.R., C.R. Allen, A.A. Bishop, R. Grosse, C.F. Jorgensen, T.G. LaGrange, R.G. Stutheit and M.P. Vrtiska. In press. Predictions of future ephemeral springtime waterbird habitat availability under global change. *Ecosphere*.

Uden, D.R., C.R. Allen, T.D. McCoy, R.B. Mitchell and Q. Guan. 2015. Predicted avian responses to scenarios of biofuel-based landuse change in an intensive agricultural landscape. *Global Change Biology Bioenergy* 7:717–726.

Uden, D.R., C.R. Allen, R.B. Mitchell, T.D. McCoy and Q. Guan. 2015. Predicted avian responses to bioenergy development scenarios in an intensive agricultural landscape. *Global Change Biology Bioenergy* 7:717–726.

Uden, D.R., M.L. Hellman, D.G. Angeler and C.R. Allen. 2014. The role of reserves and anthropogenic habitats for functional connectivity and resilience of ephemeral wetlands. *Ecological Applications* 24:1569–1582. DOI 10.1890/13-1755.1

Whitby, M.D., T.C. Carter, E.R. Britzke, and S.M. Bergeson. 2014. Evaluating the effectiveness of three acoustic monitoring techniques for landscape level bat population monitoring. *Acta Chiropterlogica* 16:223–230.

Presentations

Bieber, N.R. September 2015. River otter distribution and abundance in Nebraska: A recovery story. Nebraska Natural Legacy Project Conference, Kearney, NE.

Birgé, H. April 2015. Disturbance, resilience, soil health and the Conservation Reserve Program. American Association of Geographers, Chicago, IL.

Chizinski, C.J., D.R. Martin, and K.L. Pope. June 2015. Angler-catch networks over space and time. EIFAAC International Symposium on Recreational fisheries: Managing freshwater recreational fisheries in an era of change, Lillehammer, Norway.

Chizinski, C.J., N.T. Stewart, K.L. Pope, D.R. Martin, and J.J. Jackson. February 2015. The influence of a fish invasion on a recreational angling network. 75th Midwest Fish and Wildlife Conference, Indianapolis, IN.

Chizinski, C.J., N.T. Stewart, K.L. Pope, D.R. Martin, and J.J. Jackson. 2015. The influence of white perch (*Morone americana*) on angling in Branched Oak Reservoir from 1994–2014. 46th Annual Meeting of the Nebraska Chapter of the American Fisheries Society, Nebraska City, NE.

Cole, N.W., A.D. Fedele, C.J. Chizinski, and K.L. Pope. 2015. Catchability outcomes for naïve fish populations after the introduction of recreational angling. 46th Annual Meeting of the Nebraska Chapter of the American Fisheries Society, Nebraska City, NE.

Corral, L., L.A. Powell, T. Frinke, and J.J. Fontaine. February 2015. Canid community distribution in Western Nebraska. Nebraska Chapter of The Wildlife Society, Ogallala, NE.

Fedele, A.D., N.W. Cole, C.J. Chizinski, and K.L. Pope. February 2015. Change in catchability of harvested and non-harvested sportfish in a naïve population. 75th Midwest Fish and Wildlife Conference, Indianapolis, IN.

Fontaine, J.J. April 2015. Research on pheasants and pheasant hunters in Nebraska. Regional pheasant working group, Brookings, SD. *Invited.*

Fontaine, J.J. and L.N. Messinger. 2015. A brief history of pheasant ecology in Nebraska. Nebraska Game and Parks Commission, State Habitat Meeting, Kearney, NE. *Invited.*

Fontaine, J.J. 2015. The state of pheasants and pheasant hunters in Nebraska. Nebraska Game and Parks Commission, Public Meeting, Lincoln, NE. *Invited.*

Fricke, K.A., C.R. Allen, and J.J. Fontaine. February 2015. Unwanted plant management in Nebraska. Nebraska Chapter of The Wildlife Society Annual Conference, Ogallala, Nebraska.

Fricke, K.A., C.R. Allen, and J.J. Fontaine. January 2015. Applying adaptive management to invasive species: woody plant management in the Niobrara River Valley, Nebraska. Nebraska Game and Parks Commission Wildlife Division, Management Section Meeting, Lexington, NE.

Fricke, K.A., C.R. Allen, and J.J. Fontaine. July 2014. Adaptive management of invasive species to promote ecosystem services. Soil and Water Conservation Society Annual Meeting. Special Symposium: Adaptive Management for Ecosystem Services, Chicago, IL.

Hart, N.M., C.R. Allen, K. Stoner, and R. Schneider. October 2014. When and how to apply adaptive management for the Nebraska Natural Legacy Project and other state wildlife action plans. Poster session presented at the Collaborative Adaptive Management Network Rendezvous, Weaverville, CA.

Hellman, M., and N. Smeenk. February 2015. Amphibian monitoring in the Rainwater Basin: Where do we go from here? The Rainwater Basin Joint Venture meeting, Grand Island, NE.

Gillespie, C. and J.J. Fontaine. October 2014. Stopover habitat decisions in a vanishing landscape. American Ornithologist Union and Cooper Ornithological Society, Estes Park, CO.

Gillespie, C. and J.J. Fontaine. July 2015. Severe weather impacts on an unpredictable system: Wetland dynamics and shorebird stopover decisions in a highly-altered landscape. American Ornithologists Union and Cooper Ornithological Society Joint Meeting, Norman, OK. *Invited.*

Gillespie, C. and J.J. Fontaine. February 2015. Shorebird migration in Nebraska: Stopover habitat decisions in a vanishing landscape. Nebraska Chapter of The Wildlife Society, Ogallala, NE.

Gillespie, C. and J.J. Fontaine. 2015. Shorebird migration in Nebraska: Stopover habitat decisions in a vanishing landscape. Rainwater Basin Joint Venture Informational Seminar, Hastings, NE.

Jezierski, C. and M. Koch. February 2015. Developing mitigation guidelines for wind energy in Nebraska. 75th Midwest Fish and Wildlife Conference, Indianapolis, IN.

Jezierski, C. and M. Koch. March 2015. Developing mitigation guidelines for wind energy in Nebraska. American Wind Energy Association Project Siting Seminar, Austin, TX.

Martin, D.R. and J.J. Fontaine. October 2014. Perceptions of the Conservation Reserve Program: is it time for a change? Pathways 2014: Integrating human dimensions into fisheries and wildlife management, Estes Park, CO.

Messinger, L.N. and J.J. Fontaine. October 2014. Hunting in a modern landscape: Public lands as regional hunting networks. Pathways 2014: Common Futures—Integrating human dimensions into fisheries and wildlife management, Estes Park, CO.

Messinger, L.N. and J.J. Fontaine. August 2015. Hunting in a modern landscape: A large-scale assessment of hunter use of publically accessible hunting lands. Annual meeting of the Central Mountains and Plains Section of The Wildlife Society, Manhattan, KS.

Messinger, L.N. and J.J. Fontaine. February 2015. Should we care about fear in wildlife populations? Nebraska Chapter of The Wildlife Society, Ogallala, NE.

Messinger, L.N., and J.J. Fontaine. 2015. Public land use by hunters in Nebraska. Nebraska Game and Parks Commission, Management Section meeting, Lexington, NE. *Invited.*

Pope, K.L., C.J. Chizinski, and M.A. Pegg. June 2015. Assessment of ecosystem services using data collected from anglers. EIFAAC International Symposium on Recreational fisheries: Managing freshwater recreational fisheries in an era of change, Lillehammer, Norway.

Simonsen, V., J. Laskowski, L.N. Messinger, and J.J. Fontaine. February 2015. Examining the influence of landscape context on nest survival. Nebraska Chapter of The Wildlife Society, Ogallala, NE.

Spier, S. and J.J. Fontaine. April 2015. The effects of urbanization on fear. University of Nebraska–Lincoln Research Fair, Lincoln, NE.

Stewart, N.T., L.K. Kowalewski, C.J. Chizinski, K.L. Pope, and J.J. Jackson. 2015. Effectiveness of low-dose-rotenone application for controlling White Perch and Gizzard Shad. 46th Annual Meeting of the Nebraska Chapter of the American Fisheries Society, Nebraska City, NE.

Stewart, N.T., L.K. Kowalewski, C.J. Chizinski, and K.L. Pope. February 2015. Diel distribution of superabundant fish in a Great Plains flood-control reservoir. 75th Midwest Fish and Wildlife Conference, Indianapolis, IN.

Twidwell, D., C.R. Allen, D.G. Angeler, J.J. Fontaine, A.S. Garmestani, N.M. Hart, and K.L. Pope. February 2015. Prescribed burn associations in an adaptive management framework. Society of Range Management Annual Meeting, Sacramento, CA.

Uden, D.R., and K. Stoner. October 2014. Scenario planning in the Pine Ridge Biologically Unique Landscape. The Nebraska Natural Legacy Conference, Gering, NE.

Varner, D. March 2015. The Rainwater Basin Region of Nebraska. Wind Energy Spring Migration Informational Field Trip, Woodriver, NE.

Whitby, M.T. Carter, and E. Britzke. October 2014. Evaluating the effectiveness of three acoustic monitoring techniques for bat population monitoring. North American Society for Bat Research, Albany, NY.

Whitby, M. March 2015. National Bat Blitz 2014. North American Joint Bat Working Group Meeting, St. Louis, MO.

Wszola, L.S. and J.J. Fontaine. August 2015. Pheasant hunting in the landscape of fear: Modeling interactions between predator and prey habitat decision. Annual Meeting of the Central Mountains and Plains Section of The Wildlife Society, Manhattan, KS.

Zach, A.M. July 2015. Nebraska invasive species identification. Master Naturalist Training, Cedar Point Biological Station, Ogallala, NE.

Zach, A.M. May 2015. Terrestrial invasive species prevention. Missouri River Watershed School Festival, Yankton, SD.

Zach, A.M. July 2015. Preliminary results of summer 2015 aquatic invasive species boater surveys. Nebraska Game and Parks, Fisheries Division Meeting, Burwell, NE.

Zach, A.M. May 2015. Zebra mussel infestation and aquatic invasive species threats to Offutt Air Force Base Lake. National Air Force Environmental Coordinator Conference, Bellevue, NE.

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