



ANNUAL REPORT OCT 2018 - SEPT 2019

NEBRASKA COOPERATIVE

FISH & WILDLIFE RESEARCH UNIT

Identifying the Mechanisms
**SHAPING THE DISTRIBUTION
OF AVIAN COMMUNITIES**
Across Nebraska

Also See

Leadership Update [page 17](#)

Highlights of Angler Assessment and Behavior, [page 27-31](#)

The Social-Ecology of an Intensively Managed Ecosystem, [page 53](#)

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NEBRASKA

COOPERATIVE

FISH & WILDLIFE RESEARCH UNIT



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We extend our appreciation to the staff and students of the Nebraska Cooperative Fish and Wildlife Research Unit, University of Nebraska–Lincoln for photographs and images.

Editor and Design Production: Wilma Gerena
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Layout Design: Abigail Ahmed



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Cover Photo: Pheasant Project, Broken Bow, NE
Photo: Tristan Powell



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INTRODUCTION

What is the Nebraska Cooperative Fish and Wildlife Research Unit?

A simple answer: The Nebraska Cooperative Fish and Wildlife Research Unit (NECFWRU) is a formal partnership between the University of-Nebraska-Lincoln (UNL), Nebraska Game and Parks Commission (NGPC), U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service (USFWS), and the Wildlife Management Institute (WMI).

A more profound answer: The NECFWRU is a complex system comprised of people working access difficult-to-define scales within difficult-to define boundaries. A complex system has many interacting components with no central control or global communication, and the interactions give rise to emergent behaviors. The NECFWRU has a tripartite mission: technical assistance, applied research, and graduate education. This mission carries with it some implied temporal scales (e.g., M.S. students generally operate on a 2-3 year scale), but does not define all temporal or spatial scales in which the unit is to operate. The NECFWRU is one of forty units that compose the national Cooperative Research Unit (CRU) program. The CRU program is poised to address natural-resource issues on regional and national scales.

Components of the NECFWRU include three federal scientists, two state administrate assistants, and grant-funded graduate students, postdoctoral associates, and technicians; also included are some biologists, managers, and decision makers of government agencies, some faculty members, administrators of universities and colleges, and some personnel of non-governmental agencies.

Oversight on broad direction of NECFWRU is provided by a five-member (representative form each signatory agency) coordinating committee. Oversight on safety is provided by CRU Headquarters and UNL safety committees. Oversight on publications is provided by USGS. Oversight on laboratories is provided by each scientist, thought broad oversight of research is generally provided by granting agencies and university review boards (i.e., IACUC and IRB). Oversight on each graduate project is provided by graduate committees.

You are, in some way big or small, part of the Nebraska Cooperative Fish and Wildlife Research Unit. We thank you for your valuable contributions. You are what makes us great.



NE Cooperative Fish and Wildlife Research Unit

PERSONNEL & COOPERATORS



Rainwater Basin Waterfowl Outside Mullen, NE
Photo: Evan Ward

UNIT PERSONNEL

Staff – U.S. Geological Survey, Cooperative Research Units Program

Kevin Pope, Unit Leader	Craig Allen, Unit Leader, (retired April 2019)	Joseph (TJ) Fontaine, Assistant Unit Leader (March 2009 – March 2019)
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Staff – University of Nebraska–Lincoln

Caryl Cashmere, Unit Staff Assistant	Tyler Reed, Field Crew Leader (April 2017 – December 2018)
David Damsky, Field Crew Leader	Baxter Seguin, Coordinator, North American Bat Monitoring Program
Alexis Fedele, Research Assistant (June 2017 – December 2018)	Shana Sundstrom, Post-Doc (February 2018 – December 2018)
Wilma Gerena, Unit Administrative Assistant	Dana Varner, Science Coordinator, Rainwater Basin Joint Venture
Lutz Gruber, Post-Doc (February 2017 – December 2018)	Allison Zach, Coordinator, Nebraska Invasive Species Program
Mark Kaemingk, Research Assistant Professor, Aquatic Biologist	

Research Technicians

Michelle Hellman	Anna Oetting	Matthew Rahko	Christine Ruskamp
Holly North			

Creel Clerks

Logan Dietrich	Jeremy Johnson	Alex McGee	Trey Wortman
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Student Workers

Anastasia Madsen	Tristan Powell
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GRADUATE DEGREE CANDIDATES

Master of Science

Olivia DaRugna School of Natural Resources January 2018 – present	Hugh Ellerman School of Natural Resources August 2017 – present	Derek Kane School of Natural Resources January 2019 – present
Brittany Dueker Department of Agronomy August 2016 – present	Christopher Fill School of Natural Resources January 2018 – present	

Doctor of Philosophy

Christine Bielski Department of Agronomy January 2017 – May 2019	Sarah Gaughan School of Natural Resources August 2016 – present	Bethany Teeters School of Natural Resources August 2012 – present
Dillon Fogarty Department of Agronomy January 2017 – present	Katharine Hogan School of Natural Resources January 2018 – present	Michael Whitby School of Natural Resources January 2014 – present



From left to right: Christine Ruskamp, Victoria Simonsen, Nadeja Mirochnitchenko, Nicholas Cole
Photo: Mark Kaemingk

GRADUATES

Jessica Burnett, Ph.D., August 2019

Regime Detection Measures for the Practical Ecologist.
University of Nebraska–Lincoln, Natural Resources. Advisor(s), Craig Allen, Dirac Twidwell, David Angeler, John DeLong, and Andrew Tyre

Nicholas Cole, Ph.D., December 2018

Values of Consumptive Outdoor-recreation Participants.
University of Nebraska–Lincoln, Natural Resources. Advisor, Kevin L. Pope

Lucía Corral, Ph.D., December 2018

Spatial and Temporal Structure of a Canid Community in Nebraska.
University of Nebraska–Lincoln, Natural Resources. Advisor, Joseph J. Fontaine

Nadejda Mirochnitchenko, M.S., December 2018

Relationships Among Biodiversity Dimensions of Birds in Nebraska.
University of Nebraska–Lincoln, Natural Resources. Advisor, Joseph J. Fontaine

Caleb Roberts, Ph.D., May 2019

Managing for Ecosystem Resilience in a Non-stationary World.
University of Nebraska–Lincoln, Department of Agronomy. Advisor(s), Dirac Twidwell, Craig R. Allen

Christine Ruskamp, M.S., December 2018

Landscape Structure and Dynamics of Recreational Fisheries.
University of Nebraska–Lincoln, Natural Resources. Advisor(s), Kevin L. Pope, Mark Kaemingk

Baxter Seguin, M.S., May 2019

Implementing the North American Bat Monitoring Program in Nebraska: An Assessment of Nebraska Bats with an Emphasis on Citizen Science.
University of Nebraska–Lincoln, Natural Resources. Advisor, Craig R. Allen

Victoria Simonsen, M.S., December 2018

Examining Patterns in Next Predation Using Artificial Nests.
University of Nebraska–Lincoln, Natural Resources. Advisor, Joseph J. Fontaine

Nicholas Smeenk, Ph.D., August 2019

Assessing the Ecological Condition of Nebraska's Wetland Resources and Amphibian Communities: An Intensification of the Environmental Protection Agency's 2011 National Wetland Condition Assessment.
University of Nebraska–Lincoln, Natural Resources. Advisor, Craig R. Allen

Zachary Warren, M.S., December 2018

Distribution and Habitat Association of the Northern Long-eared Bat.
University of Nebraska–Lincoln, Natural Resources. Advisor, Craig R. Allen



Mark Kaemingk, Christine Ruskamp, and Kevin Pope at the December 2018 Commencement.
Photo: Mark Kaemingk



Jessica Burnett, Craig Allen, Nicholas Smeenk at the August 2019 Commencement.
Photo: Nathaniel Price

COORDINATING COMMITTEE MEMBERS

U. S. Geological Survey

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Cooperative Research Units Program
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Wildlife Management Institute

Bill Moritz, Midwest Field Representative
93 Central Station Place
Johnstown, OH 43031–8400
(740) 966–0496

U.S. Fish and Wildlife Service

Greg Watson, Chief
Office of Landscape Conservation
Region 6, Mountain–Prairie Region
134 Union Blvd, PO Box 25486
Denver, CO 80225
(303) 236–4602

COOPERATING ORGANIZATIONS

Central Nebraska Public Power and Irrigation District
Chadron State College
Emory University, Georgia
Iowa State University
Natural Resource Ecology and Management
James S. McDonnell Foundation
National Socio–Environmental Synthesis Center
National Science Foundation
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 Invasive Species Advisory Council
Nebraska Natural Resources Districts
Nebraska Public Power District
Nebraska Weed Control Association
Rainwater Basin Joint Venture Partnership
Swedish University of Agricultural Sciences, Sweden
The Nature Conservancy

University of Montana
University of Nebraska–Lincoln
Center for Grassland Studies
Daugherty Water for Food Institute
Department of Agricultural Leadership, Education And Communication
Department of Agronomy and Horticulture
Department of Computer Science
Engineering Department of Earth and Atmospheric Sciences
Nebraska Water Center
School of Biological Sciences
School of Natural Resources
University of Nebraska at Omaha
Department of Biology
U.S. Department of Agriculture
Animal and Plant Health Inspection Service
U.S. Department of Defense
U.S. Army Corps of Engineers
U.S. Department of Interior
National Park Service
U.S. Fish and Wildlife Service
Valentine National Wildlife Refuge
U.S. Geological Survey
Climate Adaptation Science Center
Fort Collins Science Center
U.S. Environmental Protection Agency
Wyoming Game and Fish Department



Storm over Lake McConaughy, NE
41°15'46.4"N 101°46'11.6"W
Photo: Logan Dietrich

AWARDS & RECOGNITION

Nebraska Sandhills
Photo: Hannah Birgé

Scholarships, Fellowships & Grants



Jessica Burnett, Ph.D. 2019 Graduate
Photo: trashbirdecology.github.io/about/

Jessica Burnett was awarded a recruitment fellowship for Ph.D.s and the prestigious Othmer Fellowship from UNL.

Dillon Fogarty received the Arthur W. Sampson Fellowship (2019-2020). A \$5000 fellowship awarded by the Center for Grassland Studies to one outstanding graduate student with an interest in the study of grassland management.

Katherine Hogan was named Graduate fellow for the Center for Great Plains Studies for the years 2019-2021. An interdisciplinary group of graduate students with common goals of research relevant to the Great Plains.

Caleb Roberts received the Nebraska Pheasants Forever and Quail Forever \$1000 scholarship.

Mendenhall Fellowship

Jessica Burnett was awarded the USGS Mendenhall Postdoctoral Fellowship for the upcoming fall. The Mendenhall Fellowship Program honors Walter C. Mendenhall, the fifth director of the USGS. Now in its second year, this post-doctoral

research program provides the opportunity for the selected fellow to conduct concentrated research in association with a selected member of the USGS professional staff.

Travel Awards

Dillon Fogarty received the David H. & Annie E. Larrick Student Travel Funds (2018). A \$400 travel award from UNL Agriculture Research Division

to present his research at the Community on Ecosystem Services (ACES) annual conference in Washington, D.C.

Where are they now?

Unit program graduate Lyndsie Wszola, M.S. (2018) and former Unit technician in the Fontaine Lab, Anastasia (Annie) Madsen were accepted to the National Science Foundation National Trainee Program (NRT) in the School of Natural Resources at UNL and they are on track to complete their Ph.D., and M.S. to Ph.D. programs. Congratulations to both!



Lyndsie Wszola (left) and Anastassia Madsen (right)
Photo: NRT Program website

NECFWRU Stalwarts

Vision and political savvy...that is what **Craig Allen** used to propel the Nebraska Cooperative Fish and Wildlife Research Unit to one of the most productive and respected units in the Cooperative Research Unit program. Craig's leadership and oversight of NECFWRU is astonishing; he set a standard that will be remarkably challenging, likely impossible, for future leaders to achieve.

Prior to coming to the University of Nebraska-Lincoln in July 2004 to start NECFWRU from the ground up. Allen was the unit leader at the South Carolina Cooperative Fish and Wildlife Research Unit at Clemson University from 2002 to 2004, and its assistant leader from 1998 to 2001.

Before the Cooperative Research Unit Program was on Allen's radar, he completed a Wildlife Ecology, Ph.D. from the University of Florida in 1997 where he conducted research for the U.S. Department of Agriculture thus beginning a 20 year career with the federal government.

In Nebraska, Allen found a state with dedicated collaborators with whom he developed partnerships benefiting the collective. Under his 15 year tenure the unit grew from a staff of two to a staff of eight, with 25+ graduate students, and



Craig Allen, first NECFWRU Unit Leader
Photo: University Communications

hundreds of temporary summer workers.

Craig retired from USGS on March 31 heading for a well earned-vacation to Portugal with his vson Reece. Thankfully, Craig will continue to be a staunch advocate of NECFWRU and CRU program.

Joseph (TJ) Fontaine exudes enthusiasm and passion. Enthusiasm for students, enthusiasm for outdoor recreation; and passion for natural resources and its effective management. His interest in biology began in his home state of Montana leading him to earn a Ph.D. in Wildlife Ecology from the University of Montana in 2006. He then pursued post-doctoral research with the Sonora Desert Research Station at the University of Arizona before becoming Assistant leader of NECFWRU in 2009, where his passion influenced many members and stakeholders driving them to be better scientists, managers, and stewards.

TJ renounced his position with USGS on March 1 in support of his wife's passions and enthusiasms that perfectly align with and complement his. We wish him well.



Joseph (TJ) Fontaine
Photo: Kevin Pope

MILESTONES & HIGHLIGHTS

Farm land with bales
Photo: Unit File

Pope named Nebraska Coop Unit leader

The leadership of the Nebraska Cooperative Fish and Wildlife Research Unit at the University of Nebraska-Lincoln has changed hands. After 14 years at the helm, Craig Allen has stepped down, and Kevin Pope has stepped up to become the unit's newest leader.



Craig Allen

The two have worked together since 2005 when Allen hired Pope as a fisheries research scientist for the unit that was just one-year-old at the time.

"It started when we had one (graduate) student each, and now there are

25," Pope said with a grin. Over that time, the original staff of two grew to eight, with nearly 100 temporary workers hired during summer months, and for many years, Pope served as one of two assistant unit leaders.

The unit, embedded within the School of Natural Resources, is one of 40 based in 38 states, and is a cooperative agreement between the university, the U.S. Geological Survey; the Nebraska Game and Parks Commission; the U.S. Fish and Wildlife Service, and the Wildlife Management Institute.

That was part of the reason Pope felt compelled to move into Allen's position. The two have invested their careers thus far to building a program that can provide research-based solutions to state and federal fish and wildlife management problems.

"Looking back, it's been very much a honeymoon phase for the unit," Pope said. "A lot of folks with state agencies and with other organizations worked hard to get Congress to authorize us as a unit." The effort took 20 years, and the unit benefited handsomely from that effort.

But now Pope sees a transition on the horizon as those committed individuals begin to retire and people who haven't been there since the beginning start to take over leadership positions in partnering agencies.

"We'll need to think differently about how we fit into the landscape," he said, "and it will be more important to show the benefit our research has on the state."

In the unit's past, research has spanned topics from invasive trees to fish; otters to anglers; bats to quail to grasslands. Only some of it has had a regional focus.

"Lots of issues go beyond the state boundary," Pope said. "But there is a lot of pressure to do research just in the state."

Pope is confident he'll be able to juggle the competing research needs of the state and region, while also meeting the expectations of the university and USGS. The biggest challenge he sees in the next five to 10 years is personnel changes as employees move on or up and as graduate students swap out. "It's going to be busy," he said.

But he foresees a few easy jobs will fall under his new title, too. Cheer-leading for one.

"I am part of a great team from the School of Natural Resources and beyond," he said. And when the people are great, the rest just seems to fall into place.

Shawna Richter-Ryerson, School of Natural Resources

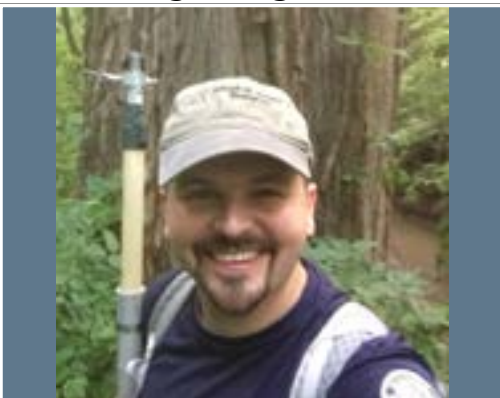


Kevin L. Pope, Unit Leader
Photo: Shawna Richter-Ryerson

Nebraska has joined the North America Bat Monitoring Program

The Nebraska Cooperative Research Unit in collaboration with the Nebraska Game and Parks Commission, the Wyoming Game and Fish Department, and state and federal natural resource managers in the Midwest has joined U.S. Geological Service North American Bat Monitoring Program (NABat). Our unit is focused on developing a strategic approach to bat conservation across Wyoming and Nebraska by monitoring impacts, and by providing decision makers with decision-support tools and a conservation plan.

Coordinating the efforts is former unit student and recent M.S. graduate Baxter Seguin. For more information visit the NABat website at www.nabatmonitoring.org.



Baxter Seguin, Program Coordinator
North American Bat Monitoring
2019 NECFWRU Graduate
Photo: Social Media



OUTREACH ACTIVITIES

Angler Survey Project, Omaha, NE
Photo: Tristan Powell



Nebraska Invasive Species Program

The Nebraska Invasive Species Program (NISP) attended over 50 events between October 2018 and September 2019 facilitating presentations or had a display at each. Examples of these events include: Nebraska Game and Parks Commission outdoor expo, Lower Platte South NRD Nature Nights and private lake association meetings.

Throughout the year the program disseminated over 500 sets of invasive species education cards to K-12 grade teachers along with backpacks containing specimen samples. Similar educational bags were dispersed to independently owned fish shops throughout the state in an effort to educate patrons and public not to release unwanted aquatic pets into the wild reducing the introduction of non-native species.

In a collaborative community outreach effort with the University of Nebraska State Museum the NISP provided invasive species specimen via an invasive species education drawer in the Museum’s new 4th floor exhibit when it reopened in 2019 to the delight of children and parents alike.

Continuing watercraft enthusiast education, the NISP funded billboards at Lewis and Clark Lake, and Lake McConaughy to educate the public to “clean, drain and dry” watercrafts. To this end the NISP purchased a waterless watercraft cleaning unit in 2019 which was placed at Weigand Marina at Lewis and Clark Lake for public use to help prevent the spread of zebra mussels and other aquatic invasive species.

The program provided the Nebraska Game and Parks Commission (NGPC) brochures, rack cards and promotional items to be shared with



Lake McConaughy billboard
Photo: Allison Zach

the public during watercraft inspections and at outreach events throughout 2019. Trained NISP technicians were at selected watercraft inspections documenting the process for further review and analysis of its educational impact and effectiveness.

Allison Zach, NISP Coordinator, served as the Nebraska representative on regional aquatic invasive species panels, chair of the Western Regional Panel on Aquatic Invasive Species Outreach Committee, hosted monthly meetings for the Nebraska Invasive Species Advisory Council, and co-taught and hosted a hazard analysis critical control point U.S. Fish & Wildlife Service training to Nebraska resource agency staff.

The NISP is committed to continue outreach, management and prevention efforts for aquatic and terrestrial invasive species working with the Nebraska Invasive Species Advisory Council, Nebraska Game and Parks Commission and partners.


Media Coverage

- Husker researchers to survey anglers at Omaha lakes. Nebraska Today. April 2019
- Researchers: Focus policy to better control red cedar invasion. Nebraska Today. April 2019
- Nebraska Invasive Species Program: Digging Deeper, NET TV, Lincoln. July 2019
- Using a Decision-Support Framework to Advance Land Management Research. Wildlife Management Institute. February 2019

Twitter Moments

Nebraska Coop F&W RU @NECFWRU Just now

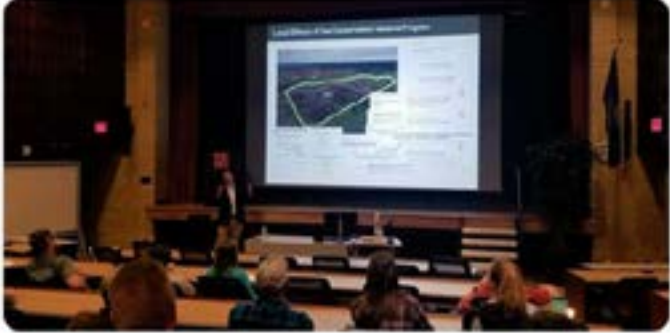
No #InvasiveSpecies segment is complete without a #ZebraMussles chat. If you are curious, slide to the 10:00 min section on the video timeline. If this doesn't inspire continuous #CleanDrainDry equipment and gear between waterbodies use, unsure what will. <https://www.youtube.com/watch?v=AqrKY1yQVrk>



Digging Deeper with Backyard Farmer| Invasive Species
Kim Todd explores invasive species and how homeowners can deal with them with guests Mitch Coffin from Nebraska Department of Agriculture... <https://www.youtube.com/watch?v=AqrKY1yQVrk>

Nebraska Coop F&W RU @NECFWRU


Dr. James Martin presenting on #BobwhiteQuail #wildlifeConservation #WildlifeManagement @UNLSNR



9:42 AM - May 9, 2019 - Twitter for Android

Nebraska Coop F&W RU @NECFWRU


Keith Hurley collaborator @NEGameandParks facilitating on data management @UNLSNR #Strength in #collaboration



2019 - Twitter for Android

Nebraska Coop F&W RU @NECFWRU


The 2018 Coordinating Committee Meeting is underway. Can you believe its been 15 years? We can't. @UNLSNR



1:27 PM - Oct 2, 2018 - Twitter Web App

Nebraska Coop F&W RU @NECFWRU

Hey @UNLSNR Can you spot the endangered species in this photo? If you said Gopherus polyphemus you are correct! Otherwise, stop by Hardin Hall main lobby today from 1-2:30 PM wish farewell to the other highly valued species.



9:23 AM - April 9, 2019 - Nebraska RU

RESEARCH PROJECTS



Angler Survey Project, Omaha, NE
Photo: Tristan Powell

AMPHIBIAN OCCUPANCY, FUNCTIONAL CONNECTIVITY, AND RESILIENCE OF RAINWATER BASIN WETLANDS

Principal Investigator(s): Dan D. Snow, Craig R. Allen
Graduate Student(s): Michelle Hellman, Ph.D.
Duration: : April 2013 – September 2019
Funding: National Science Foundation IGERT Program, 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.

The Rainwater Basin is a region of Nebraska characterized by shallow wetlands. 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 effects of proximity of intensive agriculture and widespread landscape change on the remaining wetlands and the amphibian population. Specifically, we are investigating how environmentally relevant concentrations of an agricultural fungicide, azoxystrobin, may affect development of larval anurans. We measured concentrations of a suite of agrichemicals in surface waters throughout the basins in 2016. In 2018, we collected mating pairs of Boreal Chorus Frogs (*Psuedacris maculata*) and allowed them to oviposit in the lab. We then replicated previously detected levels of azoxystrobin and exposed newly hatched tadpoles. The tadpoles were reared through metamorphosis and assessed for growth characteristics including weight and size at metamorphosis, time to metamorphosis, and mortality. Our trial did not find a significant difference between tadpoles exposed

to the azoxystrobin and those in the control groups for any of the characteristics measured. Toxicity can be complex, and developing larvae are rarely exposed to a single contaminant during development, but we can conclude that the levels of azoxystrobin alone in Rainwater Basin wetlands are unlikely to affect larval development of Boreal Chorus Frogs.



Boreal Chorus tadpoles in the laboratory
Photo: Michelle Hellman

ANGLER BEHAVIOR IN RESPONSE TO MANAGEMENT ACTIONS ON NEBRASKA RESERVOIRS - PART II

Principal Investigator(s): Kevin L. Pope, Christopher J. Chizinski
Research Asst. Professor: Mark A. Kaemingk
Graduate Student(s): Nicholas Cole, Ph.D.,(2018), Alexis Fedele, M.S. (2017), Alexis Park, M.S. (2017), Olivia DaRugna, M.S., Brian Harmon, M.S. (2017), Christine Ruskamp, M.S. (2018)
Duration: January 2014 – December 2018
Funding: Nebraska Game and Parks Commission
Location: Statewide Nebraska
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. 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



Ten pound Northern Pike at Lake McConaughy, Nebraska
Photo: Logan Dietrich

mechanisms between and among angler groups and fish communities.

This project has seven study components.

1. Statewide Angler Survey. Anglers were interviewed at Branched Oak Lake, Calamus Reservoir, Gracie Creek Pond, Harlan County Reservoir, Lake McConaughy, Merritt Reservoir, Pawnee Reservoir, Sherman Reservoir, and Lake Wanahoo from April through October, 2014 – 2018. These interviews added 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 allow for

relational assessments of changes in angling participation with environmental conditions and management actions on large scales.

2. 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. At Wanahoo, we observed a marked decrease in the CPUE of release-oriented species, but we did



Angler with 37 inch Wiper at Lake McConaughy, Nebraska
Photo: Logan Dietrich

not observe declines in CPUE for harvest-oriented fish. This suggests that individuals may develop learned behavior to avoid recapture and has strong implications for efficacy of management regulations and angler satisfaction. However, we did not achieve the same results at Prairie Queen, highlighting the complexities of the system and the need for continued research.

3. 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 investigated the effect of a fish's personality on its ability to learn. Behavioral tests and repeated fishing trials were conducted in a laboratory to determine where an individual falls along a boldness continuum, and if certain fish personality types are better able to learn to avoid a lure. Fish offered a worm on a hook-less wire increased their probability of taking the worm over the seven-day fishing trials. Fish offered a worm on a simple hook displayed a decreasing probability of capture over time, and fish offered a worm on a lure started out at a lower probability of capture and also showed evidence of decreasing probability of capture over time. Learning ability did not differ between bold and shy phenotypes; however, bold individuals did demonstrate a greater initial probability of capture across treatments. Therefore, anglers may disproportionately affect bold individuals through angling activities.

4. Spatial Distribution of Angler Parties. 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. Behavior for anglers fishing from the shoreline was recorded for entire, individual, fishing trips, and behavior was compared to angler-perceived fishing objectives. Angler objectives had little influence on behavior, and behavior had little influence on outcome. However, anglers that failed to capture

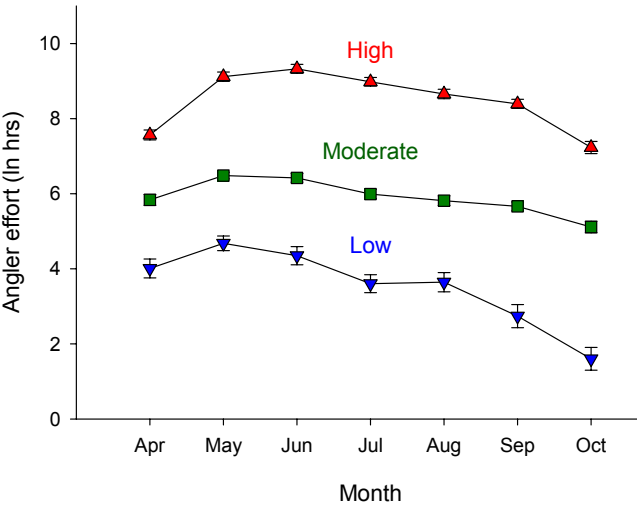
a fish were more likely to shift to a non-catch-related objective during their fishing trip. Further, ease-of-access had the greatest effect on angler densities. By measuring within-trip angler behavior and site choice, we may be able to more effectively manage recreational fisheries at greater scales.

5. Catchment dynamics in recreational fisheries. An angler's mobile nature, driven by a desire to participate in angling, coupled with the seasonality of a year, creates assumed fluctuations in participation at a waterbody. Despite this, there is little understood about angler behavior, especially spatiotemporal participation dynamics on patch and ecosystem scales. We completed an investigation of creel survey data with regard to spatial and temporal dynamics of angler participation using social-ecological catchments (anglersheds) to quantify participation patterns. Patterns in angler participation at a waterbody can be linked to local, angler, and landscape attributes. The area of catchments varied across waterbodies, but was not dynamic through space or time. The goal of this research is to create a link between participation and resource use at the landscape scale to provide managers with a greater understanding of clientele, and to inform scientists about attributes that are potentially driving an angler's decision to participate in recreational fishing.

6. Length-based Economic Assessment of Sportfish. Recreational fisheries are a unique industrial component to Nebraska's economy. Anglers derive value in a variety of forms by taking part in recreational fisheries. Quantifying this value requires assessing individual angler's willingness-to-pay to capture a fish and for each successive capture. Anglers also express unique preferences and motivations. Thus, we correctly predicted angler's willingness-to-pay to vary widely for different angling-trip outcomes (i.e., species and size). We used a length-based valuation framework that generalizes the preferences and motivations of Nebraska anglers across a variety of sociological metrics. This assessment provided a length-specific value of captured sportfish (channel catfish, crappie, largemouth bass, and walleye) stratified

across Nebraska's angling groups.

7. Moral domains of anglers. Cross-participation of outdoor recreational activities is increasingly being studied within the context of participation and recruitment efforts. We hypothesized that perceptions of legitimate use of fish and wildlife would be predicative of the types of activities in which recreators choose to participate. We limited the study population to Nebraska anglers and assessed whether their position on the moral-extensionalism continuum would be predicative of their reported alternate activities. Anglers who also preferred to participate in hunting were dominated by the anthropocentric position on the continuum. Similarly, non-consumptive outdoor activities were dominated by the pathocentric position on the continuum. The results of this experiment suggest that certain individuals may be predisposed or restricted to certain outdoor activities based their environmental philosophies and perceptions of the use of wildlife.



Patterns among the three different angler-effort groups identified using time-series cluster analysis.
Graphic: Mark Kaemingk

ANGLER BEHAVIOR ON NEBRASKA'S URBAN WATERBODIES

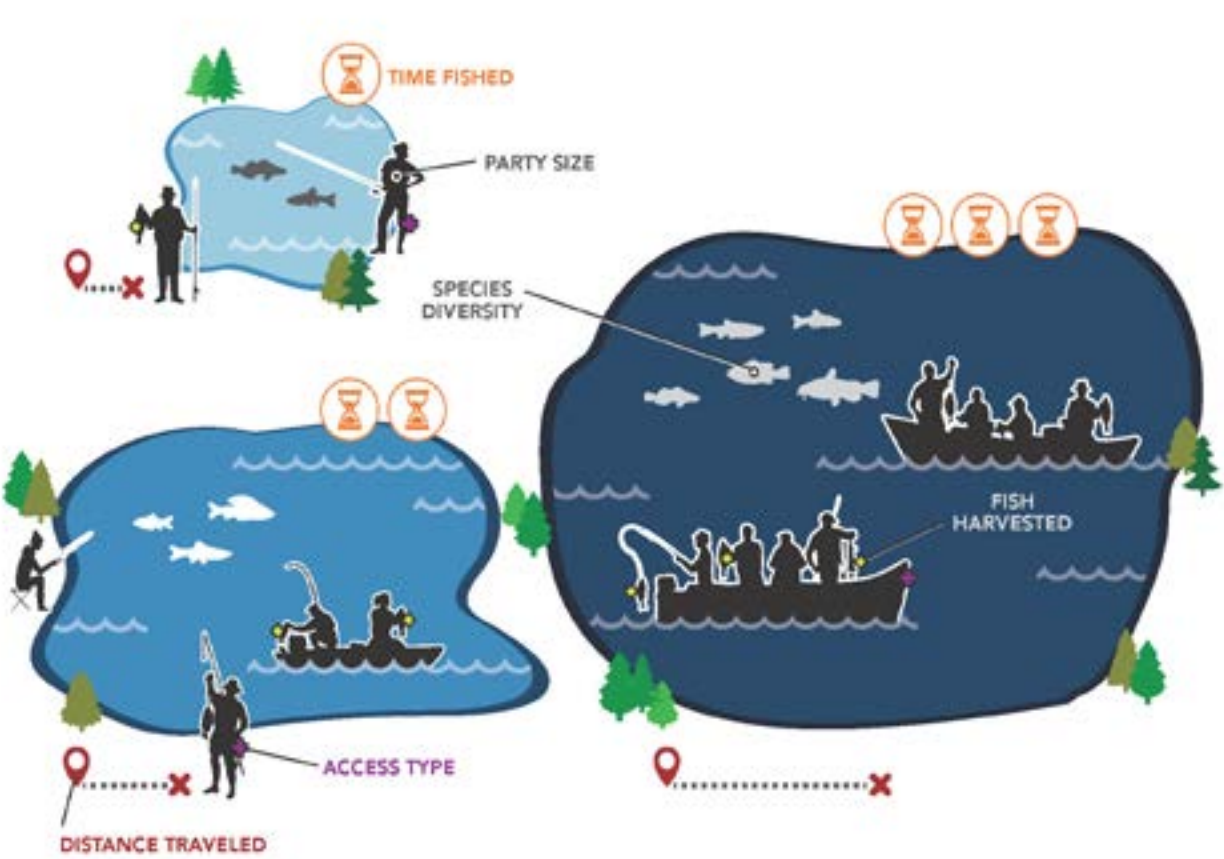
Principal Investigator(s): Kevin L. Pope, Christopher J. Chizinski, Mark A. Kaemingk
Graduate Student(s): Olivia DaRugna, M.S., Derek Kane, M.S.
Duration: January 2019 – December 2023
Funding: Nebraska Game and Parks Commission
Location: Statewide Nebraska
FISHHUNT.UNL.EDU

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 manage angler-fish interactions to ensure long-term sustainability. Arguably, most of our current understanding and management efforts of recreational fisheries have been directed toward larger fisheries that are located in rural environments. These waterbodies are highly visible resources and often attract many anglers. However, we know less about anglers in urban environments and how they interact with smaller waterbodies. It is important to understand angler behavior in metropolitan areas because the distribution of people on the landscape is becoming more urbanized. We anticipate that urban fisheries function differently than their rural counterparts.

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.

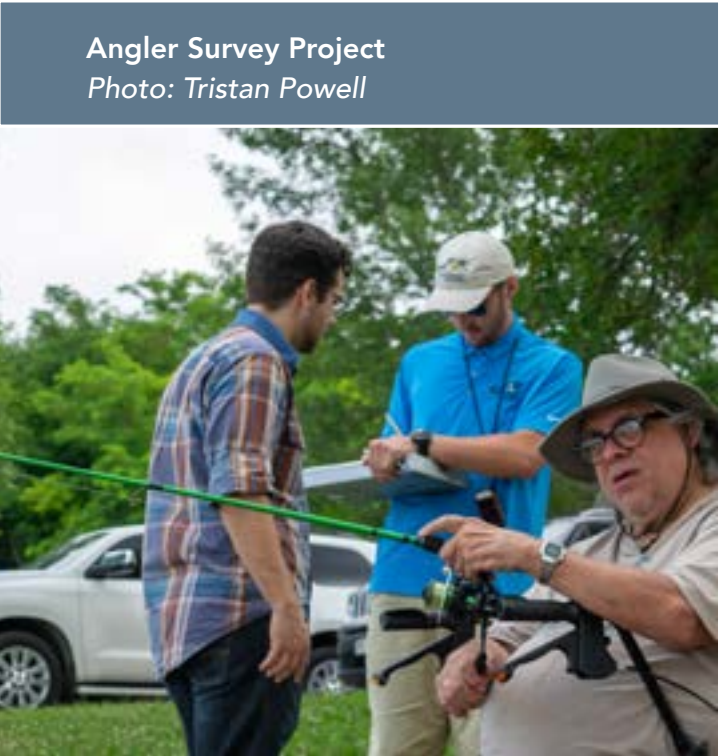
This project currently has four study components:

1. Omaha Angler Survey. Anglers were interviewed at Prairie Queen, Schwer, Halleck, and Standing Bear from April through October 2019. These interviews add to statewide angler survey datasets that are valuable for assessment of temporal changes in angler participation. In particular, these extended data sets allow for relational assessments of changes in angling participation with environmental conditions and management actions on large scales.
2. Omaha Angler Pressure. Anglers will be counted at 24 waterbodies in the Omaha metropolitan area from February 2019 through January 2020. These counts will allow for extrapolated estimates of year-round fishing pressure on Omaha's public waterbodies.
3. Understanding Variation of Recreational Fishing Pressure. Recreational fishing is a billion-dollar industry, yet little is known about what drives spatial and temporal variation in recreational fishing pressure. Recreational fishing pressure is the fundamental variable that affects all estimates of creel surveys. We aim to 1) identify factors that explain variation in fishing pressure and 2) develop models that can be used to predict and forecast future changes in fishing pressure. We will leverage our current datasets on fishing pressure with additional datasets (e.g., climate, standardized fish sampling, socioeconomic) to predict monthly variation in fishing pressure. Models developed will enable managers to plan for and adjust to potential future changes in fishing pressure.
4. Recreational Use of Valentine National Wildlife Refuge. Valentine National Wildlife Refuge is an important social-ecological system that provides a variety of recreational opportunities for visitors. However, frequency of activities and characteristics of participants are poorly understood.



Above: Conceptual infographic illustrating nonlinear angler behavior responses to water body size.
Illustration: Jonathan Marohl

We distributed windshield surveys from July 2017 to July 2018 to understand 1) the frequency of consumptive and non-consumptive recreational activities and 2) evaluate the sociodemographic characteristics and spatiotemporal distributions associated with these recreational activities. Most respondents participated in an intermediate-consumptive activity (fishing), followed by a consumptive recreational activity (hunting), and non-consumptive recreational activities (wildlife watching, photography, touring, hiking). Sociodemographic attributes of visitors differed significantly among consumptive and non-consumptive recreational activities. Heterogeneity among recreational activities and visitors participating in these activities should be assessed and considered when managing this refuge and other social-ecological systems.



Angler Survey Project
Photo: Tristan Powell

AQUATIC INVASIVE SPECIES (AIS) PREVENTION PROGRAM

Principal Investigator(s): Kevin L. Pope
Project Coordinator: Allison Zach
Duration: April 2011 – December 2021
Funding: USFWS Aquatic Nuisance Species Taskforce
Location: Statewide Nebraska
NEINVASIVES.COM

The Nebraska Invasive Species Program (NISP) continues to administer a multi-institutional Aquatic Invasive Species (AIS) Prevention Program.

Goals are to:

1. Decrease the risk of aquatic invasive species introduction into Nebraska;
2. Increase public awareness of AIS;
3. Monitor to help focus prevention efforts; and
4. Increase local and regional collaboration in the prevention of AIS.

The NISP has conducted boater surveys and watercraft inspections each summer during 2012 - 2018 at high-risk waterbodies throughout Nebraska to gauge public awareness of AIS, study watercraft movements, and to educate the public on AIS prevention. In 2019 the NISP coordinator trained Nebraska Game and Parks Commission (NGPC) aquatic invasive species technicians to continue this effort. The NISP provided NGPC with tablets to document watercraft inspections and items including brochures and towels to give to the public to increase clean, drain and dry behaviors. The NISP purchased a waterless watercraft cleaning station installed at Weigand Marina on Lewis & Clark Lake during May 2019. This unit allows the public to clean, drain and dry their watercrafts to prevent the spread of AIS including zebra mussels which are established in that reservoir. The CD3 unit includes a vacuum, air compressor, wrench to remove drain plugs, brush, grabber tool, and flood lights allowing users to

use the unit at night. The NISP coordinator worked with the Nebraska Lake Association (which includes 39 lakes) to provide outreach materials to members and helped develop guidelines their members use for preventing the spread of AIS. NISP provided boat launch signs to NGPC and private lakes throughout the state to promote clean, drain and dry behaviors to prevent the spread of AIS. The NISP Coordinator served on regional AIS panels and the Asian carp technical committee.

There were no new infestations of zebra mussels in Nebraska in 2019. Glenn Cunningham Lake was drawn down to freeze and kill a newly established zebra mussel infestation during the winter of 2018. The length of the draw down is believed to be sufficient to eradicate the population but the lake will be monitored closely to determine the long-term success of the effort. NISP disseminated boat launch signs for posting at public waterbodies and at private lakes to educate the public on clean, drain and dry procedures.

Nebraska now has four waterbodies infested with zebra mussels which include: Lewis & Clark Lake, Lake Yankton, the entire length of the Missouri River and Offutt Air Force Base Lake (Bellevue, NE). The NISP coordinator consulted with Offutt Air Force Base regarding a planned water management project specifically identifying zebra mussel management items for the project. The NISP ran ads in the NGPC boating and fishing guides and the Voice News to promote cleaning, draining and drying watercrafts to prevent the spread of AIS. The NISP coordinator works with AIS coordinators in other states to coordinate AIS prevention efforts across state lines.



CD3 unit at Weigand Marina, Crofton, NE
Photo: Allison Zach



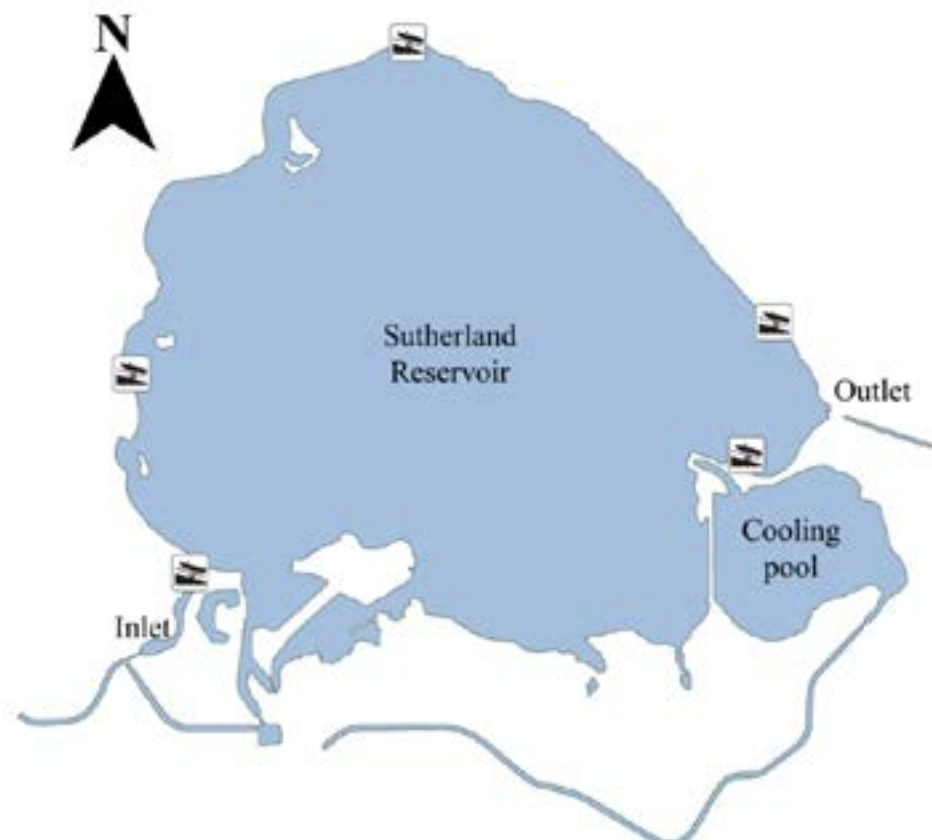
Zebra Mussel locations in Nebraska
Illustration: Allison Zach

ASSESSMENT OF ANGLER USE AND CATCH DURING 2018 AT SUTHERLAND RESERVOIR, NEBRASKA

Principal Investigator(s): Kevin L. Pope, Mark A. Kaemingk, Christopher Chizinski
Duration: March 2018 – January 2019
Funding: Nebraska Public Power District
Location: Sutherland Reservoir, Nebraska

Recreational fishing provides many socioeconomic and ecological benefits. These benefits are derived in many different forms that can lead to an increased quality of life and income generated across many different spatial scales. This importance has led to increased demands on these fisheries, often causing overexploitation, selective harvest, sub-lethal effects, and disturbance or harvest during critical reproductive periods. Consequently, there is a need to better understand

social-ecological relationships and impacts between humans and fish populations. The purpose of this study is to estimate angler use and catch at Sutherland Reservoir, Nebraska, from April through October 2018. Specifically, we obtained monthly estimates of angler pressure, catch, and harvest. This information will allow the Nebraska Public Power District to evaluate angler use and influence of the fishery at Sutherland Reservoir. Collected data could also be used to guide management efforts between optimizing hydropower and maintaining a quality fishery at this multi-use reservoir.



Sutherland Reservoir

AVIAN HABITAT RELATIONSHIPS ACROSS ECOLOGICAL SCALES

Principal Investigator(s): Joseph J. Fontaine, Erica F. Stuber
Graduate Student(s): Nadya Mirochnitchenko, M.S. (2018), Christopher Jorgensen, M.S., (2012)
Undergraduate Student: Victoria Simonsen, UCARE Student (2015)
Duration: January 2010 – December 2018
Funding: Nebraska Game and Parks Commission, University of Nebraska–Lincoln UCARE Program
Location: Statewide Nebraska
PRAIRIEBIRDS.UNL.EDU

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. Unfortunately management efforts sometimes fail to demonstrate the desired outcome for wildlife populations. Understanding why management is 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 birds associate with 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. Since 2011 more than 5,000 avian point count surveys have been conducted on State Wildlife Management Areas, private properties enrolled in the Open Fields and Waters program, and road transects. 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 on the ground conservation efforts may be determined by the landscape context. The findings from this study are now being used by the Nebraska Game and Parks Commission to help direct pheasant management efforts in Nebraska.



Priority pheasant management areas defined by the Nebraska Game and Parks Commission in the Berggren Plan using models developed through this study
Illustration: Nebraska Game and Parks Commission

BAT CONSERVATION AND RECOVERY IN NEBRASKA AND WYOMING

Principal Investigator(s): Dirac Twidwell, Kevin L. Pope
Program Coordinator: Baxter Seguin
Duration: May 2019 – May 2022
Funding: Nebraska Game and Parks Commission
Location: Statewide Nebraska, statewide Wyoming

There are mounting concerns for North American bats due to continuing and emerging threats from disease, habitat loss, fragmentation and wind energy development. These threats are likely to increase in severity, but there is an opportunity to improve our knowledge of bat occurrence and habitat use, to learn how

landscape changes impact local bat populations, and to establish regional monitoring that can inform local and national resource management decisions. The Nebraska Cooperative Research Unit is collaborating with the Nebraska Game and Parks Commission, the Wyoming Game and Fish Department, and state and federal natural resource managers in the Midwest; this collaboration is focused on developing a strategic approach to bat conservation across Wyoming and Nebraska by monitoring impacts, and by providing decision makers with decision-support tools and a conservation plan. Data collection on this new project includes a large component of citizen science, with local volunteers helping collect data across these states.



Acoustic detector by the Missouri River, NE
Photo: Zac Warren



BAT MOVEMENTS ACROSS TRANSFORMING LANDSCAPES

Principal Investigator(s): Craig R. Allen,
Graduate Student(s): Michael Whitby, Ph.D.
Duration: May 2010 – December 2019
Funding: Nebraska Environmental Trust, Nebraska Game and Parks Commission
Location: East-central Nebraska
WIND-ENERGY-WILDLIFE.UNL.EDU/BAT

Bats provide critical ecosystem services across the globe. In the United States, all bats are insectivorous and consume up to twice their body weight in insects every night. Their voracious appetite is estimated to replace at least \$3.7 billion dollars in pesticide use across the U.S., saving farmers \$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 for bat populations. Across North America, wind turbines are estimated to kill over 800,000 bats annually. As the energy sector positions itself to harness Nebraska’s wind resources, we must consider and minimize the unintended consequences to Nebraska’s agricultural and natural resources. Potential negative impacts of wind energy development on bats can be minimized through siting and operations that consider bat activity. By studying bat migratory patterns in Nebraska, we will help utility companies, wind energy developers, and wind facility owners avoid, manage, and mitigate the effects of new and existing wind energy facilities.

To achieve this goal, we used acoustic detectors to record the echolocation calls of passing bats at locations across east-central Nebraska. Twenty-two detectors were placed on grain legs and silos with the cooperation of private landowners, these

detectors recorded from April to November 2015 and 2016. We recorded almost 1 million bat passes and identified 677,000 species. The data is being used to identify the timing of bat migration in the area and to create a spatial map of bat activity, allowing us to determine if any migratory corridors exist in the area. A separate acoustic grid of more than 50 detectors was placed along the Missouri River floodplain during the fall migratory period to determine if and how the river and bluff lines are being used during migration.

Additional work has explored (a) the use of weather RADAR to estimate bat activity across the landscape, (b) the use of isotopes to determine the origin of migratory bats, and (c) analysis of diet of migratory and resident bat species.



Michael Whitby with bat
Photo: Mandy Lipinski

CANID DISTRIBUTION AND THE POTENTIAL IMPACTS OF ENERGY DEVELOPMENT IN NEBRASKA

Principal Investigator(s): Joseph J. Fontaine, Teresa J. Frink (Chadron State College)
Graduate Student(s): Lucía Corral, Ph.D.
Duration: January 2013 – December 2018
Funding: Nebraska Game and Parks Commission, Nebraska Department of Roads
Location: Western Nebraska
SWIFTFOX.UNL.EDU

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 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 (*Vulpes velox*) has undergone significant declines. In Nebraska, swift fox is currently estimated to occupy only 21% of its historical range, while coyotes have increased in numbers and range throughout Nebraska. It is not surprising that generalists such as coyotes are capable of



Swift Fox detected on trail camera
Photo: Trail cam

thriving in highly altered human landscapes, but what is less clear is why swift fox fail to occupy the 42% of Nebraska that continues to contain suitable habitat.

As the largest canid in Nebraska, coyote is dominant to swift fox and is often cited as an important source of mortality for swift fox. As such, increase 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.

From 2014 to 2016, we surveyed for canids across 26,000 square miles of western Nebraska using baited camera traps. With the help of 130 private landowners, we were able to deploy 2,300 camera trap sets, for nearly 28,000 trap nights resulting in over 5 million photos. We have used the camera trap data to develop predict models relating local and regional vegetation to the presence of various canid species.

Overall, our results reiterated the importance of native shortgrass prairies for swift fox, and show that increasing tree, row-crops, and developed areas within the landscape negatively impact swift fox. Our results suggest that swift fox populations in Nebraska are restricted to two subpopulations within its available habitat; there is little genetic structure or geographic isolation, but our findings draw attention to the potential for future reduction of genetic diversity due to swift fox small population size in light of increasingly diminished and fragmented suitable habitat.

CLIMATIC CONSTRAINTS ON BOBWHITE QUAIL POPULATIONS ALONG THEIR NORTHERN EXTENT

Principal Investigator(s): Joseph J. Fontaine, Gwen C. Bachman
Graduate Student(s): Amanda (Mandy) Lipinski, Ph.D., Victoria (Vicky) Simonsen, M.S. (2018)
Duration: June 2014 – December 2020
Funding: Nebraska Game and Parks Commission
Location: South-central Nebraska
PRAIRIEBIRDS.UNL.EDU

Northern bobwhite quail (*Colinus virginianus*) is among the most popular game birds in North America; however, the loss of suitable habitat has led to precipitous population declines throughout its range. With significant grassland and farmland habitats, Nebraska has the potential to maintain



Bobwhite quail with transmitter
Photo: Mandy Lipinski

viable quail populations, but because of harsh winters and periodic wet springs, quail populations in Nebraska tend to be highly dynamic. Local habitat management may be capable of overcoming some environmental constraints, but effective management strategies necessitate a comprehensive understanding of the impacts of larger scale climate conditions on Nebraska's quail resources.

Although there are numerous studies focused on water constraints for quail populations in arid environments, the role of climate 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 climate, 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 how climate and weather (e.g., snow storms, spring rains) alter quail physiology and behavioral decisions to impact population stability in Nebraska so we can further inform management strategies. Using 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.

Beginning in the fall of 2016, we began catching quail at 19 field sites in southern Furnas County. Individual quail were fitted with radio-collars and monitored to evaluate movement and habitat selection from the onset of winter through the onset of the nesting season.

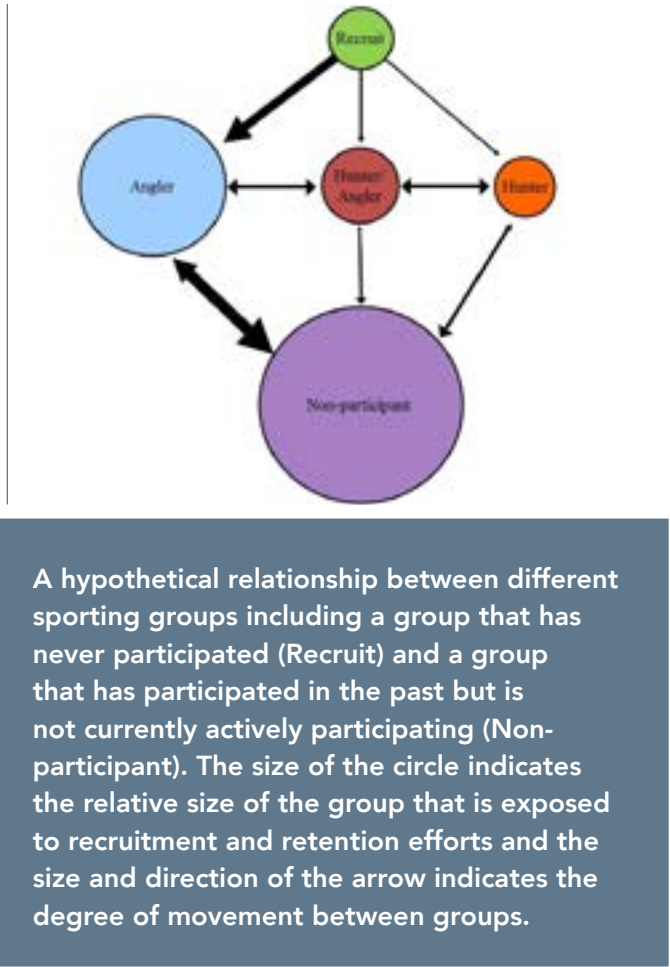
COMPREHENSIVE EVALUATION OF THE NEBRASKA OUTDOOR ENTHUSIAST

Principal Investigator(s): Christopher J. Chizinski, Joseph J. Fontaine, Kevin L. Pope
Data Scientist: Nathaniel Price
Duration: January 2016 – January 2019
Funding: Nebraska Game and Parks Commission
Location: Statewide Nebraska
FISHHUNT.UNL.EDU

The decline in hunters and anglers is a concern to natural resource management agencies nationwide. Fishing and hunting license sales and taxes on fishing and hunting equipment are vital sources of funding for wildlife management agencies, and in many cases, management objectives are met under the stewardship of sportspersons. The dependence on hunters and anglers by management agencies like the Nebraska Game and Parks Commission makes the North American Model of Conservation unique, but vulnerable to declining participation in outdoor recreation. Hunter Education programs, Family Fishing Events, Outdoor Expos, and other programs can increase participation in outdoor recreation; but to ensure the future of hunting and fishing in Nebraska we need to understand how hunters and anglers use Nebraska’s fish and wildlife resources, how they perceive the outdoor opportunities available in Nebraska, and most importantly what differentiates the types of hunters, types of anglers, and movement among groups including non-participants, those that do not yet participate through license purchases.

The U.S. Fish and Wildlife Service supports the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation Survey in a nationwide attempt to understand the sporting public. Conducted every five years, the National Survey identifies generalizations concerning patterns of outdoor enthusiast participation in the USA. Many state agencies, including the Nebraska

Game and Parks Commission, conduct surveys to individual license holders. State surveys are often highly directed because of the extraordinary effort necessary to survey completely, limiting their applicability across user groups and state boundaries. Given the challenges of both national and state surveys, there is a need to bridge the information gap and understand hunters and anglers, as well as hunter education participation, at spatial and temporal scales that may more directly assist in creating hunting and angling opportunities. We are analyzing a comprehensive database on license holders and hunter education participants in Nebraska with the goal of helping inform and direct wildlife and fisheries management, as well as recruitment and retention efforts within the state.



GENERATION OF NOVELTY IN COMPLEX SYSTEMS

Principal Investigator(s): Craig R. Allen
Post-Doc(s): Shana Sundstrom, Ph.D. (2017)
Duration: January 2013 – December 2019
Funding: James S. McDonnell Foundation
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 that 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 convened 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 was 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?

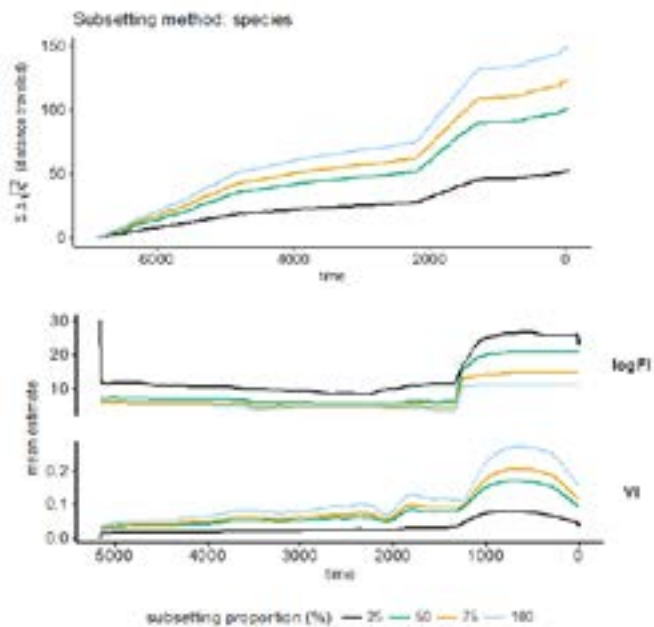
In March, 2019, we held a workshop in Lincoln, Nebraska, to discuss these and other ideas and questions. The workshop brought together about a dozen scientists, representing neurosciences and resilience theory. A manuscript focused on the idea of convergence is being developed from this meeting.

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. (2019)
Duration: August 2015 – May 2019
Funding: U.S. Department of Defense—Strategic Environmental Research and Development Program (SERDP)
Location: Statewide Nebraska

Our objectives for this 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 are utilizing monitoring and surveying data that are currently available in North America (e.g., Breeding Bird Surveys) with novel statistical tools and theory to assess long-term trends in the resilience of landscapes, changes in ecological regimes in both space and time, and species vulnerable to decline and extinction.

A growing concern with effects of climate change and globalization include rapid and undesirable shifts in the structure and functioning of ecological systems. Identifying and predicting these changes (or ‘regime shifts’, ‘state changes’ or ‘abrupt changes’) would be of great utility to ecological systems management. Numerous quantitative methods are proposed for detecting these changes, however, most have yet to be implemented by practitioners. We present a regime shift detection metric that tracks the trajectory of systems data and is simple to calculate, intuitive, and appears insensitive to variable selection and data availability. The metric, distance traveled (Figure, right), is simply calculated as a cumulative summation of changes in state variables over time. Using resampling techniques, we found evidence to suggest the distance traveled metric is more robust to sampling errors that are common in ecological data collection (e.g., unequal sampling, sampling only a subset of the community).



Signals of abrupt community change are lost in the regime detection metrics “Fischer Information (log scale) and the Variance Index (bottom panel), but not in the distance traveled metric (top panel). As the percent of species analyzed decreases (subsetting portion).

IMPLEMENTING THE NORTH AMERICAN BAT MONITORING PROGRAM (NABat)

Principal Investigator(s): Craig R. Allen
Graduate Student(s): Baxter Seguin, M.S. (2019)
Duration: January 2016 – November 2018
Funding: Nebraska Game and Parks Commission
Location: Statewide Nebraska

Goals of the project:

1. Maintain bat sampling in (35) 10 km x 10 km NABat grid cells throughout the state.
2. Contribute bat data to the U.S. Geological Survey for use in the continent-wide North American Bat Monitoring Program.
3. Collaborate with stakeholders and land managers to help increase our knowledge of bat populations and species composition in various areas of concern throughout the state.
4. Increase public awareness and involvement with bats and bat research throughout the state through Citizen Science and outreach.
5. Provide land managers and Nebraska Game and Parks Commission with data-supported insight into how to better conserve NE bats.

NE NABat was first established in 2016 through a NGPC grant funding a master student to establish the program. Since its success in providing a plethora of data concerning the bats of Nebraska, the program received funding to continue for the next three years starting in May 2019 (see Bat Conservation and Recovery in Nebraska and Wyoming, page 40 in this report).

Over the past decade bat species in North America have been under immense stress due to anthropogenic activities throughout the continent along with severe declines from foreign invaders. Though many specific anthropogenic related activities such as deforestation, land-use alteration, and hibernacula disturbance were the primary

culprits of negative impacts on bat species in the past, they pale in comparison to the threats bats face today. White nose syndrome (a disease caused by the fungus *Pseudogymnoascus destructans*) and wind energy development have caused declines and disruptions to the bat populations of North America at an unprecedented rate.

Due to the significant contribution to insect population control that bats exhibit throughout the continent they are considered to be a major benefit to both ecosystems and agricultural industries. Though they are known to provide significant services to ecosystems large information gaps exist in what physical properties influence their presence on the landscape. Especially in states like Nebraska where the large extent of agricultural and grassland ecosystems has made their study difficult in the past. In order to address these information gaps we implemented the North American Bat Monitoring Program throughout Nebraska in order to answer baseline questions about bat habitat use and ensure that monitoring efforts continued into the future and benefit bat research throughout the continent.



Central NE bat assessment
Photo: Baxter Seguin

INVASION, COST-SHARE, AND PRIVATE LANDOWNERS: RESOLVING THE CHALLENGES OF SCALE WITH MANAGING *JUNIPERUS VIRGINIANA* ON NEBRASKA'S RANGELANDS

Principal Investigator(s): Dirac Twidwell
Graduate Student(s): Brittany Dueker, M.S.
Duration: August 2016 – December 2018
Funding: Nebraska Game and Parks Commission
Location: Statewide Nebraska

With the rise of globalization, the spread of invasive species has become increasingly prevalent and problematic. A characteristic of many biological invasions is a period of rapid population growth following introduction; management and control is most likely to be successful if it occurs prior to that period of rapid growth. *Juniperus virginiana*, commonly known as Eastern Redcedar (ERC) is a woody species invading the Great Plains of the USA. Although native to Nebraska, it is spreading into grasslands and rangelands where it has not been historically present and has the potential to seriously disrupt the local economy, including cattle production. Cedar can be controlled via regular burning to remove woody brush and revitalize native grasses, however, public opinion of prescribed fire is uncertain. Because so much of Nebraska is privately owned, it is critical that the public understands the seriousness of the ecological and economic costs of cedar invasion, and the importance of its proper management in private and public lands.

Cost-share programs provide funding that offsets the cost of, and provides technical assistance for, management that improves the environment, and engaging landowners educates them on local ecological issues and solutions, potentially educating their friends and neighbors. Joining a cost-share program is voluntary, so to increase participation, much research has been done to

determine which incentives are preferred by the majority of landowners. Although these studies have discussed the social aspect of cost-share, they overlook the ramifications of structuring a program based on landowner preferences rather than ecological science. If cost-share management is at a smaller scale than ERC invasion, management will not be successful in the long run. The purpose of this study is to understand the perceptions of Nebraskan landowners in regards to ERC and ERC management, and the ways participation-based incentives influence the scale of cost-share programs to remove ERC to identify where these programs are succeeding at their conservation goals and where improvements can be made.

In November 2017, surveys were distributed to 2,262 land owners in rural Nebraska, inquiring about their perception of ERC and prescribed fire management. Data collection was completed in January 2018, analysis and write-up is underway. Landowners prefer smaller scales of management, even given cost-share program incentives that cover the entire monetary cost, and that the amount of land that they prefer to manage is more influenced by restrictions to land use before, during, and after management than by management cost. Analysis of data from the 2015 - 2016 NASIS survey and the 2016 Fire Chief survey has been completed and write-up of the results is in progress. Results from these surveys indicate that cedar is seen as a problem by more landowners in the central areas of the state and that fire departments in Nebraska agree more with using prescribed fire for range management than for livestock production, even though the two are directly linked.

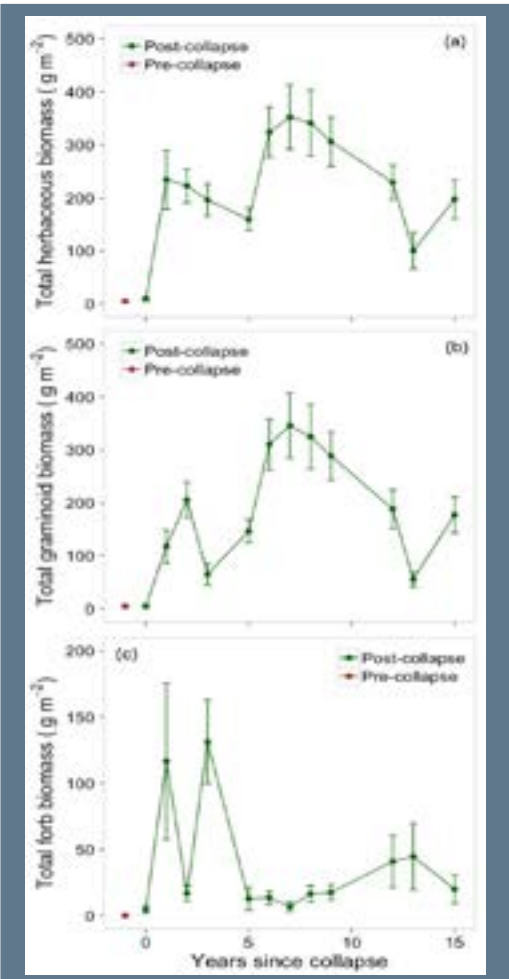
MANAGING REDCEDAR INVASION OF NEBRASKA GRASSLANDS - PART I

Principal Investigator(s): Dirac Twidwell
Graduate Student(s): Christine Bielski, Ph.D.
Undergraduate Student(s):
Duration: January 2017 – January 2021
Funding: Nebraska Game and Parks Commission
Location: Statewide Nebraska

Eastern Redcedar is the most rapidly expanding woody plant species in the Great Plains and is now recognized as the number one threat to Nebraska's rangelands by the Nebraska Conservation Roundtable. The impacts of redcedar invasion in grasslands are wide-ranging, including reducing grassland bird diversity and abundance, decreasing livestock production by 75%, reducing small mammal and insect diversity, and costing Nebraska Public Schools over \$2,440,000 from 2006 - 2016. The objective of this grant is to assess the vulnerability of Nebraska's grasslands to redcedar invasion, and develop predictive tools that enhance the potential to implement landscape interventions that (1) prevent the spread of redcedar trees or (2) restore degraded wildlife habitat following transformation to a redcedar-dominated state.

Two field experiments have been conducted since January 2018 with preliminary fire models conducted in BehavePlus, (Windows based fire management application to calculate fire behavior). The first field experiment involved collecting thermal imaging data on extreme prescribed fires conducted in the Loess Canyons Biologically Unique Landscape (BUL). Information from these prescribed fires expanded on similar data collected in 2017 and will be used to validate future experimental investigations on extreme fire effects in grasslands as well as provide evidence for increased wildfire risk in juniper-invaded grasslands. The second field experiment was also conducted in the Loess Canyons BUL with the

objective of quantifying rates of juniper recovery following extreme fire. This project was led by an undergrad student enrolled in the USDA Research Experience for Undergrads (REU) program. Data from the second field experiment show that Eastern Redcedar re-invades woodlands previously collapsed by extreme fire at surprisingly fast rates. Multiple mathematical fire models have been conducted in BehavePlus to quantify ember transport distances to better inform prescribed fire designs. Model outputs from these simulations will be used to quantify the maximum ember transport distance and likelihood of spotfire occurrence in large-scale prescribed fires.



Graph: Christine Bielski

MANAGING REDCEDAR INVASION OF NEBRASKA GRASSLANDS - PART II

Principal Investigator(s): Dirac Twidwell
Graduate Student(s): Dillon Fogarty, Ph.,D.
Duration: January 2016 – May 2021
Funding: Nebraska Game and Parks Commission
Location: Statewide Nebraska

Eastern redb cedar invasion is a major threat to grassland resources in Nebraska. In this project we are working with Nebraska Game and Parks Commission to answer four primary questions to better address cedar invasion.

- 1. What are the consequences of cedar invasion?
- 2. Where can cedar invasion occur in Nebraska?
- 3. How is current cedar management performing?
- 4. How can cedar management be improved?

To date we have (a) synthesized the consequences of invasion, (b) determined where in the Nebraska Sandhills is vulnerable to invasion, (c) assessed statewide management performance, and (d) quantified how cedar recovers following local eradication with prescribed fire. Cedar invasion is associated with many surprising and unexpected consequences including a loss of grassland biodiversity, increased wildfire risk,

decreased freshwater supply and quality, loss of school funding, decreased forage and livestock production, endangerment of rural livelihoods, increased spring allergens, increased risk of species extinctions, and a risk of apple trees becoming infected with cedar-apple rust. The range of where these potential consequences can be realized in the Sandhills extends well beyond what is widely expected. Results from the Sandhills show that cedar invasion is occurring throughout the Sandhills—in areas west of the 100th meridian previously expected to be too dry for invasion to occur—and planted cedar windbreaks are contributing to this invasion. In our Nebraska-wide assessment of cedar management, we found that management is under performing relative to targets of stabilizing and/or reversing trends of increasing tree cover in grasslands. However, trends of increasing tree cover in the Loess Canyons have recently been stabilized as a result of partnerships between prescribed burn associations and natural resource professionals. Additionally, our research in the Loess Canyons shows that following prescribed burning cedar can recover quickly; sprouting seedlings within 1-2 years of initial restoration and forming dense thickets within 16 years. Future research will engage a diversity of Nebraska stakeholders to envision how future management can be improved.



Juniperus virginiana in Loess Canyon

Photo: Erin McCready

MISSOURI RIVER BASIN MITOCHONDRIAL GENOME DATABASE

Principal Investigator(s): Kevin L. Pope, Guoqing Lu (UNO), Sarah J. Gaughan
Graduate Student(s): Sarah Gaughan, Ph.D.
Duration: June 2017 – August 2019
Funding: National Science Foundation EO³ program
Location: Statewide Nebraska

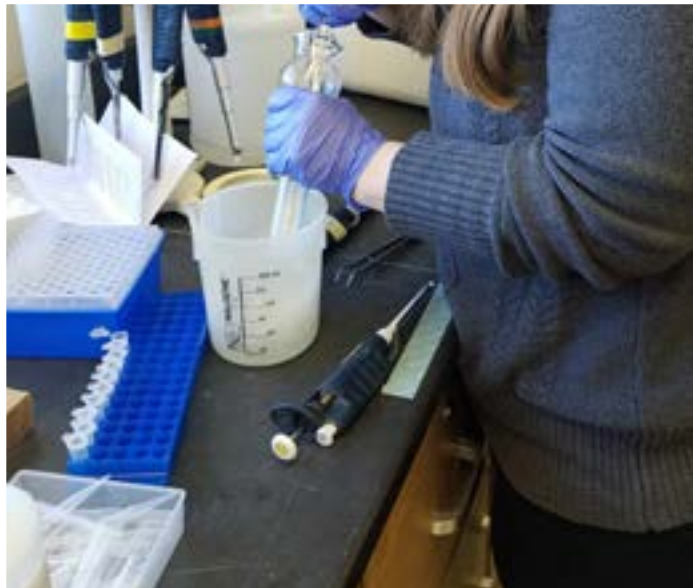
The Mississippi River watershed, including the Missouri River tributary, is the fourth largest watershed in the world. This watershed has undergone dramatic ecological changes in the past century as a result of human activity including channelization, the construction of dams, removal of natural formations and agricultural discharge. One of the major limitations for genetic studies in this region is a lack of a genetic database for general comparison. The major goal of this project is to provide genetic resources for native species throughout the Mississippi River Basin to facilitate future research interests including eDNA, diet composition, and restoration efforts.

The stability of mitochondrial genomes in addition to their high mutation rate and relatively low number of genes make mitochondrial genomes ideal markers to begin addressing some of the evolutionary questions and conservation concerns of native species in the Mississippi River Basin. This project had a focus toward native-fish genomes in Nebraska. Thus far, we have sequenced the mitochondrial genomes of 61 native fishes.

In addition to native fish mitochondrial genomes, the Northern Long Eared Bat was also sequenced to showcase the functionality of mitochondrial genomes across diverse taxa. The Northern Long Eared Bat was chosen as a representative species because it has experienced significant population declines as a result of White-nose Syndrome, an emerging disease caused by a white psychrophilic fungus that prematurely depletes fat reserves in hibernating bats and ultimately results in death.



Genotyping Asian carp in Shanghai, China
Photo: Sarah Gaughan



Extracting mitochondrial DNA.
Photo: Stephanie Purcell

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

Principal Investigator(s): Kevin L. Pope
Coordinator: Allison Zach
Duration: January 2010 – December 2019
Funding: Nebraska Game and Parks Commission
Location: Statewide Nebraska
NEINVASIVES.COM

The goals of this project are to:

1. Provide outreach to, and facilitate communication among, stakeholders regarding biological invasions, coordinate the Nebraska Invasive Species Advisory Council, and assist with any additional legislation regarding invasive species as needed;
2. 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 (NISP) continues to coordinate monthly meetings for the Nebraska Invasive Species Advisory Council, which is a formalized Council created by a law in 2012. This Council is comprised of 17 appointed members and a total of 25 regularly attending members that discusses topical invasive species

issues, develops management plans and Early Detection-Rapid Response (EDRR) plans and informs the Nebraska Legislature of the status of invasive species in the state. EDRR efforts were expanded through identification courses council members provided their own staff and other groups as well as dissemination of the NISP's invasive identification guides to the public. The public and resource agency staff reported sightings of invasive species on the NISP website and accessed information on the species. An adaptive management plan was updated by the Council in 2018 and provided to the Governor and legislative agricultural committee. The Council was instrumental in the passage of a law in 2015 creating an aquatic invasive species prevention program within the Nebraska Game and Parks Commission. The Council submitted comments on a proposed transbasin diversion project in 2018. The council updated the Nebraska weed watch list to identify key species of concern for management efforts (available on the NISP website). The NISP coordinator serves on several regional panels on aquatic invasive species to coordinate outreach, management and prevention efforts across state lines. The NISP coordinator coordinated the watercraft inspection tablet system that was used by the Nebraska Game and Parks Commission in 2019. Inspection results will be analyzed to plan future aquatic invasive species outreach and prevention efforts.



PLANT FUNCTIONAL COMMUNITY DYNAMICS AND POLLINATOR RESOURCE PROVISIONS WITHIN NEBRASKA'S RESTORE PRAIRIES

Principal Investigator(s): David A. Wedin
Graduate Student(s): Katharine Hogan, Ph.D.
Duration: January 2018 – May 2022
Funding: National Science Foundation Research Traineeship (NRT), City of Lincoln, Lincoln Parks and Recreation
Location: Statewide Nebraska

Recently, there has been a decline in pollinators across the globe, creating concern about their diversity, the provision of their related ecosystem services for humans and the environment, and what declines might say about the resilience of the ecosystems in which they live. In the Central Platte River Basin of Nebraska, these concerns are in tandem with questions of how grasslands adapt under stress and disturbance, and how they may maintain resilient function in a changing climate and continuing habitat fragmentation. Diverse entities, including government agencies, businesses and non-profits have explored the support and facilitation of pollinator communities with various methods of grassland habitat restoration and management. However, there are still knowledge gaps regarding what aspects of restored habitat are most valuable to wild pollinators and when. Among other research opportunities, there is much we don't know about the nutritional resources available for wild bees in current prairie restorations, and how they directly affect the native bees that use them. This research will explore plant functional community dynamics (including temporal nectar and pollen provision) in restored prairies. These field studies will be complemented by a controlled study assessing the impact of prairie nutritional resources on a Nebraska native bumblebee species, *Bombus impatiens*. In a rapidly changing world and climate, this research will construct a quantitative framework

from which to assess restored prairies for pollinator benefit and their contribution to crucial ecosystem services and ecological resilience in years to come.



Nebraska Prairie
Photo: Hannah Birgé

RAINWATER BASIN JOINT VENTURE SCIENCE

Principal Investigator(s): Kevin L. Pope, Andy A. Bishop (Rainwater Basin Joint Venture Partnership)
Science Coordinator: Dana Varner
Duration: October 2014 – December 2019
Funding: Rainwater Basin Joint Venture
Location: Statewide 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.

As science coordinator, Dana works 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. In addition, Dana helps monitor and evaluate the success of ongoing and past habitat conservation projects, collaborating with researchers from various federal and state conservation organizations. Dana recently worked with a group of partners to complete a research project looking at wetland functionality by tracking changes in magnitude of playa inundation, use by migrating whooping cranes, and an assessment of sediment quality. This project used inundation and precipitation data to look at the effects of irrigation pitfalls on the potential availability of habitat for migrating whooping cranes. Dana serves on the Executive Committee of the North American Waterfowl Management Plan Science Support Team, contributing to evaluation and planning efforts in diverse geographies. Dana is involved with several other projects currently in progress including monitoring of spring-migrating waterfowl use of playas in the Rainwater Basin region and an inventory of eastern red cedar in the Sandhills.



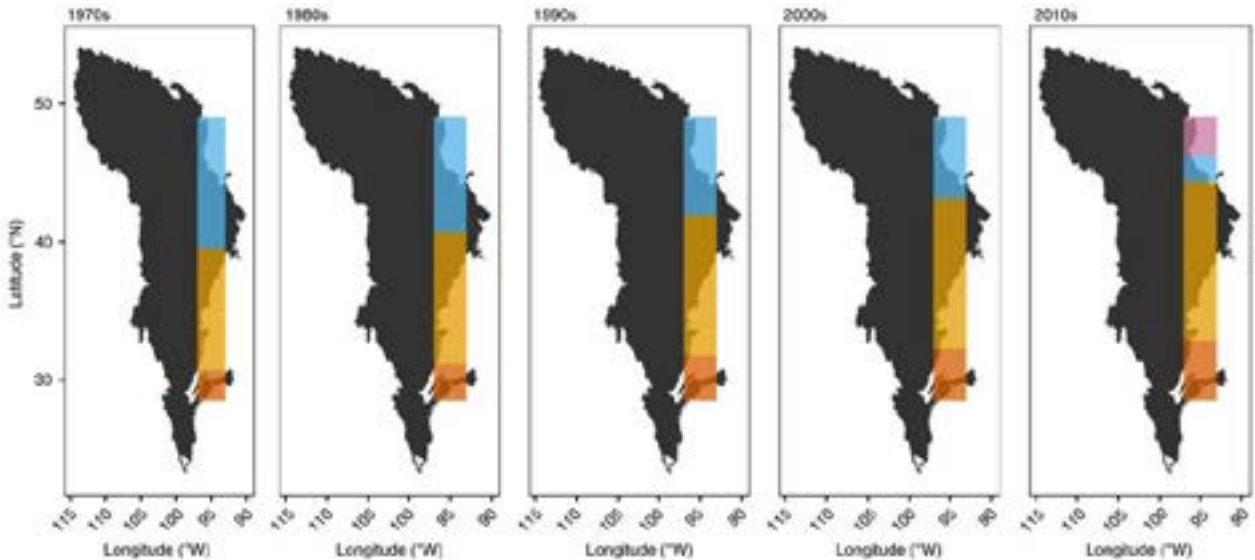
Sunset in the Rainwater Basin
Photo: Michelle Hellman

SHIFTING AVIAN SPATIAL REGIMES IN A CHANGING CLIMATE

Principal Investigator(s): Craig R. Allen, Dirac Twidwell, David G. Angeler (Swedish University of Agricultural Sciences, Sweden)
Graduate Student(s): Caleb Roberts, Ph.D. (2019)
Duration: August 2015 – September 2019
Funding: U.S. Department of Defense, Strategic Environmental Research and Developmental Program (SERDP)
Location: Statewide Nebraska, Continental USA

Rapid environmental change may alter the ability of the Department of Defense to maintain readiness, and require costly remediation and mitigation when formerly abundant species become rare. The uncertainties associated with global change support the need for a framework that allows the explicit incorporation of non-linear responses of complex systems. Our project addressed this uncertainty by identifying ecosystems with potential current high vulnerability

to global change (risk of an impending regime shift). We identified spatial regimes in avian community data and tracked their movements over 46 years (1970 – 2015) in the North American Great Plains biome. In 46 years, we found the northernmost spatial regime boundaries moved >590 km northward, the southernmost boundary moved >260 km northward. Additionally, we demonstrate that, at the scale of a military installation, avian spatial regimes moved in tandem with vegetation regime spatial boundaries, and in fact, avian spatial regimes provided a spatial early warning of regime shift by responding to vegetation regime shifts > 1 km from vegetation regime boundaries. We demonstrate an eminent biome-level regime shift in the Great Plains and how tracking spatial regimes provides spatially and temporally explicit estimates of vulnerability to ecological change. Spatial regimes provided early warnings of regime shifts >10 years prior to the regime shift, suggesting that spatial regimes can provide decades worth of ecological planning horizons.



Black polygons represent the historic Great Plains biome extent. Coloured bars represent the predicted extents of spatial regimes in the study area over five decades.

SPATIO-TEMPORAL FORAGING ACTIVITY OF BATS IN THE AGRICULTURAL LANDSCAPE

Principal Investigator(s): Dirac Twidwell, Eric A. North
Graduate Student(s): Christopher Fill, M.S.
Duration: January 2018 – May 2020
Funding: National Science Foundation Program (NRT), National Park Service
Location: Lancaster and Gage counties, Nebraska

As the primary predator of night-flying insects, bats are generally regarded as playing a vital role in suppressing insect populations. Areas of tree cover are important habitat for bats in modified agricultural landscapes, and in Nebraska, forest-dependent tree-roosting bats in particular are affected negatively by habitat fragmentation.

The purpose of this study is to investigate the use of monocultural fields by insectivorous bats in different land use configurations in Nebraska’s intensively managed agricultural landscape. Understanding the spatial patterns of each species over space and time will lead to a better understanding of bat foraging ecology, the ecosystem services they provide by eating harmful insects, and additional measures to conserve these species. To do this we are systematically placing acoustic detectors in a variety of crop fields and recording the echolocation calls different bats make when active at night.

We will also be studying federally threatened Northern Long-Eared bats through capture and telemetry efforts, in order to understand the roosting ecology of this imperiled species at the western edge of its range.

Immediate findings from this study have revealed spatial trends among the eight different bat species recorded since the start of the project, with dramatic differences in activity patterns over time and open crop field airspace. Species affinities for the various habitat types have also become

apparent in the amount of space each covers. The extents of these foraging distributions present a different way to view bat movements, offering a deeper insight into bat ecology, with considerable implications for the ecosystem services they may provide.



Acoustic bat detector deployed in Gage County, NE
Photo: Christopher Fill

THE SOCIAL-ECOLOGY OF AN INTENSIVELY MANAGED ECOSYSTEM: PHEASANTS AND PHEASANT HUNTERS IN SOUTHWEST NEBRASKA

Principal Investigator(s): Joseph J. Fontaine
Graduate Student(s): Jessica Laskowski, M.S. (2014), Lindsey Messinger, M.S. (2015)
Duration: January 2012 – May 2019
Funding: Nebraska Game and Parks Commission
Location: Southwestern Nebraska
PRAIRIEBIRDS.UNL.EDU

Ring-necked pheasants (*Phasianus clochicus*) are a culturally and economically important game species across the Midwest. Agroecosystems have historically served as important habitat for pheasants, but the intensification of agricultural has significantly altered the landscape resulting in a long-term decline in pheasant populations. The Conservation Reserve Program (CRP) has helped to mitigate habitat loss and slow the rate of population decline, but enrollment in CRP is declining. Given the importance of pheasants to Nebraska, managers are interested in developing programs that will continue to support pheasant populations while ensuring hunting opportunities.

In southwest Nebraska, the Nebraska Game and Parks Commission intensively manages for pheasant habitat and pheasant hunting opportunities with the goal of producing the best pheasant hunting experience for the most hunters. Starting in 2012 we began to monitor pheasants and pheasant hunters in the region to better understand how pheasants use managed agroecosystems, how hunters perceive and use public access, and how pheasants and pheasant hunters interact.

Since the start of the project we have captured and radio collared hundreds of pheasants and recorded thousands of locations on where pheasants are roosting, eating, loafing and nesting.

At these locations we have collected information on vegetation characteristics, climatic conditions, and food resources to understand the ecological needs of pheasants. To understand changing population dynamics, we monitor the survival of pheasants throughout the year and each spring we monitor 20 – 70 nests collecting information on reproductive investment and success. We also monitor seasonal movements of pheasants and responses to management and regulations such as the opening of the hunting season or wheat stubble management. In addition to monitoring pheasants, we are collecting information on hunter movements and harvest to understand how hunters interact with pheasants in the field.

The findings from this study are helping us to understand the complex dynamics between how uncontrollable factors such as weather interact with habitat and harvest management to affect pheasant population dynamics in an intensively managed ecosystem.



Pheasant tracking
Photo: Tristan Powell

USE AND SATISFACTION OF PUBLIC HUNTING OPPORTUNITIES

Principal Investigator(s): Joseph J. Fontaine
Project Manager(s): Lindsey Messinger (August 2014 – October 2016), Michael Winkler (August 2015 – August 2016)
Graduate Student(s): Lyndsie Wszola, M.S. (2017)

Duration: January 2010 – December 2018
Funding: Nebraska Game and Parks Commission
Location: Statewide Nebraska
FISHHUNT.UNL.EDU

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 access 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, traditional data sources do 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. 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. 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. From 2014 to 2017 we worked on more than 500 individual properties from eight focal areas spread across Nebraska. In total, we conducted more than 110,000 point-surveys that identified in excess of 11,000 cars. We also interviewed more than 7,000 users of publically accessible lands in Nebraska. Users represented an array of outdoor enthusiasts from 44 different states, with upwards of 80% of the fall users being hunters. Indeed, public-access hunters represented a range of typologies, ages, and residency, but lacked diversity in gender. Hunters perceived opportunities largely positively across a diverse landscape of public access. By surveying multiple hunter typologies across sites that encompass a range of social and ecological conditions, we gained a broader understanding of how hunters perceive public access in real-time and help to inform future management decisions to foster and improve public access programs.



Hunter being interviewed
Photo: Joseph Fontaine

VEGETATIVE AND LARGE CARNIVORE RESPONSES IN AN ENCROACHED LANDSCAPE

Principal Investigator(s): Dirac Twidwell
Graduate Student(s): Hugh Ellerman, M.S.
Duration: August 2017 – May 2020
Funding: University of Nebraska–Lincoln, Nebraska Game and Parks Commission
Location: Statewide Nebraska

This project concerns vegetative and large carnivore responses to Nebraska’s encroached landscapes and is split into three parts with distinct goals. First, the efficacy of grassland restorations by tree removal will be determined by revisiting sites where tree removals were used in grassland restorations in 2006, to determine if these sites have been reinvaded or not. Vegetative community composition (particularly invasive tree species) and structure (measured with visual obstructing readings – VOR) will be quantified. Preliminary results, indicate invasive tree presence by site.

Second, the efficacy of oak plantings following tree removal will be determined to assess oak survival and subsequent tree invasion. This strategy is part of an effort to increase oak regeneration in riparian woodlands where such regeneration has suffered, particularly due to shading by encroaching trees and high herbivory rates. Sites where tree removals occurred and oaks were planted along the Niobrara river will be revisited to quantify oak survival and invasive tree presence to determine whether this method of tree removal followed by oak planting is effective for restoring oak presence in Nebraska’s riparian woodlands at the sites. The third component of this research is to determine mountain lion interactions with Eastern redcedar (*Juniperus virginiana*). To do so, data on mountain lion from the Niobrara Valley, Nebraska provided by Sam Wilson from the Nebraska Game and Parks Commission will be analyzed to create home range of mountain lions, use of habitat features, with particular interest in woody cover, and eastern redcedar plantings/encroachment.

Site	Species					
	<i>Juniperus virginiana</i>			<i>Gleditsia triacanthos</i>		
	2005	2007	2018	2005	2007	2018
1	3	7	10	2	2	0
2	16	2	11	2	3	3
3	2	0	3	9	13	7
5	1	1	2	29	31	19
6	5	1	1	5	6	18
7	1	0	0	9	12	13
8	1	0	0	21	27	57
9	6	0	0	9	5	33
11	16	3	26	1	0	0

Occurrence of Eastern redcedar (*Juniperus virginiana*) and Honey locust (*Gleditsia triacanthos*) as percentage of plots in which the woody species was detected at three surveys done in 2005, 2007, and 2018 at nine sites.

PROFESSIONAL ACTIVITIES

Pheasant Project, Broken Bow, NE
Photo: Tristan Powell

TEACHING

Craig Allen

Fall 2018: Foundations of Resilience. This course develops an understanding of the concept of resilience, especially ecological resilience. Students explored both theoretical and applied aspects of ecological resilience, and the development of resilience theory. To further explore these concepts, students developed and completed a group project focusing on a resilience appraisal of a system of people and nature in Nebraska. At the conclusion of the course, students will have knowledge of a number of prominent issues in resilience theory, its development and application. Co-instructed with Dirac Twidwell.

Kevin Pope

Spring 2019: Quantitative Fishery Assessment This course provides information necessary to address scientific and management questions. It is designed to increase students’ understanding of current fishery assessment practices. Emphasis is placed on quantitative assessments of populations (e.g., recruitment, growth, and mortality), communities (predator–prey interactions) and ecosystems (biostressors). At the completion of this course, students are able to apply current quantitative methods used in fishery data analysis, effectively communicate statistical ideas, and critique scientific studies—in particular, to identify strengths and weaknesses of statistical assessments.

Joseph Fontaine

Fall 2018: 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.

GRADUATE COMMITTEE SERVICE

Craig Allen

Tori Donovan (Ph.D., Agronomy and Horticulture, UNL)
Tonya Haigh (Ph.D., School of Natural Resources, UNL)
Julianne Matczyszyn (Ph.D., Department of Agronomy, UNL, graduated May 2019)
Sophia Renes (Ph.D., Swedish University of Agricultural Sciences, Uppsala, graduated)

Joseph Fontaine

Laura Vander Meiden (Ph.D., School of Biological Science, UNL)
Nicholas Cole (Ph.D., School of Natural Resources, UNL, graduated December 2018)
Connor Gearin (M.S., Department of Biology, UNO, graduated May 2018)

Mark Kaemingk

Lindsay Ohlman (M.S., School of Natural Resources, UNL, graduated May 2019)
Garrett Rowles (M.S., School of Biology, UNK)

Kevin Pope

Quintin Dean (M.S., School of Natural Resources, UNL)
Henry Hansen (M.S., School of Natural Resources, UNL, graduated May 2018)
Matt Reichenbach (Ph.D., Department of Mathematics, UNL)
Ryan Ruskamp (M.S., School of Natural Resources, UNL)
Jake Werner (M.S., School of Natural Resources, UNL)

PROFESSIONAL AND FACULTY SERVICE

Craig Allen

- Associate Editor. Ecology and Society
- Board of Trustees. The Nature Conservancy Nebraska
- Executive Board. The Resilience Alliance
- Member. Nebraska Conservation Roundtable

Mark Kaemingk

- Poster Judge. University of Nebraska Science Literacy 101 Course
- Presentation Judge. University of Nebraska Spring Research Fair
- Moderator. Nebraska Chapter AFS Conference
- Reviewer. Journal of Applied Ecology and Knowledge and Management of Aquatic Ecosystems

Kevin Pope

- Member. Nebraska Conservation Roundtable
- Member. Book Editorial Advisory Board. American Fisheries Society
- USGS Representative. Reservoir Fisheries Habitat Partnership

OTHER PROFESSIONAL SERVICE

Jessica Burnett

- Journal referee. Ecological Modeling, Wilson Journal of Ornithology, & PloS One, Bioinvasions Records

Dillon Fogarty

- Contributor. Nebraska Legislature on cedar invasions (LR 387)
- Director. Eastern redcedar science literacy video series: Overcoming misconceptions
- Coordinator. Eastern redcedar working group

Katherine Hogan

- Student Representative. National Science Foundation, National Research Trainee Project Steering Committee
- Appointee. Chancellor’s Environment Sustainability and Resilience Commission, Teaching and Learning action team
- Founding member. Council for Resilience Education

Caleb Roberts

- Reviewer. Ecosphere Journal.
- Officer: Center for Great Plains Studies Graduate Fellows

Kevin Pope

- USGS Detail. Landscape Science Coordinator. Fall 2018

Baxter Seguin

- Representative. School of Natural Resources representative Academic Affairs Committee
- Member. ASUN Graduate Student Association
- Team member. Natural Resources Diversity Initiative Leadership

Dana Varner

- Member. Executive Committee of the North American Waterfowl Management Plan Science Support Team

Allison Zach

- Coordinator. Nebraska Invasive Species Advisory Council
- Member. Asian Carp Technical Committee
- Representative. Mississippi River Basin Panel on Aquatic Nuisance Species

Pheasant Project, Broken Bow, NE

Photo: Tristan Powell

TRAINING ASSISTANCE, WORKSHOPS, AND OUTREACH ACTIVITIES

Caleb Roberts

- Collaborator. Nebraska Television station interviews, Nature Climate Change publication implications for Sandhill Cranes
- Presenter. National Willa Cather Foundation ecotourism trip

Christopher Fill

- Instructor. Summer school students, Homestead National Monument, Beatrice, NE
- Presenter. Howling Homestead, Homestead National Monument, Beatrice NE

Dillon Fogarty

- Instructor. Rangeland Research (AGRO 496) UNL. Spring 2019
- Teacher Assistant. Great Plains Ecosystems (AGRO 440/840) UNL. Spring 2019
- Presenter. Wildlife Education at Everett Elementary School, Lincoln, NE
- Presenter. Advanced prescribed fire workshop, Niobrara, NE
- Co-producer. Real-time invasive species impacts assessments, Nebraska Weed Control annual training day, Kearney, NE

Katharine Hogan

- Guest Lecturer. Introduction to Ecology lab (NRES 222), UNL. Spring 2019
- Facilitator. Science Education Partnership Award Summer Camp

Kevin Pope

- Instructor. Over-the-Water training, Lincoln, NE

Baxter Seguin

- Instructor. Nebraska NABat Training sessions

Allison Zach

- Instructor. Aquatic invasive species technician training, Lincoln, NE
- Instructor. Hazard analysis critical control point training, Lincoln, NE
- Instructor. Level II watercraft inspection & decontamination training, Yankton, SD
- Presenter. Aquatic invasive species training for creel clerks, Lincoln, NE
- Presenter. Digging Deeper on Backyard Farmer Facebook Show
- Presenter. Earth Wellness Festival, Lincoln, NE
- Presenter. Invasive species investigation workshop, Morrill Hall, Lincoln, NE

- Presenter. Kearney outdoor expo, Kearney, NE
- Presenter. Lower Platte South NRD nature nights
- Presenter. Lauritzen Garden's arbor day festival, Omaha, NE
- Presenter. Morrill Hall Archie's Nature Night, Lincoln, NE
- Presenter. Mississippi River Basin Panel on Aquatic Nuisance Species annual meeting, Cadiz, KY
- Presenter. South Dakota Invasive Mussel Summit, Yankton, SD
- Presenter. Western Invasive Species Coordinating Effort Workshop
- Presenter. Western Regional Panel on Aquatic Nuisance Species Annual Meeting, Tacoma, WA

PEER-REVIEWED PUBLICATIONS

Abbey-Lee, R., Y. Araya-Ajoy, A. Mouchet, E.F. Stuber, B. Kempnaers, and N. Dingemanse. 2018. Does perceived predation risk affect patterns of extra-pair paternity? A field experiment in a passerine bird. *Functional Ecology*. 32:1001-1010.

Allen, C.R., H.E. Birgé, D. Angeler, C. Anthony, T. Arnold, B.C. Chaffin, D. DeCaro, A.S. Garmestani, L.H. Gunderson. Uncertainty and Trade-Offs in Resilience Assessments. 2018. Pages 243-268 in Gunderson, L.H., and B. Cosens, Eds. *Practical Panarchy for Adaptive Water Governance*. Springer.

Allen, C.R., H.E. Birgé, D.G. Angeler, C.A. Arnold, B.C. Chaffin, D.A. DeCaro, A.S. Garmestani, and L.H. Gunderson. 2018. Quantifying uncertainty and trade-offs in resilience assessments. *Ecology and Society* 23(1):3.

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Birgé, H.E., C.R. Allen, R.K. Craig, and D. Twidwell. 2018. Resilience and Law in the Platte River Basin Social-Ecological System; Past, Present, and Future. Pages 115-130 in Cosens, B., and L.H. Gunderson, Editors. *Practical Panarchy for Adaptive Water Governance*. Springer.

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R. Arlinghaus, and J.R. Post. 2019. The future of recreational fisheries: Advances in science, monitoring, management, and practice. *Fisheries Research* 211:247-255.

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PRESENTATIONS

Burnett, J.L. 2018. Advances in ecological regime shift detection, International Institute for Applied Systems Analysis. Laxenburg, Austria.

Burnett, J.L. 2019. Detecting abrupt change in bird community time series using distance traveled. Association for Women in Math Biology Symposium, Special session “Current Challenges in Mathematical Biology “. Houston, Texas.

Burnett, J.L., N.B. Price, and A.J. Tyre. 2019. A novel method for tracking ecosystem trajectory and abrupt change in space-time: distance traveled. International Association for Landscape Ecology. Fort Collins, Colorado.

Burnett, J.L., R. Crystal-Ornelas, D. Fogarty, K. Hogan, C.R. Allen, M. Bomberger Brown, D. Twidwell, and C.A. Lepczyk. 2018. Impacts of non-native birds on native wildlife in urban ecosystems: where is the evidence? Natural Areas Conference, Indiana.

DaRugna, O.A., and M.A. Kaemingk. 2018. Recreation dynamics on Valentine National Wildlife Refuge. Sandhills Prairie Refuge Association Annual Meeting. Valentine, Nebraska.

DaRugna, O.A., M.A. Kaemingk, and K.L. Pope. 2018. Recreational activity dynamics on Valentine National Wildlife Refuge. Nebraska Sportsperson Summit. Nebraska City, Nebraska.

DaRugna, O.A., M.A. Kaemingk, and K.L. Pope. 2019. Who is using Valentine National Wildlife Refuge? Annual Meeting, Nebraska Chapter, American Fisheries Society. Nebraska City, Nebraska.

DaRugna, O.A., M.A. Kaemingk, and K.L. Pope. 2019. Recreational activities on Valentine National Wildlife Refuge. Annual meeting, Nebraska Chapter, Wildlife Society. York, Nebraska.

DaRugna, O.A., M.A. Kaemingk, and K.L. Pope. 2019. Sociodemographic attributes of public land visitors. Pathways: Human Dimensions of Wildlife Conference. Estes Park, Colorado.

Ellerman, H. 2019. Do tree removals effectively restore grasslands? University of Nebraska-Lincoln Spring Research Fair. Lincoln, Nebraska.

Fogarty, D.T., D. Twidwell, and C.R. Allen. 2018. Disciplinary bias in ecosystem service assessments threatens environmental outcomes. A Community on Ecosystem Services. Washington, District of Columbia.

Fogarty, D.T., D. Twidwell, and C.R. Allen. 2019. Incipient tree invasions signal heightened vulnerability of an “uninvadable” grassland. Society for Range Management Annual Conference. Minneapolis, Minnesota.

Fogarty, D.T., D. Twidwell, and C.R. Allen. 2018. Potential extent of Eastern redcedar woodlands in the Nebraska Sandhills. Nebraska Natural Legacy Conference. Ainsworth, Nebraska.

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Fontaine, J.J. 2018. Advancing our understanding of pheasant agroecosystems. Pheasants Forever National Board Meeting. Sioux Falls, South Dakota.

Fontaine, J.J. 2018. Drought and pheasants: understanding the mechanisms of population responses to extreme climatic events. South Dakota Chapter of The Wildlife Society. Chamberlain, South Dakota.

Fontaine, J.J. 2018. Living on the edge: pheasants in our new agricultural landscape. South Dakota Wildlife Society. Oacoma, South Dakota.

Fontaine, J.J. 2018. Some thoughts on the people of the Rainwater Basin. Rainwater Basin Joint Venture Informational Seminar. Hastings, Nebraska.

Hellman, M. 2018. Agricultural Contaminants in the Rainwater Basin: An Assessment of Toxicity to Larval Amphibians. Region 7 Bi-Annual Enhancing State and Tribal Programs (ESTP) Grant Sharing Workshop. Lenexa, Kansas.

Hogan, K.F.E. Plant Functional Community Dynamics and Pollinator Resource Provision within Nebraska’s Restored Prairies. 2019. External Advisory Board meeting, NSF Research Traineeship. Lincoln, Nebraska.

Kaemingk, M.A, C.N. Ruskamp, C.J. Chizinski, and K.L. Pope. 2019. Social-ecological catchments. Joint Meeting, American Fisheries Society and Wildlife Society. Reno, Nevada.

Kaemingk, M.A., C.J. Chizinski, K.L. Hurley, and K.L. Pope. 2019. The allocation, use, and management of fisheries resources. Annual Meeting, Nebraska Chapter, American Fisheries Society. Nebraska City, Nebraska.

Kaemingk, M.A., K.L. Hurley, C.J. Chizinski, and K.L. Pope. 2019. Understanding angler harvest to optimize aquatic resources. International Symposium, Food Safety and Conservation in Inland Fisheries and Aquaculture, Food and Agriculture Organizations of the United Nations. Dresden, Germany.

Kane, D.S., M.A. Kaemingk, C.J. Chizinski, and K.L. Pope. 2019. Are boat anglers superior to bank anglers? Annual Meeting, Nebraska Chapter, American Fisheries Society. Nebraska City, Nebraska.

Madsen, A., L. Corral, and J.J. Fontaine. 2018. Weather and length of deployment period affect detection rates at camera traps. International Society for Behavioral Ecology. Minneapolis, Minnesota.

Mirochnitchenko, N., E.F. Stuber, and J.J. Fontaine. 2018. Phylogenetic and functional diversity of grassland bird communities across an alter landscape. Central Mountains and Plains Section of the Wildlife Society. Kearney, Nebraska.

Pope, K.L., M.A. Kaemingk, C J. Chizinski, C.N. Ruskamp, and M.T. Porath. 2019. Social-ecological catchments for prioritizing restoration efforts. 8th World Conference on Ecological Restoration. Cape Town, South Africa.

Roberts, C.P., V.M. Donovan, C.L. Wonkka, L.A. Powell, C.R. Allen, D.G. Angeler, D.A. Wedin, and D. Twidwell. 2019. Fire legacies drive complexity in eastern ponderosa pine forests. North American Forest Ecology Workshop. Flagstaff, Arizona.

Roberts, C.P., C.R. Allen, D.G. Angeler, and D. Twidwell. 2018. Rethinking vulnerability, conservation goals, and ecological monitoring in an era of global change. Nebraska Natural Legacy Conference. Ainsworth, Nebraska.

Roberts, C.P., D. Twidwell, D.G. Angeler, V.M. Donovan, and C.R. Allen. 2019. Rethinking vulnerability, conservation goals, and ecological monitoring in an era of global change. Society for Rangeland Management Annual Conference. Minneapolis, Minnesota.

Ruskamp, C.N. M.A. Kaemingk, C.J. Chizinski, and K.L. Pope. 2019. Anglersheds: a powerful and practical management tool. Annual Meeting, Nebraska Chapter, American Fisheries Society. Nebraska City, Nebraska.

Ruskamp, C.N., M.A. Kaemingk, and K.D. Koupal. 2019. Why walleye? North Central Division of the American Fisheries Society Joint Esocid, Walleye, and Centrarchid Technical Committee Meeting. Webster, South Dakota.

Seguin, B. 2019. Implementing The North American Bat Monitoring Program in Nebraska: An Assessment of Nebraska Bats with an Emphasis on Citizen Science. Nebraska Chapter of The Wildlife Society. Holthus Convention Center, York, Nebraska.

Simonsen, V. and J.J. Fontaine. 2018. Large or small patches? How patch size and nest density influence nest survival and conservation in grasslands. Central Mountains and Plains Section of the Wildlife Society. Kearney, Nebraska.

Simonsen, V., A. Fedele, and J.J. Fontaine. 2018. Large or small patches? How patch size and nest density influence nest survival and conservation in grasslands. South Dakota Chapter of The Wildlife Society. Chamberlain, South Dakota.

Sorensen, A.E., L Corral, J.M. Dauer, and J.J. Fontaine. 2018. Authentic scientific data collection in support of an integrative model-based class: A framework for student engagement in the classroom. Ecological Society of America. New Orleans, Louisiana.

Stuber, E.F. and J.J. Fontaine. 2018. Human-induced rapid environmental change and spatial mismatches in species distribution. International Association for Landscape Ecology, Chicago. Illinois.

Stuber, E.F. and J.J. Fontaine. 2018. Human-induced rapid environmental change and spatial mismatches in species distribution. Central Mountains and Plains Section of the Wildlife Society. Kearney, Nebraska.

VanDeHey, J.A. and M.A. Kaemingk. 2019. The AFS/TWS certification process and its role in educational competencies. Joint Meeting, American Fisheries Society and Wildlife Society. Reno, Nevada.

Wszola, L.S., E.F. Stuber, L.F. Gruber, and J.J. Fontaine. 2018. Hunter distribution in a unique public access landscape. South Dakota Chapter of The Wildlife Society. Chamberlain, South Dakota.

Team building event
Photo: Wilma Gerena



Kevin Pope and Craig Allen
Photo: Wilma Gerena

