Quadrennial Report

August 2018 - August 2022

Including a Summary of Accomplishments from 2012-2022

Kansas Cooperative
Fish and Wildlife Research Unit

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Summary of Accomplishments 2012-2022

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Unit Cooperators

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Kansas Department of Wildlife, Parks, and Tourism
Kansas State University
Wildlife Management Institute
U.S. Fish and Wildlife Service

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Preface

The Kansas Cooperative Fish and Wildlife Research Unit is jointly sponsored and financed by the U.S. Geological Survey-Biological Resources Division, Kansas Department of Wildlife, Parks, and Tourism, Kansas State University, U.S. Fish and Wildlife Service, and the Wildlife Management Institute.

In 1960, Congress gave statutory recognition to the Cooperative Research Unit program by enactment of Public Law 86-686. The act reads:

> "To facilitate cooperation between the Federal Government, colleges and universities, the States, and private organizations for cooperative unit programs of research and education relating to fish and wildlife, and for other purposes. Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That, for the purpose of developing adequate, coordinated, cooperative research and training programs for fish and wildlife resources, the Secretary of the Interior is authorized to continue to enter into cooperative agreements with colleges and universities, with game and fish departments of the several States, and with nonprofit organizations relating to cooperative research units: Provided, That Federal participation in the conduct of such cooperative unit programs shall be limited to the assignment of the Department of the Interior technical personnel by the Secretary to serve at the respective units, to supply for the use of the particular unit's operations such equipment as may be available to the Secretary for such purposes, and the payment of incidental expenses of Federal personnel and employees of cooperating agencies assigned to the units. There is authorized to be appropriated such sums as may be necessary to carry out the purposes of this Act."

The Kansas Unit opened in October 1991 at Kansas State University in Manhattan. Dr. Timothy R. Modde was appointed as the first Unit Leader. Ms. Joyce Brite was hired as office manager. In May 1992, Dr. Modde left the Unit to take a position with the Colorado River Fisheries Project, U.S. Fish and Wildlife Service, in Vernal, Utah. Dr. Michael R. Vaughan of the Virginia Cooperative Fish and Wildlife Research Unit was assigned to the Kansas Unit as Acting Unit Leader for a six-week period.

Dr. Philip S. Gipson was selected as the Unit Leader in May 1993. In 1994, Dr. Christopher S. Guy was hired as Assistant Leader-Fisheries and Dr. Jack F. Cully, Jr. was hired as Assistant Leader-Wildlife.

Dr. Guy left in August 2002 to become Assistant Leader-Fisheries at the Montana Cooperative Fishery Research Unit in Bozeman. In November 2003, Dr. Craig P. Paukert joined the Kansas Unit as Assistant Leader-Fisheries.

In May 2008, Dr. Philip S. Gipson retired from the Kansas Unit. He accepted a position as department head at Texas Tech University in Lubbock. Dr. Craig P. Paukert was appointed as Acting Unit Leader.

In May 2010, Dr. Paukert assumed the Unit Leader position at the Missouri Cooperative Fish and Wildlife Research Unit. Dr. Jack Cully was appointed Acting Unit Leader. Dr. Martha Mather joined the Kansas Unit in October 2010 as Assistant Leader-Fisheries. Dr. David Haukos was hired as Unit Leader in February 2011. In September 2012, Dr. Jack Cully retired from the Kansas Unit. Joyce Brite retired in December 2017. Maiah Diel was hired as Unit office manager and administrative assistant in January 2018 and resigned in February 2019. Tara Dreher was hired as Unit office manager and administrative assistant in June 2019.

The Unit Leader and the Assistant Unit Leaders are faculty members in the Division of Biology at Kansas State University. Graduate students are typically associated with the Unit are part of the Division of Biology and graduate degrees are awarded through the Division; however, graduate students have been associated with the Departments of Geography and Geospatial Sciences; Horticulture and Natural Resources; Statistics; and Animal Science. Unit staff and students often work on partnership projects that involve specialists from Kansas State University, other universities, state and federal agencies, and other cooperating groups.

During the reporting period, 8 new projects were initiated and ongoing, and 11 projects were completed. Eight students finished M.S. degrees and 4 finished Ph.D. degrees.

New/On-going Projects:

Identification of Landscape Thresholds and Patch Dynamics for Lesser Prairie-Chickens

Movements, Space Use, and Vital Rates of Mourning Doves

Identification of Landscape Thresholds and Patch Dynamics for Lesser Prairie-Chickens

Multi-scale Response of Lesser Prairie-Chickens to Future Changes in Land Use and Land Cover

Reconstruction of Landscape Composition and Vegetation Characteristics in the Sand Sagebrush Prairie Ecoregion

Patterns of Greenness (NDVI) in the Southern Great Plains and Their Influence on the Habitat Quality and Reproduction of a Declining Prairie Grouse

The Impact of Future Climate Variability on Shorebirds and Their Wetland Habitats in the South-Central U.S.

Guiding Present and Future Native Fish Restoration Using a Strategic Planning Process, Literature Synthesis, Database Analysis, Field Protocol Development/Testing, and Adaptive Management

Completed Projects:

Response of Greater Prairie-Chickens to Military Operations on Fort Riley

Survival Rates, Habitat Selection, and Movement of Sympatric Mule Deer and White-tailed Deer in Kansas

Assessment of Resident Canada Goose Management in Kansas

Assessment of Lesser Prairie-Chicken Response to Translocation

Lesser Prairie-Chicken and Grassland Response to Intensive Wildfire in the Mixed-Grass Prairie

Ring-necked Pheasant Use of Cover Crops in Western Kansas

Use of Grazing Management and Prescribed Fire for Conservation of Lesser Prairie-Chickens

Dams and Fish Communities: Developing and Testing a Spatially-Explicit, Science-Based, Decision-Support Tool for Making Riverscape-Scale Management Decisions for Native Stream Fish Communities in the Neosho and Smoky Hill Rivers, KS

Lesser Prairie-Chicken Response to USDA Conservation Practices in Kansas and Colorado

Plum Island Ecosystems LTER

Coupled Climate, Cultivation and Culture in the Great Plains: Understanding Water Supply and Water Quality in a Fragile Landscape

Master's Theses Completed:

Maureen Kinlan (M.S., 2021, Haukos). Survival, movement, and resource selection of male mule deer and white-tailed deer in western Kansas. (Bear Biologist, New Jersey Department of Environmental Protection, Fish and Wildlife Division)

Jackie Gehrt (M.S., 2021, Haukos). Response of greater prairie-chickens to natural and anthropogenic disturbance on Fort Riley. (Biologist, Federal Aid, U.S. Fish and Wildlife Service, Twin Cities, MN)

Elisabeth Teige (M.S., 2021, Haukos). Assessment of lesser prairie-chicken translocation through survival, space use, and resource selection. (Contract Biologist, USGS, Fort Collins, Colorado).

Nick Parker (M.S., 2021, Sullins/Haukos). Lesser prairie-chicken demography, resource selection, and habitat response following megafire in the mixed-grass prairie. (Ph.D Candidate, Colorado State University).

Liam Berigan (M.S., 2019, Haukos). Dispersal, reproductive success, and habitat use by translocated lesser prairie-chickens. (PhD Candidate, University of Maine)

Chris Gulick (M.S., 2019, Haukos). Spatial ecology and resource selection by female lesser prairie-chickens within their home ranges and during dispersal. (PhD Candidate, University of Florida)

Mitchell Kern (M.S., 2019, Ricketts/Haukos). Fawn survival and bed-site selection of mule deer and white-tailed deer in western Kansas. (Game Warden, Wyoming Game and Fish)

Adela Annis (M.S., 2019, Haukos). Ring-necked pheasant survival, nest habitat use, and predator occupancy in Kansas spring cover crops. (Biologist, Pheasants Forever, Nebraska)

<u>Ph.D. Dissertations Completed</u>:

Talesha Kalish (Ph.D, 2022, Haukos). Survival, activity patterns, movements, home ranges and resource selection of female mule deer and white-tailed deer in western Kansas. (Assistant Area Manager, Baudette Area Wildlife, MN DNR)

John Malanchuk (Ph.D, 2021, Haukos). Assessment of resident Canada goose management in Kansas. (Research Associate, Quantico, Virginia Tech University)

Alixandra Godar (Ph.D., 2020, Haukos). Ring-necked pheasant population and space use response to landscapes including spring cover crops. (Post-Doctoral Research Associate, Post-Doctoral Research Associate, Patuxent Science Center, USGS).

Carly Aulicky (Ph.D., 2020, Haukos). Lek dynamics and range-wide morphometric patterns of lesser prairie-chickens. (Field Director, Texas Native Prairie Association)

KANSAS COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

Mission Statement

The agreement establishing the Kansas Cooperative Fish and Wildlife Research Unit in 1991 stated that the purpose was to... "provide for active cooperation in the advancement, organization, and conduct of fish and wildlife research, graduate education, in- service training, technical assistance, public relations, and demonstration programs" (Cooperative Agreement, Section II, Purpose). Unit research contributes to understanding ecological systems within the Great Plains. Unit staff, collaborators, and graduate students conduct research with both natural and altered systems, particularly those impacted by agriculture. Unit projects investigate ways to maintain a rich diversity of endemic wild animals and habitats while meeting the needs of people.

The Unit focuses on projects that involve graduate students, and the research needs of cooperators are given priority. Unit professionals function as faculty in the Division of Biology at Kansas State University. Unit professionals work with state and federal agencies, private industry, nongovernmental organizations, and interest groups to develop and conduct projects. Partnership projects are common where graduate and undergraduate students, and Unit staff work with multidisciplinary teams, often including other university faculty members and specialists from collaborating groups.

Personnel and Cooperators

Coordinating Committee Members

U.S. Geological Survey
Dr. J. Barry Grand
USGS CRU

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1608 Packwood Road
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Manhattan, KS 66506

U.S. Fish and Wildlife Service
John Carlson
Grassland Conservation Coordinator
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Cooperative Unit Staff

David A. Haukos, Ph.D, Unit Leader, Wildlife and Adjunct Associate Professor, Division of Biology
Martha Mather, Ph.D, Assistant Unit Leader, Fisheries and Adjunct Associate Professor, Division of Biology
Tara Dreher, Office Manager and Administrative Assistant
Bram Verheijen, Ph.D, Research Associate – Wildlife, Division of Biology
Alix Godar, Ph.D, Research Associate – Wildlife, Division of Biology
Carly Aulicky, Ph.D, Research Associate – Wildlife, Division of Biology
Andrew Whetton, Ph.D, Research Associate – Wildlife, Department of Statistics
Fraser Comb, Ph.D, Research Associate – Wildlife, Division of Biology

Faculty Cooperators at Kansas State University

Division of Biology
Dr. Alice Boyle
Dr. Walter Dodds
Dr. Keith Gido
Dr. Andrew Hope

Department of Geography
Dr. Doug Goodin
Dr. Shawn Hutchinson

Department of Horticulture and Natural Resources
Dr. Adam Ahlers
Dr. Andrew Ricketts
Dr. Dan Sullins
Dr. Joseph Gerken

Department of Animal Science
Dr. K.C. Olson

Department of Statistics
Dr. Trevor Hefley

Additional Universities

Oklahoma State University
Dr. Craig Davis
Dr. Dwayne Elmore
Dr. Sam Fuhlendorf

Emporia State University
Dr. William Jensen

Texas Tech University
Dr. Warren Conway
Dr. Blake Grisham

State of Kansas

Kansas Department of Wildlife and Parks

Chris Berens
Tom Bidrowski
Kent Fricke
Jake George
Shane Hesting
Jordan Hofmeier
Levi Jaster
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Ron Marteney
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Matt Peek
Jeff Prendergast
John Reinke
Richard Schultheis
Kraig Schultz
Mark Van Scoyoc
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Federal Government

U.S. Fish and Wildlife Service, Kansas
Susan Blackford
Mike Disney
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Aron Flanders
Greg Kramos
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Jason Lugenbill
Chris O'Meilia

U.S. Fish and Wildlife Service, Texas
Bill Johnson
Duane Lucia
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U.S. Fish and Wildlife Service, New Mexico
Dr. Dan Collins
Dr. Grant Harris
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Dr. Steve Sesnie

U.S. Fish and Wildlife Service, Colorado
Dr. Mindy Rice

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Andy Bishop
Dana Varner

U.S. Geological Survey
Dr. David Anderson
Dr. Clint Boal
Dr. Donna Parrish
Dr. Kevin Pope
Dr. Elizabeth Webb

U.S. Department of Agriculture,
Natural Resources Conservation Service
Dr. Christian Hagen
David Kraft
Charlie Rewa
Kelsey McCullough

U.S. Army, Fort Riley
Derek Moon
Caroline Skidmore
Shawn Stratton

Other State Agencies

Colorado Wildlife and Parks
Brian Dreher
Dr. Jim Gammonly
Dr. David Klute
Liza Rossi
Jonathan Reitz

Private Organizations and NGOs

Stroud Water Research Center
Dr. Melinda Daniels
Ducks Unlimited
Joe Kramer
Matt Hough
Grasslans Charitable Trust
Willard Heck
Jim Weaver

The Nature Conservancy
Matt Bain
Rob Manes
Kansas Alliance for Wetlands & Streams
Jessica Mounts
Kansas Rangeland Trust
Stephanie Manes
Playa Lakes Joint Venture
Dr. Anne Bartuszevige

Graduate Students Supported by Unit Projects, 2018-present
Kansas State University

Student and Degree Sought	Thesis Project	Previous Education	Advisor
*Adela Annis, M.S.	Ring-necked pheasant survival, nest habitat use, and predator occupancy in Kansas spring cover crops	B.S., Unity College	Dr. Haukos
*Carly Aulicky, Ph.D	Lek dynamics and range-wide morphometric patterns of lesser prairie-chickens	B.S., Rutgers University M.S., University of Glasgow	Dr. Haukos
Caitlyn Aymami, M.S.	Guiding present and future native fish restoration using a strategic planning process, literature synthesis, database analysis, field protocol development/testing, and adaptive management	B.S., University of Arizona	Dr. Mather
*Liam Berigan, M.S.	Dispersal, reproductive success, and habitat use by translocated lesser prairie-chickens	B.S., Cornell University	Dr. Haukos
*Jackie Gehrt, M.S.	Response of greater prairie-chickens to natural and anthropogenic disturbance on Fort Riley.	B.S., Kansas State University	Dr. Haukos
*Alixandra Godar, Ph.D	Ring-necked pheasant population and space use response to landscapes including spring cover crops	B.S., University of Wisconsin – Stevens Point M.S., Texas Tech University	Dr. Haukos
. *Chris Gulick, M.S.	Spatial ecology and resource selection by female lesser prairie-chickens within their home ranges and during dispersal	B.S., Texas Tech University	Dr. Haukos
*Talesha Karish, Ph.D	Survival, activity patterns, movements, home ranges and resource selection of female mule deer and white-tailed deer in western Kansas	B.S., Delaware Valley College M.S., New Mexico State University	Dr. Haukos Dr. Ricketts
*Mitchell Kern, M.S.	Factors affecting survival of fawns of sympatric white-tailed deer and mule deer among Kansas landscapes	B.S., Virginia Tech	Dr. Ricketts Dr. Haukos

*Maureen Kinlan, M.S.	Survival, movement, and resource selection of male mule deer and white-tailed deer in western Kansas.	B.S., King's College	Dr. Haukos Dr. Ricketts
*John Malachuk, Ph.D	Assessment of resident Canada goose management in Kansas	B.S., Rhodes College M.S., University of Wisconsin – Stevens Point	Dr. Haukos
Ashley Messier, M.S.	Patterns of greenness (NDVI) in the Southern Great Plains and their influence on the habitat quality and reproduction of a declining prairie grouse	B.S., Unity College	Dr. Sullins Dr. Haukos
*Nick Parker, M.S.	Lesser prairie-chicken and grassland response to intensive wildfire in the mixed-grass prairie	B.S., University of California – Berkley	Dr. Sullins Dr. Haukos
Natalie Pegg, Ph.D	Movements, space use, and vital rates of mourning doves	B.S., Butler University M.S., University of Florida	Dr. Haukos
Camille Rieber, M.S.	Movement models for lesser prairie-chickens in multiple landscapes.	B.S., Washington University, St. Louis	Dr. Haukos
Olivia Rode, M.S.	Guiding present and future native fish restoration using a strategic planning process, literature synthesis, database analysis, field protocol development/testing, and adaptive management	B.S., Rockhurst University	Dr. Mather
*Elisabeth Teige, M.S.	Assessment of lesser prairie-chicken translocation through survival, space use, and resource selection.	B.S., Minnesota State University – Moorhead	Dr. Haukos
Megan Vhay, M.S.	Reconstruction of landscape composition and vegetation characteristics in the Sand Sagebrush Prairie Ecoregion	B.S., University of Maine	Dr. Haukos

*Graduated

Fisheries Projects

Completed Fisheries Projects

Dams and Fish Communities: Providing a Scientific Basis for Making Riverscape-Scale Management Decisions for Native Stream Fish Communities in the Neosho and Smoky Hill Rivers, KS.

Student Investigators
Jane Fencl, M.S.
Sean Hitchman, Ph.D.

Professional Colleagues
Dr. Joseph Smith, NOAA
Jason Luginbill, USFWS
Dr. Katie Costigan
Jordan Hofmeier, KDWPT
Dr. James Nifong, USACOE

Project Supervisor
Dr. Martha Mather

Funding
Kansas Department of Wildlife and Parks

Cooperators
Kansas Department of Wildlife and Parks

Kansas State University

Objectives
Quantify how dams and habitat affect fish communities

Identify the role of heterogeneity in stream networks

Location
Neosho River, KS
Smoky Hill River, KS

Completion
March, 2019

Status
Completed

Results

Team and Focus
The valued native fish communities that inhabit Kansas streams and rivers are threatened by human impacts, such as dams. Dam impacts on biodiversity can be mediated by natural habitat heterogeneity and implemented through dam-related habitat alterations. In order to help managers make science-based decisions on the impact of dams on native fish communities, the Neosho River research team (Jane Fencl, M.S. student; Sean Hitchman, Ph.D student; Dr. Joseph Smith, post-doctoral fellow; Dr. James Nifong, post-doctoral fellow; Dr. Katie Costigan, post-doctoral fellow; and Dr. Martha Mather, Principal Investigator) sampled fish communities and instream habitat at dammed and undammed sites within the upper Neosho River, KS, and Smoky Hill River, KS.

Methods
In consultation with our project liaisons at Kansas Department of Wildlife, Fisheries, and Parks (KDWPT), our research efforts have focused on the collection of fish and habitat data at sites with dams as well as at paired undammed reference sites. As a team, we identified the best gear to use to sample fish upstream and downstream of dammed and undammed sites. Our gear test showed that the mini-Missouri trawl, the gear we chose to use for all stream sampling, caught as many species as other common stream sampling gears and more individuals than other gears. Once we determined that the mini-Missouri trawl performed as well as other gears, we conducted a trawl length experiment to determine the optimal trawl length (30 m). These results have been incorporated into our standardized sampling protocols.

In 2012, we sampled three dams and one undammed site. Fish and habitat were sampled at 20 transects above and below all dams (or the site centerline of the undammed location) resulting in 90 fish samples at transects around dams. To assess microhabitat (width, depth, velocity, substrate), we sampled 42 habitat transects at four sites (168 microhabitat samples). In addition, we categorized mesohabitat (pool, riffle, run, glide) across 16.1 km of stream for a total of 65, 100-m long mesohabitat samples. Within these mesohabitats, we sampled fish with an additional 44 trawls.

In 2013, we expanded the number of sample sites from 4 to 11 and extended the distances we sampled at each site to include 22 transects that extended 3 km above and below each dam or undammed site centerline. We sampled habitat and native fish communities using standardized methods at 22 transects (13 transects downstream and 9 transects upstream of each dam or centerline at undammed sites) at 11 sites. At these 11 sites, in 2013, collectively we sampled fish and habitat at 52 upstream transects, 70 downstream transects, 70 transects at undammed sites, 73 additional transects to address temporal variation, for a total of 265 fish and habitat transect samples. At these same 11 sites, in 2013, we also collected samples to identify the relationship between fish communities and specific habitat types. Specifically, at 11 locations, we sampled five replicates of four mesohabitat types (pool, riffle, run, and glide) during 64 days of field sampling. This sampling resulted in 220 habitat-specific fish samples (42 total species), 220 stream width measurements, 1,100 depth, flow velocity, substrate measurements, and mesohabitat data for patch mosaics across 51 km of stream. At the six dam sites, we quantified the geomorphic dam footprint to identify the spatial extent of the dam effect. These dam footprints helped us interpret dam impacts on fish communities.

Results

In contrast to well documented adverse impacts of large dams, little is known about how smaller low-head dams affect fish biodiversity. Over 2,000,000 low-head dams fragment United States streams and rivers and can alter biodiversity. The spatial impacts of these common low-head dams on geomorphology and ecology are largely untested. A select review of how intact low-head dams affect fish species identified four methodological inconsistencies that impede our ability to generalize about the ecological impacts of low-head dams on fish biodiversity. This project tested the effect of low-head dams on fish biodiversity (1) upstream vs. downstream at dams and (2) downstream of dammed vs. undammed sites. Fish assemblages for both approaches were evaluated using three community summary metrics and seven habitat guilds (based on empirically based species occurrence in pools, riffles, and runs). Downstream of dams vs. undammed sites, this project tested if (a) spatial extent of dam disturbance, (b) reference site choice, and (c) site variability altered fish biodiversity at dams. Based on information from geomorphic literature, this research quantified the spatial extent of low-head dam impacts using width, depth, and substrate. Sites up- and downstream of dams had different fish assemblages regardless of the measure of fish biodiversity. Richness, abundance and Shannon's index were significantly lower upstream compared to downstream of dams. In addition, only three of seven habitat guilds were present upstream of dams. Methodological decisions about spatial extent and reference choice affected observed fish assemblage responses between dammed and undammed sites. For example, species richness was significantly different when comparing transects within the spatial extent of dam impact but not when transects outside the dam footprint were included. Site variability did not significantly influence fish response.

Furthermore, these small but ubiquitous disturbances may have large ecological impacts because of their potential cumulative effects. Therefore, low-head dams need to be examined using a contextual riverscape approach. How low-head dam studies are designed has important ecological insights for scientific generalization and methodological consequences for interpretations about low-head dam effects. This research provides a template on which to build this approach that will benefit both ecology and conservation.

A mosaic-based approach can identify keystone habitats, increase scientific understanding of organismal-habitat relationships, and facilitate conservation of native biodiversity in disturbed freshwater ecosystems. Rivers and streams provide valuable goods and services to society. Freshwater biodiversity is a key attribute of streams and rivers. Organisms that comprise biodiversity are influenced by habitat. A suite of anthropogenic impacts, exacerbated by climate change, threaten aquatic habitats and freshwater biodiversity. Because many ecological processes require spatially-connected data, a mosaic approach offers a scientific foundation for understanding and managing a range of disturbance-related conservation problems. In another component of the larger project, we ask if patterns of aquatic biodiversity differ for habitat mosaics (i.e., connected series of individual juxtaposed habitats) compared to isolated, individual habitats. Traditional approaches to conserving native biodiversity will be inadequate if mosaics create different patterns of biodiversity than isolated mesohabitats. This research yielded four important insights. First, mesohabitats (pool, riffle, run, and glide) formed discrete habitat categories based on three physical characteristics. Together juxtaposed mesohabitats formed diverse mosaics. Second, multivariate, community analysis on three fish biodiversity data sets confirmed guild-based organism-habitat associations identified from type and strength of species-mesohabitat associations. Third, patterns of biodiversity were different in mosaics than for isolated mesohabitats. Fourth, riffles acted as keystone habitats in that mosaics with more riffle mesohabitat (<5% of sampled area) had higher native species diversity. Links among human impacts, water use, land use change, climate change predictions, precipitation, discharge, aquatic habitat, and biodiversity make a suite of diverse and often complex spatial and temporal impacts inevitable in disturbed aquatic ecosystems. Thus, developing a new approach for quantifying connected biodiversity-habitat relationships is essential to construct baselines to which future human impacts and climate disturbances can be compared. A mosaic approach can provide this framework for examining ecological processes in both reference and disturbed ecosystems.

Implications

This research advanced riverscape-scale understanding of the structure and function of aquatic ecosystems in a way that informs aquatic conservation. Ultimately, this research can be used to manage fish and dams in Great Plains stream and river networks.

Products

Publications

Fencl J. S., M. E. Mather, K. B. Costigan, and M. D. Daniels. 2015. How big of an effect do small dams have?; Using geomorphological footprints to quantify spatial impact of low-head dams and identify patterns of across-dam variation. PLoS ONE 10(11): e0141210. doi:10.1371/journal.pone.0141210

Fencl, J. S., M. E. Mather, J. M. Smith, and S. M. Hitchman. 2017. The blind men and the elephant examinebiodiversity at low-head dams: Are we all dealing with the same dam reality? Ecosphere 8(11):e01973.

Hitchman, S. M., M. E. Mather, J. M. Smith, J. S. Fencl. 2018. Habitat mosaics and path analysis can improve biological conservation of aquatic biodiversity in ecosystems with low-head dams. Science of the Total Environment 619–620:221–231

Hitchman, S.M., M. E. Mather, J. Smith, and J. Fencl. 2018. Identifying keystone habitats with a mosaic approach can improve biodiversity conservation in disturbed ecosystems. Global Change Biology 24:308-321.

Hitchman, S. M., M. E. Mather, and J. M. Smith. 2021. Does type, quantity, and location of habitat matter for fish diversity in a Great Plains riverscape? Fisheries 46:495-504.

Professional Presentations

Fencl, J.S., K.H. Costigan, M.E. Mather and S.M. Hitchman. 2014. How long is a dam footprint?: Applying methodology that quantifies the geomorphic extent of low-head dams in the Neosho River Basin, KS, 7th Kansas Natural Resources Conference, Wichita, KS (poster)

Fencl, J.S., M.E. Mather, S.M. Hitchman and J.M. Smith. 2014. Quantifying impacts of river fragmentation: How low-head dams alter geomorphology, fish biodiversity, and habitat in the Neosho River, Kansas, American Fisheries Society Meeting, Quebec, Canada.

Fencl J.S., Mather M.E., Smith J.M., and S.M. Hitchman. 2015. Quantifying river fragmentation: impacts of low-head dams on geomorphology and fish biodiversity in the Neosho River, Kansas. 75th Midwest Fish and Wildlife Conference; Indianapolis, Indiana.

Hitchman, S.M., M.E. Mather, J.M. Smith and J.S. Fencl. 2014. Do FRAGSTATS sink or swim? Calculating metrics of heterogeneity for aquatic macrohabitat within the Neosho River, KS. Kansas Natural Resource Conference. Wichita, KS.

Hitchman, S.M., M.E. Mather, J.M. Smith and J.S. Fencl. 2014. Does heterogeneity in habitat type, size, and arrangement influence patterns of fish biodiversity in the Neosho River, Kansas? American Fisheries Society. Quebec City, Quebec, Canada.

Hitchman, S.M., M.E. Mather, J.M. Smith and J.S. Fencl. 2015. Are riffles keystone habitats in a low-gradient prairie stream?; implications for riverscape ecology and stream conservation. American Fisheries Society. Portland, Oregon.

Hitchman, S.M., M.E. Mather, J.M. Smith and J.S. Fencl. 2016. Viewing streams as a habitat mosaic; implications for riverscape ecology and stream conservation. American Fisheries Society. Kansas City, MO.

Thesis

Fencl J. 2015. How big of an effect do small dams have? Using ecology and geomorphology to quantify impacts of low-head dams on fish biodiversity. Thesis, Kansas State University, Manhattan.

Dissertation

Hitchman, S. 2017. A mosaic approach can advance the understanding and conservation of native fish biodiversity in natural and fragmented riverscapes. Dissertation, Kansas State University, Manhattan.

Fish Biodiversity and Coupled Climate, Cultivation and Culture in the Great Plains

Student Investigator:
Richard Lehrter

Post-Doctoral Assoc.:
James Nifong

Professional Colleagues:
Dr. Melinda Daniels
Dr. Marcellus Caldas
Dr. J. Heier Stamm
Dr. Jason Bergtold
Dr. Aleksey Sheshukov
Dr. Matthew Sanderson
Dr. Gabe Granco

Project Supervisor:
Dr. Martha Mather

Funding:
National Science Foundation

Cooperators:
Kansas State University Division of Biology

Objectives:
Address how interacting dynamics between climate variation, human land and water use decisions, and aquatic ecosystem dynamics will affect fish biodiversity.

Location
Smoky Hill River, KS

Completion:
December 2019

Status
Complete

Results

Overall
Throughout the U.S., freshwater ecosystems provide valuable societal goods and services that are being adversely affected by humans. Climate, likely is exacerbating these adverse impacts. Great Plains rivers are model systems for looking at a coevolved animal community that inhabit naturally-connected dendritic ecosystems which are adversely affected by climate change and human land and water use. Because biodiversity is valued by a diverse human stakeholders including groups interested in conservation, recreation, and hunting-fishing, aquatic (i.e., fish) biodiversity is a natural link for coupling human and natural systems.

Aquatic biodiversity (e.g., fish biodiversity) has intrinsic ecological value. For example, communities with native biodiversity are often more resilient and better able to respond to disturbances. Fish comprise a large biomass in aquatic systems and have several attributes that make them an ideal focus for interdisciplinary research on natural and anthropogenic process drivers of biodiversity. First, fish distribution is strongly linked to geomorphology, hydrology, and land use. Second, fish represent an important component of ecological diversity. As such, they are a good taxa to examine how biodiversity is affected by human and climatic influences. Third, many human groups value fish. Thus, these charismatic megafauna, are an obvious link between natural and human systems.

Our collaborative research is unique in that it integrates multiple disciplines with the goal of understanding how water systems in the Great Plains (geomorphology, hydrology, ecology) are affected by human land and water use, as well as, how humans value the components of an aquatic ecosystem. All stakeholders (farmers, ranchers, urban residents, conservationists, anglers) will benefit from our interdisciplinary insights about how aquatic ecosystems are structured and function

Understanding empirical relationships between biotic diversity and components of the environment is crucial for effective interdisciplinary research and conservation in highly disturbed watersheds. The Smoky Hill River, a semi-arid prairie stream in central Kansas, is the focus of a NSF Coupled Natural and Human System grant that seeks to promote watershed sustainability by maintaining biodiversity. Following a literature review on environmental variables, diversity responses, and statistical methods, the team evaluated the importance of land use, instream flow, discontinuities (dams and confluences), and stream site type (mainstem-tributary) on fish biodiversity across three watershed regions (upper, middle, and lower) using AIC_c model selection. This analysis was repeated using multiple linear, Poisson, and negative-binomial regressions. Using fish data collected at 48 sites within the same year and season (summer 2015), patterns and drivers of fish biodiversity differed with watershed region, land use, flow, and stream site type. Fish species richness in the lower region of the Smoky Hill watershed below Kanopolis Reservoir was negatively correlated with percent developed land. However, in the upper region of the watershed, fish biodiversity was positively correlated with percent herbaceous grassland, the reference prairie condition. Summer mean flow was consistently and positively related to species richness in the middle and upper regions of the watershed where flow was limited. In the lower region of the watershed, species richness was higher in moderate-flow tributaries compared to high-flow, mainstem sites. In the flow-limited middle and upper regions, species richness was lower in the low-flow tributaries than in the moderate-flow mainstem sites. Mainstem sites hosted more Cypriniformes fishes while tributary sites contained more Perciformes species. A comparison of trends from the above-described research dataset (48 sites, 1 season, 1 year) with a broader monitoring database (different sites in different years) showed that different goals, questions, and study designs can provide alternative insights. As such, an explicit and thoughtful choice of goals prior to biodiversity sampling is critically important.

Major accomplishments under this grant included developing a CNH model incorporating linkages among atmospheric, terrestrial, aquatic, and social processes to predict impacts of climate variability, land-use, and human activity on water resources and biodiversity in the Central Great Plains. The research, described above, is a central component of this project-wide, interdisciplinary agent model that tests how interactions among hydrosystem, aquatic ecosystem, and the human system affect policy options. These results should have substantial implications for ecology and sustainable natural resource management. Resulting publications include Caldas et al. 2015, 2019; Lehrter 2018; Granco et al. 2019.

Products

Publications

Caldas, M., M. Mather, J. Bergtold, M. Daniels, G. Granco, J. Aistrup, D. Haukos, A.Y. Sheshukov, M. Sanderson, and J.L. Heier Stamm. 2019. Lessons learned in operationalizing interdisciplinary collaboration. Pages 265-294 in Dr. Stephen Perz, editor. Social-Ecological Systems Science, University of Florida, Gainesville, USA.

Caldas, M.M., M. Sanderson, M. Mather, M. Daniels, J. Bergtold, J. Aistrup, J.H. Stamm, D. Haukos, K. Mankin, A. Sheshukov, and D. Carr-Lopez. 2015. Bringing culture into sustainability science research and policy. Proceedings National Academy of Sciences 112:8157-8159.

Granco, G., J.L. Heier Stamm, J.S. Bergtold, M.D. Daniels, M.R. Sanderson, A.Y. Sheshukov, M. Mather, M.M. Caldas, S.M. Ramsey, R. Lehrter, D. Haukos, J. Gao, S. Chatterjee, J. Nifong, and J. Aistrup. 2019. Evaluating environmental change and behavioral decision-making for sustainability policy using an agent-based model: a case study for the Smoky Hill River Watershed, Kansas. Science of the Total Environment 695 (2019) 133769.

Granco, G., M. Caldas, J. Bergtold, J. L. Heier-Stamm, M. Mather, M. Sanderson, M. Daniels, A. Sheshukov, D. Haukos, and S. Ramsey. 2022. The role of cultural behavior and natural environment in shaping public support for sustainability policy. Journal of Environmental Management 301 (2022) 113776.

Bergtold, J. S., M. M. Caldas, S. R. Ramsey, M. R. Sanderson, G. Granco, and M. E. Mather. 2022. The gap between experts, farmers and non-farmers on perceived environmental vulnerability and the influence of values and beliefs. Journal of Environmental Management 316, 115186.

Thesis

Lehrter, R. 2018. Links between food web structure, biodiversity, and resilience: effects of anthropogenic disturbance on aquatic communities in the Smoky Hill River, KS. Thesis, Kansas State University, Manhattan.

Plum Island Ecosystems LTER

Student Investigator:
Ryland Taylor

Principal Investigators:
12 Principal Investigators from multiple universities including Dr. Martha Mather

Lead PI:
Dr. Anne Giblin, MBL, Woods Hole. MA

Project Supervisor:
Dr. Martha Mather

Funding
National Science Foundation

Cooperators
Kansas State University Division of Biology

Objectives
Evaluate ecological drivers for the spatial arrangements and connectivity between ecological habitat patches

Determine the spatial arrangement and the connectivity between ecological habitat patches

Quantify distribution and movements of mobile fish predators

Location
Plum Island Estuary

Completion
December 2019

Status
Complete

Results

Overview
The Plum Island Ecosystems (PIE) LTER has been working towards a predictive understanding of the long-term response of coupled land -water ecosystems since its inception in 1998. The Plum Island Estuary-LTER includes the coupled Parker, Rowley, and Ipswich River watersheds. The present grant builds upon past progress that the research team has made in understanding the importance of spatial patterns and connections across the land-margin ecosystem. Higher trophic levels, such as fish, rely on seascape configurations that create 'hot spots' of energy that transfer up the food web.

Justification
Determining patterns and drivers of organismal distribution and abundance are fundamental and enduring challenges in ecology, especially for mobile organisms at a 'scape scale. Understanding these same issues are also fundamental for sportfish managers to satisfy anglers, a core clientele of state resource agencies.

Methods
To address the problem presented by individual predators whose distributions are dynamic across large geographic areas, here we tracked 59 acoustically-tagged migratory striped bass (*Morone saxatilis*) with an array of 26 stationary receivers in Plum Island Estuary (PIE), MA.

Questions
Specifically, we asked (1) how these predators were distributed across the estuarine seascape, (2) if these fish used three types of geomorphic sites (exits, confluences, and non-confluences) differently, (3) if distinct types of distributional "groups" existed across individual fish, and (4) if fish within distinct distributional groups used geomorphic site types and regions differently.

Results
Based on three components of predator trajectories (site specific *numbers of individuals, residence time,* and *number of movements*), striped bass were not distributed evenly throughout PIE. Confluences attracted tagged striped bass although not all confluences or all parts of confluences were used equally. Use of non-confluences sites was more variable than exits or confluences. Thus, geomorphic drivers and regions link mobile organisms to

physical conditions across the seascape. Based on spatial and spatial-temporal cluster analyses, these striped bass predators assembled into four seasonally-resident distributional groups. These included the (1) *Rowley River* group (fish that primarily resided in the Rowley River), (2) *Plum Island Sound* group (fish that primarily resided in the Middle Sound region), (3) *Extreme Fidelity* group (fish that spent most of their time in PIE at a single receiver location), and (4) the *Exploratory* group (fish that showed no affiliation with any particular location). These distributional personalities used geomorphic site types and regions differently. Thus, our data show a rare link between behavioral (i.e., individual animal personalities) and field ecology (seascape geomorphology) that can advance the understanding of field-based patterns and drivers of organismal distribution. This basic data can help resource managers with sampling and other management plans.

Implications:
The scientific questions, methods, and management applications for this project are very similar to the KS KDWPT blue catfish project. Both projects are ground-breaking scientifically. Both projects provide major insights into predator distribution in large systems throughout the U.S., information that is essential for sportfish management.

Products

Publications

Taylor, R. B., M. E. Mather, J. M. Smith, and K. M. Gerber 2019. Confluences function as ecological hotspots: geomorphic and regional drivers can identify patterns of fish predator distribution within a seascape. Marine Ecology Progress Series 629:133-148.

Taylor, R. B., Mather, M. E., Smith, J. M., Gerber-Boles, K. 2021. Can identifying discrete behavioral groups with individual-based acoustic telemetry advance the understanding of fish distribution patterns? Frontiers in Marine Science 8:Art. 723025.

Professional Presentations

Taylor, R., M. Mather, C. Kennedy, J. Smith, and K. Gerber. 2015. Confluence network dynamics can create a spatial mosaic of predator interactions. Annual Meeting of the Ecological Society of America, Baltimore, MD.

Taylor, R. T., M. E. Mather, J. Smith, K. Gerber. 2017. Examining the concept of site fidelity for a mobile fish predator in an estuarine seascape. Contributed Paper, Ecological Society of America, Portland, OR.

Thesis

Taylor, R. 2017. Using geomorphology and animal “individuality” to understand ‘scape-scale predator distributions. Thesis, Kansas State University, Manhattan.

Modeling the Effects of Climate Change on Fish Populations, Distribution, Movements, and Survival in Large Rivers

Investigators:
Dr. Martha Mather
Dr. Donna Parrish
Dr. Elizabeth Marschall

Funding
NMFS

Cooperators:
Kansas State University

Objective
Model the effects of climate change on mobile fish in rivers

Location
US Rivers

Completion
May, 2019

Status
Complete

Results

Mobile organisms including native fish, fish predators, and anadromous fish may be affected by climate change through several mechanisms. These include increased water temperature and altered discharge patterns. Anthropogenic impacts, especially fragmentation by dams, can exacerbate these effects by preventing, delaying, or otherwise altering distribution and movement. In this project, we use a series of individual based and statistical models to understand the relationships among water temperature, discharge, dams, fish distribution, movement, and survival.

Our present efforts are using a watershed wide model to test how American shad (*Alosa sapidissima*) offspring recruitment is affected by water temperature, water velocity, and food availability. Although previously this research has focused only on anadromous fish (salmon, shad) in large northeastern US rivers, the methods and insights have relevance to motile organisms in other stream networks where temperature and discharge are changing with climate (e.g., pallid sturgeon, paddlefish, Asian carp) in the Midwest and Northeast U.S.

Climate change is altering the spatial and temporal patterns of temperature and discharge in rivers, which is expected to have implications for the life stages of anadromous fish using those rivers. We developed an individual-based model to track American Shad within a coarse template of spatially and temporally variable habitat conditions defined by a combination of temperature, river velocity, and prey availability models. We simulated spawning at each river kilometer along a 142-km reach of the Connecticut River on each day (April 1–August 31) to understand how spawning date and location drive larval recruitment differentially across years and decades (1993–2002 and 2007–2016). For both temperature and flow, interannual variation was large in comparison to interdecadal differences. Variation in simulated recruitment was best explained by a combination of season-specific spawning temperature and location along the course of the river. The greatest potential recruitment occurred during years in which June temperatures were relatively high. In years when June and July were warmer than average, maximum recruitment resulted from spawning taking place at the upstream portion of the modeled reach. Model scenarios (stationary or passive-drift larvae; and dams or no dams) had predictable effects. We assumed that the pools above dams had negative impacts on eggs and yolk-sac larvae that may have been deposited there. Allowing eggs and larvae to drift passively with the current reduced spatial differences in recruitment success among spawning sites relative to stationary eggs and larvae. Our results demonstrate the importance of spatiotemporal environmental heterogeneity for producing positive recruitment over the long term. In addition, our results suggest the importance of successful passage of spawners to historical spawning sites in the Connecticut River upstream of Vernon Dam, especially as conditions shift with climate change.

Both these results and this methodology are widely applicable to mobile fish in large and small Great Plains rivers as well as elsewhere in the United States.

Products

Publications

Marschall, E. A., D. C. Glover, M. E. Mather, and D. L. Parrish. 2020. Modeling larval American Shad recruitment in a large river. North American Journal of Fisheries Management 41:939-954.

On-Going Fisheries Projects

Developing Communities of Expert Practice (COEP) to Apply Intergenerational Expertise to Challenging Aquatic Conservation Problems.

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Professional Colleagues
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Dan Shoup, Oklahoma State University;
Quinton Phelps, Missouri State University;
John Dettmers, Great Lakes Fisheries Commission

Project Supervisor
Dr. Martha Mather

Cooperators
Kansas State University

Kansas Department of Wildlife and Parks

U.S. Fish and Wildlife Service

U.S. Geological Survey

Wildlife Management Institute

Location
Kansas and Nationwide

Status
Ongoing

Progress
The fisheries profession can benefit from increased opportunities for relevant innovation that merge the experience and judgement of seasoned professionals with the skills and energy of younger professionals. Many fisheries professionals, employed by state and federal agencies and universities, are currently overwhelmed by existing job responsibilities. Furthermore, criteria for advancement typically prioritize the completion of mandated tasks (teaching, monitoring) or the acquisition of grants that use focused current approaches or enhance existing datasets. As a result, our professional status quo provides limited opportunities and incentives for thinking about innovative approaches to complex problems within an intergenerational framework.

Analysis skills and grasp of new tools (fluid intelligence) can peak early in one’s career and can decrease in older professionals. However, skills that seek to understand/interpret complex ideas (crystalized intelligence) peak later in one’s career and can stay high indefinitely. Young professionals can solve problems with which they are familiar quickly. Older professionals can identify which problems are worth solving. Fisheries can benefit from integration of both types of intelligence for addressing complex natural resource problems. Existing professional advancement criteria include little guidance and few rewards for intergenerational teams to pursue innovative solutions to challenging problems.

A community of expert practice (COEP) is a network of expert professionals who have an interest in a common set of problems and who seek to share information on best practices in a focused, connected way for an extended time period (i.e., not just a one-time collaboration). Yet, existing communities of expert practice frequently do not prioritize the strategic planning that creates new and better “best practices.” This project seeks to develop guidelines for forming COEP to develop better “best” practices using the combined skills of intergenerational teams of professionals who continuously interact in a focused way over a prolonged period. Examples of ongoing COEPs follow.

Scale
At the 2021 AFS meeting in Baltimore, 15 teams of researchers working across diverse ecosystems, geographic regions, and taxa, participated in a symposium entitled “*Scale 2021: choosing and matching scales for aquatic field data: status, options, and*

knowledge gaps." In this COEP, participants presented their perspectives on status and challenges related to the choice of spatial and temporal scale in the collection and analysis of aquatic field data. By asking each collaborator to address the same set of questions, we were able to identify six future directions related to scale. Of these, four spatial scale themes were further developed in presentations at the 2022 Joint Aquatic Sciences Meeting (JASM). This COEP has worked together through two national professional meetings and continues to collaborate on multiple publications. By structuring synthesis activities to match rewardable criteria (talks, papers, grants), we hope to integrate new ways of thinking about spatial scale into better "best practices."

A New Model For Prairie Stream Collaboration

Over 60 American Fisheries Society members from the North Central, Southern, Northeastern, and Western Divisions have expressed interest in joining a new collaboration to address problems related to prairie stream fish research and conservation. This collaboration includes remote meetings, a symposium at the 2021 national AFS meeting in Baltimore entitled "*Creating and Implementing an Ecosystem-wide Integrated Research Agenda and Conservation Plan for Prairie Streams: A Shared Vision, Next Generation Synthesis, and Future Action Plan,"* as well as an upcoming 2022 multi-day workshop.

Increasing threats to aquatic resources demand new collaborative approaches. For large ecosystems, such as prairie streams, one state, one agency, or one research lab cannot be effective alone. Collaborative synthesis in ideas, data, and action is needed for restoration and preservation of prairie fish assemblages. However, this new type of collaboration requires creative and innovative ideas, a common vision, good coordination among participants, and a clear plan for future action. In this COEP, nine organizers repeatedly interact with over 50 professionals from multiple universities, multiple state agencies, three federal agencies, and one non-governmental organization.

Questions We Should Be Asking

As experts in our respective areas, we become very competent at collecting and analyzing data in a certain way. As specialists, we may ask the same kinds of questions that may lead to the collection of the same kinds of data throughout our careers. This accumulation of skills and knowledge is laudable in many respects (e.g., promotions). Yet, this specialization can also have disadvantages in that a singular disciplinary focus can limit innovation, especially the ability to see connections across scientific disciplines. In this COEP, we hypothesize that *"Asking questions differently can identify novel directions for solving complex environmental problems through synthesis and integration*."

Why would we want to leave our silos of expertise? The parable of the blind men and the elephant has been used to illustrate the advantages of a more holistic perspective. In this parable (variously interpreted), a group of blind men encounter an elephant for the first time. Each blind person feels a different part of the elephant's body (e.g., trunk, tusk, tail, side, leg). Then, based on their own limited information, these experts disagree about the nature of the whole elephant (e.g., the whole elephant is a snake, spear, rope, wall, or tree). Of course, all of these conclusions, based on narrow perspectives, are not only contentious but also incorrect. The take home message that narrow conceptualizations of a complex problem can be counterproductive also applies to many natural resource management problems.

This COEP seeks to motivate individual professionals (biological researchers, social science researchers, managers, policy-makers) to think about how their ideas fit into a larger conservation picture, how their skills and interests connect to other sectors and disciplines, what gaps exist, and how we, as a profession, can move forward together to create a new synthetic interdisciplinary vision that better addresses complex natural resource problems.

Products

Professional Presentations

Hitchman, S. M., M. E. Mather, and J. M. Smith. 2021. Scale V.2021: identifying current issues that address future needs for making scale choices that facilitate effective field sampling. Invited Presentation for a Symposium entitled “Scale V.2021: Status, Options, and Knowledge Gaps for Choosing and Matching Scales in Aquatic Field Data,” 151st Annual Meeting of the American Fisheries Society, November 6-10, 2021, Baltimore, MD.

Smith, J. M., M. E. Mather, and S. M. Hitchman. 2021. Review, evaluation, and reimagining the landscape of practical approaches to spatial scale: where we have been and where we can go. Invited Presentation for a Symposium entitled “Scale V.2021: Status, Options, and Knowledge Gaps for Choosing and Matching Scales in Aquatic Field Data,” 151st Annual Meeting of the American Fisheries Society, November 6-10, 2021, Baltimore, MD.

Mather, M. E., C. Aymami, and O. Rode. 2021. Plotting a course for science-based, data-driven watershed conservation through the development of a regional collaboration. Invited presentation for a symposium entitled “Creating and Implementing an Ecosystem-wide Integrated Research Agenda and Conservation Plan for Prairie Streams: A Shared Vision, Next Generation Synthesis, and Future Action Plan .” 151st

Annual Meeting of the American Fisheries Society, November 6-10, 2021, Baltimore, MD.

Mather, M. E., M. Fabrizio, C. Moffitt, and D. Parrish. We have been working on this forever: why is “diversity, inclusion, and fairness” so hard? Invited presentation for a symposium entitled “Diversity and inclusion: a strategy to implement change for 2021 and beyond.” 151st Annual Meeting of the American Fisheries Society, November 6-10, 2021, Baltimore, MD.

Mather P. Angermeier, K. Pope, Chuck Hopkinson, M. Vanni 2022. Framing questions differently can catalyze innovative solutions to complex aquatic science problems. Joint Aquatic Science Meeting (JASM), May 2022.

Finn, J. T., M. E. Mather, S. Hitchman, M. P Carey, R. Tingley, O. Rode, C. Aymami, D. Oliver, J. Dettmers. 2022. Monitoring that inspires research: linking monitoring and research data. Joint Aquatic Science Meeting (JASM), May 2022.

Hitchman, S. M., M. E. Mather, J. M. Smith, K. Pope, D. DeVries, J. Garvey, R. Tingley, M. Carey. Scale: direction and progress for impactful science-based conservation. Joint Aquatic Science Meeting (JASM), May 2022.

DeVries, D., J. Garvey, M. Mather, K. Pope, S. Hitchman, J. Smith 2022. Connecting biology to policy: linking scales for data collection to scales needed for the decision-making process. Joint Aquatic Science Meeting (JASM), May 2022.

Granco, G., and M. Mather 2022. New questions to understand how culture can affect sustainability policies: linking scales in a multi-use freshwater ecosystem. Joint Aquatic Science Meeting (JASM), May 2022.

Suileman, G., J. Luginbill, and M. Mather 2022. Planning and implementing pathways for proactive biodiversity conservation. Joint Aquatic Science Meeting (JASM), May 2022.

Nepal, V., M. Fabrizio, B. Knuth, M. Mather, D. Parrish. 2022. Asking different questions can overcome obstacles and identify new solutions to achieving human diversity in the aquatic sciences. Joint Aquatic Science Meeting (JASM), May 2022.

Developing a Strategic Planning Process for Native Fish Restoration

Student Investigators
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Dr. Trisha Moore, KSU Biological & Agricultural Engineering;
Dr. Kate Nelson, KSU Geography & Geospatial Sciences

Project Supervisor
Dr. Martha Mather

Funding
Kansas Department of Wildlife and Parks

Cooperators
Kansas Department of Wildlife and Parks

Kansas State University

Location
Data associated with Kansas streams

Initiated
January 2021

Status
Ongoing

Progress

Background.
Natural resource agencies are charged with conserving native species. Freshwater biodiversity is decreasing at an alarming rate even though protecting freshwater is a priority for human security and environmental management. The ecological services sections of state natural resource agencies need new tools in their conservation toolboxes to combat the increasing number of obstacles that impede successful conservation of native freshwater biodiversity.

Objectives.
To provide these new tools that enhance the effectiveness of existing conservation approaches, here we seek to combine the efforts of university personnel, graduate students, and agency partners to provide guidance for present and future native fish restoration through five directions related to the project objectives:
(a) identify and implement a strategic planning process,
(b) synthesize existing literature on habitat needed by Kansas fish and impacts that adversely affect Kansas fish,
(c) analyze monitoring databases related to habitat and native fish distribution,
(d) as appropriate, develop / test field data protocols, and
(e) as possible, propose a program of adaptive management.
Ultimately, in this project, we seek to provide long-term guidance on conservation approaches rather than one-time one-place remedies.

Strategic Planning.
Philosophically, we seek to address the objectives in our grant as a means to improve the effectiveness of the excellent, existing Kansas State Wildlife Action Plan (KS SWAP). Strategically, we seek to provide guidelines for more effective, robust, and justifiable adaptive plans. Ideally, these plans advance knowledge-based conservation decisions and decision support by continually building on what is known. As a result, conservation planning can be modified as more information becomes available. In pursuing this overarching goal, we recognize that the KS SWAP plan is written to maintain flexibility and generality while still providing guidance for conservation decisions.

We build our project on the following foundation. We believe that the data collected, and approaches used for conservation by KDWP in Kansas (monitoring, management, research) are excellent. Yet, much knowledge and data needed to protect and restore Kansas fish species in need of conservation (SINC) are still missing. Excellent conservation related data activities (monitoring, management, research) will continue. Yet, likely, as a profession, we will *never* have *all* desired data for *all* taxa for *all* locations at *all* times. In addition, we don't know enough now about many Kansas fish taxa (e.g., distribution, life-history, ecology) to devise a representative sampling / research plan for all locations, taxa, life-stages, habitats, and type of impacts. In summary, although our profession is taking thoughtful steps for conservation now, our current agenda will not provide the future outcome we desire. In this project, we propose to rethink where we are now, as a conservation profession, and where we ideally would like to be in the future related to conservation data and decision-making. With this rethinking, we can assess if there is a different way to use what we know now to guide future conservation actions in order to anticipate and prevent future species listings.

Relative to developing strategic goals, we have written an article for the Wildlife Management Institute newsletter entitled "*Incorporating Big Hairy Audacious Goals into Natural Resource Research, Management, & Conservation.*" Related to practical approaches to implementing strategic rethinking, we have also published a peer-reviewed manuscript entitled "*Adaptive Problem Maps: Connecting the Data-Dots to Build Increasingly Informed, Robust, and Defensible Fisheries and Aquatic Conservation Decisions*." The adaptive problem map for population restoration in this manuscript is intended for a general audience, and, as such, is overly simplistic for the goals of this grant. Yet, this example provides an illustration of how different concepts, datasets, and decisions can be concurrently connected. The strategy component of the project was further developed in the 2021 American Fisheries Society presentation entitled "*Plotting a course for science-based, data-driven watershed conservation through the development of a regional collaboration.*" Finally, a version of the conceptual framing for how to better link research and monitoring data was developed in a 2022 Joint Aquatic Sciences Meeting presentation by Finn, Mather, Rode, Aymami et al entitled *"Monitoring that inspires research: linking monitoring and research data."*

Current Status of Fish

The diverse suite of fish native to Great Plains streams and rivers requires an array of different habitats to survive and thrive. Yet, no detailed, systematic and consistent literature and data synthesis exists that summarizes habitat needs for Kansas native fish species in a standardized format.

What have we learned and what's next? Thus far, our literature review on fish habitat has identified several inconsistencies in how researchers collect habitat data. These gaps limit synthesis across studies. For example, no study examined all of the same habitat variables with the same metrics in the same way. This lack of standardization and consistency among researchers limits generality. Nevertheless, our literature review has also suggested several functional ways that habitat studies could be meaningfully grouped in a standard way to promote synthesis across studies. In summary, our new approaches to categorizing fish habitat studies can help combat existing inconsistencies in fish habitat research that presently impede comparisons across studies. The new approaches that we describe above represent fundamentally different ways of systematically defining and classifying habitat to identify similarities and differences in habitat studies.

Integration of Objectives.

We have been working to integrate all objectives (i.e., strategic plan, literature review, data synthesis) to fill existing gaps and advance the effectiveness of the Kansas State Wildlife Action Plan (SWAP). Specifically, we are working on the following integrative activities.

What Works and Doesn't Work with Existing Species Distribution Models (SDM)

Species distribution models are a very common set of conservation biology tools that seek to predict species distribution. In this approach, large-scale data on organismal occurrence and environmental variables are combined with a statistical model to predict where species might occur. Intellectually and conceptually, species distribution models are an excellent approach. Yet, several problems exist for all organisms and are especially problematic for fish. In general, occurrence and environmental data are limited, models are incomplete, and tests of the models are statistically not empirically based (i.e., they use existing data not new data to test model predictions). In the rare circumstances where predictions are tested in the field, accuracy of SDMs is very limited. For fish, these challenges are even more problematic. On the one hand, habitat variables that are relevant to fish have geographically-limited original data collection. On the other hand, the most easily available and commonly used GIS data layers are irrelevant to fish.

Gaps We Fill - Literature Reviews and Monitoring Database

This project adds a new connection that links literature reviews to existing data (empirical and GIS). The gap we seek to fill is between (a) conditions that specific fish taxa need to thrive, and (b) what habitat and GIS data are widely available. We seek to make this connection by identifying then creating new fish-centric data layers from the GIS/original data that we have. The meshing of what fish need, GIS data layers available, and the creation of new more fish-centric data layers has not been previously addressed and has the potential to add substantial power to existing fish and environmental datasets.

Our Prototype Framework
Our general approach will create a framework and proof of concept for a prototype system (limited fish taxa in one or two river basins) using seven steps. First, we will clearly document the goals for the prototype. Second, we will select a limited suite of fish taxa that co-occur in the same river basin for which we have adequate data. Third and fourth, we will review habitat and impact literature for these test fish taxa and make predictions about under what conditions each test fish taxa should occur/not occur. Fifth, we will identify relevant existing GIS data layers and adjust these to match fish-centric habitat needs. Sixth, we will assemble hydrology, fish distribution, and habitat and impact layers at standard locations via data wrangling. Finally, we will make maps of fish distribution (presence and absence) and relevant variables. With this literature-data-conceptual synthesis, we will test hypotheses about distribution using logistic regression and other species distribution models.

We have expanded our university collaboration to include GIS experts (1 faculty, 2 graduate students, 1 undergraduate), a statistician (1 faculty), and experts on spatial data analysis with R (1 faculty, 2 graduate students). We will work with this larger group on strategic planning, literature, and data analysis for this prototype over the summer 2022.

Products

Publications

Mather, M. E., and J. M. Dettmers. 2022. Adaptive problem maps (APM): Connecting data dots to build increasingly informed and defensible environmental conservation decisions. Journal of Environmental Management 312 (2022) 114826.

Professional Presentations
Mather, M. E., C. Aymami, and O. Rode. 2021. Plotting a course for science-based, data-driven watershed conservation through the development of a regional collaboration. Invited presentation for a symposium entitled “Creating and Implementing an Ecosystem-wide Integrated Research Agenda and Conservation Plan for Prairie Streams: A Shared Vision, Next Generation Synthesis, and Future Action Plan .” 151st Annual Meeting of the American Fisheries Society, November 6-10, 2021, Baltimore, MD.

Mather, M., P. Angermeier, K. Pope, Chuck Hopkinson, and M. Vanni 2022. Framing questions differently can catalyze innovative solutions to complex aquatic science problems. Joint Aquatic Science Meeting (JASM), Grand Rapids, MI.

Finn, J. T., M. E. Mather, S. Hitchman, M. P Carey, R. Tingley, O. Rode, C. Aymami, D. Oliver, and J. Dettmers. 2022. Monitoring that inspires research: linking monitoring and research data. Joint Aquatic Science Meeting (JASM), Grand Rapids, MI.

A Strategic Process for Fisheries Management and Aquatic Conservation

Project Supervisor
Dr. Martha Mather

Cooperators
Kansas Department of Wildlife and Parks

Kansas State University

U.S. Fish and Wildlife Service

Wildlife Management Institute

Objectives
Provide strategic planning syntheses and reviews to aid management effectiveness.

Status
Ongoing

Progress and Results

Overview
A core goal of the Cooperative Research Unit program is to assist cooperators in the effective execution of their fisheries management and aquatic conservation mission. To achieve this goal, unit scientists can help state and federal colleagues be more effective in managing resources through the organizations of symposium at meetings and talks/publications that provide relevant reviews and syntheses. In 2019-2022, I have contributed talks, symposia, and syntheses that can improve natural resource agency effectiveness through strategic planning. Below are select examples.

Gear
Implementation of rigorous methodologies, including gear evaluation and standardization, is critically important for effective fisheries research and management. Although few fisheries professionals disagree with the urgent need for detailed, quantitative protocols prior to data collection, challenges exist in executing representative and generalizable gear evaluations and standardizations. Three primary areas require attention. Addressing these challenges can advance the establishment and implementation of improved sampling methodologies. As a first challenge, unless a complete census is undertaken every time resource data are collected, uncertainty about context-specific bias at the time of each individual data collection event (related to time-, place- and personnel-related sampling variation) will affect efforts to evaluate and standardize gear. Consequently, practical and philosophical cautions about data interpretation related to the inevitable uncertainty in bias need to be integrated into the development, validation, and application of standardized data including context for estimates of precision and accuracy. As a second challenge, the type of data needed, and impact of specific gear bias differ with the question asked. For example, regardless of the gear used, data needed to estimate population size are quite different from those needed to quantify the impact of specific conditions on fish populations (e.g., habitat type, season, disturbances such as dams). Thus, the question asked alters the appropriateness of the sampling design for the same and different gears. As a third challenge, an integrated analysis is needed of how standardized data relates to the fisheries questions asked (e.g., what will be done with the standardized data once it is collected?; are the right questions being asked for the problem at hand?; will the resulting data be useful if unanticipated trends are detected?). By addressing these

challenges, fisheries professionals can develop a more balanced portfolio of tools that provide a broader context for the development, validation, and application of standardized data.

Strategic Planning For Fisheries.

Resource agencies manage fisheries and conserve aquatic resources based on sound data and scientific principles. This always-difficult task is ever more challenging as fish species and systems that require management are assaulted by an increasing diversity of human disturbances. Here we identify a multi-step pathway by which resource agencies and their collaborators can advance sustainable conservation and science-based fisheries management. We illustrate this approach using successful examples from a variety of agencies and fisheries. First, a shared vision created by a collaborative group of researchers and managers is essential. Second, linked goals, objectives, and questions must be established for each fisheries management problem. Third, a framework for how different types of information interact and contribute to success is needed (e.g., monitoring, applied research, basic research). Fourth, a commitment to rigorous scientific principles in research and monitoring is fundamental. Fifth, commitment to and evaluation of an agreed-upon set of goals for 5-10 years is essential. Finally, a question-driven portfolio of integrated data can operationalize this framework for specific fisheries goals. Inland and marine fisheries agencies face different challenges. However, all conservation stakeholders can benefit from developing components of this pathway because a question-based, integrative, data-driven approach can increase successful science-based management.

Fish Harvest Regulation Evaluation

Harvest regulations are essential tools that fisheries managers use to alter fish populations and achieve angler satisfaction. Evaluation of regulations is essential but evaluating all regulations for all species in all systems across multiple time periods is not logistically feasible. Thus, a strategic plan is needed that identifies what regulations need to be evaluated where, when. Specifically, an integrated framework of assessment and research (i.e., the portfolio approach) can provide a larger context in which to design, implement, and interpret harvest regulation evaluations. Using examples, we illustrate this multi-step approach. First, a shared vision for individual fisheries (species, system, individual/population, goal) that is jointly created by a collaborative group of researchers and managers is essential. Second, using a series of linked questions, objectives, and goals, the collaborative team can conceptualize (a) desired outcomes of specific harvest regulations given population characteristics, (b) challenges to achieving those outcomes, and (c) data needed to differentiate among population responses to regulations. Third, by applying a portfolio of interacting data types (e.g., assessment, applied research, basic science, synthesis), researchers and managers can operationalize a pathway to achieve the desired angler outcome given existing population conditions. Fourth, by using rigorous scientific principles, the team can improve all aspects of assessment and research. Specifically, a strategic plan that considers multiple starting population conditions, a range of harvest regulations, and different angler outcomes can integrate all assessment and research data to better inform management decisions. Fifth, adhering to a set of agreed-upon, regularly-evaluated 10-year goals allows fisheries professionals to track progress and plan next steps. Although agencies face different challenges across species, systems, and populations, all fisheries professionals can advance successful science-based management by utilizing components of this portfolio approach for harvest regulation evaluation.

Habitat

Habitat data are central to successful resource conservation. Although environmental professionals know much about habitat, managers, administrators, and policy-makers still find it difficult to make wise habitat-based conservation and restoration decisions. To achieve a larger vision for research-management collaborations, professionals need to establish “stretch” goals, which, if achieved, completely change all aspects of an activity, and, for which, the pathway to achievement is often inconceivable at the outset. Two “stretch” goals for fish habitat research are to (1) identify data needed to make defensible, science-based fish habitat decisions across a range of aquatic systems, species, and years, and (2) clarify what types of decisions are realistic under different mixes of knowledge and uncertainty. Several steps are needed for this transformative process. Philosophically, decision makers should recognize the value of data-based decisions, acknowledge inevitable knowledge gaps, and embrace some mix of data and uncertainty. Empirically, decision makers and researchers must improve connections between decision-support data and management actions, and, through synthesis, better link multiple data sources (including mechanisms and patterns). Iterative, adaptive problem maps that integrate questions, actions, data, methodologies (including species distribution models) with a discussion of data strengths, weaknesses, and uncertainty can provide defensible scientific-based habitat management.

Using Technology

Fisheries can benefit from advanced technologies (e.g., telemetry, remote sensing, social media, quantitative approaches). However, advanced technologies do not solve complex fisheries problems, improve data quality, or reduce bias by themselves. In fact, the tool utility hypothesis proposes four relationships between technology and successful problem-solving. (1) Initially, the perceived relationship is strong as general agreement exists that new tools could be valuable. (2) An assumed but often untested positive relationship follows as previously-unavailable technologies are developed and perfected. (3) However, this relationship can weaken with increased use of the technology if data collection objectives prioritize *how* to (rather than *why*) use the technology. (4) Nevertheless, benefits from advanced technology can accelerate if strategic planning structures data collection so that important questions drive technology use. We provide a framework to focus advanced technologies on common fisheries management problems (e.g., standard/standardized assessments, harvest regulation application/evaluation, habitat improvement, invasive species control, managing barriers). For these shared problems, an adaptive, iterative approach integrates questions, methods, and tool application in a way that increases data comparability across agencies and institutions. Thus, the technology we propose (a strategic framework) can enhance the utility and increase the benefits of diverse advanced technologies.

Products

Professional Presentations

Mather, M. E., D. Shoup, and Q. Phelps. 2018. Placing gear evaluation and standardization in a broader context that advances science-based fisheries management. Invited symposium presentation, Midwest Fish and Wildlife Conference, Milwaukee, WI.

Mather, M. E., J. M. Dettmers, D. L. Parrish, R. A. Stein, and E. A. Marschall. 2018. A portfolio of integrated monitoring and research can advance successful science-based conservation and fisheries management. (Invited Symposium Presentation - From Catastrophe to Recovery: Stories of Fishery Management Success). National Meeting, American Fisheries Society, Atlantic City, NJ.

Phelps, Q. E., M. E. Mather, and D. E. Shoup. 2019. Harvest regulations: what do we know, what do we need to know, what should we do next to develop and implement standardized assessments to evaluate harvest regulations. Invited Participant, North Central Division, American Fisheries Society Symposium. Using Assessments to Evaluate Harvest Regulations: Advancing Science-based Fisheries Management, 79th Midwest Fish and Wildlife Meeting, January 2019, Cleveland, OH.

Carl, D.D., D. E. Shoup, M. E. Mather, Q. E. Phelps. 2019. Standardized and robust analyses for evaluating fishing regulation effectiveness. Invited Participant, North Central Division, American Fisheries Society Symposium. Using Assessments to Evaluate Harvest Regulations: Advancing

Science-based Fisheries Management, 79th Midwest Fish and Wildlife Meeting, January 2019, Cleveland, OH.

Mather, M. E., J. M. Dettmers, R. A. Stein, D. L. Parrish, and D. Glover. 2019. A portfolio approach to integrated assessment and research can provide a larger context for the successful evaluation of fisheries harvest regulations. Invited Participant, North Central Division, American Fisheries Society Symposium. Using Assessments to Evaluate Harvest Regulations: Advancing Science-based Fisheries Management, 79th Midwest Fish and Wildlife Meeting, January 2019, Cleveland, OH.

Mather, M. E., D. Shoup, and Q. Phelps. 2019. Ensuring that technological advances actually advance the fisheries profession: Developing a strategic framework that uses advanced technologies to solve persistent fisheries problems. Presentation is part of a symposium entitled "Integrating Advanced Technologies to Improve Data Quality and Reduce Bias in Fisheries and Wildlife Population Research and Management." 149th Annual American Fisheries Society Meeting and Joint Conference with The Wildlife Society in Reno, Nevada, September 29-October 3, 2019.

Mather, M. E. 2020. Why aren't we more successful in conserving rivers and river fish? 150th Annual Meeting of American Fisheries Society. September 14-25, 2020. Columbus, Ohio. Invited Presentation for Symposium Entitled "River Stressors."

Mather, M. E. 2020. Combining Freakonomics with data fusion to advance big data approaches for fisheries and aquatic conservation problem solving. 150th Annual Meeting of American Fisheries Society. September 14-25, 2020. Columbus, Ohio. Invited Presentation for Symposium Entitled "Merging Data Science and Fisheries and Aquatic Science to Solve Big Problems."

Mather, M., P. Angermeier, K. Pope, Chuck Hopkinson, and M. Vanni 2022. Framing questions differently can catalyze innovative solutions to complex aquatic science problems. Joint Aquatic Science Meeting (JASM), Grand Rapids, MI.

Finn, J. T., M. E. Mather, S. Hitchman, M. P Carey, R. Tingley, O. Rode, C. Aymami, D. Oliver, and J. Dettmers. 2022. Monitoring that inspires research: linking monitoring and research data. Joint Aquatic Science Meeting (JASM), Grand Rapids, MI.

Publications

Chestnut, K., M. E. Mather, Q. Phelps, and D. Shoup. 2022. A review of empirical evidence related to the effectiveness of harvest regulation evaluations: a professional call to action for a more systematic, standardized collaborative approach to data collection. Fisheries *In Press*.

Wildlife Projects

Completed Wildlife Projects

Ring-necked Pheasant Population and Space Use Response to Landscapes Including Spring Cover Crops

Investigators
Alixandra Godar

Project Supervisor
Dr. David Haukos

Collaborator
Jeff Prendergast

Funding
Kansas Department of Wildlife and Parks

Cooperators
Kansas Department of Wildlife and Parks

Objectives
Test the potential influence of cover crops on ring-necked pheasant population demography and develop spatial models predicting potential effects of cover crop presence on pheasant abundance at the landscape scale

Assess relationships among availability of invertebrates among cover crop seed mixes, chick foraging space use and forage choice, and the potential

Status
Completed

Results

Planting spring cover crops as part of a crop rotation is a potential management practice to increase nesting and brood-rearing habitat for grassland birds in agricultural landscapes. Managers consider spring cover crops beneficial for wildlife populations while providing agricultural benefits by converting fallow fields to green fields during the breeding season. Populations of ring-necked pheasants (*Phasianus colchicus*) are declining in Kansas, USA primarily due to intensification of row-crop agriculture reducing availability of quality habitat. Use of spring cover crops may increase recruitment of ring-necked pheasants by providing nesting and brood-rearing habitats when the field would normally be fallow. Plant composition of spring cover crop seed mixes varies based on the relative amount of small grains, grasses, and forbs. To maximize the influence of cover crops on local wildlife, an understanding of how wildlife species use landscapes containing cover crops and the potential role of cover crops on population growth is required. My objectives were to (1) estimate the effect of spring cover crops on ring-necked pheasant population demography, (2) measure brood habitat and resource selection, (3) measure hen habitat and resource selection during the breeding season, and (4) test vegetation and insect composition among cover crop mixes and across other cover types. I compared ring-necked pheasant, plant, and insect response among three cover crop seed mixes and chemical fallow control treatments in 26 study sites on private land in four counties in western Kansas during 2017-2019. The three cover crop mixes were GreenSpring© (73 kg/ha; cool-season peas [*Pisum sativum*] and oats [*Avena sativa*]; 321.4 ha), Chick Magnet© (28 kg/ha; warm-season, broad-leafed forbs; 322.8 ha), and a Custom Wildlife Mix (41 kg/ha; multispecies mix for wildlife; 334.6 ha). In Conservation Reserve Program (CRP) fields within 2 km of treatments fields, I captured pheasants via nightlighting. Captured female pheasants (n = 139) were outfitted with a 15-g necklace-style very-high-frequency transmitter with an 8-hr mortality switch and a unique numbered aluminum leg band. Radio-collared individuals were monitored a minimum of twice a week from capture through September each year to measure movements and habitat use through nesting, brood rearing, and brood break-up periods. When conditions allowed, nesting females were monitored daily to determine nest success and nest hatch day. I conducted weekly vegetation surveys and biweekly insect sweep surveys in cover crop fields and surrounding potential habitat patches (i.e., CRP, native pasture, wheat, and other crop fields). I estimated home ranges for hens with ≥30 locations during the breeding season (= 91.05 ha, SE = 14.43, n = 55). Selection of cover types was based on use versus availability of different cover types within each home range. Every location was assigned a cover type and 2 weekly locations were randomly selected for vegetation and insect surveys with a paired random location. I found that (1) pheasant population growth increased in cover crop fields, (2) broods used cover crop fields, (3) pheasants selected for CRP cover types across all time periods, but resource selection varied based on availability of resources and physiological requirements, and (4) cover crop fields provided more cover and insects than chemical fallow fields. Insect (Wilks λ =

invertebrate community in the landscape

Assess selection of cover crops and other available landscape patches by pheasants during multiple ecological states and at different spatial scales

Compare characteristics (e.g., vegetation cover, nutrient availability) among different spring cover crop types relative to potential benefits for wildlife and producer

Location: Graham, Norton and Russell counties, Kansas

Completion August 2020

0.07, $F_{5,376} = 18.66$, $P < 0.0001$, $n = 382$) and vegetation measurements (Wilks $\lambda = 0.15$, $F_{5,3247} = 256.94$, $P < 0.0001$, $n = 3{,}316$) varied by cover type. Chick Magnet provided the most forb cover of all cover types and the greatest average count of insects. Pheasant hens showed strong selection for CRP (2nd order: $\lambda = 0.203$, $P = 0.001$; 3rd order: $\lambda = 0.204$, $P = 0.015$). Broods used cover crops, crops fields, CRP, and grass. Cover crops comprised <5% of the landscape though it supported >25% of brood locations. Nest survival and hen survival estimates were lower than recommended for a stable population but pheasant hens with cover crops within their home range showed greater population growth than those without cover crops within their home range. Cover crops placed closely to CRP land may increase local pheasant population growth. Spring cover crops help mitigate the negative effects of intensive agriculture practices on grassland birds by providing additional insect forage and connecting isolated habitat patches during the breeding season.

Products

Professional Presentations

Godar, A., A.C. Annis, D. Haukos, and J. Prendergast. 2017. Ring-necked pheasant use of spring cover crops in western Kansas. Annual conference of The Wildlife Society, Albuquerque, NM.

Godar, A., A. Annis, D. Haukos, and J. Prendergast. 2018. Can you find pheasants in spring cover crops? Kansas Natural Resources Conference, Manhattan, Kansas.

Godar, A., A. Annis, D. Haukos, and J. Prendergast. 2018. Cover crops: Altering an altered landscape to benefit wildlife? Annual Meeting of the Central Mountains and Plains Section of The Wildlife Society, Kearney, Nebraska.

Godar, A., A. Annis, D. Haukos, and J. Prendergast. 2018. Do pheasants use spring cover crops? Midwest Fish and Wildlife Conference, Milwaukee, Wisconsin.

Godar, A., A. Annis, D. Haukos, and J. Prendergast. 2018. Pheasant habitat selection: logical or mysterious. Annual Meeting of The Wildlife Society, Cleveland, Ohio.

Godar, A., A. Annis, D. Haukos, and J. Prendergast. 2019. For the birds: modifying western Kansas using spring cover crops to manage for pheasants. Kansas Natural Resource Conference, Manhattan, Kansas.

Godar, A., A. Annis, D. Haukos, and J. Prendergast. 2019. Grassland bird response to spring cover crops in an agricultural landscape. Annual Meeting of the American Ornithological Society, Anchorage, Alaska.

Godar, A., A. Annis, D. Haukos, and J. Prendergast. 2019. Scale dependency: influencing pheasant populations using cover crops. Annual Meeting of The Wildlife Society, Reno, Nevada.

Godar, A., and D. Haukos. 2019. Resource selection of pheasants in response to use of cover crops. Graduate Student Forum, Division of Biology, Kansas State University, Manhattan.

Godar, A., and D. Haukos. 2020. Bugs and Birds. Nebraska Pheasants Forever Team Meeting. Fall meeting, virtual (Invited presentation).

Godar, A., and D. Haukos. 2020. Ring-necked pheasant population and space use response to landscapes including spring cover crops. "Frontiers in Agriculture" speaker, Agricultural Conservation Committee, Association of Fish and Wildlife Agencies, Fall meeting, virtual (Invited presentation).

Godar, A., A. Piernicky, D. Haukos, and J. Prendergast. 2020. Adding diversity to the landscape with spring cover crops. Kansas Natural Resource Conference, Manhattan, Kansas.

Godar, A., A. Piernicky, D. Haukos, and J. Prendergast. 2020. Influence of spring cover crops on ring-necked pheasant populations in Kansas. Annual Meeting of The Wildlife Society, Louisville, Kentucky.

Godar, A., A. Piernicky, D. Haukos, and J. Prendergast. 2020. Supporting grassland birds using spring cover crops. Annual meeting of the Kansas Ornithological Society, virtual.

Godar, A., A. Piernicky, D. Haukos, and J. Prendergast. 2021. Influence of spring cover crops on ring-necked pheasant populations in Kansas. Changing the Agricultural Landscape with Cover Crops, Symposium, Midwest Fish and Wildlife Conference, virtual. (Invited presentation)

Godar, A., A. Piernicky, D. Haukos, and J. Prendergast. 2021. Reliance on CRP for breeding by ring-necked pheasants in Kansas. Annual Conference of The Wildlife Society (virtual).

Godar, A., A. Piernicky, D. Haukos, and J. Prendergast. 2022. Ring-necked pheasant use of spring cover crops. Kansas Natural Resource Conference, Manhattan (poster).

Dissertation

Godar, A. 2020. Ring-necked pheasant population and space use response to landscapes including spring cover crops. Dissertation, Kansas State University, Manhattan.

Ring-necked Pheasant Survival, Nest Habitat Use, and Predator Occupancy in Kansas Spring Cover Crops

Investigators
Adela Annis

Project Supervisor
Dr. David Haukos

Funding
Kansas Department of Wildlife and Parks

Cooperators
Jeff Prendergast
Kansas Department of Wildlife and Parks

Objectives

Determine factors influencing survival of adults, broods, and nests within cover crop and chemical fallow crop treatments within Kansas

Assess nest-site selection of used verses available cover crop and chemical fallow treatments

Measure mesocaarnivore occupancy in different cover crop and chemical fallow crop treatments

Location:
Western and Mid-Central Kansas

Completion
September 2019

Status
Completed

Results

The ring-necked pheasant (*Phasianus colchicus*) is a popular and economically important upland gamebird in Kansas. Population declines have stakeholders seeking methods to manage populations on agricultural lands. Cover crops planted during the breeding period may provide important resources pheasants require for survival and successful reproduction. I evaluated three cover crop mixes; a custom mix, commercial mix, a wildlife mix, and a chemical fallow control in three counties in western Kansas, during 2017 and 2018 to determine their potential as a management practice for increasing pheasant habitat. I tested the relative effects of spring cover crops on female pheasant survival, nest survival, nest-site selection, and mesocarnivore occupancy. Females pheasants (73) were captured via nightlighting during February – April and fitted with 15-g very-high-frequency radio collars and monitored them by telemetry.

I placed 58 camera traps on field edges and within cover crop treatments from April to September. Vegetation data were collected at nests and random points to assess nest-site selection and weekly random vegetation points were sampled within treatments. I used known fate and nest survival models in the package RMark interface in R to investigate adult and nest survival (R Core Team 2018). Adult breeding season survival was 0.57 (SE < 0.0001, CI = 0.5739 – 0.5740). Percent spring cover crop positively influenced adult survival (AIC_c w_i = 0.450). Nest survival was 0.361 (SE < 0.001, CI = 0.3614 - 0.3614). Daily nest survival followed a pattern of high survival that gradually declined over the breeding season. Resource selection functions suggest female ring-necked pheasants selected vegetation between 5-7 dm at 50% VOR for nest sites (AIC_c w_i = 0.97). Chi-square analyses suggest females selected Conservation Reserve Program (CRP) patches for nest sites more than expected during both years (2017 $\chi^2_4 = 26.49$, $P < 0.001$; 2018 $\chi^2_4 = 9.80$, $P = 0.04$). CRP supported 57% of nests and 56% of successful nests relative to other cover types. All three of the monitored nests in cover crops were depredated.

Ring-necked pheasant occupancy from April through August on was greatest on edges (ψ = 0.98, SE = 0.02) and influenced by distance to nearest woody vegetation (AIC_c w_i = 0.98). Occupancy of mesocarnivores was greatest on treatment edges with a constant occupancy of 1.00 (SE = 0.00, AIC_c w_i = 0.75). Brood occupancy was from late-May through August was biologically significant on edges (95% CI, $\psi = 0.20$, SE = 0.11) with occupancy influenced by distance to Conservation Reserve Program (AIC_c $w_i = 0.72$).

Spring cover crops provide cover and foraging resources when the majority of agricultural practices are fallow. Spring cover crops do not provide sufficient vertical cover for nesting until after peak nesting occurs, especially during cooler than average winter and spring conditions such as 2018. However, there are tangible benefits of spring cover crops to other biological periods, such as adult female survival, and brood resources if placement of cover crops is targeted near quality nest habitat. My results indicate wheat is an ecological trap for nesting due to increased predation and destruction during harvest. Providing quality nest structure will reduce females nesting in wheat. Incorporation of spring cover crops is a beneficial wildlife management tool that can increase ring-necked pheasant habitat on the landscape.

Products

Professional Presentations

Annis, A.C., A. Godar, D. Haukos, and J. Prendergast. 2017. Kansas ring-necked pheasant habitat use and survival in summer cover crops. Kansas Natural Resource Conference, Wichita, KS.

Annis, A.C., A. Godar, D. Haukos, and J. Prendergast. 2017. Survival of ring-necked pheasants in western Kansas spring cover crops. Annual conference of The Wildlife Society, Albuquerque, NM.

Annis, A., D. Haukos, and J. Prendergast. 2017. Mesocarnivore occupancy within Kansas spring cover crops. Kansas Ornithological Society, Junction City, Kansas.

Annis, A. C., A. Godar, D. Haukos, and J. Prendergast. 2018. Effects of spring cover crops on ring-necked pheasant survival and resource selection with notes on mesocarnivore occupancy. Annual Meeting of the Central Mountains and Plains Section of The Wildlife Society, Kearney, Nebraska.

Annis, A. C., A. Godar, D. Haukos, and J. Prendergast. 2018. What drives nest-site selection of Kansas ring-necked pheasants? Kansas Natural Resources Conference, Manhattan, Kansas.

Annis, A.C., A. Godar, D. Haukos, and J. Prendergast. 2018. Survival and nest-site selection of ring-necked pheasants in western Kansas spring cover crops. Annual Meeting of The Wildlife Society, Cleveland, Ohio.

Annis, A.C., A. Godar, D. Haukos, and J. Prendergast. 2019. Are spring cover crops a hot ticket item for chicks? Kansas Natural Resource Conference, Manhattan, Kansas.

Annis, A.C., A. Godar, D. Haukos, and J. Prendergast. 2019. Are cover crops a hot ticket item for chicks? Annual Meeting of The Wildlife Society, Reno, Nevada.

Thesis

Annis, A. 2019. Ring-necked pheasant survival, nest habitat use, and predator occupancy in Kansas spring cover crops. Kansas State University.

Dispersal, Reproductive Success, and Habitat Use by Translocated Lesser Prairie-Chickens

Investigator
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Project Supervisor
Dr. David Haukos

Funding
Kansas Department of Wildlife and Parks

Colorado Parks and Wildlife

Cooperators
Kansas Department of Wildlife and Parks
Kent Fricke
Kraig Schultz

Colorado Parks and Wildlife:
Liza Rossi
Jonathan Reitz

Objectives
Restore long-term persistence and distribution of LEPC within the Sand Sagebrush Ecoregion

Assess the feasibility of translocations as a management tool for restoring LEPC populations

Location
Capture sites: Gove, Lane, Ness, and Finney Counties of NW Kansas

Release sites: Morton and Baca Counties of SW Kansas and SE Colorado

Completion
August 2020

Status
Completed

Results
The U.S. Forest Service Cimarron and Comanche National Grasslands in southwestern Kansas and southeastern Colorado were strongholds of the lesser prairie-chicken historic range. However, grazing practices on the grasslands, coupled with several years of intense winters and severe drought, led to their near extirpation by 2013. Since then, increased precipitation and a new management plan were believed to have restored lesser prairie-chicken habitat in these areas. In an attempt to restore and bolster populations in the Sand Sagebrush Ecoregion, state agencies translocated 411 lesser prairie-chickens to the U.S. Forest Service Cimarron and Comanche National Grasslands during 2016-2019. Of these lesser prairie-chickens, 279 were marked with VHF radiotransmitters and 115 were marked with SAT-PTT GPS transmitters to track their survival, movements, habitat use, and nest locations.

We estimated the nest success of lesser prairie-chickens translocated to the National Grasslands using Program MARK and determined which factors were most important in predicting nest success. We found that the number of years that had elapsed since the bird's release was the best predictor of its nesting success in any given year, indicating that a first-year effect may be suppressing the nest success of newly translocated birds. This fits with existing literature on grouse translocations, which state that translocation effects dissipate in years following release. Unfortunately, only 10.3% of translocated birds survived into the second year to take advantage of the increased nest success rate.

We measured visual obstruction and vegetation composition on the National Grasslands and nearby Conservation Reserve Program (CRP) grasslands to quantify the amount of nesting habitat available for released birds. Our objectives were to 1) determine whether extant vegetation on the National Grasslands would be used by lesser prairie-chickens and 2) determine if the implemented management plan had restored nesting habitat for lesser prairie-chickens. In regard to habitat use, we found that all 7 cover types on the Cimarron National Grassland and 2 of 3 cover types on the Comanche National Grassland were avoided in favor of selection for nearby CRP grasslands. Avoided cover types included areas of sand sagebrush prairie, which formerly hosted dozens of lesser prairie-chicken leks and seems to indicate a perceived deficiency in these cover types. Nesting was also rare on the National Grasslands, with a low rate of nesting in these areas (Cimarron: 33.3% of nests; Comanche: 26.9% of nests) compared to nearby CRP (KS CRP: 54.4% of nests; CO CRP: 71.2% of nests) despite similar area on the landscape (Cimarron: 43,416 ha; KS CRP: 31,218 ha;

Comanche: 22,020 ha; CO CRP: 31,218 ha). This low rate of nesting can be explained by a low occurrence of nesting habitat in these cover types, as only a small portion of observations on the National Grasslands recorded high value grass species (Cimarron: 1.3%-17.7% of observations within each cover type; Comanche: 1.5%-1.7%) or met visual obstruction guidelines (Cimarron: 5.3%-21.8% of observations within each cover type; Comanche: 1.5%-3.0%). The current lack of habitat on the National Grasslands is problematic, as lesser prairie-chickens depend on >63% of the landscape being grassland to reach a viable population size. Neither of the counties in which translocated lesser prairie-chickens were released (Morton, KS: 17.7% CRP; Baca, CO: 16.6% CRP) can reach this statistic with CRP grassland alone. Efforts to restore lesser prairie-chicken nesting habitat (e.g., vegetation composition and structure) on the National Grasslands are therefore likely vital to future occupancy by lesser prairie-chicken populations.

Finally, our analysis of lesser prairie-chicken movement after release showed extensive dispersal away from the release site, with 99% of birds undergoing a dispersal movement >5 km from the release site. We conducted a behavioral change point analysis on translocated birds as they dispersed to determine where they settled down and how long their dispersal lasted. Birds moved an average of 144 km during their 1-2 month dispersal movement following release. Despite the presence of leks and habitat at the release sites, 69% of released birds settled >5 km from their release site after their movements. These results indicate that dispersal is an innate response to translocation, and release site placement will not be sufficient to minimize the dispersal movement.

Products

Publications

Berigan, L.A., C.S.H. Aulicky, E.C. Teige, D.S. Sullins, D.A. Haukos, K.A. Fricke, J.H. Reitz, L.G. Rossi, K.A. Schultz, and A.M. Ricketts. 2022. Lack of lesser prairie-chicken nesting habitat impairs translocation success. Wildlife Society Bulletin *In Press*

Professional Presentations

Berigan, L., D. Haukos, D. Sullins, and K. Fricke. 2018. Lesser prairie-chicken translocation: minimizing dispersal to ensure translocation success. Kansas Natural Resources Conference, Manhattan, Kansas.

Berigan, L., D. Sullins, D. Haukos, K. Fricke, J. Reitz, L. Rossi, and K. Schultz. 2018. Translocation of lesser prairie-chickens: does lek presence limit dispersal? Annual Meeting of The Wildlife Society, Cleveland, Ohio.

Berigan, L., D. Sullins, D. Haukos, K. Fricke, J. Reitz, L. Rossi, and K. Schultz. 2018. Role of natal habitat preference induction in prairie-grouse translocation success. International Grouse Symposium, Logan, Utah.

Berigan, L., C. Aulicky, and D.A. Haukos. 2019. Avoidance of traditional habitat types by translocated lesser prairie-chickens. Annual Conference of oSTEM, Houston, Texas.

Berigan, L., C. Aulicky, D. Sullins, D. Haukos, K. Fricke, J. Reitz, L. Rossi, and K. Schultz. 2019. Overcoming post-release dispersal to successfully translocate lesser prairie-chickens. Annual Meeting of The Wildlife Society, Reno, Nevada.

Berigan, L., C. Aulicky, D. Sullins, D. Haukos, K. Fricke, J. Reitz, L. Rossi, and K. Schultz. 2019. Landscape composition explains high rates of dispersal in translocated lesser prairie-chickens. Annual Meeting of the American Ornithological Society, Anchorage, Alaska.

Berigan, L., C. Aulicky, D. Sullins, D. Haukos, K. Fricke, J. Reitz, L. Rossi, and K. Schultz. 2019. Conservation implications of lesser prairie-chicken habitat selection on the Cimarron National Grasslands. Kansas Natural Resource Conference, Manhattan, Kansas.

Berigan, L., C. Aulicky, E. Teige, D. Sullins, D. Haukos, K. Fricke, J. Reitz, L. Rossi, and K. Schultz. 2019. Dispersal, habitat use, and eventual settlement of translocated lesser prairie-chickens. 33rd Biennial Meeting of the Prairie Grouse Technical Council, Bartlesville, Oklahoma.

Thesis

Berigan, L. 2019. Dispersal, reproductive success, and habitat use by translocated lesser prairie-chickens. Thesis, Kansas State University, Manhattan.

Landscape Patterns Contributing to Lek Establishment and Morphometrics of Attending Lesser Prairie-Chickens

Investigators
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Project Supervisor
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Funding
Kansas Department of Wildlife, Parks and Tourism

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Objectives

Assess morphological patterns across the lesser prairie-chicken range, and determine the influence of environmental and landscape factors

Status
Completed

Results

The lesser prairie-chicken (*Tympanuchus pallidicinctus*) is a lek breeding species. As with other lek breeding species, lesser prairie-chicken habitat use can be characterized by differences in paternal care. Male lesser prairie-chickens leks in areas of short vegetation while females prioritize vegetation structure with cover for nests and broods. As nonmigratory grassland obligates, despite differences in habitat utilization, both lesser prairie-chicken sexes spend their annual cycle closely associated with lek locations. Current lesser prairie-chicken management relies on lek counts to estimate population size and conservation strategies assume leks form according to the hotspot hypothesis in areas of female home range overlap.

The density of leks on the landscape is dynamic, changing between breeding seasons and even within a breeding season. Short grass suitable for lek formation is also not limiting, raising questions about how males select where to form leks and what determines if a lek persists into subsequent breeding season. As lek density provides the best estimation of prairie-grouse populations, understanding mechanisms of lek formation a conservation issue.

The need to understand lesser prairie-chicken lek dynamics is exasperated by the conversion of native grasslands to row-crop agriculture and declining habitat quality. Lesser prairie-chickens require 486-20,234 ha of grassland, with a both short vegetation structure for male lek displays and sufficient vegetation height and visual obstruction for nesting and brooding to complete. In addition to understanding how lesser prairie-chicken breeding constraints determine their use of available grasslands, questions regarding changes to physiological attributes across the lesser prairie-chicken range are needed to supplement investigations of behavior.

The lesser prairie-chicken range is comprised of harsh environments, where precipitation strongly influences availability of resources and is a determinant of lesser prairie-chicken population density and occupied range, which boom-bust in response to weather. The contemporary lesser prairie-chicken range is divided among four ecoregions, the Short-Grass Prairie/CRP Mosaic, Sand Sagebrush Prairie, Mixed-Grass Prairie, and Sand Shinnery Oak Prairie across Colorado, Oklahoma, Texas, New Mexico, and Kansas. Across these four ecoregions, runs a ~40 cm gradient with average annual precipitation running from east (70 cm) to west (43 cm) and growing season averaging from 220 in the southern and 160 days in the northern portions of the range. The High Plains have intensive droughts every 5-10 years, which drives boom-bust pattern in lesser prairie-chicken population demography and large-scale droughts occur almost every 20 years.

Lesser prairie-chickens of each ecoregion may adapt and react differently to weather and resource stress. Because the lesser prairie-chicken is a boom-bust species largely affected by precipitation, the number of surviving individuals and past periods of drought may strongly influence current morphological phenotype across the range. Furthermore, morphometric characteristics can reflect available resources (i.e., habitat quality) during periods of growth, and patterns in morphometric traits may reflect morphological phenotypes that are better suited to times of food stress.

To address the questions about lesser prairie-chicken lek dynamics and morphometrics, my research drew upon data from across the lesser prairie-chicken range from a variety of lesser prairie-chicken projects. Researchers trapped lesser prairie-chickens on leks on variation of morphological traits

Test spatial hypotheses underlying mechanisms for the formation of leks using lesser prairie-chicken data

Identify factors that determine the persistence of a lek into a subsequent breeding season

Assess the formation and persistence of lek at translocation release sites and compare to dynamics of leks for non-translocated males

Location:
Kansas, Colorado, New Mexico, Texas, and Oklahoma

Completion:
August 2020

using funnel traps, drop nets, and rocket nets during spring 1986-2019. I used the entirety of the study period for my range-wide morphometric analyses, which comprised a data set of 555 in Short Grass, 1195 Mixed Grass, 88 Sand Sagebrush, and 641 Sand Shinnery Oak records of birds measured in each ecoregion. I employed lek vegetation measurements and satellite telemetry data from females (n=72) captured in the Short Grass and Mixed Grass prairie of Kansas from 2013-2019 in my analyses regarding lek formation and persistence.
My morphometric analyses focused on lesser prairie-chicken morphometrics commonly collected across the range, which range include mass, wing lengths, pinnae lengths, tail lengths, and tarsus lengths. Additionally, I used body mass as a proxy for energy reserves and estimated fat and protein composition based on the mathematical relationship between bird mass and fat and protein composition for lesser prairie-chicken determined by Haukos et al. (1989). I determined grams of fat and protein for 969 adult male, 648 juvenile male, 243 adult female, and 477 juvenile records. I incorporated the Palmer Drought Severity Index (PDSI) to explore the relationship between weather events and lesser prairie-chicken morphology.
I tested the hotspot hypothesis and lek persistence using 53 lek locations across three Kansas field sites and 165 estimated female lesser prairie-chicken home ranges. I examined shifts in female space use from GPS telemetry point locations with an optimized hotspot analysis by study year as a test of the hotspot hypothesis I tested female density, surrounding nesting and brooding habitat, and changes to vegetation at lek sites to determine what factors influence the persistence of a lek from one breeding season to the next.

My results indicate that leks form in locations with high overlap of female home ranges, consistent with the hotspot hypothesis. Female satellite locations in the year prior influence both lek stability and formation in the subsequent breeding season (Fig 1). Where hen movements are concentrated prior to a breeding season are areas where new leks form and, in areas that have decreasing space use, leks either shrink or disappear.

Female space use also determines lek persistence at broad scales. Within 1-5km of a lek, persistence is determined by both the female space use from the previous year and the percent of surrounding grassland surrounding the lek. The number of female satellite locations increases with the percent of grassland around leks, and together percent grassland and female utilization drives stability or increased numbers in male counts. This continues at broader scales (10km), where surrounding landcover is the greatest determinant of lek persistence.

At a small scale, the number of neighboring leks within a 1km buffer is also a determining factor in lek persistence. At the level of individual lek, visual obstruction is the biggest determinant of persistence up to 40m from the lek center. The percent of horizontal grass cover up to 40m from lek center has a positive relationship with observed male max counts.

My work illustrates that lesser prairie-chicken lek dynamics are largely determined by hen movements overtime. New leks and increased maximum male counts follow shifts in female movements from the previous year, and leks that shrink or disappear do so with the corresponding decrease in female space use. Female movements are determined by the availability of grassland and the surrounding percentage of grassland landcover has a positive interaction of leks with percent grassland at all scales (Fig 2). At the lek scale, visual obstruction is the greatest determinant of male numbers from year to year.

The relationship between lek formation and female space has management implications. Since lek dynamics are driven by female lesser prairie-chickens, increasing grassland vegetation structure suitable to female nesting is more important to lek longevity and the formation of new leks than trying to maintain existing lek vegetation. Managing for short vegetation suitable for lek formation may assisting in keeping an active lek in the same area, but it cannot provide persisting lesser prairie-chicken leks without nesting habitat and female utilization in the surrounding 2-5km. This is also evident in the substantial number of lesser prairie-chickens leks in crops where the vegetation is sufficiently short and there are sufficient female locations. The positive interaction of leks with percent grassland at all scales (1-10km) despite whether or not a lek is placed in grassland habitat or cropland, is likely a larger reflection of female habitat needs.

A second important consideration is that these findings indicate that female lesser prairie-chickens are the dispersing sex, which suggests that efforts to connect populations of lesser prairie-chickens should concentrate on facilitating the movements of hens.

My research on range wide patterns in lesser prairie-chicken morphometrics indicates that ecoregion specific and age and sex morphometric differences are tied to the Great Plains drought cycle, which is largely driven by temperature and precipitation over the summer months. Previous summer precipitation has a lag effect on morphometric traits throughout all four ecoregions regardless of where they fall within the east-west precipitation gradient. Mixed Grass and Sand Shinnery Oak prairie share morphometric patterns following periods of summer drought, despite falling at opposite ends of the temperature and precipitation gradient. This suggests that allocation of resources during periods where access is likely limited is universal across the lesser prairie-chicken range.

Across all four ecoregions, it is especially notable that adult female lesser prairie-chicken morphometric traits are relatively fixed and unresponsive to changes to temperature or precipitation across all four ecoregions. However, the proceeding summer's weather does affect the traits of juvenile females. This age specific difference in influence of weather effects may be related to differences in resource allocation between juvenile and adult birds. Juvenile development necessitates allocation of resources to both fixed and annually replaced morphometric traits, while adult birds allocate resources to maintenance of feathers during molt or body mass.

Within the morphometric suite of body mass, wing chord, pinnae length, tail length, and tarsus length, body mass explains up to 95% of morphometric variation among ecoregions. This variation in mass is driven by the lower masses of lesser prairie-chickens in the Mixed Grass ecoregion, which typically have smaller morphometric characteristics than birds of the other three ecoregions within the range. The largest lesser prairie-chickens in the range are often Short Grass and Sand Shinnery Oak birds, with Sand Shinnery Oak birds exhibiting larger tarsus lengths than birds in other ecoregions and larger morphometrics of the Short Grass prairie driven by females. This suggests a selective pressure acting to increase the size of morphometric attributes in Short Grass prairie that may be distinct from climatic pressures of the Sand Shinnery Oak prairie birds.

Feather traits are subject to annual development, reflecting the access to resources prior and during the periods of their growth and for lesser prairie-chickens they also reflect differences in allocation of sexually selected traits. For female lesser prairie-chickens, feather lengths for tail and pinnae decrease after periods of extreme moisture and severe drought. However, male lesser prairie-chickens exhibit longer tail and pinnae lengths after proceeding summers of moderate to extreme drought or extreme moisture. As a sexually selected characteristic, pinnae and tail length may be an important indication of male quality after extreme weather events and may act as an important signal to distinguish healthy males from others on a lek. The sexually selected feather lengths of male lesser prairie-chickens can be juxtaposed with juvenile tarsus lengths. Tarsus lengths are a fixed feature mirroring the available resources at the time of development. Juvenile male and female lesser prairie-chickens that develop during years of drought are smaller than birds that develop in periods of normal or greater precipitation.

Out of all the morphometric characteristics considered, mass is the only one subject to rapid change. the tight constraint of female mass across ecoregions and lag Palmer Drought Severity Index conditions is a striking in comparison to the fluctuation within male mass. The constraint in female mass is likely constraints associated with the breeding season and the strong division of reproductive effort in lesser prairie-chickens as a lek breeding species. The sexually dimorphic constraint in mass is reflected in the differences in nutrient reserves, where percent body fat that is tightly constrained across lag Palmer Drought Severity Index influence and ecoregion with 8% fat for females and 2-3% in males (Fig 3).

It is intuitive to assume that breeding season nutrient reserves will have an influence on nesting outcomes. The tight percentage of breeding season body fat in hens across drought and wet years, alludes to a biological constraint on fat required to successfully breed. However, my analyses found no support for a morphometric influence on nest survival Perhaps this percentage of body fat is a determinant of the ability of hens to breed, however, hen nutrient reserves are not a significant determinant of nest survival for first nests. With increasingly dramatic climatic swings in a species range that is prone to drought every 5-10 years it is unclear what this will mean for the ability of hens to maintain ~8% body fat prior to nesting across the precipitation gradient.

As the easternmost ecoregion within the lesser prairie-chicken range, Mixed Grass prairie has the most consistent annual Palmer Drought Severity Index and the greatest amount of precipitation. Despite the increased precipitation, the influences of lag summer Palmer Drought Severity Index values on Mixed Grass prairie lesser prairie-chicken morphometric traits follows the much more dynamic drought cycles of the Sand Shinnery Oak and Short Grass prairies. Morphometric response to drought is essentially uniform across the lesser prairie-chicken range, regardless of the potential buffering effects of a more consistent annual average precipitation or greater annual rainfall than the other three ecoregions in the range. Even within the Mixed Grass ecoregion it is uncertain if lesser prairie-chickens will be able to maintain nutrient reserves to breeding constraints with increasing propensity for drought and erratic precipitation events across the Great Plains.

Together, patterns of male morphological plasticity and relatively fixed female morphology is indicative of sexual selection and breeding constraints by sex acting to shape morphological traits in the lesser prairie-chicken across the range despite some differences in size among ecoregions. As a management tool, morphometrics offer a time-capsule of selective influences on birds throughout the range that can be utilized to understand implications of changes to those selective pressures. Management can make inferences about resource access available during growth based on the size of tarsus lengths, seasonal influences in wing lengths, and rapid response in changes in bird mass. Furthermore, changes to the constrained ranges of adult female morphometric traits could act as important signal of massive underlying change in future management that would be overlooked without collecting and examining morphometric traits.

Products

Professional Presentations

Aulicky, C., and D. Haukos. 2018. Testing the hotspot hypothesis: lesser prairie-chickens lek formation and female space use. International Grouse Symposium, Logan, Utah.

Aulicky, C., and D. Haukos. 2018. What can we learn from morphology? A study of the lesser prairie-chicken (Tympanuchus pallidicinctus) in Kansas. Kansas Natural Resources Conference, Manhattan, Kansas.

Aulicky, C., and D.A. Haukos. 2018. What the lek: testing the hotspot hypothesis. Annual Conference of oSTEM, Houston, Texas.

Aulicky, C., D. Haukos, and K. Fricke. 2018. Not just dusty data: what can we learn from range-wide analyses of lesser prairie-chicken morphology? Annual Meeting of The Wildlife Society, Cleveland, Ohio.

Aulicky, C., and D. Haukos. 2019. Size matters: effects of climate on lesser prairie-chicken body size. Annual meeting, oSTEM, Detroit, Michigan. Poster

Aulicky, C., and D. Haukos. 2019. Testing the Hotspot Hypothesis: lesser prairie-chicken lek formation and female space use. Annual Meeting of The Wildlife Society, Reno, Nevada.

Aulicky, C., and D. Haukos. 2019. Testing the hotspot hypothesis: lesser prairie-chicken lek formation and female space use. Annual Meeting of the American Ornithological Society, Anchorage, Alaska.

Aulicky, C., and D.A. Haukos. 2019. Testing the hotspot hypothesis: lesser prairie-chicken lek formation and female space use. Kansas Natural Resource Conference, Manhattan, Kansas.

Aulicky, C.S.H., and D.A. Haukos. 2019. Not just dusty data: what can we learn from range-wide analyses of lesser prairie-chicken morphology? 33rd Biennial Meeting of the Prairie Grouse Technical Council, Bartlesville, Oklahoma.

Aulicky, C., and D. Haukos. 2020. Lesser prairie-chicken lek formation, lek persistence, and female space use. Annual Meeting of The Wildlife Society, Louisville, Kentucky.

Aulicky, C., and D. Haukos. 2020. What determines lesser prairie-chicken lek persistence? Kansas Natural Resource Conference, Manhattan, Kansas.

Dissertation

Aulicky, C. 2020. Lek dynamics and range-wide morphometric patterns of lesser prairie-chickens. Dissertation, Kansas State University, Manhattan.

Assessment of Lesser Prairie-Chicken Translocation through Survival, Space Use, and Resource Selection

Investigators
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Funding
Kansas Department of Wildlife and Parks

Colorado Parks and Wildlife

Cooperators
Kansas Department of Wildlife and Parks

Colorado Parks and Wildlife

USDA Forest Service

Objectives
Assess the feasibility of translocations as a management tool for restoring LEPC populations through survival and lek counts

Determine nest site selection and survival of translocated LEPC and compare to non-translocated

Status
Completed

Results
Translocation is defined as the deliberate movement of organisms from one site to another where the main objective is a conservation benefit. Translocations are used frequently as a management tool to restore or augment wildlife populations but generally have varying degrees of success. The lesser prairie-chicken (*Tympanuchus pallidicinctus*) is found in the southwestern Great Plains of the United States and currently occurs in four distinct ecoregions (Short-Grass Prairie/CRP Mosaic, Mixed-Grass Prairie, Sand Sagebrush Prairie, and Sand Shinnery Oak Prairie) across five states (Kansas, Colorado, Oklahoma, Texas, and New Mexico, USA). Recent estimates suggest the lesser prairie-chicken currently occupies only 15% of their estimated historical range.

Within the current occupied range, lesser prairie-chicken populations have been experiencing moderate to severe population declines. Since a contemporary peak of an estimated 150,000 birds in the mid-1980s, lesser prairie-chicken populations have declined to an estimated abundance of 34,408 in 2020. The largest contemporary decline in population abundance and occupied range is occurring in the Sand Sagebrush Prairie Ecoregion. Historically, the Sand Sagebrush Prairie Ecoregion was the epicenter of the lesser prairie-chicken population despite a large area of vegetation in the ecoregion being decimated during the Dust Bowl of the 1930s. In 2020, only 171 birds were estimated for the ecoregion. In response to the extreme population decline and elevated extinction risk for the lesser prairie-chicken population in the Sand Sagebrush Prairie Ecoregion, myself, along with the Kansas Department of Wildlife and Parks, Colorado Parks and Wildlife, and U.S. Forest Service translocated lesser prairie-chickens from the Short-Grass Prairie/CRP Mosaic Ecoregion in northwest Kansas, where lesser prairie-chickens are currently most abundant, to release sites in sand sagebrush prairie landscapes on the U.S. Forest Service, Cimarron and Comanche National Grasslands in southwestern Kansas and southeastern Colorado, respectively.

We captured, marked, translocated, and monitored 411 lesser prairie chickens during spring 2016-2019 to understand how translocation affects demographic rates, space use, and habitat selection for assessing translocation as a conservation tool for this declining prairie-grouse. My objectives were to estimate lek counts, nest success, reproductive success, adult survival, home range establishment and land cover composition, and selection of habitat vegetation characteristics at local and broad scales to assess lesser prairie-chickens response to translocation in a novel landscape.

Within two weeks of release, 22.8% of birds either died or were never located.
I used known-fate and nest survival models in Program MARK to determine adult survival and nest success of lesser prairie-chickens. I estimated breeding season survival for both males and females to be 0.44 ± 0.02 (SE) and nest success as 0.37 ± 0.04 (SE) but with a declining trend for the entire study period (2017-2020). Overall, vital rates were average to low and male high counts on established lek started to decline in 2021, two years following active translocation. Habitat availability in a

Evaluate space use of translocated LEPC and compare the results to non-translocated LEPC

Calculate resource selection of translocated LEPC and compare to non-translocated LEPC

Location:
Capture site: Gove, Lane, Ness, and Finney Counties of NW Kansas

Release sites: Morton and Baca Counties of SW Kansas and SE Colorado

Completion:
August 2021

novel environment may become an increasing concern as translocated lesser prairie-chickens have consistently larger home ranges than their native counterparts.

Home ranges of translocated birds was comprised of greater area of Conservation Reserve Program land than any other cover type on the landscape. Lastly, on a local scale (300 m), I found little selection for vegetation at used locations, but lesser prairie-chickens used thicker and taller cover for nest sites. This vegetation use was expected and conveys the importance of the vegetation structure needed at a translocation release site. My results highlight the importance of land management conservation and its role in the conservation of lesser prairie-chicken populations. The translocation may have some short-term success but current vital rates of lesser prairie chickens may not be enough to overcome inherent limiting factors of the ecoregion for the population to become self-sustaining and the translocation to be deemed a long-term success.

Products

Publications

Teige, E.C., N.J. Parker, M.P. Vhay, and D.A. Haukos. 2022. Durability and longevity of *Tympanuchus pallidicinctus* (Lesser Prairie-Chicken) fence tags in Kansas and Colorado. Ecological Restoration 40:83-87.

Teige, E., N. Parker, M. Vhay, and D. Haukos. 2021. Evaluation of the durability and longevity of lesser prairie-chicken fence tags in Kansas and Colorado. Grouse News 61:14–20.

Professional Presentations

Teige, E., L. Berigan, C. Aulicky, D. Haukos, K. Fricke, J. Reitz, L. Rossi, and K. Schultz. 2021. After the dust settles: survival, space use, and resource selection of translocated lesser prairie-chickens. Annual Conference of The Wildlife Society (virtual).

Teige, E., L. Berigan, C. Aulicky, D. Haukos, K. Fricke, J. Reitz, L. Rossi, and K. Schultz. 2021. Habitat space use of translocated lesser prairie-chickens to the Sand Sagebrush Prairie Ecoregion. Midwest Fish and Wildlife Conference, virtual.

Teige E.C. Lesser Prairie-chicken response to translocation to southwestern Kansas and southeastern Colorado. Kansas Ornithological Society. Virtual 2021. (Oral Presentation)

Teige, E., L. Berigan, C. Aulicky, D. Haukos, K. Fricke, J. Reitz, L. Rossi, and K. Schultz. 2020. Assessing the role of translocation in lesser prairie-chicken conservation. Annual Meeting of The Wildlife Society, Louisville, Kentucky.

Teige, E., L. Berigan, C. Aulicky, D. Haukos, K. Fricke, J. Reitz, L. Rossi, and K. Schultz. 2019. A new hope: monitoring the effectiveness of lesser prairie-chicken translocation in the Sand Sagebrush Ecoregion of southwestern Kansas and southeastern Colorado. Annual Meeting of The Wildlife Society, Reno, Nevada.

Teige, E., L. Berigan, C. Aulicky, D. Haukos, K. Fricke, K. Schultz, J. Reitz, and L. Rossi. 2020. Where do they go? Lesser prairie-chicken space use following translocation to the Sand Sagebrush Prairie Ecoregion. Kansas Natural Resource Conference, Manhattan, Kansas.

Teige, E.C., L.A. Berigan, C.S.H. Aulicky, D.A. Haukos, K. Fricke, K. Schultz, J. Reitz, and L. Rossi. 2019. Assessing a lesser prairie-chicken translocation in the sand sagebrush prairie ecoregion. 33rd Biennial Meeting of the Prairie Grouse Technical Council, Bartlesville, Oklahoma.

Thesis

Teige, E. C. 2021. Assessment of lesser prairie-chicken translocation through survival, space use, and resource selection. Thesis, Kansas State University, Manhattan, USA.

Lesser Prairie-Chicken Response to Patch-Burn Grazing

Investigators
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Project Supervisor
Dr. David Haukos

Funding
WAFWA, NRCS
LPCI, KSU

Cooperators
Kansas Department of Wildlife and Parks

Objectives

Measure effects of cattle space use intensity on vegetative structure and composition within multiple grazing systems

Assess effects of cattle space use and subsequent vegetation response on lesser prairie-chicken space-use and home ranges during key life stages

Investigate characteristics of female lesser prairie-chicken dispersal routes to determine what features affect dispersal at the landscape scale

Status
Completed

Results

The lesser prairie-chicken (*Tympanuchus pallidicinctus*) is a grassland obligate whose decline has been associated with anthropogenic fragmentation and land use change. Historical habitat drivers (i.e., natural fires and free roaming grazers) created vegetation heterogeneity across the species' range, providing resources for each of their life stages. Currently, most of the lesser prairie-chicken's eastern range consists of rangelands managed with confined continuous livestock grazing without fire as a disturbance. Lesser prairie-chicken habitat is also fragmented at larger scales, limiting dispersals and threatening genetic connectivity. A need exists to determine optimum landscape management that provides seasonal habitat at small scales, and allows for dispersal and metapopulation connectivity at large scales. My first objective was to determine the relationship between cattle distributions and lesser prairie-chicken habitat among patch-burn and rotationally grazed rangelands. My second objective was to determine differences in seasonal selection by female lesser prairie-chickens, relative to fine-scale cattle distributions on these two rangelands. My final objective was to determine movement patterns and resource selection of lesser prairie-chickens during dispersal. I tracked cattle (*Bos taurus*) and lesser prairie-chickens via satellite telemetry in patch-burn and rotationally grazed pastures to model their space use at fine scales. I estimated vegetation change along the resulting gradient of cattle distributions. I determined seasonal selection of lesser prairie-chickens relative to cattle distributions within each management treatment. I tracked GPS-tagged lesser prairie-chickens in the Mixed-Grass Prairie and Short-Grass Prairie/CRP Mosaic ecoregions and delineated dispersals. I used step selection analysis to determine differences in resource selection along each dispersal route. Year-of-fire patches drove cattle site-selection on patch-burn grazed rangelands, which created greater vegetation heterogeneity within pastures. Lesser prairie-chickens selected for different cattle densities during different life stages. On rotationally grazed pastures, lesser prairie-chickens selected for moderate cattle densities during breeding, moderate-to-high densities during post-breeding, and selected for the greatest fine-scale cattle densities during nonbreeding. Within the patch-burn grazed treatment, females avoided moderate cattle densities during breeding and post-breeding, and selected for the lowest cattle densities during nonbreeding. Patch-burn grazed pastures were more heterogeneous and contained greater forb abundance in areas with low cattle densities, which could create better brooding and post-breeding habitat near nesting habitat. In the Mixed-Grass Prairie Ecoregion, lesser prairie-chickens selected for lower tree densities and increased grassland cover at the landscape scale during dispersal. On the Short-Grass Prairie Ecoregion, lesser prairie-chickens avoided areas containing electrical transmission lines. During dispersal, young females traveled further and took longer

Location: Throughout southern, western, and central Kansas

Completion
May 2019

movement steps. Successful dispersals were also shorter distances than failed dispersals. Drivers of dispersal may be innate and could occur regardless of annual variation in local habitat; however, there is likely a fitness cost associated with increased dispersal length. Land-use alterations influenced habitat within home ranges and affected population connectivity by altering dispersals. Managers can benefit lesser prairie-chickens by altering grazing management to mimic historical drivers of habitat. Population connectivity could be increased by limiting electrical transmission line establishment along corridors in the Short-Grass Prairie Ecoregion and by removing trees and increasing grassland within the Mixed Grass-Prairie Ecoregion.

Products

Professional Presentations

Gulick, C., J. Lautenbach, and D.A. Haukos. 2017. Space use by cattle, and its cascading effects on lesser prairie-chicken habitat selection. Annual conference of The Wildlife Society, Albuquerque, NM.

Gulick, C., D. Haukos, and J. Lautenbach. 2018. Effect of grazing management systems on space use by cattle and lesser prairie-chickens. Annual Meeting of The Wildlife Society, Cleveland, Ohio.

Gulick, C., and D. Haukos. 2018. Spatial patterns of lesser prairie-chickens in response to different disturbance regimes. International Grouse Symposium, Logan, Utah.

Gulick, C., and D.A. Haukos. 2018. Factors affecting habitat availability for lesser prairie-chickens across different land management regimes. Kansas Natural Resources Conference, Manhattan, Kansas.

Gulick, C., and D.A. Haukos. 2019. Influence of grassland management systems on fine-scale distribution of lesser prairie-chickens and their habitat. Annual Meeting of the Society for Range Management, Minneapolis, Minnesota.

Gulick, C., and D.A. Haukos. 2019. Influence of landscape features on female lesser prairie-chicken dispersal routes. Kansas Natural Resource Conference, Manhattan, Kansas.

Gulick, C., J. Lautenbach, and D.A. Haukos. 2017. Space use by cattle, and its cascading effects on lesser prairie-chicken habitat selection. Annual conference of The Wildlife Society, Albuquerque, NM.

Gulick, C., D. Haukos, and J. Lautenbach. 2018. Effect of grazing management systems on space use by cattle and lesser prairie-chickens. Annual Meeting of The Wildlife Society, Cleveland, Ohio.

Thesis

Gulick, C. 2019. Spatial ecology and resource selection by female lesser prairie-chickens within their home ranges and during dispersal. Kansas State University.

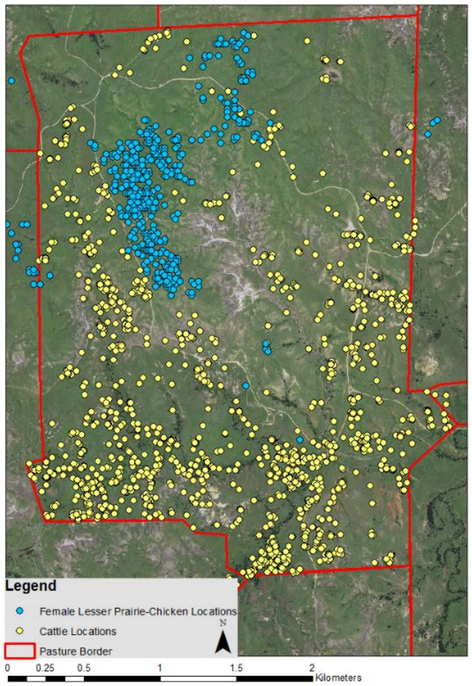

Figure 1: Cattle and female lesser prairie-chicken locations in a patch-burn grazed pasture

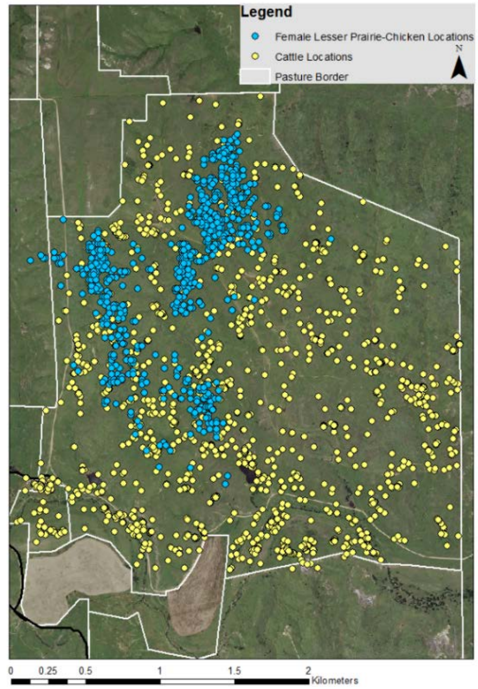

Figure 2: Cattle and female lesser prairie-chicken locations in a rotationally grazed pasture

Woody Species Mortality Following Megafire in the Mixed-Grass Prairie

Investigators
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Nick Parker
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Project Supervisor
Dr. David Haukos

Funding
NRCS

Kansas Department of Wildlife and Parks

Cooperators
Kansas Department of Wildlife and Parks

U.S. Fish and Wildlife Service

Objectives

Estimate tree canopy change due to the Starbuck wildfire from ground surveys and remote sensing techniques

Evaluate woody species conditions including rates of dead and top-killed plants following the Starbuck Fire.

Location:
Clark County, Kansas

Completion:
September 2020

Status
Completed

Results

The lack of fire in contemporary grasslands has contributed to the invasion of woody plants that resist mortality to fire upon reaching a certain size. Responses to fire by woody plants can vary by species, timing of fire, and fire intensity. Knowledge of intense megafires on mortality of trees in grasslands is limited, and examination of tree encroachment dynamics will help us better manage habitat for grassland obligate species like the lesser prairie-chicken (*Tympanuchus pallidicinctus* Ridgway) that avoid tall features on the landscape. We evaluated the effect of a 2017 megafire (>40,000 ha) on tree mortality within and around lesser prairie-chicken habitat in the mixed-grass prairie of Clark County, Kansas, USA. We used remote sensing techniques to estimate burn severity and tree canopy change. We also conducted ground surveys to assess the accuracy of postfire tree canopy estimates, measure additional aspects of woody and herbaceous species postfire condition, and examine the influence of herbicide and wildfire interaction on nonnative saltcedar (*Tamarix ramosissima* Ledeb.). Our results suggest that the severity of the megafire was low relative to forest fires with higher fuel loads, but killed 25 ± 39% (mean ± SD) of trees, including 100% of eastern redcedar (*Juniperus virginiana* L.). Another 53 ± 43% of trees were top-killed and resprouted. In plots where trees were detected before the fire, 99% had tall woody features >1 m a year and a half after the fire. This indicates that trees were damaged, but habitat for grassland obligate species may not have increased because of the fire. We conclude that further postfire management is required to limit woody encroachment and promote habitat for grassland obligate species.

Products

Publications

Sirch, M.W., D.S. Sullins, N.J. Parker, D.A. Haukos, J.D. Kraft, C.A. Hagen, and K.A. Fricke. 2022. Woody species mortality due to a megafire within the mixed-grass prairie. Prairie Naturalist *In Press.*

Professional Presentations

Sirch, M., D.S. Sullins, D.A. Haukos, and J.D. Kraft. 2018. Lesser prairie-chicken response to intensive wildfire: one year post wildfire. Annual Meeting of the Kansas Ornithological Society, Lawrence, Kansas.

Sirch, M.S., D.S. Sullins, D.A. Haukos, and J. Kraft. 2019. Influence of burn severity on tree mortality and lesser prairie-chicken habitat in the mixed-grass prairie. Kansas Natural Resource Conference, Manhattan, Kansas.

Figure 1. Photo points collected in Clark County, Kansas, on the Gardiner ranch in April 2017 (a month after the fire) and in the following October 2017. Photos on the left are from the same location and facing the same direction as photos on the right.

Lesser Prairie-Chicken and Grassland Response to Megafire in the Mixed-Grass Prairie

Investigators
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Project Supervisor
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Funding
Kansas Department of Wildlife and Parks

USDA Lesser Prairie-Chicken Initiative

Cooperators
Kansas Department of Wildlife and Parks

Objectives

Estimate effects of megafire on lesser prairie-chicken demography

Assess impacts of megafire on vegetation and the distribution, availability, and quality of lesser prairie-chicken habitat

Compare lesser prairie-chicken resource selection before and after megafire

Location:
Clark County, Kansas

Completion
July 2021

Status

Completed

Results

Fire is an ecological driver that historically interacted with grazing and periodic drought throughout large portions of the Great Plains to maintain grasslands used by several wildlife species. More recently, fire suppression, coupled with changing climate and landscapes, has led to altered grassland ecosystems that may be more likely to experience massive wildfire events known as megafires. Megafires (>40,000 ha) have extreme socioeconomic impacts and may also affect grassland-dependent wildlife including lesser prairie-chickens (*Tympanuchus pallidicintus*). The lesser prairie-chicken is a grouse species of the southern Great Plains that has experienced population declines since the 1980s, primarily as a result of grassland habitat degradation and loss. While fire has long functioned as an ecological driver to shape grassland habitat, knowledge about the influence of megafires on lesser prairie-chickens and their habitat is lacking. To better understand how remaining grasslands and lesser prairie-chickens may be impacted by megafire, I hierarchically evaluated lesser prairie-chicken survival, reproduction, resource selection, and habitat response to a 2017 megafire at a site inhabited by lesser prairie-chickens in the mixed-grass prairie of Kansas, USA (Starbuck fire, ~254,000 ha). I captured lesser prairie-chickens on leks during the spring before (2014–2015) and after (2018–2019) the fire, attached VHF radio and GPS satellite transmitters, and tracked individuals to evaluate survival, reproduction, and habitat selection. To estimate population trends, I conducted counts of male attendance on leks before and after the fire. There was a 67% decline in the number of attending males on leks post-fire and a 46% decline in the number of occupied leks post-fire. Despite the population decline indicated by lek counts, female breeding season adult survival remained similar before (0.63 ± 0.08) and after the fire (0.64 ± 0.08), as did chick survival (before: 0.27 ± 0.03; after: 0.32 ± 0.11), while nest survival trended lower post-fire (before: 0.42 ± 0.06; after: 0.27 ± 0.07). Individual space use was evaluated using 95% isopleth Brownian Bridge home ranges, and did not differ before (828 ± 110 ha) and after (719 ± 101 ha) the fire. However, home ranges included 5 times more percent cover of Conservation Reserve Program (CRP) fields after the fire compared to before, suggesting CRP/cropland landscapes with disjointed fire fuel availability can provide refugia during extreme events. An analysis of lek attendance corroborated home range results, with greatest male lek attendance in areas with more surrounding cropland post-fire, opposite of trends seen before the fire and lesser prairie-chicken literature. Step selection revealed lesser prairie-chickens strongly avoided wooded areas before and after the fire, indicating that although I did see mortality of woody species, burned woodlands did not become available for use by lesser prairie-chickens. Furthermore, lesser prairie-chickens avoided burned areas post-fire, suggesting limited habitat availability up to 3 years post-fire and emigration from the study site. My analysis of fine-scale habitat and grassland vegetation characteristics response supported a decrease in available cover, with a 32% decrease in 100% visual obstruction, 17% decrease in litter depth, and a 16% increase in bare ground. Based on vegetation criteria, abundance of nest habitat decreased 34% one year post-fire; however, nest habitat and many vegetation characteristics returned to pre-fire levels within two years post-fire, thanks in part to substantial growing season precipitation received in the years following the fire (>70 cm/year). The large size and intense nature of the fire affected lek attendance, habitat abundance, and nest survival, but had no lasting (>2 year) detrimental impacts for grasslands or lesser prairie-chicken habitat. Post-fire recovery of grasslands did not correspond with a rebounding population and it will likely take >3 years for lesser prairie-chickens to fully recolonize burned grasslands. My results indicate that multiple management strategies (e.g., CRP enrollment, post-fire removal of snags, prescribed fire) are needed to manage lesser prairie-chicken habitat and limit future megafires.

Products

Publications

Parker, N.J., D.S. Sullins, D.A. Haukos, K.A. Fricke, and C.A. Hagen. 2022. Recovery of working grasslands following a megafire in the southern mixed-grass prairie. Global Ecology and Conservation 36:e02142.

Parker, N.J., and D.S. Sullins. 2022. Grouse, grass and gargantuan fire: megafire may be a new threat to imperiled lesser-prairie chicken. Wildfire Magazine 32(2):*In press*.

Professional Presentations

Parker, N.J., D.S. Sullins, D.A. Haukos, K.A. Fricke, and C.A. Hagen. 2021. Lesser prairie-chicken space use following megafire in the mixed-grass prairie. The Wildlife Society Annual Conference, Virtual. (Oral presentation)

Parker, N.J., D.S. Sullins, D.A. Haukos, K.A. Fricke, and C.A. Hagen. 2021. Lesser prairie-chicken survival and space use after megafire in the mixed-grass prairie. Kansas Ornithological Society Meeting, Virtual. (Oral presentation)

Parker, N.J., Sullins, D.S., Haukos, D.A., Fricke, K.A., Hagen, C.A., Influence of a megafire on lesser prairie-chicken habitat use and quality in the mixed-grass prairie. Kansas Natural Resources Conference. Manhattan, KS. 2020. (Oral Presentation)

Parker, N.J., Sullins, D.S., Haukos, D.A., Fricke, K.A., Hagen, C.A., Lesser prairie-chicken and grassland response following intense wildfire in Kansas. 33rd Meeting of the Prairie Grouse Technical Council. Bartlesville, OK. 2019. (Oral Presentation)

Parker, N.J., Sullins, D.S., Haukos, D.A., Fricke, K.A., Hagen, C.A., Rising from the ashes? Lesser prairie-chicken and grassland response to intense wildfire in Kansas. American Fisheries Society and The Wildlife Society Joint National Conference. Reno, NV. 2019. (Poster)

Thesis

Parker, N. 2021. Lesser prairie-chicken demography, resource selection, and habitat response following megafire in the mixed-grass prairie. Thesis, Kansas State University, Manhattan.

How Spatial Heterogeneity Surrounding Leks Drives Lek Attendance by Lesser Prairie-Chickens

Investigators
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Funding
Kansas Department of Wildlife and Parks

USDA Natural Resources Conservation Service, Lesser Prairie-Chicken Initiative

Cooperators
Kansas Department of Wildlife and Parks

USDA Natural Resources Conservation Service, Lesser Prairie-Chicken Initiative

Objectives

Examine vegetation characteristics at two spatial scales from the lek, the micro-habitat 100-m and lek landscape (5-km) scales, to assess which vegetation characteristics drive lek attendance.

Quantify the presence and juxtaposition of nesting and brooding habitat across the northern portion of the Lesser Prairie-chicken range.

Assess the impact that potential brooding and nesting habitat surrounding leks have on lek attendance, especially by males, as described in the hotspot hypothesis

Status
Completed

Results

Contemporary lesser prairie-chicken populations have been on the decline since the mid-1980s. In response to these declines, the lesser prairie-chicken was briefly listed as threatened under the Endangered Species Act and numerous conservation efforts were launched to restore population abundance. Despite these measures, status of local populations remain uncertain. To better understand the cause of such dramatic population changes, perhaps we need to re-examine the understanding of reproductive habitat requirements to sustain a lesser prairie-chicken population. There have been many papers published that report the vegetative structure and location of successful nests as well as successful brood-rearing areas, but there is a gap in the literature on describing characteristics of successful leks in context of requirements to support the entire reproductive ecological state. To fill this knowledge gap while also addressing the issue of declining lesser prairie-chicken populations, we need to define drivers of lesser prairie-chicken lek site selection within the context of other reproductive requirements (i.e., nesting and brooding) that contributes to recruitment. Based on the literature, we quantified nesting habitat as points that have bare ground between 0-20% cover and average visual obstruction reading (VOR) at 75% coverage between 1.5-3.5 dm tall. Brooding habitat was defined as points that have 50% cover VOR readings between 2-5 dm, and forb cover within one standard deviation of the average between 7%-37%.

In effort to assess drivers of lek attendance, we found a strong correlation between lek attendance and VOR readings at the 5-km scale. We found that leks experienced highest attendance by both sexes when VOR readings at 75% coverage were between 1-2 dm which also falls within the desired VOR for suitable nesting habitat. When quantifying nesting and brooding habitat surrounding leks, we discovered that within all sites, 29.64% of locations within 5 km of a lek were available quality nesting habitat and 24.56% were available brooding habitat. Gove County in northwest Kansas had the most available nesting sites at 34.74% with Red Hills having the second most at 33.63%. Red Hills had the most available brooding sites at 32.98%. When assessing how these results affect lek attendance, we found that leks within the Red Hills study site experienced the most attendance with an average daily attendance of 12 birds. This supports the claim that birds are attend leks because of surrounding vegetation, specifically that which supports the nesting and brooding stages of reproductive ecology.

Location:
Throughout Kansas and eastern Colorado

Completion
August 2018

Products

Publications

Gehrt, J.M., D.S. Sullins, and D.A. Haukos. 2020. Looking at the bigger picture: how abundance of nesting and brooding habitat influences lek-site selection by lesser prairie-chickens. American Midland Naturalist 183:52-77.

Professional Presentations

Gehrt, J.A., D.S. Sullins, and D.A. Haukos. 2018. Looking at the bigger picture: how availability of nesting and brooding habitat influences lek-site selection by lesser prairie-chickens. Annual Meeting of The Wildlife Society, Cleveland, Ohio.

Intrinsic and Extrinsic Drivers of Home Range Area, Daily Displacements, and Long-Distance Movements of Lesser Prairie-Chickens

Investigators
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Project Supervisor
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Funding
Kansas Department of Wildlife and Parks

United States Department of Agriculture (USDA) Farm Services CRP Monitoring, Assessment, and Evaluation

USDA Natural Resources Conservation Service, Lesser Prairie-Chicken Initiative

Cooperators
Kansas Department of Wildlife and Parks

U.S. Fish and Wildlife Service

U.S. Department of Agriculture

Great Plains LCC

Objectives
Estimating home range areas and daily displacements by female lesser prairie-chickens at four sites in Kansas and Colorado to improve our understanding of breeding season space use in the three northernmost occupied ecoregions

Comparing home range areas and daily displacements among study sites and breeding stages to test the relative effects of extrinsic site

Status

Completed

Results

Grassland ecosystems in the conterminous United States have experienced large-scale declines since European settlement, which have led to habitat loss and fragmentation for many wildlife species. Lesser prairie-chickens (*Tympanuchus pallidicinctus*) have been especially affected, as their occupied range and population numbers have declined by ~90%. An important consideration in the conservation and management of Lesser prairie-chickens is an assessment of space estimated by home range areas and daily movements during the breeding season. Unfortunately, available estimates are largely limited to one of the four currently occupied ecoregions, and large spatial variation in landscape fragmentation, and vegetative structure and composition complicates management of the species. Management of lesser prairie-chickens is further complicated because habitat needs vary among the lekking, nesting, brooding, and post-breeding stages of the breeding season. Although breeding stage-specific habitat requirements of breeding stages have been previously described, home ranges and movements of female lesser prairie-chickens during these stages remains relatively unclear.

During 2013-2018, we tested home range areas and daily displacements of female lesser prairie-chickens varied among ecoregions and breeding stages at 4 study sites in Kansas and Colorado, USA, that together represent 3 of the 4 currently occupied ecoregions. We captured and equipped females with VHF ($n = 39$) or GPS transmitters ($n = 157$), and estimated home range areas and daily displacements with kernel density estimators or biased random bridge models. Across all sites, home range areas averaged 190.4 ha (± 19.1 ha SE) for birds with VHF and 283.6 ha (± 23.1 ha) for birds with GPS transmitters, while daily displacement averaged 374.8 m (± 14.3 m). Average home range areas and daily displacements were greater in the Short-Grass Prairie/CRP Mosaic ecoregion (233.0–420.8 ha, 468.5 m, respectively) compared to our sites in the Mixed-Grass Prairie in southcentral Kansas (146.4–183.9 ha, 281.0–319.5 m). Home range areas and daily displacements were greatest during lekking (252.8 ha, 539.7 m) and smallest during the brooding stage (81.4 ha, 221.3 m), when hen movements are restricted by mobility of chicks.

Ecoregion- and breeding stage-specific estimates of movements and space use of lesser prairie-chickens will help managers determine the spatial configuration of breeding stage-specific habitat on the landscape. Furthermore, ecoregion- and breeding stage specific estimates are crucial when estimating the amount of breeding habitat needed for lesser prairie-chicken population to persist.

differences and individual resource needs on variation of space use by breeding female lesser prairie-chickens

Location
Kansas and eastern Colorado

Completion
May 2021

Products

Publications

Verheigen, B.H.F., R.T. Plumb, C.K.J. Gulick, C.A. Hagen, S.G. Robinson, D.S. Sullins, and D.A. Haukos. 2021. Breeding season space use by lesser prairie-chickens (*Tympanuchus pallidicinctus*) varies among ecoregions and breeding stages. American Midland Naturalist 185:149-174.

Professional Presentations

Verheijen, B.H.F., C.K.J. Gulick, J.D. Kraft, J.D. Lautenbach, J.M. Lautenbach, R.T. Plumb, S.G. Robinson, D.S. Sullins, and D.A. Haukos. 2019. How can breeding stage-specific estimates of home range size of female lesser prairie-chickens aid conservation efforts? American Fisheries Society & The Wildlife Society 2019 Joint Annual Conference, Reno, Nevada.

Verheijen, B.H.F., C.K.J. Gulick, J.D. Kraft, J.D. Lautenbach, J.M. Lautenbach, R.T. Plumb, S.G. Robinson, D.S. Sullins, and D.A. Haukos. November 2019. How can breeding stage-specific estimates of home range size of female lesser prairie-chickens aid conservation efforts? 33rd Meeting of the Prairie Grouse Tech Council. Bartlesville, Oklahoma.

Response of Greater Prairie-Chickens to Natural and Anthropogenic Disturbance on Fort Riley

Investigators
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Collaborators
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Derek Moon

Project Supervisor
Dr. David Haukos

Funding
Fort Riley Environmental Division

Cooperators
Fort Riley Environmental Division

Objectives
Estimate female survival rates and nest success of Greater Prairie-chickens during the breeding season on Fort Riley Military Reserve

Assess resource selection by female Greater Prairie-chickens during the breeding season. Resource selection will be measured at multiple scales and in response to landscape disturbances experienced at Fort Riley Military Reserve

Evaluate space use by female Greater Prairie-chickens during the breeding season. Home

Status

Completed

Results

Greater Prairie-chickens (*Tympanuchus cupido*) historically occupied 20 states within the contiguous United States and four Canadian provinces; however, due to habitat degradation and loss, they are currently found in 11 states; only four of which have a stable population. Kansas supports a relatively large abundance of Greater Prairie-chickens, where the Flint Hills ecoregion historically supported the largest population of all ecoregions. In the past decade, however, the Flint Hills population has declined to an estimated 8,334 individuals in 2021 from 34,180 individuals in 2015 due to changes and intensification of grassland management practices. The Fort Riley Military Reservation in the northeast portion of the Flint Hills ecoregion is one of a few areas within the ecoregion that does not implement grazing or vast annual burning. The Greater Prairie-chicken population within Fort Riley has remained stable over the past 25 years despite being constrained by surrounding landscape features and development. To understand why this population is doing relatively well compared to populations in surrounding areas, I trapped, collared, and tracked 46 female Greater Prairie-chickens from March-April 2019-2020 on Fort Riley. My goals with this project were to assess female survival, nest survival, resource selection, and space use during the breeding season (Apr-Aug) on the military reservation. Despite being free from grazing and annual burning, Fort Riley experiences fairly constant military activity, which may elicit responses from Greater Prairie-chickens. I used known-fate and nest survival models in Program MARK to estimate female survival and nest success of Greater Prairie-chickens. I estimated breeding season survival as 0.275 ± 0.065 (SE) and nest survival as 0.2643 ± 0.0689 (SE), which are average and high for the Flint Hills, respectively. I used logistic regression models to assess resource selection by Greater Prairie-chicken females. I analyzed landscape features, vegetation variables, and burn mosaics to understand which features had the most influence on resource selection and found landscape features to impact resource selection. Females avoided trees within Fort Riley (probability of use greatest at 2,000 m from nearest tree) at a greater margin than any other study in Kansas. Lastly I calculated home ranges, net, and total daily displacement across the lekking, nesting, and post-nesting stages of the breeding season to understand how Greater Prairie-chickens responded to military activity. Home ranges were slightly smaller than those in surrounding areas yet breeding stage trends remained constant (lekking: 238 ± 43 ha, nesting: 115 ± 20 ha, post-nesting: 113 ± 11 ha) when compared to past literature. Lastly, total daily movements did not differ significantly between days where activity was occurring versus when it was not (training occurring: 1,121 ± 127m, training not occurring: 1,309 ± 63m). My findings suggest that despite being in a constrained environment, Greater Prairie-chickens on Fort Riley are doing well demographically and are not showing signs of being affected by military activity. Because of the constrained environment, however, it is important for land managers to range and daily displacement will be calculated while evaluating landcover types and movements in response to disturbances on the landscape

Location:
Riley and Geary counties, Kansas

Completion
August 2021

monitor woody encroachment and other tall vertical features as this may lead to loss of habitat and cause potential negative effects on the Fort Riley population.

Products

Publications

Gehrt, J.M., D.A. Moon, S.C. Stratton, and D.A. Haukos. 2022. Role of landscape features in resource selection by female Greater Prairie-chickens within a constrained environment. Global Ecology and Conservation *In Press.*

Presentations

Gehrt, J.M., D.A. Moon, and D.A. Haukos. 2021. Effects of military activity on greater prairie-chicken space use in a constrained environment on Fort Riley Military Reservation in Kansas. Annual Conference of The Wildlife Society (invited, virtual).

Gehrt, J.A., D.A. Moon, and D.A. Haukos. 2021. Greater prairie-chicken habitat selection in response to fire and manmade structures on Fort Riley Military Reservation. Midwest Fish and Wildlife Conference, virtual.

Gehrt, J.A., S. Stratton, and D.A. Haukos. 2020. Demographic responses of greater prairie-chickens to fire, haying, and military activity on Fort Riley Military Reservation in Riley, Kansas. Kansas Natural Resource Conference, Manhattan, Kansas.

Gehrt, J.A., D. Moon, and D.A. Haukos. 2020. Effects of management strategies and military activity on greater prairie-chicken ecology on Fort Riley Military Reservation. Annual Meeting of The Wildlife Society, Louisville, Kentucky.

Gehrt, J.A., D. Moon, and D.A. Haukos. 2020. Greater Prairie-chicken habitat selection within a mosaic burning regime on Fort Riley Military Reservation. Annual meeting of the Kansas Ornithological Society, virtual.

Thesis

Gehrt, J. 2021. Response of greater prairie-chickens to natural and anthropogenic disturbance on Fort Riley. Thesis, Kansas State University, Manhattan.

Fawn Survival and Bed-site Selection of Mule Deer and White-tailed Deer in Western Kansas

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Cooperators
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Kansas Bowhunters Association
Mule Deer Foundation

Funding
Kansas Department of Wildlife and Parks

Kansas State University

Objectives

Establish survival rates, bed-site selection, and cause-specific mortalities of fawns in white-tailed and mule deer

Location
Lenora, Kansas
Scott City, Kansas

Completion
August 2020

Status
Completed

Results:

Mule deer (*Odocoileus hemionus*) and white-tailed deer (*O. virginianus*) are common sympatric deer species in the Great Plains and western United States that have exhibited divergent population trends temporally and spatially. Mule deer populations are declining and contracting to the west while white-tailed deer populations are expanding. Species-specific differences in fawn recruitment is one proposed explanation for these observed trends, although the underlying causes remain unknown. To determine if landscape or other habitat changes are affecting the two deer species in different ways, we studied bed-site selection of mule deer and white-tailed deer fawns in western Kansas at microhabitat and landscape scales. We also assessed how fawn intrinsic factors, doe maternal condition, and bed-site habitat characteristics influenced survival of mule deer and white-tailed deer fawns. In February 2018 and 2019, we captured 120 adult does (60 mule deer, 60 white-tailed deer) using helicopter net-gun techniques and deployed 120 vaginal implant transmitters (VITs) synchronized with GPS collars deployed on does. Upon VIT expulsion, a birthing event notification was triggered, which narrowed search efforts for fawns. We captured and radio-collared 100 fawns (53 mule deer, 47 white-tailed deer) during 12 May- 23 June in 2018 and 2019. Fawns were visually located daily using ground-based radio-telemetry and we assessed bed-site selection, cause-specific mortality, and survival rates until fawns reached 10 weeks of age. Overall, fawn survival was low (0.32 ± 0.06) and did not differ between species (mule deer: 0.25 ± 0.08; white-tailed deer: 0.41 ± 0.08). Adult chest girth was positively associated with 70-day white-tailed deer fawn survival, longer fawn body length increased 7-day white-tailed deer fawn survival, and fawn sex best predicted 7-day mule deer fawn survival. Model uncertainty indicated fawn intrinsic factors and maternal conditions may be poor predictors of fawn survival. White-tailed deer survival was lower for fawns with more woodland in their home ranges and mule deer fawn survival exhibited a positive quadratic relationship with the amount of grassland within the home range. Mule deer fawn survival increased with the amount of edge and disaggregation within a home range, but landscape configuration did not explain survival of white-tailed deer fawns. We analyzed microhabitat characteristics at 2689 fawn bed-sites and 2689 paired random points. Bed-site selection differed by species; however, vegetative structure was the most influential microhabitat characteristic for both deer species. Mule deer fawns selected for 75% visual obstruction 8.4 dm tall, less grass cover, more succulent cover, and 56% shrub cover at bed-sites. White-tailed deer fawns selected for 25% visual obstruction 9.2 dm tall, 71% forest canopy cover, and less grass cover and bare-ground at bed-sites. The two species also showed differences in landscape selection. The odds of a white-tailed deer fawn bed-site increased 5.88 times in woodlands, whereas odds of a mule deer fawn bed-site increased 2.85 times in CRP. Our research suggests white-tailed deer fawns and mule deer fawns selected different characteristics for bed-sites at the microhabitat and landscape scale. Bed-site selection likely influences fawn survival, which could affect fawn recruitment. Managers should focus on maintaining heterogeneous landscapes composed mainly of native and Conservation Reserve Program grasslands with abundant cover to enhance mule deer fawn survival and bolster adult populations.

Products

Professional Presentations

Kern, M., A. Ricketts, D. Haukos, and L. Jasper. 2018. Survival and cause-specific mortality of white-tailed and mule deer fawns in western Kansas. Annual Meeting of The Wildlife Society, Cleveland, Ohio.

Kern, M., M. Kinlan, T. Karish, A. Ricketts, D. Haukos, and L. Jaster. 2019. Neonate survival rates and bed-site selection of two sympatric deer species in western Kansas. Annual Meeting of The Wildlife Society, Reno, Nevada.

Kern, M., M. Kinlan, T. Karish, A. Ricketts, D. Haukos, and Levi Jaster. 2019. Neonate survival rates and bed-site selection of two sympatric deer species in western Kansas. Kansas Natural Resource Conference, Manhattan, Kansas.

Thesis

Kern, M. 2019. Fawn survival and bed-site selection of mule deer and white-tailed deer in western Kansas. Thesis, Kansas State University, Manhattan.

Survival, Movement, and Resource Selection of Male Mule Deer and White-tailed Deer in Western Kansas

Investigators
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Project Supervisors
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Collaborators
Levi Jaster

Funding
Kansas Department of Wildlife and Parks

Cooperators
Kansas Department of Wildlife and Parks

U.S. Fish and Wildlife Service

U.S. Geological Survey

Kansas State Department of Horticulture and Natural Resources, Division of Biology

Location:
Western Kansas

Completion:
Fall 2020

Status

Completed

Results

Abundance and occupied range of mule deer (*Odocoileus hemionus*) in Kansas have been declining for 20 years. The two predominant hypotheses for the reduction of mule deer and concurrent expansion of white-tailed deer (*O. virginianus*) are changes in land use and competitive dominance of white-tailed deer over mule deer. Despite the popularity and income that stem from hunting revenue, there have been no recent studies that provide critical insight on how to improve management and conservation of sympatric populations of either deer species in Kansas. My objectives were to (1) test for differences in annual and weekly survival rates between species, identify temporal mortality patterns, and assess influences of hunting and rut on survival; and (2) examine movement patterns, space use, and population-level resource selection by adult male mule deer and white-tailed deer in western Kansas during three time periods (annually, rut, and 12-day firearm season). I deployed GPS-collared 60 (30 mule; 30 white-tailed deer), 25 (12 mule; 13 white-tailed deer), and 26 (13 mule; 13 white-tailed deer) male mule deer and white-tailed deer at two different study sites (north and south) located in western Kansas in 2018, 2019, and 2020, respectively, maintaining a sample size of 60 at the start of each study year. Each deer was fitted with a high resolution GPS/VHF collar that recorded bi-hourly locations and used an activity sensor to identify mortality events. I assigned each deer to an age class (<3 or ≥3 years old). I analyzed the influence of single variable models (age class, species, study site, year, site and year interaction, and morphological measurements [total body length, chest girth, hind foot, and neck girth]) to identify variables that influenced survival. I calculated average daily and average bi-hourly movement rate for all groups (north mule deer, south mule deer, north white-tailed deer and south white-tailed deer) and analyzed peak movement trends to define the rut periods for each species. I used Biased Random Bridge Movement Models to estimate period home ranges and core use areas by species and sites and tested for species*site interactions. I identified temporal space use of different land cover categories during the annual, rut, and 12-day firearm season periods. I compared used and available proportions of categorical land cover and continuous macro habitat features at second-order resource selection. Annual survival did not differ between species during 2018-2020 (mule deer 0.54 ± 0.05, white-tailed deer 0.58 ± 0.05); pooled survival for combined species was 0.56 ± 0.04. December was the most hazardous time of year for both species. Harvest was the predominant cause of mortality (50% of mortalities [firearm = 42%, archery = 8%]. Other sources of mortality stemmed from natural causes (21%), unknown (25%), and deer-vehicle collisions (4%). Kaplan-Meier cumulative survival results showed that survival of both mule deer and white-tailed deer was affected by harvest season and rut; the two weeks of firearm season heavily reduced survival by 19.6%, and 12.4% for mule deer and white-tailed deer, respectively. Survival was reduced by 10.6% and 9.8% during rut for mule deer and white-tailed deer, respectively. Additionally, site and year interaction ($\omega = 0.38$) was the most parsimonious model for predicting adult male survival, the model site, was also competitive. Localized periods of high mortality occurred; compared to 2018 and 2019, deer survival in the north site during 2020 was drastically lower (0.26 ± 0.09) than other annual species-site combinations. Space use at the landscape scale varied temporally by site and species. Population-level selection of macro habitat differed between species Males reduced both bi-hourly movement rate and daily distance during the 12-day firearm period compared to their rut movements; north mule deer reduced their total daily movement by 35%, south mule deer by 33%, north white-tailed deer by 5% and south white-tailed deer by 32%. Rut (~Nov 5-25 for both species of north deer; ~Oct 29-Nov 18 for south mule deer; ~Oct 29-Nov 25 for south white-tailed deer) begins for both species approximately 3-4 weeks prior to the 12-day firearm period. Peak movement periods occurred during rut simultaneously for both species, with all deer moving at least twice as fast (bi-hourly) and twice as much (in 24 hr. intervals) during their rut seasons compared to their annual movements. Males reduced movement during the 12-day firearm season compared to their rut movements because of the proximity of the successive 12-day firearm season to the post-rut period; a time in which males may move less in an attempt to recover from the physiological demands of rut. Speculatively, hunters on the landscape may have been a contributing factor to the decrease in movement. To combat the current population trajectory of mule deer abundance and augment the management and conservation of mule deer, I suggest decreasing the harvest limit of male mule deer to directly increase annual survival of adult male mule deer.

Products

Publications

Combe, F. J., L. Jaster, A. Ricketts, D. Haukos, and A. G. Hope. 2022. Population genomics of free ranging Great Plains white-tailed and mule deer reflects a long history of inter-specific hybridization. Evolutionary Applications 15:111-131.

Professional Presentations

Kinlan, M., D. Haukos, A. Ricketts, and L. Jasper. 2018. Seasonal survival and movements of male mule deer and white-tailed deer in western Kansas. Annual Meeting of The Wildlife Society, Cleveland, Ohio.

Kinlan, M., D. Haukos, A. Ricketts, and Levi Jaster. 2019. Movement patterns and resource selection of male mule deer and white-tailed deer in western Kansas. Annual Meeting of The Wildlife Society, Reno, Nevada.

Kinlan, M., D. Haukos, A. Ricketts, and Levi Jaster. 2019. Seasonal survival, land-cover selection, and movements of male mule deer and white-tailed deer in western Kansas. Kansas Natural Resource Conference, Manhattan, Kansas.

Kinlan, M.A., D. Haukos, A.M. Ricketts, and L. Jaster. 2020. Influence of hunting on survival of adult male mule and white-tailed deer in western Kansas. Annual Meeting of The Wildlife Society, Louisville, Kentucky.

Thesis

Kinlan, M. 2021. Survival, movement, and resource selection of male mule deer and white-tailed deer in western Kansas. Thesis, Kansas State University, Manhattan.

Survival, Activity Patterns, Movements, Home Ranges and Resource Selection of Female Mule Deer and White-tailed Deer in Western Kansas

Investigators
Talesha Karish

Project Supervisors
Dr. David Haukos
Dr. Andrew Ricketts

Cooperators
Levi Jaster, KDWP

Funding
Kansas Department of Wildlife and Parks

Kansas State University

Objectives
Evaluate differences in seasonal multi-scale resource selection by female mule deer and white-tailed deer in western Kansas

Measure differences in home range area, composition, and overlap; movements; and activity patterns between adult female mule deer and white-tailed deer at seasonal and fine temporal scales in western Kansas

Estimate annual and seasonal survival rates and cause-specific mortality of female mule deer and white-tailed deer in western Kansas

Location
Lenora, Kansas
Scott City, Kansas

Completion
April 2022

Status

Completed

Results:
White-tailed deer (*Odocoileus virginianus*) and mule deer (*O. hemionus*) occur in sympatric populations across the Great Plains in North America. Mule deer abundance and occupied range has been declining during the past three decades while white-tailed deer abundance and occupied range has been increasing. Factors contributing to the dichotomous population growth and distribution patterns across their sympatric range are unknown, but potentially include differential survival, space use, and resource selection, all of which may be contributing to indirect competition that may be negatively affecting mule deer populations. Overlap in resource use or space use between mule deer and white-tailed deer could be evidence of competition or competitive exclusion. Activity patterns could provide insights for temporal segregation or competition. Differential space use could allow these species to spatially segregate and co-occur without competing for the same resources. My objectives were to 1) estimate annual and seasonal survival rates, 2) identify cause-specific mortality of adult female mule deer and white-tailed deer, 3) compare behavior patterns between adult mule deer and white-tailed deer of both sexes at seasonal and fine temporal period scales, 4) evaluate the difference in movements between adult female mule deer and white-tailed deer at seasonal and fine temporal scales, 5) test for differences in home range area and composition of adult female mule deer and white-tailed deer at seasonal and fine temporal scales, and 6) evaluate differences in seasonal multi-scale resource selection by female mule deer and white-tailed deer in western Kansas. I deployed collars on 184 pregnant females (94 mule deer and 90 white-tailed deer) at two different study sites in western Kansas (North, South) over three years, 2018, 2019 and 2020. Each deer received a high-resolution GPS/VHF collar that recorded hourly locations, activity accelerometer data along 3 axes, and used an activity sensor to identify mortality events. I used a Kaplan-Meier model to estimate cumulative weekly and annual survival and fit a hazard function to each survival model. I tested for relative influence of factors on estimated survival. I categorized activity points into three behavioral states (feeding, resting, and running). I converted activity points into a proportion of total behavior for each deer and tested for differences in the proportion of behavior categories between species and among seasons. I calculated individual hourly and daily movements seasonally and compared them between species and among seasons. I calculated annual and seasonal 95% home ranges and 50% core areas for each individual deer using a

Biased Brownian Bridge movement model. Using logistic regression, I modeled resource selection by mule deer and white-tailed deer at the landscape scale, within home range scale, and within the core home range to identify selection for potential habitat variables and cover types. There was no difference in annual survival of adult female deer between species (mule deer [0.78 ± 0.04] and white-tailed deer [0.77 ± 0.05]). Harvest was the leading known cause of female mortality at 14% of the total mortality, but it was low compared to other studies in the Great Plains. Behavior of both species was similar in all seasons except for rut for males. In rut, males doubled their running behavior. Firearm season produced no changes in behavior for either species or sex. However, the greatest movements and home ranges were in the firearm season. There were greater movements and home ranges in the cold seasons than in the warm seasons. Mule deer were found to use steeper slopes than white-tailed deer, and white-tailed deer used riparian and woodland areas more than mule deer. Habitat patches enrolled in the U.S. Department of Agriculture Conservation Reserve Program were strongly selected by both species in every season and scale. Managers should focus on preserving CRP to stabilize the mule deer population. Given harvest rates of females are low, survival of adult females of both species of deer appears to be little affected by harvest, so there is no need to alter harvest rates of either species.

Products

Professional Presentations

Karish, T., D. Haukos, A. Ricketts, and L. Jasper. 2018. Resource selection and movements of female mule deer and white-tailed deer during parturition and lactation in western Kansas. Annual Meeting of The Wildlife Society, Cleveland, Ohio.

Karish, T., D. Haukos, A. Ricketts, L. Jaster, M. Kinlan, and M. Kern. 2019. Seasonal activity patterns of female white-tailed deer and mule deer in western Kansas. Annual Meeting of The Wildlife Society, Reno, Nevada.

Karish, T., D. Haukos, A. Ricketts, Levi Jaster, M. Kinlan, and M. Kern. 2019. Resource selection and movements of female mule deer and white-tailed deer in western Kansas. Kansas Natural Resource Conference, Manhattan, Kansas.

Karish, T., D. Haukos, A.M. Ricketts, and L. Jaster. 2020. Resource selection in multiple spatial scales by female mule deer and white-tailed deer in western Kansas. Annual Meeting of The Wildlife Society, Louisville, Kentucky.

Dissertation

Karish, T. 2022. Survival, activity patterns, movements, home ranges and resource selection of female mule deer and white-tailed deer in western Kansas. Dissertation, Kansas State University, Manhattan.

Assessment of Temperate-Breeding Canada Goose Management in Kansas

Investigator
J. Boomer Malanchuk

Project Supervisor
Dr. David Haukos

Funding
Kansas Department of Wildlife and Parks

Cooperators
Thomas Bidrowski - Kansas Department of Wildlife and Parks

Objectives
Estimate vital rates for resident Canada geese, including normal wild and translocated groups

Assess and revise aerial survey to more accurately estimate nesting population

Determine the extent and effects of molt migration

Location:
Kansas

Status

Completed

Results

Resident Canada geese (*Branta canadensis,* geese nesting in the conterminous United States) was one of the many wildlife species declining by the early 1900s due to large-scale human disturbance (e.g., overharvest and habitat destruction). After decades without recognized breeding populations, many thought resident Canada geese were extinct in Kansas and the rest of the United States. Today, certain populations of resident Canada geese are so abundant they can be a nuisance; especially during spring breeding season. Resident Canada geese provide intrinsic value to Kansans as well as economic value through hunting licenses, travel, lodging, and taxes leveed on guns and ammunition. My goal was to address information gaps necessary to make science-based management decisions for resident Canada geese in Kansas. My objective for the first chapter was to determine the effect of translocation on urban-banded nuisance geese. My objective for the second chapter was to assess potential changes to the statewide spring breeding population survey for nesting geese in Kansas, to reduce bias and variation while maintaining or reducing survey cost. My objective for the third chapter was to determine the effect of latitude on age-class specific recovery patterns for resident Canada geese in the eastern tier of the Central Flyway. I estimated survival and recovery probabilities from hunter-harvested band recoveries for normal and translocated (i.e., urban geese relocated to rural areas) resident Canada geese. Annual survival differed between normal ($\hat{S}$ = 0.761, 95% CI 0.734-0.785) and translocated ($\hat{S}$ = 0.598, 95% CI 0.528-0.665) geese. Recovery probability also differed between normal and translocated adults (normal wild $\hat{f}$ = 0.074, 95% CI = 0.069-0.078; translocated $\hat{f}$ = 0.138, 95% CI = 0.120-0.158) and juveniles (normal wild $\hat{f}$ = 0.067, 95% CI = 0.059-0.075; translocated $\hat{f}$ = 0.250, 95% CI = 0.199-0.310). Recovery probability did not differ between status in the sub-adult age class (normal wild $\hat{f}$ = 0.126, 95% CI = 0.115-0.137; translocated $\hat{f}$ = 0.090, 95% CI = 0.055-0.144). Since 2014, Kansas Department of Wildlife and Parks has used fixed-wing aircraft to survey 160 1-mi^2 plots in 2 landcover strata (80 high and 80 medium strata) based on expected abundance of breeding Canada geese. I used survey data from 2019 to estimate change in bias of potential plot reallocation scenarios focusing on inter-plot count variation. I simulated design scenarios by reallocating plots in groups of 10 (e.g., 90 medium, 70 high). I simulated each scenario 100 times and calculated density and associated standard deviation, 90% confidence intervals, and coefficient of variation (CV) for each iteration. The top-ranked survey design based on the greatest reduction in bias predicted reallocating 40 medium stratum plots to the high strata would be the most effective method to increase statistical power and reduce coefficient of variation. Finally, I investigated the effects of banding latitude (i.e., banding state) and age-class on geospatial recovery patterns of resident Canada geese in the eastern-tier states of the Central Flyway, 2012–2019. I used optimized hot spot analyses and inverse distance weighting to measure how recoveries of sub-adult and adult geese differed spatially as insight into latitudinal effects of molt migration. Sub-adult geese from southern-banding states were recovered disproportionately at more northerly latitudes than sub-adult geese from northern banding states. Adult geese were disproportionately recovered in their respective banding state. These results will be used to inform the

Completion: August 2021

Kansas Department of Wildlife and Parks revision of the state resident Canada goose management plan.

Products

Publications

Malanchuk, J.B., B.E. Ross, D.A. Haukos, T.F. Bidrowski, and R. Schultheis. 2021. Translocation, survival, and recovery of Kansas-banded Canada geese. Ecosphere 12(7):e03659

Professional Presentations

Malanchuk, J., D. Haukos, and T. Bidrowski. 2019. Population status and vital rates of temperate-breeding Canada geese in Kansas. Annual Meeting of The Wildlife Society, Reno, Nevada.

Malanchuk, J., T. Bidrowski, and D. Haukos. 2020. Survival, recovery, and translocation of Kansas-banded Canada geese. Annual Meeting of The Wildlife Society, Louisville, Kentucky.

Malanchuk, J.B., and D. Haukos. 2020. Survival, recovery, and translocation of temperate-breeding Kansas-banded Canada geese. Kansas Natural Resource Conference, Manhattan, Kansas.

Dissertation

Malanchuk, J. 2021. Assessment of resident Canada goose management in Kansas. Dissertation, Kansas State University, Manhattan.

Effects of Large-Scale Past and Future Wetland Loss on Network Connectivity of the Rainwater Basin, Nebraska

Investigators
Dr. Bram Verheijen

Project Supervisor
Dr. David Haukos

Funding
USFWS,
Great Plains Landscape Conservation Cooperative,
NSF Macrosystems

Cooperators
Andy Bishop
Dr. Dana Varner
Rainwater Basin Joint Venture, USFWS

Objectives
Compare network characteristics between the historical network and currently remaining wetlands in the Rainwater Basin to assess the effects of large-scale loss of wetlands on network connectivity at a range of maximum dispersal distances

Quantify the role of inundation probability and hydroperiod of remaining wetlands on network connectivity

Compare the relative importance of each remaining wetland to its risk of disappearing from the landscape due to sediment accumulation

Compare the current Rainwater Basin network to future wetland loss scenarios to assess minimum, mean, and

Status
Completed

Progress and Results

The Rainwater Basin in Nebraska supports a complex network of spatially-isolated shallow wetlands that harbors diverse floral and faunal communities. Since European settlement, many wetlands have been lost to the network due to drainage, deliberate filling, land-use change, and increased sedimentation rates, thereby reducing the total available number and area of extant wetlands, and increasing the distance among remaining wetlands. Moreover, high rates of sediment accumulation due to agricultural practices have decreased the inundation probability and hydroperiod of many of the remaining wetlands. Many species of plants, insects, and amphibians rely on ponded wetlands for reproduction and survival, but have limited dispersal capabilities. As a result, populations may become isolated and face increased localized extinction rates if distances among ponded wetlands become too large. Unfortunately, it remains unclear how large-scale wetland losses and reductions in inundation of playa wetlands have affected connectivity and structure of the Rainwater Basin. Moreover, how potential future wetland losses will affect the Rainwater Basin network could depend on the characteristics and placement of remaining wetlands within the network.

We found that the number of functioning wetlands has decreased with more than 90% over the past century and that losses were relatively evenly distributed throughout the network. Wetland losses had large consequences for network connectivity by increasing the dispersal capabilities necessary to travel throughout the whole network from 3.5 to 10.0 km. Furthermore, the lack of ponding of several key wetlands during dry years further limits long-distance dispersal through the network for species with low dispersal capabilities. Last, we found that several wetlands with a high risk of disappearing from the landscape due to sediment accumulation were important in maintaining network connectivity for most dispersal distances.

When assessing effects of potential future wetland losses on the connectivity and structure of the Rainwater Basin, we found that a 10% loss of highly-ranked wetlands substantially decreased connectivity for species with dispersal capabilities <5.5 km, while a 40–50% loss reduced connectivity for all tested dispersal distances (0.5–12.0 km). When large proportions of highly-ranked wetlands were lost, the eastern and western halves of the Rainwater Basin network were no longer connected for any dispersal distance. Loss of low-ranked wetlands had minimal effects on network connectivity, until at least the lowest-ranked 50% were removed (Figure 1).

maximum effects of losses on network connectivity for a range of wildlife taxa

Location
The Rainwater Basin Region, southcentral Nebraska.

Completion
July 2019

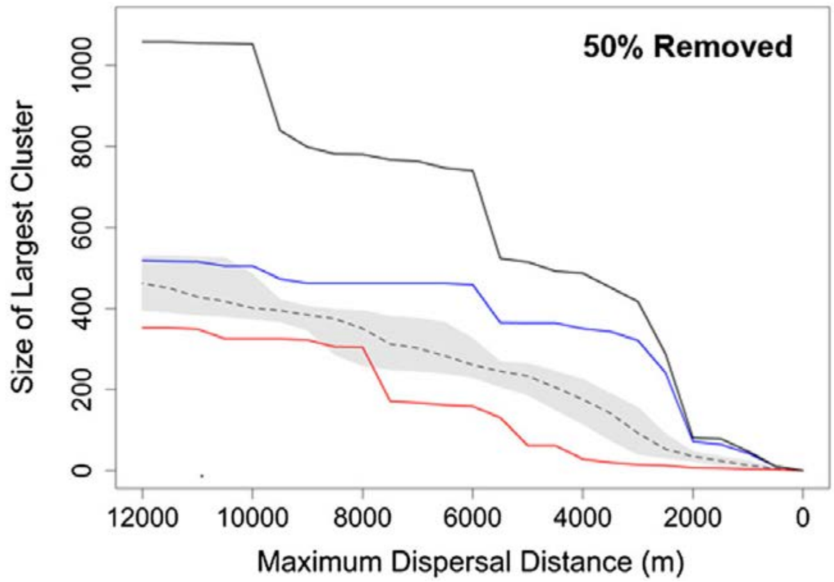


Figure 1. Maximum cluster size of the Rainwater Basin, southcentral Nebraska, USA, for maximum dispersal distances of 0–12,000 m compared among the current extent of the Rainwater Basin network (black line) and scenarios where the highest ranked (red line), lowest ranked (blue line) or a random subset (dashed gray line; 95% confidence interval in gray shading) of 50% of playa wetlands has been removed from the network

Our work suggests that conservation efforts should focus on maintaining or increasing the connectivity of the Rainwater Basin network, and should prioritize the protection of key wetlands which persistence is currently at risk. Many highly-ranked playa wetlands in the Rainwater Basin are currently unprotected and might disappear from the landscape. Protecting wetlands that are key in maintaining connectivity especially benefits species with limited dispersal capabilities (<5.5 km) for which consequences of future habitat losses might be worst.

Products

Publications

Verheijen, B.H.F., D.M. Varner, and D.A. Haukos. 2018. Effects of large-scale wetland loss on network connectivity of the Rainwater Basin, Nebraska. Landscape Ecology 33:1939–1951.

Verheijen, B.H.F., D.M. Varner, and D.A. Haukos. 2019. Future losses of playa wetlands decrease network structure and connectivity of the Rainwater Basin, Nebraska. Landscape Ecology: 35:453–467.

Professional Presentations

Verheijen, B.H.F., D.M. Varner, and D.A. Haukos. January 2018. Effects of large-scale wetland loss on network connectivity of the Rainwater Basin, Nebraska. The 78th Midwest Fish and Wildlife Conference. Milwaukee, Wisconsin.

Verheijen, B.H.F., D.M. Varner, and D.A. Haukos. February 2018. Effects of large-scale wetland loss on network connectivity of the Rainwater

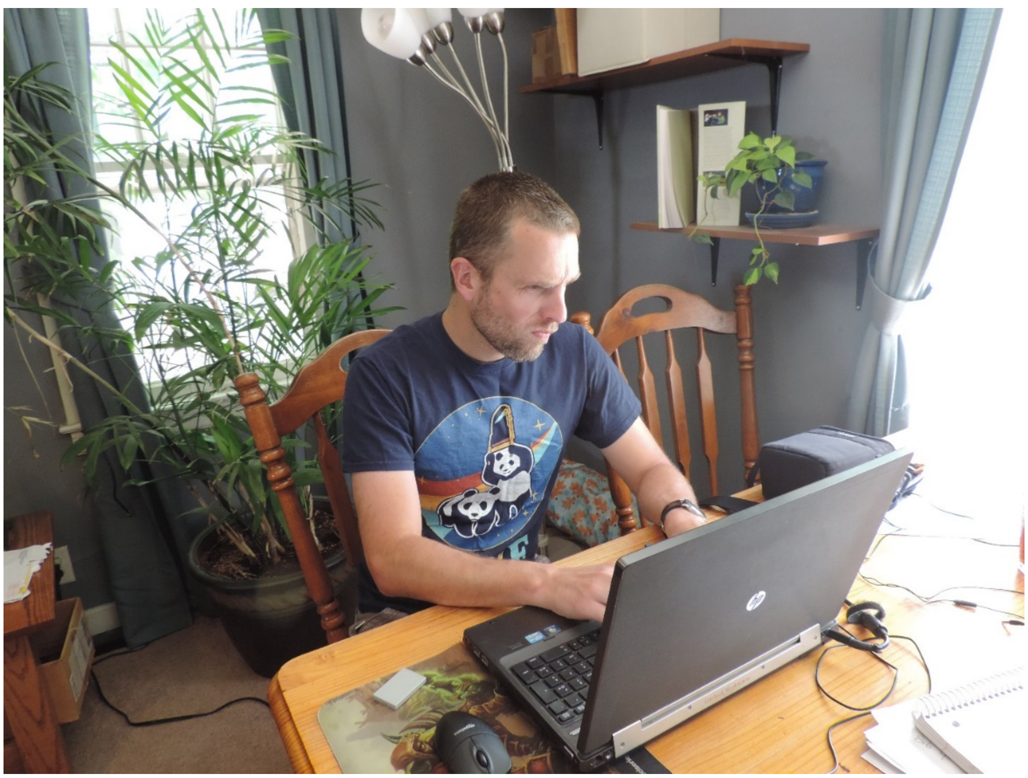
Basin, Nebraska. The 11th Kansas Natural Resources Conference. Manhattan, Kansas.

Verheijen, B.H.F., D.M. Varner, and D.A. Haukos. March 2018. Effects of large-scale wetland loss on network connectivity of the Rainwater Basin, Nebraska. The Annual Meeting of the Central Mountains and Plains Section of the Wildlife Society. Kearney, Nebraska.

Verheijen, B.H.F., D.M. Varner, and D.A. Haukos. October 2018. Effects of inundation probability and sediment accumulation on the connectivity and structure of the Rainwater Basin, Nebraska. The 25th Annual Conference of the Wildlife Society. Cleveland, Ohio.

Verheijen, B.H.F., D.M. Varner, and D.A. Haukos. January 2019. Wetland functionality and continued loss negatively affect network connectivity and structure of the Rainwater Basin, Nebraska. The 12th Kansas Natural Resources Conference. Manhattan, Kansas.

Verheijen, B.H.F., D.M. Varner, and D.A. Haukos. November 2019. Effects of past and potential future wetland losses on network connectivity of the Rainwater Basin, Nebraska. Invited speaker at the Ecology and Evolutionary Biology Seminar Series at Kansas State University. Manhattan, Kansas.



On-Going Wildlife Projects

Patterns of Greenness (NDVI) in the Southern Great Plains and Their Influence on the Habitat Quality and Reproduction of a Declining Prairie Grouse

Investigators
Ashley Messier

Project Supervisors
Dr. Daniel Sullins
Dr. David Haukos

Funding
U.S. Fish and Wildlife Service

Cooperators
Kansas Department of Wildlife and Parks (Kent Fricke)

U.S. Fish and Wildlife Service (Chris O'Meilia)

Objectives

Relate snapshot NDVI to nest site-selection

Relate NDVI-based vegetation phenology metrics to nest and brood site-selection

Predict reproductive habitat abundance

Relate snapshot NDVI to nest survival

Location:
Kansas

Completion
Expected November 2022

Status
On-going, initiated January 2020

Progress and Results
The lesser prairie-chicken (*Tympanuchus pallidicinctus*) is one of many grassland nesting species that has experienced declines in population size, range, and habitat quality as a result of anthropogenic and ecological changes. As this species continues to decline in portions of its range, it is crucial to identify and preserve optimal reproductive habitat to promote persistence in the future. However, with continuing advancements in remote sensing technology, the ability to monitor and predict the abundance of reproductive habitat for lesser prairie-chickens has never been more accessible. One of many factors influencing reproduction and reproductive success is the timing of nest initiation, which we predict to be associated with vegetative greenness. A powerful remote sensing tool that directly measures vegetative greenness is the Normalized Difference Vegetation Index (NDVI). I am using NDVI, as well as NDVI-based vegetation phenology metrics, to estimate and better characterize optimal reproductive habitat for lesser prairie-chickens.

I have access to data collected at >20,000 locations throughout western Kansas and eastern Colorado that encompass a range of conditions such as wildfire, drought, precipitation, grazing practices, and ecoregions. Data was collected from 1989-2018 from over 400 birds that were captured and fitted with either GPS or VHF transmitters. Locations include nest sites, brood sites, used locations, and random locations. For NDVI-related analyses, I used moderate resolution imagery from the Landsat 8 OLI/TIRS (30m pixel resolution) and AQUA MODIS (250m pixel resolution) sensors.

To relate NDVI variation to nesting site selection, I acquired NDVI specific to nest and random locations at the time of nest initiation ("snapshot NDVI"). Snapshot NDVI was calculated using Landsat 8 OLI/TIRS imagery. Based on results from a resource selection function, snapshot NDVI was not a reliable predictor of nest-site selection.

To evaluate potential relationships between nest and brood site selection and NDVI-based vegetation phenology metrics, I used AQUA eMODIS RSP (remote sensing phenology) imagery to extract values of 9 vegetation phenology metrics at nest, brood, and random locations. Using a resource selection function, results indicated that the amplitude metric was a reliable indicator of nest site selection. Comparatively, maximum NDVI was a reliable predictor of brood site selection.

To predict lesser prairie-chicken reproductive habitat abundance within grasslands, I incorporated 9 vegetation phenology metrics, gradient landscape metrics, and nest and brood location data from 2014 and 2015 into a random forest model. In 2014, nesting habitat abundance was best predicted by percent grassland within 5km (variable importance = 0.04), county road density within 2km (0.038), NDVI at the end of the growing season (0.02), and time integrated NDVI (0.02). In 2015, phenology variables carried more importance relative to other variables. Specifically, maximum NDVI (0.024) time integrated NDVI

(0.023), amplitude (0.023), and NDVI at the start of the growing season (0.018) best predicted nest habitat abundance. In 2014, brood habitat abundance was best predicted by density of county roads within 2km (variable importance 0.08), percent grassland within 5km (0.07), maximum NDVI (0.07), amplitude (0.06), density of vertical structures within 2km excluding power lines (0.05), density of oil within 2km (0.05), time integrated NDVI (0.05), and the end of growing season date (0.04). In 2015, brood rearing habitat was best predicted by percent grassland within 5km (0.08), time integrated NDVI (0.07), density of county roads within 2km (0.07), amplitude (0.07), maximum NDVI (0.07), density of oil within 2km (0.05), density of vertical structures within 2km excluding power lines (0.05), and start of growing season NDVI (0.05).

Additional preliminary analyses include relating snapshot NDVI to nest survival. Preliminary results based on nesting data from Clark County, KS indicate that snapshot NDVI does not have a significant influence on nest survival. Next steps include incorporating nesting data from additional study sites, which may yield different results.

In summary, vegetation phenology metrics have utility in predicting nest and brood site-selection and reproductive habitat abundance. Notably, it appears as though habitat abundance and phenology predictors may vary from year to year, potentially due to differences in precipitation. Overall, phenology metrics and anthropogenic feature densities appear to have utility in predicting within grassland lesser prairie-chicken reproductive habitat abundance, however, important predictors may vary annually, which complicates habitat monitoring.

Products

Professional Presentations:

Messier, A. A., D. S. Sullins, D. A. Haukos, and C. M. O'Meilia. 2022. Evaluating the role of vegetation phenology metrics in lesser prairie-chicken nest and brood-site selection. Kansas Natural Resources Conference (oral presentation). February 3-4th, 2022.

Messier, A. A., D. S. Sullins, D. A. Haukos, and C. O'Meilia. 2021. Evaluating the role of NDVI-based phenology metrics in lesser prairie-chicken nest-site selection. The Wildlife Society Annual Conference (virtual poster presentation). November 3rd 2021, 11:00AM-12:00PM.

Messier, A. A., D. S. Sullins, D. A. Haukos, and C. M. O'Meilia. 2021. Evaluating the role of vegetation phenology metrics in the nest-site selection of a declining prairie grouse. Kansas Ornithological Society (virtual pre-recorded oral presentation). October 8-10th, 2021.

Messier, A. A., D. S. Sullins, D. A. Haukos, and C. O'Meilia. 2021. Using NDVI to evaluate lesser prairie-chicken (*Tympanuchus pallidicinctus*) nest-site selection. Kansas Natural Resources Conference, Manhattan, Kansas (virtual poster presentation). January 28th, 2021.

Spatiotemporal Variation and Individual Heterogeneity in Resource Selection by Lesser Prairie-Chickens

Investigators
Dr. Bram H. F. Verheijen

Dr. Daniel S. Sullins

Project Supervisor
Dr. David A. Haukos

Funding
Kansas Department of Wildlife and Parks

NRCS

Cooperators
Kansas Department of Wildlife and, Parks

U.S. Fish and Wildlife Service

Great Plains LCC

USDA Forest Service

Objectives
Assess relative strength of selection by lesser prairie-chickens of covariates within four categories: landscape composition, landscape

Status
On-going, initiated June 2020

Progress and Results
Patterns in resource selection are rarely uniform within a species, instead varying with spatiotemporal variation in resource availability and individual heterogeneity in resource needs. Because of its direct link with fitness and distribution of animals, variation in resource selection has important consequences for local population dynamics and carrying capacity. Understanding this variation is especially important for species of conservation concern where active management of species should be guided by local habitat needs. Since European settlement, the lesser prairie-chicken (*Tympanuchus pallidicinctus*), a species of non-migratory prairie grouse, has declined ~90% from its historically occupied range and abundance. Occurring in four distinct ecoregions, lesser prairie-chickens show range-wide similarities in resource selection as well as variation among ecoregions, sexes, and biological seasons. We tested the extent and strength of this variation by tracking lesser prairie-chickens at five sites in Kansas and Colorado, representing the three northernmost currently occupied ecoregions. More specifically, we assessed the relative strength of selection of covariates in four distinct categories (landscape composition, landscape configuration, anthropogenic pressures, and topography) and compared our findings among sexes and between the breeding and nonbreeding seasons.

Preliminary results show that although lesser prairie-chickens selected greater amounts of grass cover on the landscape (>60% in 5-km buffer), grassland patches with lower perimeter to area ratios, and intermediate amounts of forb cover (20–40%), relative strength of selection varied among sites based on the proportion of available grassland. Lesser prairie-chickens strongly avoided trees and minor roads, but only when those features were close (<3 km), selected areas with greater shrub cover or taller vegetation at western sites, where low amounts of precipitation limit vegetation growth, and more intermediate vegetation heights at eastern sites. During the breeding season, females selected sites with taller vegetation, at lower elevations, and that were further away from trees than males, while patterns were weaker and more similar between sexes during the nonbreeding season. Observed variation in resource selection among sites and between sexes further supports the need to adapt management plans to local resource availability and needs of lesser prairie-chickens.

Products

Publications

Sullins, D.S., M. Bogaerts, B.H.F. Verheijen, D.E. Naugle, T. Griffiths, and C.A. Hagen. 2021. Increasing durability of voluntary conservation through strategic implementation of the Conservation Reserve Program. Biological Conservation 259:109177.

configuration, anthropogenic pressures, and topography

Compare resource selection among five grassland sites in Kansas and Colorado

Compare resource selection among sexes and between the breeding and nonbreeding season at each site

Location: Kansas and eastern Colorado

Completion: August 2022

Professional Presentations

Verheijen, B.H.F., D.A. Haukos, and D.S. Sullins. Spatiotemporal Variation and Individual Heterogeneity in Resource Selection by Lesser Prairie-chickens. The 28th Annual Conference of The Wildlife Society. Online, November 2021.

Verheijen, B.H.F., C.K.J. Gulick, J.D. Kraft, J.D. Lautenbach, J. M. Lautenbach, R.T. Plumb, S.G. Robinson, D.S. Sullins, and D.A. Haukos. Is grassland always grassland? Spatiotemporal variation in grassland patch selection by Lesser Prairie-chickens. The 81st Midwest Fish and Wildlife Conference. Online, January 2021.

Assessing Long-Term Changes in Lesser Prairie-Chicken Habitat Quality across the Sand Sagebrush Prairie Ecoregion

Investigators:
Megan Vhay
Dr. David Haukos
Dr. Daniel Sullins
Dr. Mindy Rice

Project Supervisor:
Dr. David Haukos

Funding:
Kansas Department of Wildlife and Parks

U.S. Geological Survey

Cooperators:
Kansas Department of Wildlife and Parks

USDA Forest Service

Objectives:
Reconstruct landscape-scale landcover changes in the Sand Sagebrush Prairie Ecoregion from the mid-1980s through 2020

Assess changes in vegetation composition and structure in the Sand

Status
On-Going, initiated September 2020

Progress and Results

The lesser prairie-chicken (*Tympanuchus pallidicinctus*) is a prairie grouse once common throughout the High Plains, particularly in the Sand Sagebrush Prairie Ecoregion of southwestern Kansas and southeastern Colorado. Lesser prairie-chickens rely on large, contiguous grassland patches to meet their life history needs including nesting and brood-rearing. Though historically resilient throughout major disturbances including Euro-American settlement, the 1930s Dust Bowl, and numerous subsequent droughts, lesser prairie-chicken populations have declined by over 90% since 1985, and are currently under consideration for federal Threatened and Endangered status. It is likely that habitat availability and quality, affected by the proliferation of anthropogenic development and dryland farming, has negatively affected the success of the grassland-dependent lesser prairie-chicken. A comprehensive retrospective analysis was needed to determine the ways in which the Sand Sagebrush Prairie Ecoregion has changed since the 1985 population peak for lesser prairie-chickens at the landscape scale.

To address landscape-scale change, I collected records for anthropogenic structures avoided by lesser prairie-chickens including oil and gas wells and transmission lines. I used landcover data to estimate change in primary landcover types (CRP, native prairie, and cropland) on private lands, including total area as well as patch composition and configuration. I used a moving-window analysis to estimate change in amount of the ecoregion with >60% prairie cover at the 5-km scale. I also estimated the change in tree frequency across the ecoregion using aerial imagery.

Landcover totals in the ecoregion changed little between 1985 and 2015, with the exception of CRP becoming an established cover type shortly after 1985. Estimated tree frequency in the ecoregion also changed little. In contrast, each of the anthropogenic structure types increased by at least 80% since 1985. The coverage of 5-km regions with >60% prairie decreased by 18.4% since 1985, with this loss of selected habitat also creating disconnect between remaining prairie-dominant regions.

The functional loss of habitat due to anthropogenic structure avoidance, together with the physical loss of selected prairie habitat, indicates a reduced capacity of the Sand Sagebrush Prairie Ecoregion to support lesser prairie-chicken populations over time. Future conservation measures should focus on protecting the remaining contiguous prairie patches from anthropogenic structure development, as well as establishing CRP fields adjacent to native prairie to increase grassland patch area.

Sagebrush Prairie Ecoregion

Determine the potential influence of CRP on space use by lesser prairie-chickens in the Sand Sagebrush Prairie Ecoregion

Location: Southwest Kansas and southeast Colorado

Completion: Expected December 2022

Products

Professional Presentations

Vhay, M., D. Sullins, and D. Haukos. 2021. Assessing long-term changes in lesser prairie-chicken habitat quality across the Sand Sagebrush Prairie Ecoregion. Annual Conference of The Wildlife Society (virtual).

Vhay, M., D. A. Haukos, D. S. Sullins, and M. B. Rice. 2022. Changing habitat quality for lesser prairie-chickens in the Sand Sagebrush Prairie Ecoregion. Kansas Natural Resource Conference, Manhattan.

Vhay, M., D. A. Haukos, D. S. Sullins, and M. B. Rice. 2022. A retrospective assessment of lesser prairie- chicken habitat quality in the Sand Sagebrush Prairie. Midwest Fish and Wildlife Conference, Des Moines, Iowa.

Vhay, M., D. Haukos, D. S. Sullins, and M. B. Rice. 2022. Declining habitat quality and quantity for lesser prairie-chickens of the Sand Sagebrush Prairie. Annual Conference of The Wildlife Society, Spokane, Washington.

Vhay, M., D. Haukos, D. S. Sullins, and M. B. Rice. 2022. Assessment of lesser prairie-chicken habitat quality in the Sand Sagebrush Prairie. North American Congress for Conservation Biology, Reno, Nevada.

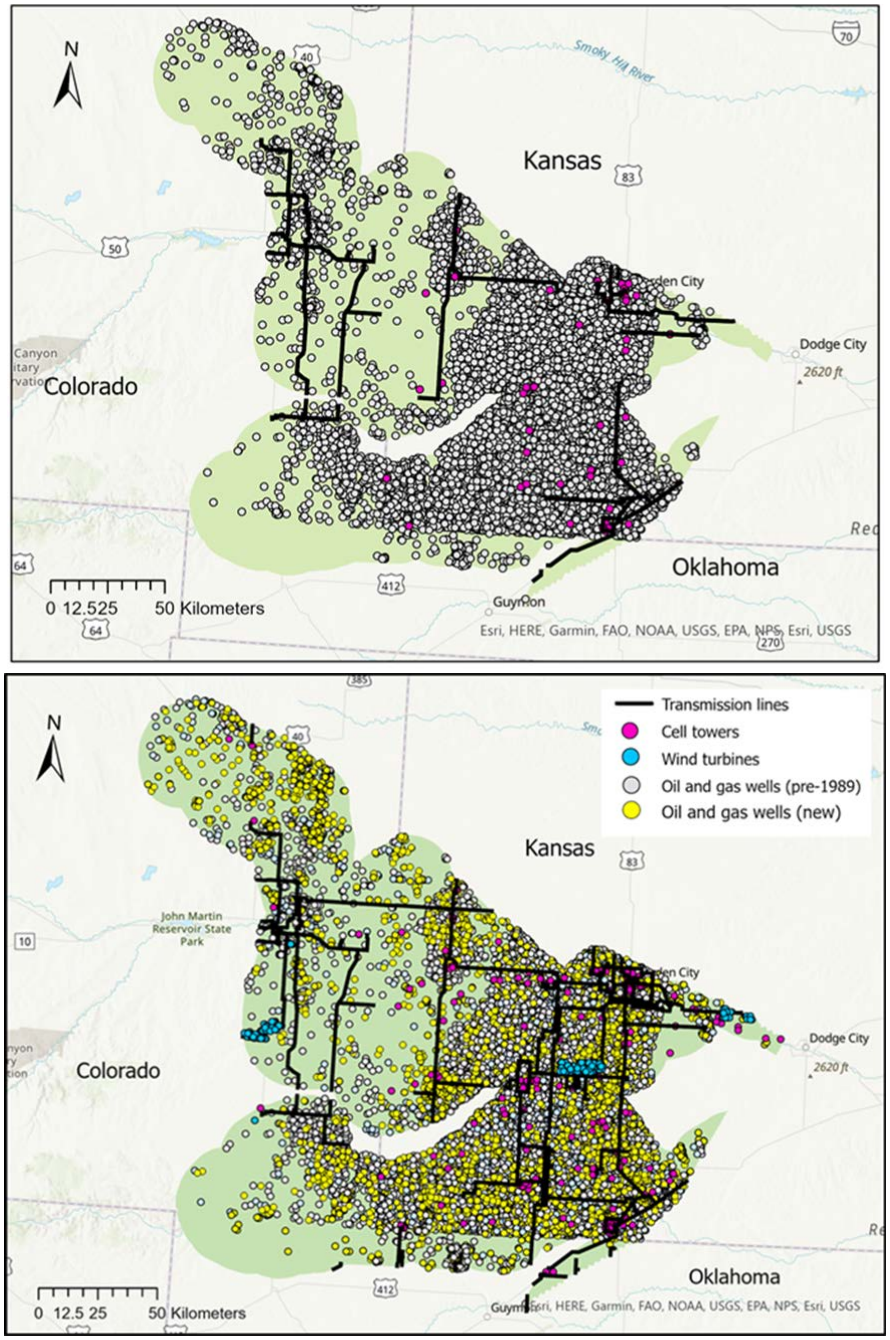


Figure 1. Number of anthropogenic structures (transmission lines, cell/radio towers, wind turbines, and oil/gas wells) present in the Sand Sagebrush Prairie Ecoregion of Kansas, Colorado, and Oklahoma, USA, in 1989 (top), around the time of the lesser prairie-chicken population peak, and by the end of 2014 (bottom).

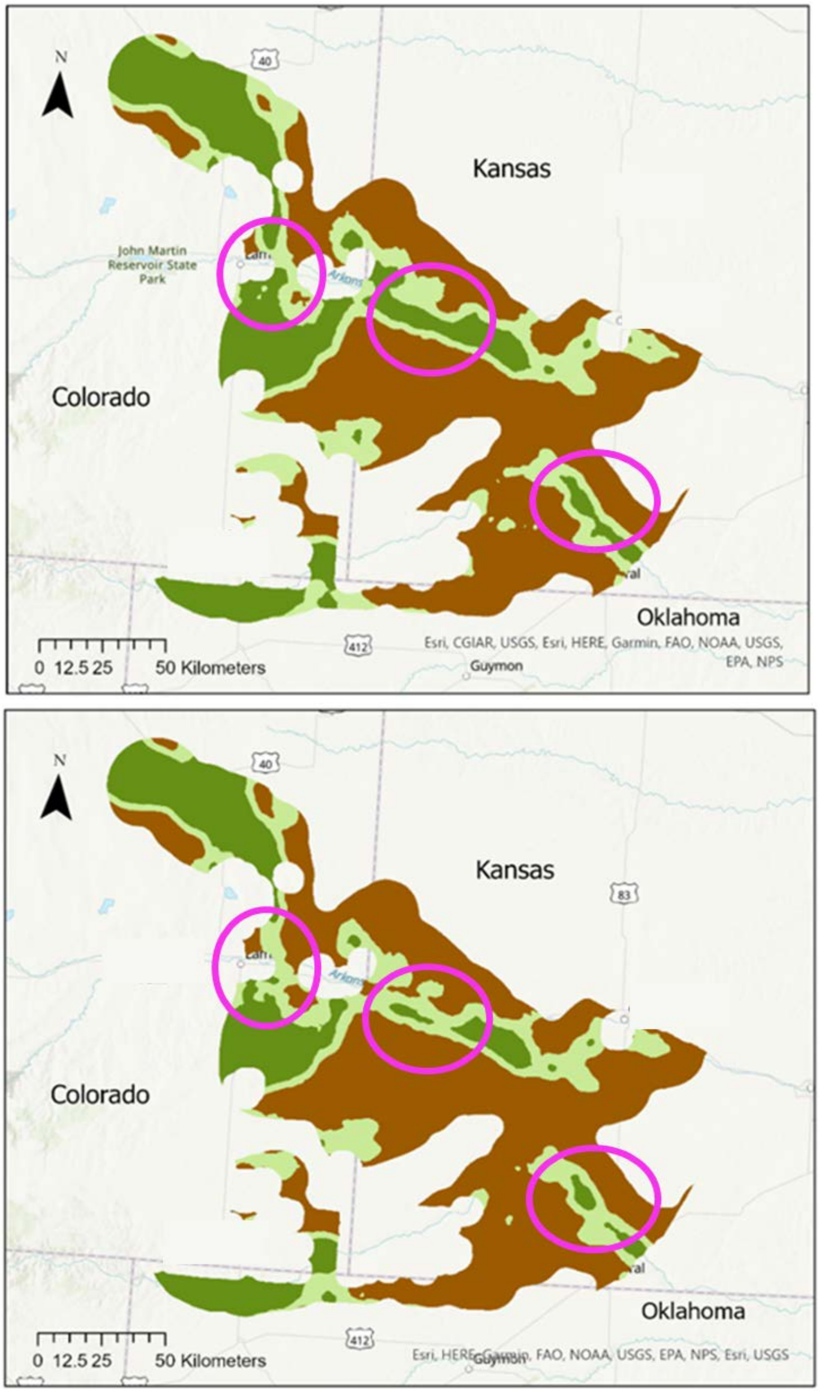


Figure 2. Comparison of private lands areas in the Sand Sagebrush Prairie Ecoregion in Kansas, Colorado, and Oklahoma, USA, composed of <30%, >30% and >60% prairie within 5-km, respectively, during 1990 (top) and by 2015 (bottom). Areas with >60% prairie represent the recommended minimum amount of prairie for supporting lesser prairie-chicken populations (Crawford and Bolen 1976). Public lands and associated edges were omitted from analysis, as cover types for those sites likely changed little over time. Circled areas highlight where most supportive habitat has become disconnected as a byproduct of habitat loss.


SILVERADO

Lesser Prairie-Chicken Movement Under Patch-Burn and Rotational Grazing Management in the Kansas Mixed-Grass Prairie Ecoregion

Investigators
Camille Rieber
Dr. Trevor Hefley

Project Supervisor
Dr. David Haukos

Funding
U.S. Geological Survey

Cooperators
Dr. Dan Sullins
Kansas Department of Wildlife and Parks

Objectives
Compare lesser prairie-chicken movements on adjacent patch-burn and rotationally grazed ranches

Use derived daily displacement estimates to make inference about habitat quality on these ranches

Develop and demonstrate a novel animal movement modeling technique with wide applications

Location:
Kiowa, Comanche, Pratt, and Barber counties, Kansas

Completion
August 2023

Status

On-Going, initiated August 2021

Progress and Results

Lesser prairie-chickens (*Tympanuchus pallidicinctus*) have suffered population declines across their range and in the Mixed Grass Prairie Ecoregion of Kansas, primarily due to loss of quality habitat. Because the majority of their range is on private land, understanding how lesser prairie-chickens behave under different land management practices is of vital importance for continued viability of the species.

Both patch-burn and rotational grazing practices can be used by cattle ranchers within the lesser prairie-chickens' range. These different management regimes create different habitat conditions for lesser prairie-chickens, with patch-burn grazing resulting in a more heterogeneous and patchier landscape of vegetation composition and structure. I am investigating how lesser prairie-chicken movements differ under these two grazing management strategies. I hypothesize that average daily displacements will be greater for birds under rotationally grazed management than for birds under patch-burn management, as rotational grazing may provide lower quality habitat and force birds to travel farther to meet their daily resource needs.

I am using data from 54 individual lesser prairie-chickens that were fitted with rump-mounted satellite transmitters between 2013 and 2019 in the Red Hills region of Kansas, within the Mixed-Grass Prairie Ecoregion. These birds were captured on adjacent patch-burn and rotationally grazed private ranches in Kiowa and Comanche counties. I am fitting Bayesian continuous time movement models to these GPS data to estimate movement paths of birds across the landscape. From these modeled paths, I will estimate daily displacements (daily distances traveled) for individual birds and compare displacement lengths for populations across the two ranches.

Results from movement models of these data will provide initial insights on how lesser prairie-chickens behave under different grazing management techniques within the Mixed-Grass Prairie Ecoregion. The development and demonstration of this statistical technique to estimate daily displacement from GPS data has wide applications to answer further questions about lesser prairie-chicken space use, and space use of any GPS-tracked species of interest.

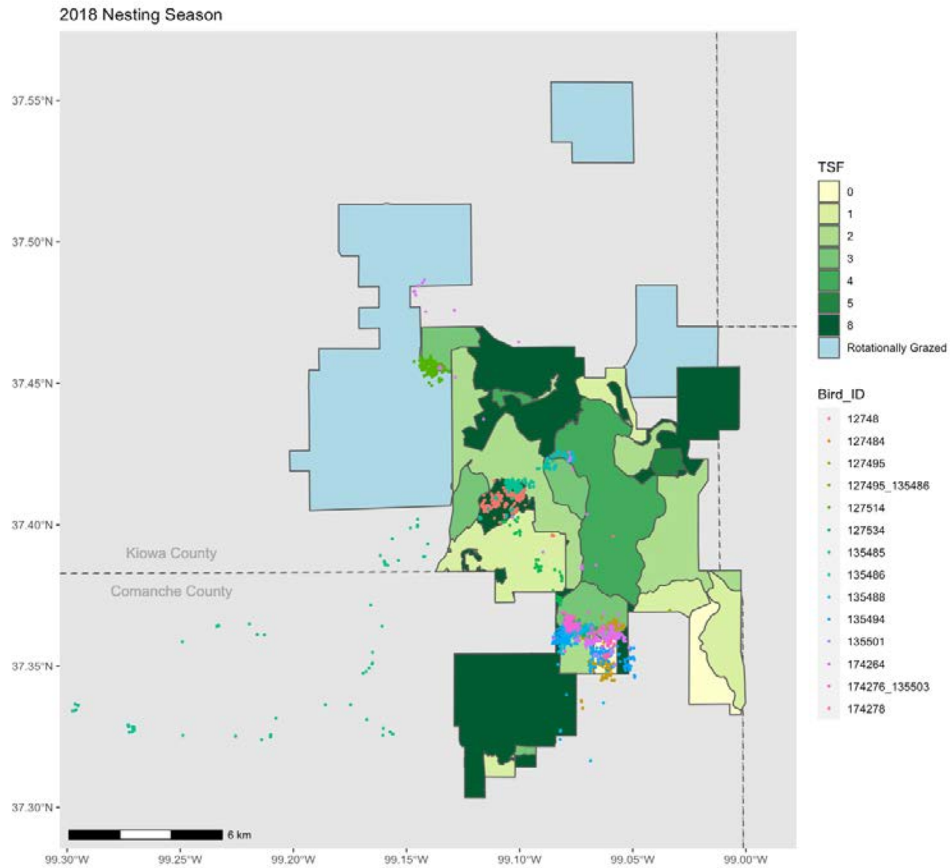


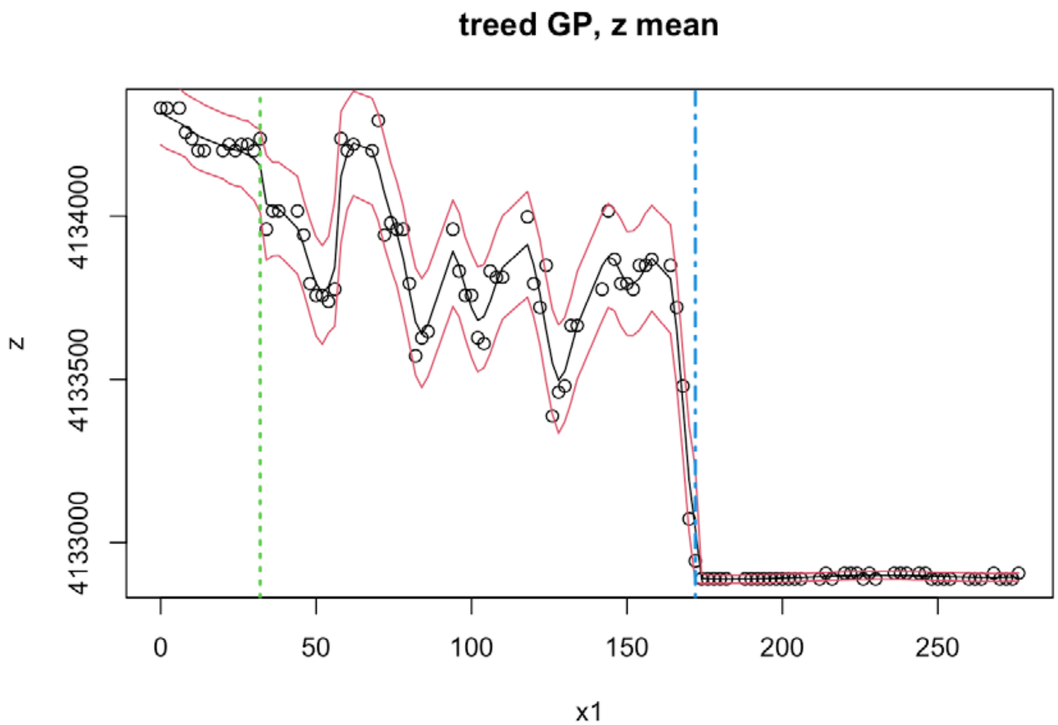
Figure 1. GPS points collected via telemetry every 2 hours for individual birds in the 2018 breeding season. Covariates represented for the two ranches, with different burn sections on the patch-burn ranch shown as time since fire (TSF).

Products

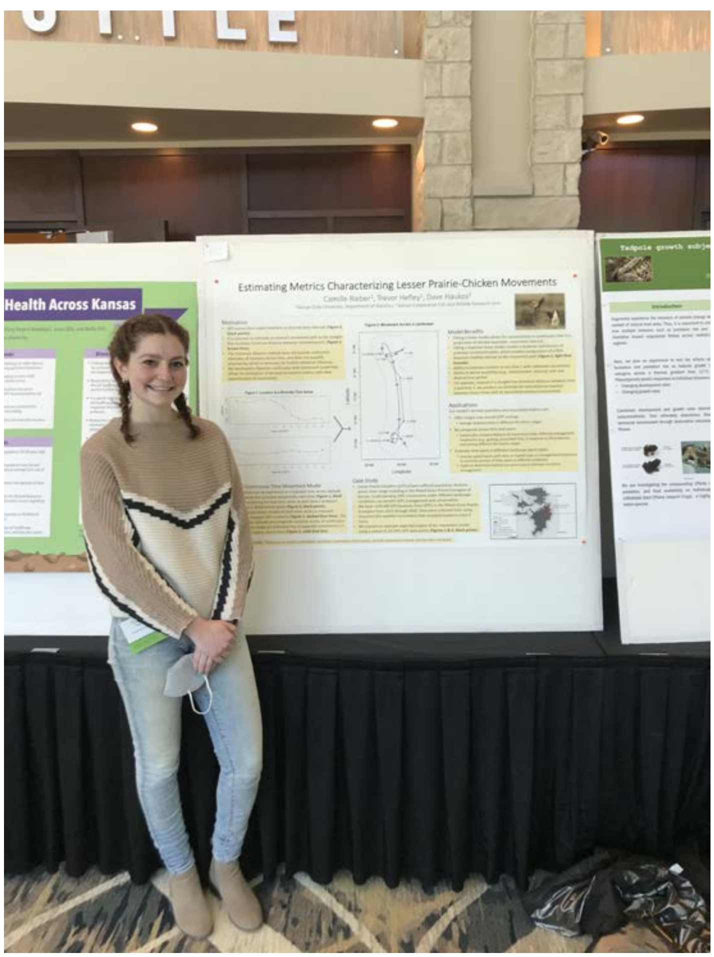
Professional Presentations

Rieber, C. T. Hefley, and D. Haukos. 2022. Bayesian machine learning for movement modeling of lesser prairie-chickens. Annual Conference of The Wildlife Society, Spokane, Washington.

Rieber, C. T. Hefley, and D. Haukos. 2022. Estimating metrics characterizing lesser prairie-chicken movements. Kansas Natural Resource Conference, Manhattan (poster).



Example of estimated lesser prairie-chicken movement trajectory based on GPS satellite locations.



List of Scientific, Peer-Reviewed Publications: 2018-present

Book Chapters

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Caldas, M., M. Mather, J. Bergtold, M. Daniels, G. Granco, J. Aistrup, D. Haukos, A.Y. Sheshukov, M. Sanderson, and J.L. Heier Stamm. 2019. Lessons learned in operationalizing interdisciplinary collaboration. Pages 265-294 in Dr. Stephen Perz, editor. Social-Ecological Systems Science, University of Florida, Gainesville, USA.

Peer Reviewed Journal Articles

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Theses and Dissertations

Talesha Kalish (Ph.D, 2022, Haukos). Survival, activity patterns, movements, home ranges and resource selection of female mule deer and white-tailed deer in western Kansas. (Assistant Area Manager, Baudette Area Wildlife, Minnesota DNR)

John Malanchuk (Ph.D, 2021, Haukos). Assessment of resident Canada goose management in Kansas. (Research Associate, Quantico, Virginia Tech University)

Maureen Kinlan (M.S., 2021, Haukos). Survival, movement, and resource selection of male mule deer and white-tailed deer in western Kansas. (Bear Biologist, New Jersey Department of Environmental Protection, Fish and Wildlife Division)

Jackie Gehrt (M.S., 2021, Haukos). Response of greater prairie-chickens to natural and anthropogenic disturbance on Fort Riley. (Biologist, Federal Aid, U.S. Fish and Wildlife Service, Twin Cities, MN)

Elisabeth Teige (M.S., 2021, Haukos). Assessment of lesser prairie-chicken translocation through survival, space use, and resource selection. (Contract Biologist, USGS, Fort Collins, Colorado)

Nick Parker (M.S., 2021, Sullins/Haukos). Lesser prairie-chicken demography, resource selection, and habitat response following megafire in the mixed-grass prairie. (Ph.D Candidate, Colorado State University)

Alixandra Godar (Ph.D., 2020, Haukos). Ring-necked pheasant population and space use response to landscapes including spring cover crops. (Post-Doctoral Research Associate, Post-Doctoral Research Associate, Patuxent Science Center, USGS)

Carly Aulicky (Ph.D., 2020, Haukos). Lek dynamics and range-wide morphometric patterns of lesser prairie-chickens. (Field Director, Texas Native Prairie Association)

Liam Berigan (M.S., 2019, Haukos). Dispersal, reproductive success, and habitat use by translocated lesser prairie-chickens. (Ph.D Candidate, University of Maine)

Chris Gulick (M.S., 2019, Haukos). Spatial ecology and resource selection by female lesser prairie-chickens within their home ranges and during dispersal. (Ph.D Candidate, University of Florida)

Mitchell Kern (M.S., 2019, Ricketts/Haukos). Fawn survival and bed-site selection of mule deer and white-tailed deer in western Kansas. (Game Warden, Wyoming Game and Fish)

Adela Annis (M.S., 2019, Haukos). Ring-necked pheasant survival, nest habitat use, and predator occupancy in Kansas spring cover crops. (Biologist, Pheasants Forever, Nebraska)

Richard Lehrter (M.S. 2018; Mather). Links between food web structure, biodiversity, and resilience: effects of anthropogenic disturbance on aquatic communities in the Smoky Hill River, KS (Aquatic Technician, NEON Project, Boulder, CO)

Undergraduate Student Research Mentorships

Lucas, Hallie. 2018. Kansas State University. Project: Comparison of avian diversity in playa wetlands along a latitudinal gradient. (Haukos)

White, Madison. 2022. Kansas State University. Project: Survey of pollinators on Fort Riley. (Haukos)

Oeding, Makayla. 2022. Kansas State University. Project: Effect of management on pollinator populations of Fort Riley. (Haukos)

List of Presentations 2018-present

Annis, A. C., A. Godar, D. Haukos, and J. Prendergast. 2018. Effects of spring cover crops on ring-necked pheasant survival and resource selection with notes on mesocarnivore occupancy. Annual Meeting of the Central Mountains and Plains Section of The Wildlife Society, Kearney, Nebraska.

Annis, A. C., A. Godar, D. Haukos, and J. Prendergast. 2018. What drives nest-site selection of Kansas ring-necked pheasants? Kansas Natural Resources Conference, Manhattan, Kansas.

Annis, A.C., A. Godar, D. Haukos, and J. Prendergast. 2018. Survival and nest-site selection of ring-necked pheasants in western Kansas spring cover crops. Annual Meeting of The Wildlife Society, Cleveland, Ohio.

Annis, A.C., A. Godar, D. Haukos, and J. Prendergast. 2019. Are spring cover crops a hot ticket item for chicks? Kansas Natural Resource Conference, Manhattan, Kansas.

Annis, A.C., A. Godar, D. Haukos, and J. Prendergast. 2017. Kansas ring-necked pheasant habitat use and survival in summer cover crops. Kansas Natural Resource Conference, Wichita, KS.

Annis, A.C., A. Godar, D. Haukos, and J. Prendergast. 2017. Survival of ring-necked pheasants in western Kansas spring cover crops. Annual conference of The Wildlife Society, Albuquerque, NM.

Annis, A.C., A. Godar, D. Haukos, and J. Prendergast. 2019. Are cover crops a hot ticket item for chicks? Annual Meeting of The Wildlife Society, Reno, Nevada.

Aulicky, C., and D. Haukos. 2018. Testing the hotspot hypothesis: lesser prairie-chickens lek formation and female space use. International Grouse Symposium, Logan, Utah.

Aulicky, C., and D. Haukos. 2018. What can we learn from morphology? A study of the lesser prairie-chicken (Tympanuchus pallidicinctus) in Kansas. Kansas Natural Resources Conference, Manhattan, Kansas.

Aulicky, C., and D.A. Haukos. 2018. What the lek: testing the hotspot hypothesis. Annual Conference of oSTEM, Houston, Texas.

Aulicky, C., D. Haukos, and K. Fricke. 2018. Not just dusty data: what can we learn from range-wide analyses of lesser prairie-chicken morphology? Annual Meeting of The Wildlife Society, Cleveland, Ohio.

Aulicky, C., and D.A. Haukos. 2019. Testing the hotspot hypothesis: lesser prairie-chicken lek formation and female space use. Kansas Natural Resource Conference, Manhattan, Kansas.

Aulicky, C., and D. Haukos. 2019. Size matters: effects of climate on lesser prairie-chicken body size. Annual meeting, oSTEM, Detroit, Michigan. Poster

Aulicky, C., and D. Haukos. 2019. Testing the Hotspot Hypothesis: lesser prairie-chicken lek formation and female space use. Annual Meeting of The Wildlife Society, Reno, Nevada.

Aulicky, C., and D. Haukos. 2019. Testing the hotspot hypothesis: lesser prairie-chicken lek formation and female space use. Annual Meeting of the American Ornithological Society, Anchorage, Alaska.

Aulicky, C.S.H., and D.A. Haukos. 2019. Not just dusty data: what can we learn from range-wide analyses of lesser prairie-chicken morphology? 33rd Biennial Meeting of the Prairie Grouse Technical Council, Bartlesville, Oklahoma.

Aulicky, C., and D. Haukos. 2020. Lesser prairie-chicken lek formation, lek persistence, and female space use. Annual Meeting of The Wildlife Society, Louisville, Kentucky.

Aulicky, C., and D. Haukos. 2020. What determines lesser prairie-chicken lek persistence? Kansas Natural Resource Conference, Manhattan, Kansas.

Aulicky, C., D. Haukos, K. Fricke, L. Rossi, J. Reitz, and K. Schultz. 2021. Translocated lesser prairie-chicken lek dynamics and female space use. Midwest Fish and Wildlife Conference, virtual.

Aulicky, C., D. Haukos, K. Fricke, L. Rossi, J. Reitz, and K. Schultz. 2021. Role of female space use in lek dynamics of translocated lesser prairie-chickens. Annual Conference of The Wildlife Society (virtual).

Aulicky, C., D. Haukos, K. Fricke, L. Rossi, J. Reitz, and K. Schultz. 2021. Translocated lesser prairie-chicken lek dynamics and female space use. Annual Meeting of the American Ornithological Society. Virtual presentation.

Berigan, L., D. Haukos, D. Sullins, and K. Fricke. 2018. Lesser prairie-chicken translocation: minimizing dispersal to ensure translocation success. Kansas Natural Resources Conference, Manhattan, Kansas.

Berigan, L., D. Sullins, D. Haukos, K. Fricke, J. Reitz, L. Rossi, and K. Schultz. 2018. Translocation of lesser prairie-chickens: does lek presence limit dispersal? Annual Meeting of The Wildlife Society, Cleveland, Ohio.

Berigan, L., D. Sullins, D. Haukos, K. Fricke, J. Reitz, L. Rossi, and K. Schultz. 2018. Role of natal habitat preference induction in prairie-grouse translocation success. International Grouse Symposium, Logan, Utah.

Berigan, L., C. Aulicky, and D.A. Haukos. 2019. Avoidance of traditional habitat types by translocated lesser prairie-chickens. Annual Conference of oSTEM, Houston, Texas.

Berigan, L., C. Aulicky, D. Sullins, D. Haukos, K. Fricke, J. Reitz, L. Rossi, and K. Schultz. 2019. Overcoming post-release dispersal to successfully translocate lesser prairie-chickens. Annual Meeting of The Wildlife Society, Reno, Nevada.

Berigan, L., C. Aulicky, D. Sullins, D. Haukos, K. Fricke, J. Reitz, L. Rossi, and K. Schultz. 2019. Landscape composition explains high rates of dispersal in translocated lesser prairie-chickens. Annual Meeting of the American Ornithological Society, Anchorage, Alaska.

Berigan, L., C. Aulicky, D. Sullins, D. Haukos, K. Fricke, J. Reitz, L. Rossi, and K. Schultz. 2019. Conservation implications of lesser prairie-chicken habitat selection on the Cimarron National Grasslands. Kansas Natural Resource Conference, Manhattan, Kansas.

Berigan, L., C. Aulicky, E. Teige, D. Sullins, D. Haukos, K. Fricke, J. Reitz, L. Rossi, and K. Schultz. 2019. Dispersal, habitat use, and eventual settlement of translocated lesser prairie-chickens. 33rd Biennial Meeting of the Prairie Grouse Technical Council, Bartlesville, Oklahoma.

Blackmore, P., J. Taylor, L. Skabelund, D. Haukos, and B. Chamberlain. 2018. Butterflies using urban green roofs in the tallgrass prairie landscape. Annual Meeting of US Regional Association of the International Association for Landscape Ecology, Chicago, Illinois.

Boal, C.W., S.A. Morris, D.A. Haukos, and B.A. Grisham. 2021. Variance in clutch size and egg morphology of lesser prairie-chickens across a climate gradient. Annual Conference of The Wildlife Society (virtual).

DeVries, D., J. Garvey, M. Mather, K. Pope, S. Hitchman, and J. Smith. 2022. Connecting biology to policy: linking scales for data collection to scales needed for the decision-making process. Joint Aquatic Science Meeting (JASM), Grand Rapids, MI.

Finn, J. T., M. E. Mather, S. Hitchman, M. P Carey, R. Tingley, O. Rode, C. Aymami, D. Oliver, and J. Dettmers. 2022. Monitoring that inspires research: linking monitoring and research data. Joint Aquatic Science Meeting (JASM), Grand Rapids, MI.

Gehrt, J.A., D.S. Sullins, and D.A. Haukos. 2018. Looking at the bigger picture: how availability of nesting and brooding habitat influences lek-site selection by lesser prairie-chickens. Annual Meeting of The Wildlife Society, Cleveland, Ohio.

Gehrt, J., D. Sullins, and D. Haukos. 2019. Taking an Incubation break: the where, when, and why of lesser prairie- chickens leaving their nests. Annual Meeting of The Wildlife Society, Reno, Nevada.

Gehrt, J., D. Sullins, and D. Haukos. 2019. Taking an incubation break: The where, when, and why of lesser prairie- chickens leaving their nests. Kansas Natural Resource Conference, Manhattan, Kansas.

Gehrt, J.M., D.S. Sullins, and D.A. Haukos. 2019. The comings and goings of lesser prairie-chickens: intrinsic and extrinsic influence on female nest attendance. 33rd Biennial Meeting of the Prairie Grouse Technical Council, Bartlesville, Oklahoma.

Gehrt, J.M., S. Stratton, and D.A. Haukos. 2020. Demographic responses of greater prairie-chickens to fire, haying, and military activity on Fort Riley Military Reservation in Riley, Kansas. Kansas Natural Resource Conference, Manhattan, Kansas.

Gerht, J.A., D. Moon, and D.A. Haukos. 2020. Effects of management strategies and military activity on greater prairie-chicken ecology on Fort Riley Military Reservation. Annual Meeting of The Wildlife Society, Louisville, Kentucky.

Gerht, J.A., D. Moon, and D.A. Haukos. 2020. Greater Prairie-chicken habitat selection within a mosaic burning regime on Fort Riley Military Reservation. Annual meeting of the Kansas Ornithological Society, virtual.

Gehrt, J.A., D.A. Moon, and D.A. Haukos. 2021. Greater prairie-chicken habitat selection in response to fire and manmade structures on Fort Riley Military Reservation. Midwest Fish and Wildlife Conference, virtual.

Gehrt, J.M., D.A. Moon, and D.A. Haukos. 2021. Effects of military activity on greater prairie-chicken space use in a constrained environment on Fort Riley Military Reservation in Kansas. Annual Conference of The Wildlife Society (invited, virtual).

Godar, A., A. Annis, D. Haukos, and J. Prendergast. 2018. Can you find pheasants in spring cover crops? Kansas Natural Resources Conference, Manhattan, Kansas.

Godar, A., A. Annis, D. Haukos, and J. Prendergast. 2018. Cover crops: Altering an altered landscape to benefit wildlife? Annual Meeting of the Central Mountains and Plains Section of The Wildlife Society, Kearney, Nebraska.

Godar, A., A. Annis, D. Haukos, and J. Prendergast. 2018. Do pheasants use spring cover crops? Midwest Fish and Wildlife Conference, Milwaukee, Wisconsin.

Godar, A., A. Annis, D. Haukos, and J. Prendergast. 2018. Pheasant habitat selection: logical or mysterious. Annual Meeting of The Wildlife Society, Cleveland, Ohio.

Godar, A.J., B.A. Grisham, B.E. Ross, C.W. Boal, D. Greene, C.P. Griffin, C.A. Hagen, D.A. Haukos, M.A. Patten, and J.C. Pitman. 2018. Rangewide lesser prairie-chicken population persistence with climate change. International Grouse Symposium, Logan, Utah.

Godar, A., A. Annis, D. Haukos, and J. Prendergast. 2019. For the birds: modifying western Kansas using spring cover crops to manage for pheasants. Kansas Natural Resource Conference, Manhattan, Kansas.

Godar, A., A. Annis, D. Haukos, and J. Prendergast. 2019. Grassland bird response to spring cover crops in an agricultural landscape. Annual Meeting of the American Ornithological Society, Anchorage, Alaska.

Godar, A., A. Annis, D. Haukos, and J. Prendergast. 2019. Scale dependency: influencing pheasant populations using cover crops. Annual Meeting of The Wildlife Society, Reno, Nevada.

Godar, A., and D. Haukos. 2019. Resource selection of pheasants in response to use of cover crops. Graduate Student Forum, Division of Biology, Kansas State University, Manhattan.
Godar, A., A. Piernicky, D. Haukos, and J. Prendergast. 2020. Adding diversity to the landscape with spring cover crops. Kansas Natural Resource Conference, Manhattan, Kansas.
Godar, A., A. Piernicky, D. Haukos, and J. Prendergast. 2020. Influence of spring cover crops on ring-necked pheasant populations in Kansas. Annual Meeting of The Wildlife Society, Louisville, Kentucky.
Godar, A., A. Piernicky, D. Haukos, and J. Prendergast. 2020. Supporting grassland birds using spring cover crops. Annual meeting of the Kansas Ornithological Society, virtual.
Godar, A., and D. Haukos. 2020. Bugs and Birds. Nebraska Pheasants Forever Team Meeting. Fall meeting, virtual (Invited presentation).
Godar, A., and D. Haukos. 2020. Ring-necked pheasant population and space use response to landscapes including spring cover crops. "Frontiers in Agriculture" speaker, Agricultural Conservation Committee, Association of Fish and Wildlife Agencies, Fall meeting, virtual (Invited presentation).
Godar, A., A. Piernicky, D. Haukos, and J. Prendergast. 2021. Influence of spring cover crops on ring-necked pheasant populations in Kansas. Changing the Agricultural Landscape with Cover Crops, Symposium, Midwest Fish and Wildlife Conference, virtual (Invited presentation).
Godar, A., A. Piernicky, D. Haukos, and J. Prendergast. 2021. Reliance on CRP for breeding by ring-necked pheasants in Kansas. Annual Conference of The Wildlife Society (virtual).
Godar, A., A. Piernicky, D. Haukos, and J. Prendergast. 2022. Ring-necked pheasant use of spring cover crops. Kansas Natural Resource Conference, Manhattan (poster).
Granco, G., J. Heier Stamm, M. Daniels, J. Bergtold, M. Caldas, M. Sanderson, A. Sheshukov, M. Mather, and D. Haukos. 2018. Culture influences on human decision-making processes toward environmental policy: an integrative model of human-environment interaction. International Congress on Environmental Modelling and Software, Fort Collins, Colorado.
Granco, G., and M. Mather. 2022. New questions to understand how culture can affect sustainability policies: linking scales in a multi-use freshwater ecosystem. Joint Aquatic Science Meeting (JASM), Grand Rapids, MI.
Griffin, C., A. Godar, D. Greene, B. Grisham, C. Boal, D. Haukos, G. Beauprez, J. Pitman, and C. Hagen. 2018. A range–wide assessment on the influence of anthropogenic structure dispersion and land cover patch size on lesser prairie-chicken lek attendance. International Grouse Symposium, Logan, Utah.
Gulick, C., and D. Haukos. 2018. Spatial patterns of lesser prairie-chickens in response to different disturbance regimes. International Grouse Symposium, Logan, Utah.
Gulick, C., and D.A. Haukos. 2018. Factors affecting habitat availability for lesser prairie-chickens across different land management regimes. Kansas Natural Resources Conference, Manhattan, Kansas.
Gulick, C., D. Haukos, and J. Lautenbach. 2018. Effect of grazing management systems on space use by cattle and lesser prairie-chickens. Annual Meeting of The Wildlife Society, Cleveland, Ohio.
Gulick, C., and D.A. Haukos. 2019. Influence of grassland management systems on fine-scale distribution of lesser prairie-chickens and their habitat. Annual Meeting of the Society for Range Management, Minneapolis, Minnesota.
Gulick, C., and D.A. Haukos. 2019. Influence of landscape features on female lesser prairie-chicken dispersal routes. Kansas Natural Resource Conference, Manhattan, Kansas.

Hagen, C., J. Kraft, J. Lautenbach, and D. Haukos. 2018. Holy cow! How grazing management strategies influence lesser prairie-chicken space use and demography. International Grouse Symposium, Logan, Utah.

Haukos, D.A. 2018. Beyond format and style. Workshop Presentation as part of "Don't Get Rejected! Tips for Writing Manuscripts That Get Accepted and Published." Annual Conference of The Wildlife Society, Cleveland, Ohio. (Invited)

Haukos, D.A. 2018. Ecosystem services and playa lakes of the Great Plains. Keynote Speaker, Playa Lakes Workshop and Tour, Kansas Alliance of Wetlands and Streams, Oakley, Kansas (Invited).

Haukos, D.A. 2018. Lesser prairie-chickens – a case study in cooperative conservation. Invited presentation in symposium "Challenges of balancing stakeholder engagement and scientific decision-making to inform wildlife policy" Annual Conference of The Wildlife Society, Cleveland, Ohio (Invited).

Haukos, D.A. 2018. Role of soil health in conservation of wetlands. Kansas Soil Health Coalition, Phase 2, Manhattan, Kansas (Invited).

Haukos, D.A. 2018. Wildlife, farming, and ranching in Kansas - ecology, economics, and expectations. Keynote address, Phi Beta Kappa Induction Ceremony, Kansas State University, Manhattan, Kansas (Invited).

Haukos, D.A., and W.C. Conway. 2018. Playas and Saline Lakes – Threatened Systems of the Semi-Arid High Plains. Annual conference of the Society of Wetland Scientists, Denver, CO. Invited presentation in symposium "Arid Wetlands: Conservation Challenges and Research Needs" (Invited).

Haukos, D., T Karish, D. Ricketts, L. Jaster, M. Kinlan, and M. Kern. 2019. Resource selection of female mule deer and white-tailed deer in western Kansas. Annual Meeting of The Wildlife Society, Reno, Nevada.

Haukos, D.A. 2019. Animals as indicators of environmental changes. Special Session "One Health and Animal Research - A Cross-Link to Promote Human, Animal, and Environmental Health", American Association for Laboratory Animal Science National Meeting. Denver, Colorado (Invited).

Haukos, D.A. 2019. Lesser prairie-chicken response to changing landscapes and climate. Plenary presentation, Western Association of Fish and Wildlife Agencies, Manhattan, Kansas (Invited).

Haukos, D.A. 2020. Ecosystem services and playa lakes of the Great Plains. Keynote Speaker, Playa Lakes Workshop and Tour, Kansas Alliance of Wetlands and Streams, Garden City, Kansas (Invited).

Haukos, D.A. 2020. Effects of saline lakes and playa wetland ecological state changes on sandhill crane space use of the Southern High Plains. North American Crane Workshop, Lubbock, Texas (Invited).

Haukos, D. 2021. Ecology of mule deer and white-tailed deer in western Kansas. Invited seminar, Colorado Division of Parks and Wildlife.

Haukos, D. 2021. The beauty and mystery of wetlands. Invited seminar, Festival of the Cranes. Flint Hill Audubon Society.

Haukos, D., A. Godar, A. Piernicky, and J. Prendergast. 2021. Managing agricultural landscapes for wildlife with cover crops. Changing the Agricultural Landscape with Cover Crops, Symposium, Midwest Fish and Wildlife Conference, Virtual (Invited).

Haukos, D.A. 2022. Science informs managing working lands for lesser prairie-chickens. Invited seminar, NRCS, USDA.

Haukos, D. 2022. Prioritization strategy for conservation of Greater Plains isolated wetland systems. Invited Seminar, Department of Natural Resource Management, Texas Tech University (Virtual).

Haukos, D. 2022. Essentials for certification by The Wildlife Society. Invited Workshop, Central Mountains and Plains Section, Kansas Natural Resources Conference, Manhattan, KS.

Hitchman, S. M., M. E. Mather, J. M. Smith, K. Pope, D. DeVries, J. Garvey, R. Tingley, and M. Carey. 2022. Scale: direction and progress for impactful science-based conservation. Joint Aquatic Science Meeting (JASM), Grand Rapids, MI.

Karish, T., D. Haukos, A. Ricketts, and L. Jasper. 2018. Resource selection and movements of female mule deer and white-tailed deer during parturition and lactation in western Kansas. Annual Meeting of The Wildlife Society, Cleveland, Ohio.

Karish, T., D. Haukos, A. Ricketts, L. Jaster, M. Kinlan, and M. Kern. 2019. Seasonal activity patterns of female white-tailed deer and mule deer in western Kansas. Annual Meeting of The Wildlife Society, Reno, Nevada.

Karish, T., D. Haukos, A. Ricketts, Levi Jaster, M. Kinlan, and M. Kern. 2019. Resource selection and movements of female mule deer and white-tailed deer in western Kansas. Kansas Natural Resource Conference, Manhattan, Kansas.

Karish, T., D. Haukos, A.M. Ricketts, and L. Jaster. 2020. Resource selection in multiple spatial scales by female mule deer and white-tailed deer in western Kansas. Annual Meeting of The Wildlife Society, Louisville, Kentucky.

Karish, T., M. Kinlan, M. Kern, D. Haukos, A.M. Ricketts, and L. Jaster. 2021. Ecology of white-tailed deer in western Kansas. Southeastern Deer Study Group, Virtual presentation.

Karish, T., D. Haukos, A. Ricketts, L. Jaster, M. Kinlan, and M. Kern. 2021. Activity patterns and movements of mule deer and white-tailed deer in western Kansas. Annual Meeting of American Society of Mammalogists, Virtual presentation.

Karish, T., D. Haukos, A. Ricketts, and L. Jaster. 2021. Resource selection by female mule deer and white-tailed deer in western Kansas. Annual Conference of The Wildlife Society (virtual).

Kern, M., A. Ricketts, D. Haukos, and L. Jasper. 2018. Survival and cause-specific mortality of white-tailed and mule deer fawns in western Kansas. Annual Meeting of The Wildlife Society, Cleveland, Ohio.

Kern, M., M. Kinlan, T. Karish, A. Ricketts, D. Haukos, and L. Jaster. 2019. Neonate survival rates and bed-site selection of two sympatric deer species in western Kansas. Annual Meeting of The Wildlife Society, Reno, Nevada.

Kern, M., M. Kinlan, T. Karish, A. Ricketts, D. Haukos, and Levi Jaster. 2019. Neonate survival rates and bed-site selection of two sympatric deer species in western Kansas. Kansas Natural Resource Conference, Manhattan, Kansas.

Kern, M. J., M. A. Kinlan, T. Karish, A. M. Ricketts, D. A. Haukos, and L. A. Jaster. 2020. Fawn survival of white-tailed and mule deer in Kansas. Kansas Natural Resource Conference. Manhattan, KS.

Kinlan, M., D. Haukos, A. Ricketts, and L. Jasper. 2018. Seasonal survival and movements of male mule deer and white-tailed deer in western Kansas. Annual Meeting of The Wildlife Society, Cleveland, Ohio.

Kinlan, M., D. Haukos, A. Ricketts, and Levi Jaster. 2019. Movement patterns and resource selection of male mule deer and white-tailed deer in western Kansas. Annual Meeting of The Wildlife Society, Reno, Nevada.

Kinlan, M., D. Haukos, A. Ricketts, and Levi Jaster. 2019. Seasonal survival, land-cover selection, and movements of male mule deer and white-tailed deer in western Kansas. Kansas Natural Resource Conference, Manhattan, Kansas.

Kinlan, M.A., D. Haukos, A.M. Ricketts, and L. Jaster. 2020. Influence of hunting on survival of adult male mule and white-tailed deer in western Kansas. Annual Meeting of The Wildlife Society, Louisville, Kentucky.

Lloyd, J.D., C. Aldridge, T. Allison, D. Haukos, C. LeBeau, L. McNew, and V. Winder. 2022. Prairie grouse and wind energy: the state of the science. Annual Conference of The Wildlife Society, Spokane, Washington (Invited).

Malanchuk, J. B., D. S. Sullins, and D. A. Haukos. 2019. Probability of mottled duck pair pond use on the Chenier Plain, Texas. North American Duck Symposium, Winnipeg, Manitoba.

Malanchuk, J., D. Haukos, and T. Bidrowski. 2019. Population status and vital rates of temperate-breeding Canada geese in Kansas. Annual Meeting of The Wildlife Society, Reno, Nevada.

Malanchuk, J., T. Bidrowski, and D. Haukos. 2020. Survival, recovery, and translocation of Kansas-banded Canada geese. Annual Meeting of The Wildlife Society, Louisville, Kentucky.

Malanchuk, J.B., and D. Haukos. 2020. Survival, recovery, and translocation of temperate-breeding Kansas-banded Canada geese. Kansas Natural Resource Conference, Manhattan, Kansas.

Mather, M. E. 2018. Implicit gender bias limits workplace diversity in the scientific profession: evidence, consequences, and remedies, Ecology and Evolutionary Biology seminar, Kansas State University, Manhattan, KS.

Mather, M. E. 2018. Strategic science–based natural resource conservation and sustainability: balancing tradition and innovation to guide change. Michigan State University, Department of Fisheries and Wildlife, East Lansing, MI.

Mather, M. E., 2018. Using empirical data on fish mobility to identify, test, and refine conceptual frameworks that can advance science-based aquatic conservation. Kansas State University Division of Biology Seminar, Manhattan, KS. Mather, M. E., D. Shoup, and Q. Phelps. 2018. Thinking critically and comprehensively about choice of sampling gear in fish data collection: a review and perspective on what we need to know about gear to improve fisheries research and science-based aquatic resource conservation. Presentation in symposium on Standardized Gear. 78th Midwest Fish and Wildlife Meeting, January, Milwaukee, WI.

Mather, M. E., D. Shoup. Q. Phelps. 2018. Placing gear evaluation and standardization in a broader context that advances science-based fisheries management. Invited presentation, Symposium, Midwest Fish and Wildlife Meeting, Milwaukee, WI, January 2018.

Mather, M. E., J. M. Dettmers, D. L. Parrish, R. A. State, and E. A. Marschall. 2018. A portfolio of integrated monitoring and research can advance successful science-based conservation and fisheries management. Invited Presentation (Symposium: Fisheries Successes), Annual Meeting, American Fisheries Society, Atlantic City, NJ.

Mather, M. E., J. M. Dettmers, R. A. Stein, D. L. Parrish, D. Glover. 2019. A portfolio approach to integrated assessment and research can provide a larger context for the successful evaluation of fisheries harvest regulations. 79th Midwest Fish and Wildlife Meeting, January, Cleveland, OH.

Mather, M. E., J. M. Smith, J. M. Dettmers, S. M. Hitchman, J. T. Finn. 2019. Identifying and operationalizing big hairy audacious goals for fish habitat research, management, and conservation. Presentation is part of a symposium entitled “Habitat Modeling Across Terrains and Disciplines: Addressing Common Challenges in Fisheries and Wildlife.”149th Annual American Fisheries Society Meeting and Joint Conference with The Wildlife Society in Reno, Nevada, September 29-October 3, 2019.

Mather, M.E., D. Shoup, and Q. Phelps. 2019. Ensuring that technological advances actually advance the fisheries profession: Developing a strategic framework that uses advanced technologies to solve persistent fisheries problems. Presentation is part of a symposium entitled “Integrating Advanced Technologies to Improve Data Quality and Reduce Bias in Fisheries and Wildlife Population Research and Management.” 149th Annual American Fisheries Society Meeting and Joint Conference with The Wildlife Society in Reno, Nevada, September 29-October 3, 2019.

Mather, M. E. 2020. Why aren’t we more successful in conserving rivers and river fish? 150th Annual Meeting of American Fisheries Society, Columbus, OH. Invited Presentation for Symposium Entitled “Merging Data Science and Fisheries and Aquatic Science to Solve Big Problems.”

Mather, M. E. 2020. Combining Freakonomics with Data Fusion to Advance Big Data Approaches for Fisheries and Aquatic Conservation Problem Solving. 150th Annual Meeting of American Fisheries Society, Columbus, OH. Invited Presentation for Symposium Entitled “Merging Data Science and Fisheries and Aquatic Science to Solve Big Problems.”

Mather, M. E. 2021. We have been working on this forever: why is “diversity and inclusion” so hard? Invited presentation for a symposium entitled “Diversity and inclusion: a strategy to implement change for 2021 and beyond.” 151st Annual Meeting of the American Fisheries Society, November 6-10, 2021, Baltimore, MD.

Mather, M. E., C. Aymami, and O. Rode. 2021. Plotting a course for science-based, data-driven watershed conservation through the development of a regional collaboration. Invited presentation for a symposium entitled “Creating and Implementing an Ecosystem-wide Integrated Research Agenda and Conservation Plan for Prairie Streams: A Shared Vision, Next Generation Synthesis, and Future Action Plan .” 151st Annual Meeting of the American Fisheries Society, November 6-10, 2021, Baltimore, MD.

Mather, M., P. Angermeier, K. Pope, Chuck Hopkinson, and M. Vanni 2022. Framing questions differently can catalyze innovative solutions to complex aquatic science problems. Joint Aquatic Science Meeting (JASM), Grand Rapids, MI.

Messier, A., D. Sullins, D. Haukos, and C. O’Meilia. 2021. Evaluating the role of NDVI-Based phenology metrics in lesser prairie-chicken nest-site selection. Annual Conference of The Wildlife Society (virtual).

Messier, A., D. Sullins, D. Haukos, and C. O’Meilia. 2021. Lesser prairie-chicken resource selection following megafire in the mixed-grass prairie. Kansas Natural Resource Conference, Virtual poster.

Messier, A., D. Sullins, D. Haukos, and C. O’Meilia. 2022. Evaluating the role of vegetation phenology metrics in lesser prairie-chicken nest and brood-site selection. Kansas Natural Resource Conference, Manhattan.

Messier, A., D. Sullins, D. Haukos, and C. O’Meilia. 2022. Predicting within grassland habitat abundance for lesser prairie-chickens using gradient landscape and vegetation phenology metrics Annual Conference of The Wildlife Society, Spokane, Washington.

Morris, S.A., C.W. Boal, D.A. Haukos, and B.A. Grisham. 2020. Variability in lesser prairie-chicken egg morphometrics and appearance across a climate gradient. Annual Meeting of the Texas Chapter of the Wildlife Society, Corpus Christi, Texas.

Nepal, V., M. Fabrizio, B. Knuth, M. Mather, and D. Parrish. 2022. Asking different questions can overcome obstacles and identify new solutions to achieving human diversity in the aquatic sciences. Joint Aquatic Science Meeting (JASM), Grand Rapids, MI.

Nifong, J., M. E. Mather, S. Hitchman, J, Smith. 2018. Integrating spatial patterns into future conservation, restoration, and management programs. Kansas Natural Resource Conference, Manhattan, KS.

Owen, R.K., D. Fowler, E.B. Webb, K.W. Goyne, and D.A. Haukos. 2019. Playas to potholes: how will climate change impact soil biogeochemistry in Great Plains prairie wetlands? Annual Meeting of the Soil Science Society of America, San Diego, California.

Parker, N.J., D.S. Sullins, D.A. Haukos, K.A. Fricke, and C.A. Hagen. 2019. Lesser prairie-chicken and grassland response following intense wildfire in Kansas. 33rd Biennial Meeting of the Prairie Grouse Technical Council, Bartlesville, Oklahoma.

Parker, N.J., D.S. Sullins, D.A. Haukos, K.A. Fricke, and C.A. Hagen. 2019. Rising from the ashes? Lesser prairie-chicken and grassland response to intense wildfire in Kansas. Annual Meeting of The Wildlife Society, Reno, Nevada.

Parker, N.J., D.S. Sullins, D.A. Haukos, K.A. Fricke, and C.A. Hagen. 2020. Effects of a megafire on lesser prairie-chickens in the mixed-grass prairie. Annual Meeting of The Wildlife Society, Louisville, Kentucky.

Parker, N.J., D.S. Sullins, D.A. Haukos, K.A. Fricke, and C.A. Hagen. 2020. Influence of a megafire on lesser prairie-chicken habitat use and quality in the Mixed-Grass Prairie. Kansas Natural Resource Conference, Manhattan, Kansas.

Parker, N.J., D.S. Sullins, D.A. Haukos, K.A. Fricke, and C.A. Hagen. 2021. Lesser prairie-chicken space use following megafire in the Mixed-Grass Prairie. Annual Conference of The Wildlife Society (virtual).

Parker, N.J., D.S. Sullins, D.A. Haukos, K.A. Fricke, and C.A. Hagen. 2021. Lesser prairie-chicken resource selection following megafire in the mixed-grass prairie. Kansas Natural Resource Conference, Virtual poster.

Parker, N.J., D.S. Sullins, D.A. Haukos, K.A. Fricke, and C.A. Hagen. 2021. Lesser prairie-chicken habitat use and selection following a megafire in the mixed-grass prairie. Midwest Fish and Wildlife Conference, virtual.

Peterson, J., S. Fuhlendorf, D. Elmore, A. Tanner, J. Earl, D. Haukos, and S. Carleton. 2018. Effects of anthropogenic structures on the long-distance movements of lesser prairie-chickens. Midwest Fish and Wildlife Conference, Milwaukee, Wisconsin.

Portillo-Quintero, C., B. Grisham, D. Haukos, C. Boal, C. Hagen, and Z. Wan. 2018. Trends of the landscape structure of plant communities of sand shinnery oak prairie in the Southern High Plains. Society of Range Management, Sparks, Nevada.

Rieber, C., T. Hefley, and D. Haukos. 2022. Bayesian machine learning for movement modeling of lesser prairie-chickens. Annual Conference of The Wildlife Society, Spokane, Washington.

Rieber, C. T. Hefley, and D. Haukos. 2022. Estimating metrics characterizing lesser prairie-chicken movements. Kansas Natural Resource Conference, Manhattan (poster).

Ross, B.E., D.S. Sullins, and D.A. Haukos. 2018. Using an individual-based model to assess monitoring for lesser prairie-chicken population growth rates. International Grouse Symposium, Logan, Utah.

Ross, B.E., D.S. Sullins, and D.A. Haukos. 2018. Using an individual-based model to assess monitoring for lesser prairie-chicken population growth rates. Kansas Natural Resources Conference, Manhattan, Kansas.

Rossi, L., K. Fricke, J. Reitz, K. Schultz, and D. Haukos. 2018. Managing for recover of a prairie icon: the future of lesser prairie-chicken management. International Grouse Symposium, Logan, Utah.

Schindler, A., B. Ross, and D. Haukos. 2018. A multi-species approach to managing the effects of weather and land cover on upland game birds. Kansas Natural Resources Conference, Manhattan, Kansas.

Schindler, A.R., B. E. Ross, and D. A. Haukos. 2019. The use of decision-support software to select candidate areas for lesser prairie-chicken conservation. Annual Meeting of US-IALE (International Association of Landscape Ecologists), Fort Collins, Colorado.

Sirch, M., D.S. Sullins, D.A. Haukos, and J.D. Kraft. 2018. Lesser prairie-chicken response to intensive wildfire: one year post wildfire. Annual Meeting of the Kansas Ornithological Society, Lawrence, Kansas.

Sirch, M.S., D.S. Sullins, D.A. Haukos, and J. Kraft. 2019. Influence of burn severity on tree mortality and lesser prairie-chicken habitat in the mixed-grass prairie. Kansas Natural Resource Conference, Manhattan, Kansas.

Sullins, D.S., B.E. Ross, and D.A. Haukos. 2018. Influence of individual heterogeneity on lesser prairie-chicken population persistence. Annual Meeting of The Wildlife Society, Cleveland, Ohio.

Sullins, D.S., D.A. Haukos, J.M. Lautenbach, and J.D. Kraft. 2018. Tradeoffs of nest and brood habitat availability for lesser prairie-chickens. International Grouse Symposium, Logan, Utah.

Sullins, D. S., B. E., Ross, and D. A. Haukos. 2018. Potential bias of lesser prairie-chicken population estimates when not accounting for individual heterogeneity. Kansas Natural Resources Conference, Manhattan, Kansas.

Sullins, D., D. Haukos, and C. Hagen. 2019. Hierarchical ecological benefits of the Conservation Reserve Program in the Southern Great Plains. Annual Meeting of The Wildlife Society, Reno, Nevada. (Invited)

Sullins, D.S., M.S. Sirch, J. Kraft, and David A. Haukos. 2019. Lesser prairie-chicken response to herbaceous vegetation change following intensive wildfire. Kansas Natural Resource Conference, Manhattan, Kansas.

Sullins, D.S., D.A. Haukos, C.A. Hagen, and K.C. Olson. 2021. Targeted tree removal to benefit prairie grouse and cattle operations. Annual Conference of The Wildlife Society (invited, virtual).

Teige, E., L. Berigan, C. Aulicky, D. Haukos, K. Fricke, J. Reitz, L. Rossi, and K. Schultz. 2020. Assessing the role of translocation in lesser prairie-chicken conservation. Annual Meeting of The Wildlife Society, Louisville, Kentucky.

Teige, E., L. Berigan, C. Aulicky, D. Haukos, K. Fricke, J. Reitz, L. Rossi, and K. Schultz. 2019. A new hope: monitoring the effectiveness of lesser prairie-chicken translocation in the Sand Sagebrush Ecoregion of southwestern Kansas and southeastern Colorado. Annual Meeting of The Wildlife Society, Reno, Nevada.

Teige, E.C., L.A. Berigan, C.S.H. Aulicky, D.A. Haukos, K. Fricke, K. Schultz, J. Reitz, and L. Rossi. 2019. Assessing a lesser prairie-chicken translocation in the sand sagebrush prairie ecoregion. 33rd Biennial Meeting of the Prairie Grouse Technical Council, Bartlesville, Oklahoma.

Teige, E., L. Berigan, C. Aulicky, D. Haukos, K. Fricke, K. Schultz, J. Reitz, and L. Rossi. 2020. Where do they go? Lesser prairie-chicken space use following translocation to the Sand Sagebrush Prairie Ecoregion. Kansas Natural Resource Conference, Manhattan, Kansas.

Teige, E., L. Berigan, C. Aulicky, D. Haukos, K. Fricke, J. Reitz, L. Rossi, and K. Schultz. 2020. Assessing the role of translocation in lesser prairie-chicken conservation. Annual Meeting of The Wildlife Society, Louisville, Kentucky.

Teige, E.C. Lesser Prairie-chicken response to translocation to southwestern Kansas and southeastern Colorado. Kansas Ornithological Society. Virtual 2021. (Oral Presentation)

Teige, E., L. Berigan, C. Aulicky, D. Haukos, K. Fricke, J. Reitz, L. Rossi, and K. Schultz. 2021. After the dust settles: survival, space use, and resource selection of translocated lesser prairie-chickens. Annual Conference of The Wildlife Society (virtual).

Teige, E., L. Berigan, C. Aulicky, D. Haukos, K. Fricke, J. Reitz, L. Rossi, and K. Schultz. 2021. Habitat space use of translocated lesser prairie-chickens to the Sand Sagebrush Prairie Ecoregion. Midwest Fish and Wildlife Conference, virtual.

Verheijen, B.H.F., D. M. Varner, and D. A. Haukos. 2018. Wetland functionality and continued loss negatively affect network connectivity and structure of the Rainwater Basin, Nebraska. Kansas Natural Resource Conference, Manhattan, Kansas.

Verheijen, B.H.F., D. M. Varner, and D.A. Haukos. 2018. Effects of inundation probability and sediment accumulation on the connectivity and structure of the Rainwater Basin, Nebraska. Annual Meeting of The Wildlife Society, Cleveland, Ohio.

Verheijen, B.H.F., D. M. Varner, and D.A. Haukos. 2018. Effects of large-scale wetland loss on network connectivity of the Rainwater Basin. Annual Meeting of the Central Mountains and Plains Section of The Wildlife Society, Kearney, Nebraska.

Verheijen, B.H.F., D. M. Varner, and D.A. Haukos. 2018. Effects of large-scale wetland loss on network connectivity of the Rainwater Basin. Kansas Natural Resources Conference, Manhattan, Kansas.

Verheijen, B.H.F., D. M. Varner, and D.A. Haukos. 2018. The effects of large-scale wetland loss on network connectivity of the Rainwater Basin, Nebraska. Midwest Fish and Wildlife Conference, Milwaukee, Wisconsin.

Verheijen, B.H.F., H.L. Clipp, A.J. Bartolo, W.E. Jensen, and B.K. Sandercock. 2018. Effects of patch-burn grazing on density and territorial space use of Dickcissels. The 27th International Ornithological Congress. Vancouver, British Columbia, Canada. August 2018.

Verheijen, B.H.F, C.K.J. Gulick, J.D. Kraft, J.D. Lautenbach, J.M. Lautenbach, R.T. Plumb, S.G. Robinson, D.S. Sullins, and D.A. Haukos. 2019. How can breeding stage-specific estimates of movements and space use of female lesser prairie-chickens (Tympanuchus pallidicinctus) aid conservation efforts? Annual Meeting of The Wildlife Society, Reno, Nevada.

Verheijen, B.H.F., and D.A. Haukos. 2019. How can breeding stage-specific estimates of movements and space use of female lesser prairie-chickens aid conservation efforts? 33rd Biennial Meeting of the Prairie Grouse Technical Council, Bartlesville, Oklahoma.

Verheijen, B.H.F., C.K.J. Gulick, C.A. Hagen, J.D. Kraft, J.D. Lautenbach, J.M. Lautenbach, R.T. Plumb, S.G. Robinson, D.S. Sullins, and D.A. Haukos. 2020. Extrinsic and intrinsic drivers of resource selection by female lesser prairie-chickens. Annual Meeting of The Wildlife Society, Louisville, Kentucky.

Verheijen, B.H.F., C.K.J. Gulick, J.D. Kraft, J.D. Lautenbach, J.M. Lautenbach, R.T. Plumb, S.G. Robinson, D.S. Sullins, and D.A. Haukos. 2020. Is grassland always grassland? Spatiotemporal variation in grassland patch selection by lesser prairie-chickens. Annual meeting of the Kansas Ornithological Society, virtual.

Verheijen, B.H.F., D.M. Varner, and D.A. Haukos. 2020. Effects of future wetland losses on network connectivity of the Rainwater Basin, Nebraska. 25th Annual Rainwater Basin Joint Venture Information Seminar, Great Bend, Nebraska.

Verheijen, B.H.F., C.K.J. Gulick, J.D. Kraft, J.D. Lautenbach, J.M. Lautenbach, R.T. Plumb, S.G. Robinson, D.S. Sullins, and D.A. Haukos. 2021. Is grassland always grassland? Spatiotemporal variation in grassland patch selection by lesser prairie-chickens. Midwest Fish and Wildlife Conference, virtual.

Verheijen, B.H.F., D.A. Haukos, and D.S. Sullins. 2021. Spatiotemporal variation and individual heterogeneity in resource selection by lesser prairie-chickens. Annual Conference of The Wildlife Society (virtual).

Vhay, M., D. A. Haukos, D. S. Sullins, and M. B. Rice. 2022. Changing habitat quality for lesser prairie-chickens in the Sand Sagebrush Prairie Ecoregion. Kansas Natural Resource Conference, Manhattan.

Vhay, M., D. Sullins, and D. Haukos. 2021. Assessing long-term changes in lesser prairie-chicken habitat quality across the Sand Sagebrush Prairie Ecoregion. Annual Conference of The Wildlife Society (virtual).

Vhay, M., D. A. Haukos, D. S. Sullins, and M. B. Rice. 2022. A retrospective assessment of lesser prairie- chicken habitat quality in the Sand Sagebrush Prairie. Midwest Fish and Wildlife Conference, Des Moines, Iowa.

Vhay, M., D. Haukos, D. S. Sullins, and M. B. Rice. 2022. Declining habitat quality and quantity for lesser prairie-chickens of the Sand Sagebrush Prairie. Annual Conference of The Wildlife Society, Spokane, Washington.

Vhay, M., D. Haukos, D. S. Sullins, and M. B. Rice. 2022. Assessment of lesser prairie-chicken habitat quality in the Sand Sagebrush Prairie. North American Congress for Conservation Biology, Reno, Nevada.

Ware, M., J. Gehrt, and D. Haukos. 2021. Non-breeding space use and survival of a constrained population of Greater Prairie-chickens on Fort Riley Military Reservation in Kansas. Annual Conference of The Wildlife Society (virtual).

Whitson, M.D., W.C. Conway, D.A. Haukos, D.P. Collins, J.A. Moon, and P. Walther. 2019. Use of moist-soil management technique for wintering waterfowl in fallow rice fields on the upper Texas coast. North American Duck Symposium, Winnipeg, Manitoba, Poster.

Whitson, M.W., W.C. Conway, D.A. Haukos, D.P. Collins, J.A. Moon, and P. Walther. 2019. Use of moist-soil management techniques for wintering waterfowl in fallow rice fields on the upper Texas Coast. Annual Meeting of The Texas Chapter of The Wildlife Society, Conroe, Texas.

Whitson, W.D., B.A. Grisham, C.A. Hagen, W.C. Conway, R. Howard, D.A. Haukos, and C. Villalobos. 2019. Lesser prairie-chicken habitat selection and nest success response to various prescribed burning and grazing regimes in eastern New Mexico. Prairie Grouse Technical Council, Bartlesville, Oklahoma.

Whitson, W.D., B.A. Grisham, C.A. Hagen, W.C. Conway, D.A. Haukos, and C. Villalobos. 2020. Habitat selection and nest success response by lesser prairie-chickens to prescribed burning and grazing treatments. Annual Meeting of the Texas Chapter of The Wildlife Society, Corpus Christi, Texas.

Whitson, M.D., B.A. Grisham, C.A. Hagen, W.C. Conway, D.A. Haukos, and C. Villalobos. 2021. Habitat selection and nest success response of lesser prairie-chicken to prescribed burning and grazing. Annual Meeting of the Texas Chapter of The Wildlife Society, Virtual presentation.

Whitson, M.D., B.A. Grisham, C.A. Hagen, W.C. Conway, D.A. Haukos, and C. Villalobos. 2022. Habitat selection and nest success response of lesser prairie-chicken to prescribed burning and grazing. Annual Meeting of the Texas Chapter of The Wildlife Society.

Committees, Service, and Other Professional Assignments
2018-present

Addie Annis (GRA, Graduated May 2019)

- Teaching Assistant, Principals of Biology (Fall 2018 [2 sections])
- Hill City, Kansas Chamber of Commerce Monthly Meeting. Ring-necked Pheasant Project Update Presentation, 2018
- 2019 Grade school Ring-necked pheasants presentation to kids aged 7-12 and outside telemetry group activity

Carly Aulicky (GTA, Graduated December 2020)

- Teaching Assistant, Principals of Biology (2 sections Fall 2018, 2 sections Fall 2019)
- US-UK Fulbright Commission Summer Institute Program, application reviewer, 2018
- Kansas State Biology Division Graduate Student Relations Committee, co-chair, 2019-present
- Flint Hills Human Rights Project, volunteer, 2017-present
- Kansas State University Graduate Student Ambassador, ambassador, 2016-present
- Kansas State University oSTEM chapter, vice president 2019-2020
- oSTEM Leadership and Education Program, volunteer 2019
- 2018Science Communication Graduate Seminar Course
- The Wildlife Society co-graduate student advisor for the Kansas State student chapter 2019-2020
- Diversity and Allies Co-chair of the Rainbow Lorikeets caucus, a joint effort with American Ornithological Society and National Organization of Gay and Lesbian Scientists and Technical Professionals
- Vice President of the Kansas State University oSTEM chapter
- Committee member of oSTEM Leadership and Education Program
- Out in Science, Technology, Engineering, and Mathematics (oSTEM) mentorship program, member of committee designing a permanent national program
- Graduate student member of Principals of Biology Course Committee
- LGBTQIA+ panel for the AOS and SCO-SOC Conference, organizer 2021; LGBTQIA+ panel for the North American Ornithological Conference, organizer 2020

Caitlyn Aymami (GRA)

- Teaching Assistant, Organismic Biology (Spring 2021, Fall 2021, Spring 2022, Fall 2022)
- Judge, Best Paper Award, Kansas AFS, 2001

Liam Berigan (GRA, Graduated December 2019)

- Teaching Assistant, Principles of Biology BIOL 198 (2 sections Fall 2018, Fall 2019)

Jackie Gehrt (GRA, Graduated August 2021)

- Teaching Assistant, Principals of Biology BIOL 198 (Spring 2018, 2019), Organismic Biology BIOL 401 (Fall 2019, 2020), Wildlife Techniques and Management (Spring 2021)
- Secretary of the BGSA, 2020

Alix Godar (GRA, Graduated August 2020)

- Teaching Assistant, Principals of Biology (Fall 2017, 2 sections Fall 2018)
- Presenter - Pollinators: Rangeland Health and Cattle Production. Kansas Grazing Lands Coalition Field Tour, June 2018
- Organized a symposium for the 2021 Midwest Fish and Wildlife Conference "Changing the Agricultural Landscape with Cover Crops"

Chris Gulick (GTA, Graduated August 2019)

- Teaching Assistant, Principals of Biology (Fall 2017, 2 sections Fall 2018)
- Presentor - Pollinators: Rangeland Health and Cattle Production. Kansas Grazing Lands Coalition Field Tour, June 2018

David Haukos

- Editor-in-Chief, Wildlife Society Bulletin 2016-2020
- Member, Playa Lakes Joint Venture Science Advisory Team
- Associate Editor, Wildlife Society Bulletin 2020-current
- Subject/Associate Editor, Journal of Fish and Wildlife Management 2013-current
- Technical Representative, Great Plains Cooperative Ecosystems Study Unit, Kansas State University 2012-current
- Member, KSU Institutional Animal Care and Use Committee 2012-current
- Faculty Advisor, KSU Student Chapter of The Wildlife Society 2012-current
- Member of the KDWPT Threatened and Endangered Task Committee 2013-current
- Adjunct Professor, Texas Tech University
- Western Association of Fish and Wildlife Agencies – Lesser Prairie-Chicken Science Work Group 2014-Current
- Board Member At Large – Kansas Chapter of The Wildlife Society (2017-2018)
- Kansas Alliance of Wetlands and Streams – Board Member 2018-Current
- Abstract Reviewer, The Wildlife Society 2018, 2019, and 2020 Annual Meetings
- External Reviewer, P/T Application, University of Wyoming, 2018
- Reviewed draft report for BLM SGP Rapid Environmental Assessment Vol II (Species and Assemblages), 2018
- External Reviewer, P/T Application, Montana State University, 2019
- Reviewed and scored 2 proposals for Wind Wildlife Research Fund, 2019
- USGS RGE Panel, 2019
- The Wildlife Society – Certification Review Board, CMPS Representative 2020-2023.
- NRES (Natural Resources and Environmental Sciences Secondary Major), Governing Board, KSU – Natural Sciences Representative 2020-2022.
- Organized a symposium for the 2021 Midwest Fish and Wildlife Conference "Changing the Agricultural Landscape with Cover Crops"
- Conducted P&T review for Texas State University 2021
- Organizing Committee, 2023 Midwest Fish and Wildlife Conference

Talesha Karish (GRA, Graduated May 2022)

- Teaching Assistant, Organismic Biology (Fall 2018, 2019) Principals of Biology (Fall 2020, Spring 2021, Fall 2021)
- May 2020- Safe Capture Chemical Immobilization through San Diego Zoo Global Academy, Safe Capture International Inc.
- Graduate Student Liaison, KSU Student Chapter of The Wildlife Society (2021)

Mitchell Kern (GRA Graduated December 2019)

- Teaching Assistant, Advanced Habitat Management, WOEM (Fall 2018, 2019), Wildlife Conflicts, WOEM (Spring 2020)

Maureen Kinlan (GRA, Graduated August 2021)

- Teaching Assistant, Principles of Biology (Fall 2018, 2019, 2020), Wildlife Management and Techniques (Spring 2019, 2020)
- May 2020- Safe Capture Chemical Immobilization through San Diego Zoo Global Academy, Safe Capture International Inc.

John Malanchuk (GRA, Graduated August 2021)

- Teaching Assistant, Wildlife Management and Techniques Lab (Spring 2018, 2019, 2020, 2021), Mammalogy (Fall 2018 [2 lab sections]; Fall 2019 [2 lab sections]), Organismic Biology (Fall 2020)
- The Wildlife Society co-graduate student advisor for the Kansas State student chapter, 2019-2020

Martha Mather

- Subject Editor, Wetlands Ecology and Management 2008-current
- Co-Chair, Kansas Chapter, American Fisheries Society, Membership Committee 2012-2020
- Most Promising Undergraduate Student Selection Committee, KSU, May 2017, 2018, 2019, 2020
- Invited Speaker WSFR Field Trip. Kansas Division of Fisheries, Wildlife, and Parks, May 2018
- Organizer and Participant, North Central Division, American Fisheries Society Symposium, 2019. Using Assessments to Evaluate Harvest Regulations: Advancing Science-based Fisheries Management, 79th Midwest Fish and Wildlife Meeting, January, Cleveland, OH.
- Judge, Kansas State University Graduate School Research Forum, 2017, 2018
- Presenter, Faculty Data Blitz, Student Recruitment, 2018, 2020
- Faculty Host, David Crook, Oz to Oz Seminar Speaker, October, 2018
- Diversity, Equity, Inclusion Committee, National, American Fisheries Society, 2019-2022
- Organizing Committee, 2023 Midwest Fish and Wildlife Conference

Ashley Messier (GRA)

- Teaching Assistant, Fauna and Flora of the Great Plains (Spring 2021, Fall 2022)

Nick Parker (GRA, Graduated August 2021)

Camille Rieber (GRA)

Olivia Rode (GRA)

- Teaching Assistant Organismic Biology (Spring 2021, Fall 2021), Principals of Biology (Spring 2022, Fall 2022)
- Judge, Best Paper Award, Kansas AFS meeting, 2001

Elisabeth Teige (GRA, Graduated August 2021)

- Teaching Assistant Principals of Biology (Fall 2019); Organismic Biology (Fall 2020, Spring 2021)

Megan Vhay (GRA)

- Teaching Assistant Organismic Biology (Fall 2020, Spring 2021, Fall 2021, Fall 2022)
- Teaching Assistant Wildlife Management and Techniques (Spring 2022)

Awards and Recognition
2018-present

Adela Annis

- Wayne Sandfort Student Travel grant from the Central Mountains and Plains Section of The Wildlife Society Fall 2018 $500
- 3rd Place in Student Poster Contest at Central Mountains and Plains Section of The Wildlife Society Annual Meeting. 2018

Carly Aulicky

- American Ornithology Society Travel Award in Support of Diversity & Inclusion $1,000, conference registration, and 2020 membership fees
- Kansas Natural Resources Conference Student Registration Scholarship 2019 $50, 2020 $65
- 2018 Kansas Chapter of the Wildlife Society Student Travel Fall 2018 $450
- Kansas State University Graduate Student Council Travel Grant Fall 2018 $450
- Student Travel Grant from KSU Graduate Student Council, Fall 2018 $350
- Biology Graduate Student Association Travel Grant Fall 2018 $500
- Kansas State College of Arts and Sciences Travel Grant Fall 2018 $800

Liam Berigan

- American Ornithological Society Travel Award of $490 to present at the 2019 American Ornithological Society Annual Meeting
- Kansas Natural Resources Conference 2018 Student Fee Scholarship $50
- Kansas Natural Resources Conference 2019 Student Fee Scholarship $50
- Student Travel Grant from KSU Graduate Student Council, Fall 2018 $450
- Biology Graduate Student Association Travel Grant Fall 2018 $500
- Kansas State College of Arts and Sciences Travel Grant Fall 2018 $800

Jackie Gehrt

- Travel grant from The Wildlife Society, 2018 $500
- Central Mountains and Plains Wayne Sandfort Travel Grant, The Wildlife Society -$115, 2020
- Janice Lee Fenske Memorial Award Finalist, Midwest Fish and Wildlife Conference, 2021
- Graduate Student Council Professional Development Certificate
- 2021 Outstanding Unit Student, Kansas Cooperative Fish and Wildlife Research Unit

Alix Godar

- First Place in the Student Poster competition at the Central Mountains and Plains Section of The Wildlife Society, 2018
- BSGA Travel Grant 2018 $500; 2019 $500
- Central Mountains and Plains Travel Grant 2018 $150
- American Ornithological Society Travel Award of $490 to present at the 2019 American Ornithological Society Annual Meeting
- Kansas Natural Resource Conference Student Registration Scholarship-2015, 2016, 2017, 2019, 2020

David Haukos

- The Wildlife Society – Wildlife Publications Award – Edited Book 2018. D. Haukos and C. Boal, editors. Ecology and Conservation of Lesser Prairie-Chickens.
- Texas Chapter of The Wildlife Society Scientific Publication of the Year Award: Book 2018 for D. Haukos and C. Boal, editors. Ecology and Conservation of Lesser Prairie-Chickens.
- The Wildlife Society – Caesar Kleberg Award for Excellence in Applied Wildlife Research. 2019
- Lifetime Member – The Wildlife Society. 2022.
- Morgart Scientific Publication Award (2021), U.S. Fish and Wildlife Service. Moon, J.A., S.E. Lehnen, K.L. Metzger, M.A. Squires, M.G. Brasher, B.C. Wilson, W.C. Conway, D.A. Haukos, B.E. Davis, F.C. Rohwer, E.M. Wehland, and B.M. Ballard. 2021. Projected impact of sea-level rise and urbanization on mottled duck (Anas fulvigula) habitat along the Gulf Coast of Louisiana and Texas through 2100. Ecological Indicators 132 (2021) 108276. https://doi.org/10.1016/j.ecolind.2021.108276. 2022.

Mitchell Kern

- Graduate Student Council Travel Grant: 2018 $400
- KNRC Registration Grant: 2019 and 2020 $60
- The Kansas Chapter of The Wildlife Society Travel Grant: 2019 $320

Maureen Kinlan

- Central Mountains and Plains Wayne Sandfort Travel Grant; $100.00, Fall 2019
- Graduate Student Council Travel Award; $400, Fall 2019
- Kansas Chapter of the Wildlife Society; $320, Fall 2019

John Malanchuk

- Kansas Natural Resources Conference Student Scholarship, 2019 $60
- Delta Waterfowl – Waterfowl breeding ecology graduate course. Prairie Pothole and Prairie Parkland region, North Dakota/ Manitoba, 11-25 May 2019.
- Smithsonian-Mason School of Conservation. Estimating animal abundance and occupancy graduate and professional short course. 8-19 July 2019.

Martha Mather

- Promoted to Adjunct Professor, Kansas State University, Spring 2019
- Longevity Award, Kansas Chapter, American Fisheries Society, 2020

Ashley Messier

- Best Oral Presentation, Kansas Chapter of The Wildlife Society, Kansas Natural Resources Conference – 2022
- Registration Scholarship, KNRC 2022 - $50

Camille Rieber

- Timothy R. Conoghue Gradate Scholarship, KSU Graduate School - $3,000
- Kansas State University Arts and Sciences Award for Three Minute Thesis Presentation

Dan Sullins

- The Wildlife Society – 2020 Wildlife Publication Award – journal paper category, shortlisted (top 5) Daniel Sullins, David Haukos, Joseph Lautenbach, Jonathan

Lautenbach, Samantha Robinson, Mindy Rice, Brett Sandercock, John Kraft, Reid Plumb, Jonathan Reitz, J.M. Shawn Hutchinson, and Christian Hagen. 2019. Strategic conservation for lesser prairie-chickens among landscapes of varying anthropogenic influence. Biological Conservation https://doi.org/10.1016/j.biocon.2019.108213.

- The Wildlife Society – 2021 Wildlife Publication Award – Outstanding Student Paper category, shortlisted (top 5) Daniel Sullins, David Haukos, Joseph Lautenbach, Jonathan Lautenbach, Samantha Robinson, Mindy Rice, Brett Sandercock, John Kraft, Reid Plumb, Jonathan Reitz, J.M. Shawn Hutchinson, and Christian Hagen. 2019. Strategic conservation for lesser prairie-chickens among landscapes of varying anthropogenic influence. Biological Conservation https://doi.org/10.1016/j.biocon.2019.108213.

Elisabeth Teige

- Central Mountains and Plains Section of The Wildlife Society - Wayne Sandfort Student Travel Grant, 2020 - $100
- Graduate Student Council Travel Grant ($300), Kansas State University, 2021
- 2022 Early Career Professional Working Group's Certification Assistance Scholarship - $500 The Wildlife Society
- 2021 Outstanding Unit Student, Kansas Cooperative Fish and Wildlife Research Unit

Megan Vhay

- Wayne Sandfort Student Travel Grant, TWS CMPS, 2022 - $100

Bram Verheijen

- Travel Grant, The Wildlife Society, 2019 - $350
- Professional Development Grant, The Wildlife Society Early Career Professional Working Group, $150

Additional Award

- The Wildlife Society's Wildlife Restoration Awards - Wildlife Management – Kansas Wildlife, Parks, and Tourism, Lesser Prairie-Chicken Project, Kansas Cooperative Fish and Wildlife Research Unit, 2019

Cooperating Landowner Awards

Ed Kroger, Hash Knife Ranch. 2018. The Wildlife Society Central Mountains and Plains Section, Citizen Conservation Award

Stacy Hoeme, Hoeme Land and Cattle. 2019. The Wildlife Society Central Mountains and Plains Section, Citizen Conservation Award

Kansas State University Courses Taught by Unit Faculty 2011-2022

Course	Years Taught	Instructor
Professional Skills and Ethics	2011-2017, 2020, 2022	Martha Mather
Introduction to Fisheries, Wildlife, Conservation, and Environmental Biology	2012-2022	David Haukos
Advanced Spatial Modeling	2012, 2014	Eugene Albanese David Haukos
River Regimes	2012	Martha Mather
Bayesian Methods in Ecology	2014	Beth Ross David Haukos
Introduction to WOEM, Pistols and Rifles, Hunter Education Instructor	2015	Thomas Becker
Habitat Ecology and Management	2016, 2017, 2019, 2022	David Haukos
Population Biology	2017, 2018	David Haukos
Modeling Distribution and Resource Section of Organisms	2018	Dan Sullins David Haukos
Natural Resources/Environmental Science Capstone Course	2019	David Haukos
Design and Analyses of Wildlife Population Studies	2019	Bram Verheijen David Haukos
Demographic Methods	2020, 2022	David Haukos

Kansas State University Degrees Completed 1996 – 2022

2022

Talesha Kalish (Ph.D, 2022, Haukos). Survival, activity patterns, movements, home ranges and resource selection of female mule deer and white-tailed deer in western Kansas. (Assistant Area Manager, Baudette Area Wildlife, MN DNR)

2021

John Malanchuk (Ph.D, 2021, Haukos). Assessment of resident Canada goose management in Kansas. (Research Associate, Quantico, Virginia Tech University)

Maureen Kinlan (M.S., 2021, Haukos). Survival, movement, and resource selection of male mule deer and white-tailed deer in western Kansas. (Bear Biologist, New Jersey Department of Environmental Protection, Fish and Wildlife Division)

Jackie Gehrt (M.S., 2021, Haukos). Response of greater prairie-chickens to natural and anthropogenic disturbance on Fort Riley. (Biologist, Federal Aid, U.S. Fish and Wildlife Service, Twin Cities, MN)

Elisabeth Teige (M.S., 2021, Haukos). Assessment of lesser prairie-chicken translocation through survival, space use, and resource selection. (Contract Biologist, USGS, Fort Collins, Colorado).

Nick Parker (M.S., 2021, Sullins/Haukos). Lesser prairie-chicken demography, resource selection, and habitat response following megafire in the mixed-grass prairie. (Ph.D Candidate, Colorado State University).

2020

Alixandra Godar (Ph.D., 2020, Haukos). Ring-necked pheasant population and space use response to landscapes including spring cover crops. (Post-Doctoral Research Associate, Post-Doctoral Research Associate, Patuxent Science Center, USGS).

Carly Aulicky (Ph.D., 2020, Haukos). Lek dynamics and range-wide morphometric patterns of lesser prairie-chickens. (Field Director, Texas Native Prairie Association)

2019

Liam Berigan (M.S., 2019, Haukos). Dispersal, reproductive success, and habitat use by translocated lesser prairie-chickens. (Ph.D Candidate, University of Maine)

Chris Gulick (M.S., 2019, Haukos). Spatial ecology and resource selection by female lesser prairie-chickens within their home ranges and during dispersal. (Ph.D Candidate, University of Florida)

Mitchell Kern (M.S., 2019, Ricketts/Haukos). Fawn survival and bed-site selection of mule deer and white-tailed deer in western Kansas. (Game Warden, Wyoming Game and Fish)

Adela Annis (M.S., 2019, Haukos). Ring-necked pheasant survival, nest habitat use, and predator occupancy in Kansas spring cover crops. (Biologist, Pheasants Forever, Nebraska)

2018

Sean Hitchman (Ph.D., 2018, advisor Mather). A mosaic approach can advance the understanding and conservation of native fish biodiversity in natural and fragmented riverscapes. (Faculty, Department of Biology, Saint Mary's College of Maryland)

Richard Lehrter (M.S. 2018; advisor Mather). Links between food web structure, biodiversity, and resilience: effects of anthropogenic disturbance on aquatic communities in the Smoky Hill River, KS (Biologist, NEON Inc., Boulder, CO)

2017

Ryland Taylor (M.S. 2017; advisor Mather). Using geomorphology and animal "individuality" to understand 'scape-scale predator distributions. (Environmental Specialist, Maryland Environmental Service)

Robert Mapes (M.S. 2017; advisor Mather). Young of year largemouth bass (*Micropterus salmoides*) relative abundance and diet: role of habitat type, spatial context, and size. (Grass Carp Fisheries Project Manager, University of Toledo)

Dan Sullins (Ph.D. 2017; advisor Haukos). Regional variation in demography, distribution, foraging, and strategic conservation of lesser prairie-chickens in Kansas and Colorado. (Assistant Professor, Wildlife and Outdoor Enterprise Management, Kansas State University)

Jonathan Lautenbach (M.S. 2017; advisor Haukos). The role of fire, microclimate, and vegetation in lesser prairie-chicken habitat selection. (Ph.D candidate, University of Wyoming)

2016

John Kraft (M.S. 2016; advisor Haukos). Vegetation characteristics and lesser prairie-chicken responses to land cover types and grazing management in western Kansas.

Willow Malone (M.S. 2016; advisor Haukos). Biodiversity in playa wetlands in relation to watershed disturbance. (NEON field biologist, Colorado)

Kelsey McCullough (M.S. 2016; advisor Haukos). A multi-scale examination of the distribution and habitat use patterns of the regal fritillary. (Spatial Analyst, USDA)

Sarah Ogden (M.S. 2016; advisor Haukos). Responses of grassland birds and butterflies to control of sericea lespedeza with fire and grazing. (Environmental Enforcement Specialist, Montana DEQ)

Thomas Becker (M.S. 2016; advisor Haukos, Horticulture and Natural Resources). Retrospective review of avian diseases in Kansas. (Biotech, Cuyahoga Valley National Park)

2015

Samantha Robinson (M.S. 2015; advisor Haukos). Landscape conservation design, movements, and survival of lesser prairie-chickens in Kansas and Colorado. (Ph.D graduate, Virginia Tech University, 2020; Program Manager for Avian Conservation, Delaware Department of Natural Resources and Environmental Control)

Zach Peterson (M.S. 2015; advisor Mather). Quantifying patterns and select correlates of the spatially and temporally explicit distribution of a fish predator (blue catfish, *Ictalurus furcatus*) throughout a large reservoir ecosystem. (Fishery Biology, City of Denton, TX)

Kayla Gerber (M.S. 2015; advisor Mather). Tracking blue catfish: quantifying system-wide distribution of a mobile fish predator throughout a large heterogeneous reservoir. (Fishery Biologist, Kentucky Department of Fish & Wildlife Resources)

Jane Fencl (M.S., 2015; advisor Mather). How big of an effect do small dams have? Using ecology and geomorphology to quantify impacts of low-head dams on fish biodiversity. (Assistant Unit Leader, TXCFWRU, Texas Tech University)

Joe Gerken (Ph.D. 2015; advisor Paukert). Fish and invertebrate community response to flow magnitude in the Kansas River. Kansas State University. (Fisheries Extension Agent, KSU)

Brian Kearns (Ph.D. 2015; advisor Haukos). Risk assessment of lead exposure by mottled ducks on the upper Texas Gulf Coast. Kansas State University. (Biologist, WRA Environmental Consultants, CA)

Joseph Lautenbach (M.S. 2015; advisor Haukos). Lesser prairie-chicken reproductive success, habitat selection, and response to trees. Kansas State University. (Chief, Upland Game Research, Ohio Department of Natural Resources)

Reid Plumb (M.S. 2015; advisor Haukos). Lesser prairie-chicken movement, space use, survival, and response to anthropogenic structures in Kansas and Colorado. (Biologist, Wildlife Biologist, Walker Unit, Chippewa NF, USFS)

2014

David Spencer (M.S. 2014; advisor Haukos, Geography). Historical changes in landscapes occupied by lesser prairie-chickens in Kansas. (GIS Cartographer, Eastview Geospatial)

Rachel Pigg (Ph.D. 2014; advisor Cully). A multi-scale investigation of movement patterns among black-tailed prairie dog colonies. (Assistant Professor, Presbyterian College, Clinton, SC)

Andrew Stetter (M.S. 2014; advisor Haukos). Nest site selection, duckling survival, and blood parasite prevalence of Lesser Scaup nesting on Red Rock Lakes National Wildlife Refuge. (Deputy Project Leader, Big Stone NWR)

2012

Jason Fischer (M.S. 2012; advisor Paukert). Fish community response to habitat alteration: impacts of sand dredging in the Kansas River.

2011

Derek Moon (M.S. 2011; advisor Cully). Small mammals in disturbed tallgrass prairie landscapes.

Amanda Goldberg (M.S. 2011; advisor Cully). Apparent survival, dispersal, and abundance of black-tailed prairie dogs.

2010

Andrea Severson (M.S. 2010; advisor Paukert). Effects of zebra mussel (*Dreossena polymorpha*) invasion ion the aquatic community of a Great Plains reservoir.

2009

Jonathan M. Conard (Ph.D, 2009; Advisor: Gipson). Genetic variability, demography, and habitat selection in a reintroduced elk (*Cervus elaphus*) population.

Mackenzie R. Shardlow (M.S., 2009; Advisor: Paukert). Factors affecting the detectability and distribution of the North American river otter.

Ron E. VanNimwegen (Ph.D [Posthumous], 2009; Advisor: Cully). Behavioral ecology of grasshopper mice and deer mice.

2008

Wesley W. Bouska (M.S., 2008; Advisor: Paukert). Road crossing designs and their impact on fish assemblages and geomorphology of Great Plains streams.

Jeffrey L. Eitzmann. (M.S., 2008; Advisor: Paukert). Effects of anthropogenic disturbance on the fish assemblage and food web structure in a Great Plains river.

Kristen Pitts (M.S., 2008; Advisor: Paukert). Assessing threats to native fishes of the Lower Colorado River Basin.

Joshua Schloesser (M.S., 2008; Advisor: Paukert). Large river fish community sampling strategies and fish associations to engineered and natural river channel structures.

2007

Jesse R. Fischer (M.S., 2007; Advisor: Paukert). Structural organization of Great Plains stream fish assemblages: Implications for sampling and conservation.

2006

Jeremy Baumgardt (M.S., 2006; Advisor: Gipson). The effects of trapping methods on estimation of population parameters for small mammals.

Brian E. Flock (Ph.D, 2006; Advisor: Gipson). The effects of landscape configuration on northern bobwhite in southeastern Kansas.

Tracey N. Johnson (M.S., 2006; Advisor: Brett K. Sandercock). Ecological restoration of tallgrass prairie: grazing management benefits plant and bird communities in upland and riparian habitats.

Andrew S. Makinster (M.S., 2006; Advisor: Paukert). Flathead catfish population dynamics in the Kansas River.

Timothy R. Strakosh (Ph.D, 2006; Advisor: Keith Gido). Effects of water willow establishment on littoral assemblages in Kansas reservoirs: Focus on Age-0 largemouth bass.

Bala Thiagarajan (Ph.D, 2006; Advisor: Cully). Community dynamics of rodents, fleas and plague associated with black-tailed prairie dogs.

2005

Tammi L. Johnson (M.S., 2005; Advisor: Cully). Spatial dynamics of a bacterial pathogen: Sylvatic plague in Black-tailed prairie dogs.

Lorri A. Newby (M.S., 2005; Advisor: Cully). Effects of experimental manipulation of coterie size on demography of Black-tailed prairie dogs in South Dakota.

2004

No degrees granted

2003

Christopher D. Anderson (M.S.; 2003; Advisor: Gipson). Recreational pressure at Fort Niobrara National Wildlife Refuge: Potential impacts on avian use and seasonal productivity along the Niobrara River.

Jonathan M. Conard (M.S., 2003; Advisor: Gipson). Responses of small mammals and their predators to military disturbance in tallgrass prairie.

William E. Jensen (Ph.D, 2003; Advisor: Cully). Spatial variation in Brown-headed Cowbird (*Molothrus ater*) abundance and brood parasitism in Flint Hills Tallgrass Prairie.

Mayee Wong (M.S., 2003; Advisor: Cully). High spatial homogeneity in a sex-biased mating system: The genetic population structure of greater prairie chickens (*Tympanuchus cupido pinnatus*) in Kansas, Missouri, and Nebraska.

Stanley L. Proboszcz (M.S., 2003; Advisor: Guy). Evaluation of habitat enhancement structure use by spotted bass in natural and experimental streams.

2002

Michael C. Quist (Ph.D, 2002, Advisor: Guy). Abiotic factors and species interactions that influence recruitment of walleyes in Kansas reservoirs.

2001

Troy R. Livingston (M.S., 2001; Advisor: Gipson). Coprophagy: An ecological investigation of the consumption of mammalian carnivore feces.

Amber D. Rucker (M.S., 2001; Advisor: Cully). Conversion of tall fescue pastures to tallgrass prairie in southeastern Kansas: Small mammal responses.

Gerald L. Zuercher (Ph.D, 2001; Advisor: Gipson). The ecological role of the Bush Dog, *Speothos venaticus*, as part of the mammalian predator community in the Interior Atlantic Forest of Paraguay.

2000

Patrick J. Braaten (Ph.D, 2000; Advisor: Guy). Growth of fishes in the Missouri River and Lower Yellowstone River, and factors influencing recruitment of freshwater drum in the lower channelized Missouri River.

Anne C. Cully (Ph.D, 2000; Advisors: Barkley and Knapp). The effects of size and fragmentation on tallgrass prairie plant species diversity.

Travis B. Horton (M.S., 2000; Advisor: Guy). Habitat use and movement of spotted bass in Otter Creek, Kansas.

Sally J. Schrank (M.S., 2000; Advisor: Guy). Population characteristics of bighead carp *Hypophthalmichthys nobilis* larvae and adults in the Missouri River and interspecific dynamics with paddlefish *Polyodon spathula*.

Patricia R. Snyder (M.S., 2000; Advisor: Gipson). Assessment of activity transmitters based on behavioral observations of coyotes, bobcats, and raccoons.

Jeffry A. Tripe (M.S., 2000; Advisor: Guy). Density, growth, mortality, food habits, and lipid content of age-0 largemouth bass in El Dorado Reservoir, Kansas.

1999

Justin E. Kretzer (M.S., 1999; Advisor: Cully). Herpetological and coleopteran communities of black-tailed prairie dog colonies and non-colonized areas in southwest Kansas.

Michael C. Quist (M.S., 1999; Advisor: Guy). Structure and function of fish communities in streams on Fort Riley Military Reservation.

James W. Rivers (M.S., 1999; Advisor: Gipson). Seasonal avian use patterns of farmed wetlands and nest predation dynamics in riparian grasslands dominated by reed canary grass (*Phalaris arundinacea*).

Stephen L. Winter (M.S., 1999; Advisor: Cully). Plant and breeding bird communities of black-tailed prairie dog colonies and non-colonized areas in southwest Kansas and southeast Colorado.

1998

Jan F. Kamler (M.S., 1998; Advisor: Gipson). Ecology and interspecific relationships of mammalian predators on Fort Riley Military Reservation, Kansas.

1997

Matthew N. Burlingame (M.S., 1997; Advisor: Guy). 1995 Kansas licensed angler use and preference survey and attitudes towards angling by secondary education students.

Greg A. Hoch (M.S., 1997; Advisor: Cully). Mapping and monitoring of disturbance from military training at Fort Riley, Kansas and an investigations into the stability of grassland ecotones using satellite remote sensing.

David E. Hoover (M.S., 1997; Advisor: Gipson). Vegetation and breeding bird assemblages in grazed and ungrazed riparian habitats in southeastern Kansas.

Raymond S. Matlack (M.S., 1997; Advisor: Gipson). The swift fox in rangeland and cropland in western Kansas: Relative abundance, mortality, and body size.

Heidi L. Michaels (M.S., 1997; Advisor: Cully). Landscape and fine scale habitat of the Loggerhead Shrike and Henslow's Sparrow on Fort Riley Military Reservation, Kansas.

Jeff S. Tillma (M.S., 1997; Advisor: Guy). Characteristics of spotted bass in southeast Kansas streams.

1996

William K. Smith (M.S., 1996; Advisor: Gipson). Responses of ring-necked pheasants to Conservation Reserve Program fields during courtship and brood rearing in the high plains.

Jennifer R. Wiens (M.S., 1996; Advisor: Guy). Effects of tree revetments on the abiotic and biotic components in two Kansas streams.

Kansas Cooperative Fish and Wildlife Research Unit
Summary of Accomplishments 2012-2022

The U.S. Geological Survey, Kansas Cooperative Fish and Wildlife Research Unit (KSCFWRU) assumed its current structure in 2012 of David Haukos as Unit Leader and Martha Mather as Assistant Unit Leader. Following establishment of a new Cooperative Agreement in 2022 establishing the KSCFWRU until 2032, the following summary will provide an overview of accomplishments during the past 10 years. The summary does include accomplishments for previous Unit scientists (Craig Paukert, Jack Cully) that occurred in 2012 or later by students at the KSCFWRU.

Unit Scientist: 2

David Haukos, Unit Leader (Wildlife, Adjunct Associate Professor, Division of Biology, Kansas State University),

Martha Mather (Fisheries, Adjunct Associate Professor, Adjunct Professor [2019])

Office Manager: 3

Joyce Brite (2012-2017), Maiah Diel (2018-2019), Tara Dreher (2019-current)

Post-Doctoral Research Associates: 11 (9 wildlife, 3 fisheries)

Graduate Students: 51 total graduate students as chair or co-chair (48 GRA funded); 42 KSU (3 GTA). Current PhD – 1 (wildlife), MS – 5 (3 wildlife, 2 fisheries); Graduated PhD – 11 (9 wildlife, 2 fisheries), MS – 35 (27 wildlife, 8 fisheries).

22 additional graduate student committees (Haukos)

Undergraduate Research Projects: 14 (12 wildlife, 2 fisheries)

REU Projects: 6 (2 wildlife, 4 fisheries)

Research Funding:

45 research grants (39 wildlife, 5 fisheries, 1 combined wildlife and fisheries) – 3 NSF, 12 KDWP, 14 DOI (USGS, USFWS), 4 DOD, 5 USDA, 7 Other

$15,913,041 Total Funding ($13,002,884 wildlife, $1,662,372 fisheries, $1,463,525 combined)

By source - $1,902,881 NSF; $8,058,654 KDWP; $1,941.174 DOI; $477,488 DOD; $1,746,424 USDA; $2,002,160 Other.

To Kansas State University – 37 grants, $14,896,682 total funding ($12,752,436 direct costs, $2,144,246 indirect costs)

Projects: 37 completed, 6 in progress

Research Work Orders: 9 (5 for KSU faculty outside KSCFWRU)

Student Travel/Conference Grants: 93, $51,735

Publications:

1 Book (Haukos, D.A., and C.W. Boal (editors). 2016. Ecology and Conservation of Lesser Prairie-Chickens. Studies in Avian Biology, CRC Press.)

12 Book Chapters (10 Haukos, 1 Mather, 1 Mather/Haukos)

148 Peer-Reviewed Journal Articles (109 wildlife, 36 fisheries, 3 combined)

9 Technical Publications

Professional Presentations:

464 (401 wildlife, 60 fisheries, 3 combined)

Teaching:

174 sections Graduate Student teaching (107 Principals of Biology, 43 Organismic Biology, 11 Wildlife Management and Techniques, 7 Mammalogy, 6 Other)

Haukos – Introduction to Fisheries, Wildlife, Conservation, and Environmental Biology (BIOL 433; Spring 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022); Advanced Spatial Modeling (BIOL 890; Fall 2012, 2014); Bayesian Methods in Ecology (BIOL 890; Fall 2014); Habitat Ecology and Management (BIOL 890; Spring 2016, Fall 2017, Fall 2019, Spring 2022); Population Biology (BIOL 640; Fall 2017, 2018); Modeling Distribution and Resource Selection of Organisms (BIOL 890; Fall 2018); Natural Resources/Environmental Science

Project (NRES) Capstone Course (BAI/DAS/GENAG 582; Spring 2019); Design and Analyses of Wildlife Population Studies (BIOL 890; Fall 2019); Demographic Methods (BIOL 823; Fall 2020, 2022).
Mather – Professional Skills (BIOL 863, Spring 2012, 2013, 2014, 2015, 2016, 2017, 2020, 2022); River Regimes (GEOL; Fall 2012)

Major Service Contributions:

Haukos

- Member, Playa Lakes Joint Venture Science Advisory Team
- Associate Editor, Wildlife Society Bulletin 2001-2015, 2020-current
- Subject/Associate Editor, Journal of Fish and Wildlife Management 2013-current
- Technical Representative, Great Plains Cooperative Ecosystems Study Unit, Kansas State University 2012-current
- Member, KSU Institutional Animal Care and Use Committee 2012-current
- Faculty Advisor, KSU Student Chapter of The Wildlife Society 2012-current
- Member of the KDWPT Threatened and Endangered Task Committee 2013-current
- Editor-in-Chief, Wildlife Society Bulletin 2016-2020
- Board Member At Large – Kansas Chapter of The Wildlife Society (2017-2018)
- Kansas Alliance of Wetlands and Streams – Board Member 2018-Current
- The Wildlife Society – Certification Review Board, CMPS Representative 2020-2023.
- NRES (Natural Resources and Environmental Sciences Secondary Major), Governing Board, KSU – Natural Sciences Representative 2020-2022.

Mather

- Subject Editor, Wetlands Ecology and Management 2008-current
- President's Committee on Improving Fisheries Education, American Fisheries Society 2013-2016
- American Fisheries Society Committee of Special Educational Requirements 2013-2015
- Kansas Chapter, American Fisheries Society, Membership Committee 2012-2021
- Division of Biology, Seminar Committee 2014-2015
- Most Promising Undergraduate Student Selection Committee, KSU, May 2017-2020
- Diversity, Equity, Inclusion Committee, National, American Fisheries Society, 2019-2021

Major Awards

Janice Lee Fenske Memorial Award Finalists, Midwest Fish and Wildlife Conference – *Kayla Gerber* (2012), *Andrew Stetter* (2014), *Jackie Gehrt* (2021)

Alix Godar, First Place in the Student Poster competition at the Central Mountains and Plains Section of The Wildlife Society, 2018

John Kraft, Best KNRC Student Presentation Award, Kansas Chapter of The Wildlife Society 2015

Joseph Lautenbach, Robert J. Robel Award for Outstanding Graduate Student Research in Wildlife Biology and Ecology, Division of Biology, Kansas State University 2014

Ashley Messier, Best KNRC Student Presentation Award, Kansas Chapter of The Wildlife Society 2015

Sarah Ogden, Celia Markum Award from Kansas Ornithological Society, Emporia, KS, October 2015

Dan Sullins

- Robert J. Robel Award for Outstanding Graduate Student Research in Wildlife Biology and Ecology, 2017
- The Wildlife Society – 2020 Wildlife Publication Award – journal paper category, shortlisted (top 5) Daniel Sullins, David Haukos, Joseph Lautenbach, Jonathan

Lautenbach, Samantha Robinson, Mindy Rice, Brett Sandercock, John Kraft, Reid Plumb, Jonathan Reitz, J.M. Shawn Hutchinson, and Christian Hagen. 2019. Strategic conservation for lesser prairie-chickens among landscapes of varying anthropogenic influence. Biological Conservation https://doi.org/10.1016/j.biocon.2019.108213.

- The Wildlife Society – 2021 Wildlife Publication Award – Outstanding Student Paper category, shortlisted (top 5) Daniel Sullins, David Haukos, Joseph Lautenbach, Jonathan Lautenbach, Samantha Robinson, Mindy Rice, Brett Sandercock, John Kraft, Reid Plumb, Jonathan Reitz, J.M. Shawn Hutchinson, and Christian Hagen. 2019. Strategic conservation for lesser prairie-chickens among landscapes of varying anthropogenic influence. Biological Conservation https://doi.org/10.1016/j.biocon.2019.108213.

Other Research-Related Award

- The Wildlife Society's Wildlife Restoration Awards - Wildlife Management – Kansas Wildlife, Parks, and Tourism, Lesser Prairie-Chicken Project, Kansas Cooperative Fish and Wildlife Research Unit. 2019

Haukos

- The Texas Chapter of The Wildlife Society, Significant Contribution to Wildlife Literature – Scientific Publication Category for Grisham, B.A., C.W. Boal, D.A. Haukos, D.M. Davis, K.K. Boydston, C. Dixon, and W.R. Heck. 2013. The predicted influence of climate change on lesser prairie-chicken reproductive parameters. PLoS ONE 8(7): e68225. doi:10.1371/journal.pone.0068225, February 2014.
- USGS- Cooperative Research Units, 2015 Excellence in Science Award – Individual
- Biology Graduate Student Association, Kansas State University, 2015 Outstanding Graduate Faculty Award, Division of Biology
- The Wildlife Society – Wildlife Publications Award-Outstanding Article 2016
  Winder, V.L., K.M. Carrlson, A.J. Gregory, C.A. Hagen, D.A. Haukos, D.C. Kesler, L.C. Larsson, T.W. Matthews, L.B. McNew, M.A. Patten, J. C. Pitman, L.A. Powell, J.A. Smith, T. Thompson, D.H. Wolfe, and B.K. Sandercock. 2015. Ecological correlates of female space use in ten populations of prairie chickens. Ecosphere 6(9):166. http://dx.doi.org/10.1890/ES14-00536.1
- Elected Fellow – The Wildlife Society, 2016
- Hamerstrom Award – Prairie Grouse Technical Council, 2015 for contributions to conservation of prairie grouse.
- The Wildlife Society – Wildlife Publications Award – Edited Book 2018. D. Haukos and C. Boal, editors. Ecology and Conservation of Lesser Prairie-Chickens.
- Texas Chapter of The Wildlife Society Scientific Publication of the Year Award: Book 2018 for D. Haukos and C. Boal, editors. Ecology and Conservation of Lesser Prairie-Chickens.
- The Wildlife Society – Caesar Kleberg Award for Excellence in Applied Wildlife Research. 2019
- Morgart Scientific Publication Award (2021), U.S. Fish and Wildlife Service. Moon, J.A., S.E. Lehnen, K.L. Metzger, M.A. Squires, M.G. Brasher, B.C. Wilson, W.C. Conway, D.A. Haukos, B.E. Davis, F.C. Rohwer, E.M. Wehland, and B.M. Ballard. 2021. Projected impact of sea-level rise and urbanization on mottled duck (*Anas fulvigula*) habitat along the Gulf Coast of Louisiana and Texas through 2100. Ecological Indicators 132 (2021) 108276.
- Lifetime Membership, The Wildlife Society 2022

Mather

- Academic promotion to Adjunct Professor 2019
- Longevity Award, Kansas Chapter, American Fisheries Society, 2020