

2024 Annual Report

July 2023 — June 2024



Iowa Cooperative Fish &
Wildlife Research Unit

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Iowa Cooperative Fish & Wildlife Research Unit Annual Report

2024

Cooperating Agencies:

**U.S. Geological Survey
Iowa Department of Natural Resources
Iowa State University
U.S. Fish & Wildlife Service
Wildlife Management Institute**

Photo Acknowledgements:

Cover photo by Dr. Stephen J. Dinsmore

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Personnel and Cooperators

Unit Coordinating Committee

Cyndy Loftin

Units Supervisor Cooperative Research Units
U.S. Geological Survey, Ecosystems

Stephen Dinsmore

Department Chair
Natural Resource Ecology & Management
Iowa State University

Pete Hildreth

Division Administrator
Iowa Department of Natural Resources

Bill Moritz

Midwest Representative
The Wildlife Management Institute

Todd Bishop

Wildlife Bureau Chief
Iowa Department of Natural Resources

Kelley Myers Tymeson

Senior Advisor for Landscape Conservation
U.S. Fish & Wildlife Service

Joe Larscheid

Fisheries Bureau Chief
Iowa Department of Natural Resources

Unit Faculty & Staff

| | |
|-------------------------|--|
| Robert W. Klaver | Unit Leader and Professor of Natural Resource Ecology & Management |
| Michael Moore | Assistant Unit Leader, Fisheries, Professor of Natural Resource Ecology & Management |
| Anna Tucker | Assistant Unit Leader, Wildlife, Professor of Natural Resource Ecology & Management |
| Jennifer McGill | Administrative Specialist, Department of Natural Resource Ecology & Management |

Faculty Collaborators

| | | | |
|------------------|------|-------------------|------|
| Julie Blanchong | NREM | Matthew O'Neal | PPEM |
| Miranda Curzon | NREM | Amy Toth | EEOB |
| Stephen Dinsmore | NREM | Weber, Michael J. | NREM |
| Adam Janke | NREM | | |

Graduate Students

| | | |
|-------------------------|--------------------------|---------------------|
| Bridget Nixon, PhD | Lindsey Gapinski, MS | Daniel Paulson, MS |
| Anne-Utelie Poicon, PhD | Erik Griffen, MS | Fanny Riand, MS |
| Rachel Siller, PhD | Justin Harms, MS | Kelsey Shepherd, MS |
| Dalton Clayton, MS | Erika Ibarra-Garibay, MS | Rachel Siller, MS |
| Victoria Fasbender, MS | Juliana Kaloczi, MS | McKensie Vaske, MS |
| Katrina Fernald, MS | Lizzy Lang, MS | Riggs Wilson, MS |
| Jo Ford, MS | Abigail Miller, MS | Aaron Yappert, MS |

Additional Collaborators

Iowa DNR

Kim Bogenshutz
Royce Bowman
Vince Evelsizer
Mark Flammang
Paul Freese
Tyler Harms

Ryan Hupfeld
Gene Jones
Orrin Jones
Karen E. Kinhead
Rebecca Krogman
Kelly Poole

George Scholten
Stephanie Shepherd
Perry Thostenson
Ben Wallace

Iowa State University

Emma Buckardt
David Delaney
Michael French
Jimena Golcher-Benavides
Jonathan Harris
Tayah Lande, Undergraduate
Kristi Brede, Undergraduate

University of Georgia

Marty Hamel

Southern Illinois University

Gregory Whitledge
Shaley Valentine

Illinois Natural History Survey (INHS)

Jim Lamer
Zachary Witzel
Emily Szott
Dominique Turney

Fish & Wildlife Service

Rebecca Neely

New Projects

Effects of Reservoir Operation on Shovelnose Sturgeon Reproduction, Movement, and Survival in the Des Moines River System

Principal Investigator: Dr. Michael J. Moore
Dr. Michael Weber

Student Investigator(s): McKensie Vaske
Daniel Paulson

Collaborators: George Scholten (IDNR)
Ryan Hupfeld (IDNR)
Rebecca Krogman (IDNR)
Gene Jones (IDNR)
Mark Flammang (IDNR)
Royce Bowman (IDNR)
Perry Thostenson (USACE)

Duration: October 2023-July 2026

Funding Source(s): U.S. Army Corps of Engineers Cooperative Ecosystems Studies Unit,
Sustainable Rivers Program

Worktag #: GR-028024-00001

Goals and Objectives:

Goal: To investigate the role of hydrologic regimes influenced by flow regulation at Red Rock and Coralville dams on Shovelnose Sturgeon reproduction, movement, and survival.

Objective 1: To assess spring migration phenology of Shovelnose Sturgeon using acoustic telemetry and larval fish sampling in two Mississippi River tributary systems, one with and one without experimental flows

Objective 2: To advance our understanding of Shovelnose Sturgeon summer movement ecology and spatial variation in water quality during the summer to inform management of summer flows to reduce mortality

Progress:

Two graduate students were recruited and began working on the project in January 2024. McKensie Vaske will be leading the research for objective 1 for her master's thesis. Since starting, she has coordinated with Dr. Moore and Dr. Weber and Iowa Department of Natural Resources Biologists to develop a sampling methodology for larval sturgeon. She has prepared our new boat for this field project and installed a winch arm to retrieve the larval nets. She began larval fish sampling April 15th, 2024. She has implanted acoustic transmitters in an additional 5 Shovelnose Sturgeon in the Des Moines and 5 in the Cedar River to track their spring movements in relation to timing of capture of eggs and larvae.

Daniel Paulson will be leading the research on objective 2 for his master's thesis. Daniel has developed a draft thesis proposal outlining his sampling and data analysis methods. He is assisting McKensie with her larval drift sampling. He has implanted 6 of 12 acoustic transmitters with acceleration sensors in fish in the Des Moines River in April 2024. He has designed new acoustic telemetry receiver mounts that will allow for flexibility in deployment location.

Future Plans:

McKensie will conduct larval sampling again in the spring of 2024. She will process samples drift samples in the lab during the fall and winter of 2024 and 2025. Daniel will finish implanting accelerometer transmitters in May or June 2024 and begin actively tracking Shovelnose Sturgeon by boat in June 2024 and repeat in June 2025. If summer refuge pools are located that are used intensively by acoustically tagged fish, he will deploy stationary receivers and dissolved oxygen loggers to collect acceleration and water quality data, which can be used to infer fish behavior and metabolic activity in relation to summer water quality that is potentially influenced by upstream dams. Both students will download detection data from stationary receivers distributed in the Des Moines, Iowa, and Cedar rivers in October 2024 and begin analysis of coarse scale movement data for the spring and summer periods, respectively.

Conservation Strategies and Actions to Support Urban Species of Greatest Conservation Need

Principal Investigator: Adam Janke
Student Investigator(s): Fanny Riand
Collaborators: Karen Kinkead, IDNR, Iowa Wildlife Federation, Story County Conservation, Polk County Conservation, Dallas County Conservation
Duration: January 2024-August 2026
Funding Source(s): USFWS via Iowa DNR
Worktag #: GR-028424-00001 DD12173

Goals and Objectives:

Conduct surveys to understand knowledge, attitudes, and beliefs of elected and governmental city leaders.

Document the nature of the barriers that constrain adoption of native plants and diverse landscapes among homeowners, gardeners, horticultural professionals, and non-governmental community leaders.

Create educational outreach materials related to urban wildlife conservation.

Progress:

We have conducted initial collaborator meetings and arranged project logistics. We have made initial contact with a random sample of homeowners and a targeted sample of wildlife-friendly gardeners that will serve as the basis of our sampling frame for Objective 2.

Future Plans:

We will develop and implement our mixed methods approach for understanding attitudes, beliefs, and constraints towards wildlife conservation in cities over the next year.

Examining Drivers of Temporal Variation in Hybridization Outcomes in Bigheaded Carp in the UMR

Principal Investigator: Dr. Michael J. Moore
Dr. Michael Weber
Dr. Jimena Golcher-Benavides (Post-Doctoral Research Scientist)

Student Investigator(s): None

Collaborators: Kim Bogenschutz (IDNR)
Jim Lamer (Illinois Natural History Survey, INHS)
Emily Szott (INHS)
Zachary Witzel (INHS)

Duration: October 2023–October 2025

Funding Source(s): United States Fish and Wildlife Service

Worktag #: GR-027705-00001 DD15913

Goals and Objectives:

Goal: Better understand the hybridization dynamics between Silver and Bighead Carp in the Upper Mississippi River

Objective 1 Assess the extent to which introgressive hybridization varies temporally in the UMR

Objective 2: To examine potential environmental drivers of temporal variation in hybridization outcomes

Progress:

DNA was extracted from fin clips from 480 Bigheaded carp (Silver or Bighead carp or hybrids). Next, we prepared genomic libraries and sequenced samples. Jimena is currently working on the necessary DNA quantification, clean-up, and concentration normalization steps prior to conducting the library preparation for low-coverage whole genome sequencing. Jimena is also analyzing test sequence data sets to build an analytical pipeline that will work with the full sequencing data set.

Future Plans:

We will use the genomic data from the high throughput sequencing to quantify both: 1) the proportion of Bighead Carp ancestry in hybrid Silver Carp or vice versa (i.e., extent of introgression q) and 2) the proportion of loci in an individual's genome that are estimated to have ancestry from both parental species, thus allowing for the distinction of recent F1 hybrids from later generation hybrid crosses (i.e., interspecific ancestry Q) across bigheaded carp year classes caught upstream of Lock and Dam 19. Quantification of temporal dynamics in hybridization outcomes may clarify observed shifts in the relative abundances of parental species along an invasion front. Recently available genomic resources facilitate unprecedented screening for potential genomic features found in hybrids that could in turn, facilitate or hamper invasion success in the MRB. Identification of mechanisms thought to explain variation in hybridization outcomes will help guide population control strategies including harvest efforts in the Mississippi River Basin.

Effects of Invasive Carp and impoundment on food web structure and fish condition in Upper Mississippi River Tributaries

Principal Investigator: Dr. Michael J. Moore
Dr. Michael Weber

Student Investigator(s): Justin Harms

Collaborators: Kim Bogenschutz (IDNR)
Rebecca Neely (USFWS)
Gene Jones (IDNR)
Rebecca Krogman (IDNR)

Duration: January 2024-July 2026

Funding Source(s): United States Fish and Wildlife Service

Worktag #: GR-027705-00001

Goals and Objectives:

Goal: To determine how fish condition and trophic position is related to the main and interactive effects of invasive species relative abundance and impoundment for multiple trophic guilds in tributaries to the Upper Mississippi River.

Objective 1: Assess the body condition of fishes in various trophic guilds using length/weights, body shape, and hepatosomatic index, and **Objective 2:** Assess trophic niche of fish occupying various trophic guilds using stable isotope analysis in relation to variation in invasive carp density and hydrologic alteration across Upper Mississippi River tributaries.

Progress:

Justin Harms began working on the project in January 2024 for his master's thesis. He has worked on a draft of his research proposal outlining his research methods. He began collecting fish tissue samples for stable isotope analysis and length and weight data as well as liver samples to assess fish condition in the Cedar River at Palisades-Kepler State Park in May 2024.

Future Plans:

Justin will continue collecting tissue samples at other sites throughout the summer of 2024. He will focus on collecting samples from Silver Carp (*Hypophthalmichthys molitrix*) and ~10 native species representative of various trophic guilds such as planktivore, detritivore, benthic invertivore, omnivore, and piscivore. Samples will encompass all length classes present in the population to help us understand ontogenetic shifts in each species' trophic niches. He will use the summer of 2025 to fill in gaps for rare species and length classes in his dataset that he was unable to collect in the first field season. He will also use standardized electrofishing protocols to estimate relative abundance of invasive carp at each of his sampling sites.

Continuing Projects

Wetland Reserve Program Properties: Importance for Iowa Breeding Birds in the Prairie Pothole Landform

Principal Investigator: Anna Tucker
Student Investigator(s): Lindsey Gapinski
Collaborators: Iowa DNR
Duration: 8/1/21 – 5/30/24
Funding Source(s): U.S. Fish and Wildlife Service State Wildlife Grant
Worktag #: GR-025148-00001

Goals and Objectives:

The Wetland Reserve Program (WRP) is one of the most significant habitat restoration programs in Iowa and has added more acres of wetland habitat than any other program since 1993. Providing habitat to benefit wildlife, with an emphasis on migratory birds, is the primary objective of the WRP program. Previous work has shown that WRP sites are used by at least 14 Species of Greatest Conservation Need. With this project, we aim to describe the use of WRP sites by SGCN and non-game birds in Iowa and evaluate the site characteristics that are associated with the greatest diversity and abundance of breeding birds. Additionally, we will compare the use of WRP sites by breeding birds in 2022-2023 to use of the same sites in 2007-2009.

Progress:

Field sampling concluded in 2023. Lindsey Gapinski defended her MS thesis in June 2024. Most analyses relevant to project objectives are complete, but we have requested a no-cost extension to also analyze bird density.

Future Plans:

We will analyze bird density and work on preparing manuscripts for submission to peer-reviewed journals as well as final report materials for Iowa DNR.

Evaluating the Benefits of Practices Implemented Under the Working Lands for Wildlife Program (WLFW) Targeting Northern Bobwhites

Principal Investigator: Anna Tucker, Adam Janke
Student Investigator(s): Jo Ford, Riggs Wilson
Collaborators: USDA NRCS, Iowa DNR
Duration: 9/25/21 – 9/29/24
Funding Source(s): USDA NRCS
Worktag #: GR-024790-00001

Goals and Objectives:

The purpose of this agreement is to enable NRCS and Iowa State University to work cooperatively to evaluate the benefits of the practices implemented under the Working Lands for Wildlife Program (WLFW) targeting northern bobwhite (*Colinus virginianus*) and avian biodiversity in midwestern working landscapes. WLFW in Iowa seeks to target Environmental Quality Incentives Program (EQIP) practices to improve habitat on working farms and ranches for northern bobwhites and a range of other wildlife species that benefit from comparable early successional ecosystems.

The objectives of this project are to:

- Describe bobwhite occurrence on sites employing EQIP or comparable CRP practices implemented under the WLFW program.

- Evaluate the local- and landscape-scale mediating factors that influence the effects of WLFW practices on bobwhite occurrence, and

- Assess co-occurrence of nongame SGCN bird species with bobwhite to test the umbrella species hypothesis.

Progress:

Riggs Wilson and Jo Ford both defended their MS theses in June 2024. All analyses pertinent to initial project objectives have been completed. We are in the process of preparing the final report and deliverables for NRCS.

Future Plans:

We are now focused on preparing manuscripts for submission to peer-reviewed journals as well as final report materials for NRCS. We have requested a no-cost extension to deploy ARUs in Fall 2024.

Using New Transmitter Technology to Evaluate the Effects of Environmental Change and Disturbance on Shorebird Breeding Phenology, Behavior, and Nest Success

Principal Investigator: Anna Tucker, Steve Dinsmore
Student Investigator(s): Aaron Yappert
Collaborators: U.S. Fish and Wildlife Service
Duration: 1/1/22 – 9/30/24
Funding Source(s): USGS Science Support Partnership
Worktag #: GR-025675-00001

Goals and Objectives:

Arctic-breeding shorebirds have experienced large population declines in the past several decades, which have been largely attributed to the effects of climate change in the Arctic. Climate change has led to changes in vegetation structure, the timing of insect prey availability, and the density of nest predators. However, it has also been suggested that increased nest predation observed over the past 20 years could be explained by research methods that involve frequent visits to active nests. Understanding the effect of human disturbance on nest success is critical for interpreting the results of many studies and identifying the key drivers of nest failure and the effects of climate on Arctic-breeding shorebirds. This study will use GPS tags deployed on dunlin (*Calidris alpina*) to understand movements and behaviors of breeding birds and to estimate nest success without human disturbance at the nest. Specifically, our objectives are:

- To obtain the first true estimates of nest survival in a shorebird species;
- To assess how conventional, human intensive monitoring techniques affect nest survival under different environmental conditions;
- To develop a best practice guide for accounting for human disturbance effects on shorebird nest survival; and
- To evaluate how adult behavior prior to and during nesting varies with environmental and ecological conditions.

Progress:

The 2024 field season (final field season) is underway, with 26 GPS tags deployed during the last week of May. Aaron Yappert has been working on data cleaning to eliminate GPS errors and preliminary analyses of the location data to characterize movements during the pre-breeding season.

Future Plans:

Aaron will be presenting preliminary results at the Western Hemisphere Shorebird Group meeting in August 2024. He will defend his M.S. thesis in Fall 2024/Spring 2025.

Evaluating Rusty Patched Bumblebee Conservation Efforts to Inform Site-Specific Management Actions

Principal Investigator: Amy Toth, Anna Tucker
Student Investigator(s): Erika Ibarra-Garibay, Kelsey Shepherd
Collaborators: U.S. Fish and Wildlife Service
Duration: 5/1/22 – 12/31/24
Funding Source(s): U.S. Fish and Wildlife Service
Worktag #:

Goals and Objectives:

The rusty patched bumble bee (*Bombus affinis*) is an endangered species that was once widely distributed across much of the Midwest. The U.S. Fish and Wildlife Service is interested in learning more about the current distribution and habitat associations of existing populations in Iowa to inform recovery planning and habitat management conducted via the Partners for Fish and Wildlife Program. The objective of this project is to evaluate the local and landscape habitat characteristics that are associated with bee occupancy and individual health indicators. To achieve this objective, we will conduct two types of surveys in the summers of 2022 and 2023. Rapid, noninvasive surveys will be used in an occupancy analysis to estimate the habitat features that are associated with bee presence. Intensive surveys in which bees are captured and released will also be conducted at a subset of sites to measure a suite of individual health indicators. This work will inform habitat management strategies for the Partners for Fish and Wildlife Program as well as targets for *B. affinis* recovery planning.

Progress:

We have completed two years of field sampling per the initial agreement, and received additional funds from USFWS along with a project extension to continue field sampling in 2024. Field surveys are currently underway at 30 sites across north-central Iowa. Kelsey Shepherd presented preliminary findings at the annual meeting of The Wildlife Society in November 2023.

Future Plans:

Kelsey Shepherd plans to defend her MS thesis in Fall 2024. After the 2024 field season is complete, both students will be working on preparing manuscripts to submit to peer-reviewed journals as well as final report materials for USFWS.

Habitat Associations and Biotic Interactions of Invasive Rusty Crayfish to Inform Risk Assessment and Management of Shallow Glacial Lakes at the Invasion Front

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|---------------------------------|--|
| Principal Investigator: | Dr. Michael Weber Dr. Michael Moore |
| Student Investigator(s): | Dalton Clayton |
| Collaborators: | Kim Bogenschutz (IDNR) Ben Wallace (IDNR) Paul Freese (IDNR) Karen Kinkead (IDNR) |
| Duration: | January 2023-August 2025 |
| Funding Source(s): | USGS Water Resources Research Act 104 G AIS Program grants |
| Worktag #: | GR-026843-00001 |

Goals and Objectives:

Goal: To understand the biotic and abiotic factors influencing invasive and non-invasive crayfish distribution in agriculturally dominated natural lakes of the Des Moines lobe at multiple spatial scales.

Objective 1: Determine which abiotic variables and biotic interactions, including the influence of active habitat management, affect the presence/absence of crayfish species at the lake scale (within Storm Lake).

Objective 2: Determine what abiotic variables and potentially biotic interactions influence presence/absence and detection probability of crayfish species at the landscape scale (among lakes).

Progress:

Dalton Clayton began his graduate program in January 2023. He has completed one of two summer field seasons and defended his research proposal to his thesis committee. From June-August 2023, he completed 381 trap-nights of sampling at Storm Lake. He captured 46 crayfish in Storm Lake including similar numbers of non-native Rusty (22 individuals) and native Virile Crayfish (24 individuals). Calico Crayfish were collected in the connected shallow Little Storm Lake but not Rusty Crayfish. Preliminary generalized linear models indicated that the probability of Rusty Crayfish presence was positively associated with macrophyte presence and cobble presence, whereas Virile Crayfish presence was positively associated with macrophyte presence.

Across the Des Moines Lobe, Dalton sampled crayfish at 20 natural lakes/wetlands and 1 impoundment with a total of 586 trap nights of effort. He captured 41 total crayfish including 29 Calico Crayfish, 12 Virile Crayfish, and 0 Rusty Crayfish. Dalton confirmed the presence of Rusty Crayfish at Lake Petocka in Bondurant, Iowa, Triumph Lake West, in Waukee, IA and Big Creek Reservoir near Polk City, IA. At Lake Petocka Dalton built and evaluated an alternate trap style that slightly improved detection probabilities of Rusty Crayfish over baited minnow traps.

Future Plans:

Crayfish sampling and habitat assessments will continue in Storm and other natural lakes from May-August 2024. Data will be analyzed in the fall of 2024. We plan to develop a full day workshop on crayfish identification and ecology that we can offer to cooperators at Iowa State University and IDNR to increase awareness and knowledge of this overlooked faunal group and equip biologists with the skills to collect data on their distribution in the state.

We will use this information to provide recommendations that can guide a variety of management decisions from outreach and education, bait use regulations, habitat management, and early detection monitoring to contain the expansion of invasive Rusty Crayfish in Iowa. Information on all species collected will also inform the update of crayfish distribution and status information in the Iowa State Wildlife Action plan that currently lists most crayfish species as “data deficient” in the state.

Estimating Age, Growth, and Mortality in a Tributary-Spawning Population of Shovelnose Sturgeon Using a Long-Term Mark-Recapture Dataset

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|---------------------------------|--|
| Principal Investigator: | Dr. Michael J. Moore |
| Student Investigator(s): | Juliana Kaloczi |
| Collaborators: | George Scholten (IDNR) Ryan Hupfeld (IDNR) Marty Hamel (University of Georgia) |
| Duration: | June 2023–April 2026 |
| Funding Source(s): | Iowa Department of Natural Resources |
| Worktag #: | GR-026827-00001 |

Goals and Objectives:

Goal: To utilize a long-term mark-recapture dataset of Shovelnose Sturgeon in the Cedar River to better understand the population dynamics to guide management and conservation of the species.

Objective 1: Develop incremental growth models to estimate age-specific growth rates

Objective 2: Develop mark-recapture models to estimate annual survival rates

Progress:

The Iowa DNR has assembled an 18-year dataset mark-recapture dataset on Shovelnose Sturgeon during spring spawning aggregations on the Cedar River near Palisades Kepler State Park, Iowa. Juliana Kaloczi began working on a master's thesis in June 2023. Her objectives are to develop mark-recapture models that can help managers better understand the population dynamics of this species. Juliana has also developed an R code script to convert data collected on IDNR tablets to a useful format for her analyses. She assisted with data collection in the field in May 2024. She has presented research on her first objective using a Fabens modification of Von Bertalanffy growth model to assess age and growth in this population. Preliminary analysis suggests that annual growth rates are low (<5mm/year for a majority of mature individuals) and do not differ significantly between males and females. Age at length estimates from these models seem to align roughly to analyses conducted by Iowa Department of Natural Resources using bomb radiocarbon dating of otoliths. Juliana continues to mentor an undergraduate honors student, Lydia Flinders, on research on Shovelnose Sturgeon, length-fecundity relationships in the Cedar and Des Moines rivers.

Future Plans:

Juliana will continue working on her detailed thesis proposal in preparation for her thesis proposal defense during the summer 2024. She will finish analysis for her first objective and begin to work on her second objective to estimate survival, which will require analytical approaches to overcome several of the challenges with this dataset including, periodic reproduction, complex movement dynamics, and tag loss. We will use these approaches to analyze the data to support the development of management alternatives for this population.

Iowa's Multiple Species Inventory and Monitoring (MSIM) Program

| | |
|---------------------------------|--|
| Principal Investigator: | Stephen J. Dinsmore, Karen E. Kinkead |
| Student Investigator(s): | ~25 seasonal field technicians |
| Collaborators: | Emma Buckardt (ISU MSIM biologist), Jonathan P. Harris (ISU post doc), U.S. Fish and Wildlife Service and Iowa Department of Natural Resources |
| Duration: | 1 January 2023-31 December 2024 |
| Funding Source(s): | U.S. Fish and Wildlife Service and Iowa State University |
| Worktag #: | GR-026926-00001 |

Goals and Objectives:

Project goals include the following:

- Conduct MSIM surveys for birds, mammals, amphibians, reptiles, fish, mussels, butterflies, odonates, and crayfish on 50 Wildlife Management Areas annually during 2020-2024.
- Conduct MSIM surveys on 10-20 additional properties in 2020-2024, if funding allows.
- Enter collected data into the MSIM on-line database, submit county occurrence records to the appropriate Iowa WAP taxonomic subcommittee, provide additional information to the IWAP subcommittees as requested, and change database records as advised.
- Analyze data using (but not limited to): Proportion of area occupied and species density (where applicable) using habitat variables from the field and/or GIS where applicable.

Progress:

In 2023 the MSIM program employed 4 field crews of 4-5 technicians each (29 technicians in total throughout the season) stationed in Boone, Chariton, Tripoli, and Iowa City. We could not hire enough field technicians for five crews and therefore lacked a crew in northwestern Iowa. Fieldwork for this project began with training in late March and ended on 13 October 2023. We completed surveys implementing MSIM protocols at 69 study sites across Iowa although only 61 sites were fully surveyed because of staffing shortfalls. This total includes traditionally surveyed "permanent" MSIM sites, additional public lands sites, and private land sites for properties enrolled in a conservation habitat program. All species observed during surveys were recorded with special focus given the Species of Greatest Conservation Need (SGCN). All collected data were entered into the MSIM online database.

This effort included >1600 wildlife surveys conducted on these study sites and approximately 125 survey-related tasks such as site setup and teardown. A summary of species seen by taxa includes 40 mammals (7 SGCN), 239 birds (75 SGCN), 45 herpetofauna (33 SGCN), 82 odonates (11 SGCN), 59 lepidoptera (10 SGCN), 85 fish (31 SGCN), and 8 crayfish (5 SGCN). We encountered many noteworthy sightings in several taxonomic groups as is usual for this program.

In addition to the fieldwork we hired Jonathan Harris as a post doc in spring 2023. He is working with Emma Buckardt to analyze and publish data collected as part of this program. They have focused on the following efforts:

- Jonathan finalized an earlier manuscript that used MSIM data to evaluate density estimates for butterflies using two sampling methodologies. A paper was submitted and published in *PeerJ*.
- Emma and Jonathan modeled herptile occupancy and colonization at 295 MSIM sites across Iowa in the period 2006-2014 using Bayesian N-mixture models. This work was summarized in a journal article that was submitted to PLoS ONE and subsequently accepted for publication.
- Jonathan completed an analysis of breeding bird richness at 494 MSIM sites spanning 2007-2021 using Bayesian hierarchical N-mixture models. The results were summarized in a journal article to be submitted to *Diversity and Distributions*.
- Emma and Jonathan are preparing a paper on drought effects on Iowa anurans using MSIM data.
- Jonathan also explored grassland bird drought sensitivity using spatio-temporal occupancy models.

Future Plans:

Plans are to complete another field season in 2024 and work on additional publications on bats and other taxa.

Project Title: Midwest Bumble Bee Atlas

| | |
|--------------------------------|---|
| Principal Investigator: | Dr. Matthew O'Neal |
| Student Investigator: | Abigail Miller |
| Collaborators: | Xerces Society, STRIPS Project |
| Duration: | Award is for January 1, 2023 to December 31, 2025 |
| Funding Source(s): | US Fish and Wildlife Service- Iowa DNR |
| Worktag # | GR-027642-00001 |

Goals and Objectives:

Overall, the goal of this project is to expand the Bumble Bee Atlas (BBA) created by the Xerces Society to Iowa (<https://www.bumblebeeatlas.org/>). With this expansion, we are exploring how conservation practices commonly used within Iowa contribute to the conservation of bumble bees. This exploration includes comparing the abundance and diversity of bumble bees observed at locations selected by community scientists enrolled in the BBA to those observed in land enrolled in conservation practices sponsored by the USDA's Conservation Reserve Program (CRP).

Progress:

Iowa State University (ISU) received funding for this project in June 2023, delaying the start of several tasks during the first year of this project. Despite this set back, several accomplishments were achieved. This included recruiting a M.S. candidate (Abigail Miller) and training her to conduct several tasks. This training included the sampling methods and reporting protocol for the BBA. This training allows Miller to recruit and train citizen scientists in Iowa to join the project. During the first year, Dr. O'Neal and Miller participated in several training sessions organized by ISU's STRIPS project (Science-Based Trails of Rowcrops Integrated with Prairie Strips; <https://www.nrem.iastate.edu/research/STRIPS/>) for employees of the Farm Service Agency (FSA) and Natural Resources Conservation Service (NRCS). These trainings were centered around the prairie strip practice (CP43) sponsored by the CRP of the USDA. At these trainings, Dr. O'Neal shared with FSA and NCSR staff the evidence for how CP43 increases bee and pollinator abundance and diversity. He also shared information about the BBA, explaining how this community scientist project will help inform their agencies of what bumble bees are of greatest need for conservation. The feedback from these four events were recently reviewed, with over 75% of the participants noting "pollinator science and practice" contribute "very well to extremely well" for their knowledge of prairie strips.

Miller and O'Neal participated in regular meetings with co-PIs of the BBA. This has led to Miller presenting the BBA at The Loess Hills Prairie Seminar (May 31- June 1, ~100 participants) and Pollinator Fest at Rieman Gardens (June 22, ~500 participants). Also, The ISU team invited the Xerces staff member responsible for Iowa, Genevieve Pugesek, to speak at the Day of Insects on 23 March, 2024 on the campus of Iowa State University.

Miller has recruited and hired undergraduates to assist in field work during the 2024 growing season (April-September). The field work includes surveying bumble bees at 15 commercial farms which have established prairie strips. As of 30 June, these sites have been visited at least once.

Future Plans:

Our future plans are to complete the tasks outlined in the original grant. This includes visiting the farm sites 2-3 more times before the end of the summer and fall. We will also continue presenting at events throughout the year to advertise the BBA in attempt to recruit additional community scientists.

Integrated Population Model for the Mountain Plover in Montana

Principal Investigator: Stephen J. Dinsmore
Student Investigator(s): Rachel Siller
Collaborators: U.S. Fish and Wildlife Service
Duration: 1 Feb 2021-31 Jan 2025
Funding Source(s): U.S. Fish and Wildlife Service and Iowa State University
Worktag #: AWD-023898-00001

Goals and Objectives:

The proposed landscape-scale collaborative research project will provide the first assessment of annual cycle movements and population limiting factors of the Mountain Plover, a species that according to the Breeding Bird Survey appears is experiencing significant long-term declines. The results of this project will provide land management agencies critical information about where the species population may be limited and identify important areas for conservation throughout the annual cycle. The information will allow conservation planners and land managers to develop effective conservation strategies for the species. Without this information, we'll continue to lack critical information to most effectively conserve and manage priority landscapes, and ultimately slow or reverse the declines of the Mountain Plover and the larger suite of focal grassland birds.

Progress:

The third field season was in summer 2023. This year we visited the study area from 15 May through 12 August to survey all prairie dog colonies for Mountain Plovers, search for plover nests, and monitor all plover nests found. The weather in 2023 was seasonal with more rain than during the previous two field seasons. These wet conditions sometimes prevented access to colonies. During 2023 surveys we located 21 plover nests and monitored them throughout the season; 7 nests were successful. We color-banded a total of 16 adult plovers and 2 chicks in 2023. Adults were captured with a walk-in trap placed over the nest or a bow-net placed around the nest and remotely triggered from a distance. All of the adults were fitted with a Milsar GPS tag. We relocated one GPS tagged adult that was originally caught in 2022. Only data from the fall migration period and part of the winter were collected. Reproductive success was low in 2023 and only one of the monitored broods was known to survive until fledging. There were few hatch-year birds in post-breeding flocks. This greatly limited the opportunity to tag juvenile birds and none were caught this year. To try to increase detection of tagged plovers that were not relocated on prairie dog colonies and increase download success from the GPS tags, we chartered three flights over the study area: one at the beginning of the field season (May 18), one in the middle (July 14), and one right at the end (August 11). We had mixed success with the flights: no downloads the first flight, one download on the second flight, and two partial downloads on the last flight. The graduate student (Rachel Siller) also passed her preliminary Ph.D. exams in fall 2023.

Future Plans:

Plans are for Rachel to complete data analyses in summer 2024, present some study findings at the Western Hemisphere Shorebird Group meeting in August 2024, and complete her dissertation and graduate in fall 2024.

Blanding's Turtle Response to Habitat and Water Management

Principal Investigator: Stephen J. Dinsmore and Anna M. Tucker
Student Investigator(s): Elizabeth Lang
Collaborators: Iowa Department of Natural Resources and U.S. Fish and Wildlife Service
Duration: 6/30/2022-3/31/2025
Funding Source(s): U.S. Fish and Wildlife Service
Worktag #: GR-026264-00001

Goals and Objectives:

The objectives of this study are to:

1. Determine turtle response to management actions using radio-telemetry and a larger mark-recapture study to attempt to quantify population size at a local scale. This portion of the study may include hatchlings and juveniles if we can find them or head-starting turtles where available.
2. Conduct surveys to update the status of historic Blanding's Turtle element occurrences at locations that have not been surveyed in the last 10 years and assess the viability of the site to maintain the turtle population under current conditions.

Progress:

M.S. graduate student Elizabeth Lang completed her first field season in 2023. During the first field season she deployed 133 traps for a total of 344 trap nights and captured and tagged 15 adult Blanding's Turtles between four sites in west-central Iowa. During summer 2023 she collected 510 locations on these turtles to estimate home range and characterize local movements. She also collected an additional 284 locations in fall to replicate home range and movement estimates in a different season. During summer we found two gravid females and collected 21 eggs for transfer to Blank Park Zoo. All eggs hatched, but none developed into hatchlings. One tagged turtle went missing in November 2023, likely because of a transmitter failure.

Future Plans:

Plans are to complete the second field season in summer/fall 2024. This will include trapping adult Blanding's Turtles, fitting them with VHF telemetry tags, tracking their movements, and monitoring females for nesting activity. Once fieldwork is completed Lizzy will finalize data entry, work on data analyses and writing, and will hope to complete her M.S. thesis in spring 2025.

Sustainable Rivers Program: Waterbird and Invertebrate Responses to Reservoir Management in Central Iowa

| | |
|---------------------------------|---|
| Principal Investigator: | Stephen J. Dinsmore |
| Student Investigator(s): | Victoria Fasbender |
| Collaborators: | U.S. Army Corps of Engineers and Iowa Department of Natural Resources |
| Duration: | 1/1/2023-12/31/2025 |
| Funding Source(s): | U.S. Army Corps of Engineers (SRP Program) |
| Worktag #: | GR-027039-00001 |

Goals and Objectives:

The objectives of this study are to:

1. Continue existing waterbird surveys during fall migration (mid-July to early September, adding to work done in 2021 and 2022).
2. Continue shorebird stopover ecology work to document residency times and site use in response to pool level and other environmental factors.
3. Sample the invertebrate community (benthos and water column) to determine the diversity and relative abundance of shorebird prey items.

Progress:

Field Methods

The study area of this project is the alluvial delta of Lake Red Rock. This delta is located at the west end of Lake Red Rock on the Des Moines River in Marion County, Iowa. This is the same study area used for waterbird and vegetation monitoring related to environmental pool management in 2021 and 2022. Altogether, 37 days were spent at the study site in 2023.

To address objective one, waterbird surveys were conducted roughly every five days. Surveys were completed during daytime, only in adequate weather, and using a standardized search method. A total of 17 waterbird surveys were completed, the first on 19 July 2023 and the last on 2 October 2023.

To address objective two, the Pectoral Sandpiper was selected as a focal species. Satellite tags were attached to 29 Pectoral Sandpipers. Mist nets were set up nine times and two tag types were used: PinPoint GPS ARGOS (Global Positioning System; Advanced Research and Global Observation Satellite) tags to gather information on fine scale movements at Red Rock and Sunbird Solar ARGOS tags to gather migration information after they departed Red Rock. PinPoint GPS ARGOS tags ($n = 25$) were attached using a temporary clip and glue method (tags fall off when the bird molts later in fall) and were programmed to take 14 points a day, one at midnight to get a roosting location and the other 13 fixes every 75 min starting at 0600 and ending at 2100. Deployment of these tags was staggered between 1 and 27 August 2023 to span the main migration period. Sunbird Solar ARGOS tags ($n = 4$) have a solar rechargeable battery and were attached using a more permanent leg loop harness. The fix frequency was variable and dependent on the charge of the tag. Deployment of these tags occurred between 4 and 13 September 2023. Birds fitted with either tag had morphometric body measurements taken.

To address objective three, 25 random transects running perpendicular to the shoreline were sampled for aquatic invertebrates weekly. Sampling started 20 July and ended 8 September 2023. At each transect, as benthic core sample was taken along the transect at three water depths: zero cm of water/wet mud, 3 cm of water, and 6 cm of water. Each sample was sieved. Invertebrates collected were identified to Family or Order and will be weighed, which will allow an estimation of total invertebrate biomass. Species richness (weekly) was computed by summing the number of families collected in each week (25 transects, 3 samples per transect).

Preliminary Results

Objective 1 – A total of 45 species were seen during 2023 waterbird surveys. There was an average of 24.5 (SD = 5.3) waterbird species per survey (range was 16 to 33). Species richness (number of species observed) peaked during the last week in August (Figure 1) and correlated with low pool levels ($r = -0.83$; in statistics, “r” denotes a simple correlation, which is a measure of how two variables are related; “r” values range from 1 to -1; an “r” value of 0 indicates that the two variables are wholly unrelated; the closer the “r” value is to 1 or -1, the stronger the statistical relationship between the two variables; a negative correlation indicates an inverse relationship, which, in this case, means that as the pool was lowered, species richness increased). Of the 45 species seen, 23 were shorebirds, 10 were waterfowl, and 12 fell into other waterbird groups. A total of >185,000 individual waterbirds were counted. American White Pelican was the most numerous with 109,590 recorded (59.2% of the total). The most numerous shorebird species was the Pectoral Sandpiper with 16,314 individuals counted (8.8% of the total). Limpkin, Hudsonian and Marbled godwits, and White-rumped Sandpiper were some of the uncommon species observed.

Objective 2 – A total of 29 Pectoral Sandpipers were fitted with a tracking tag. This group consisted of 12 adult males, 12 adult females, and five juvenile males (Appendix B). The farthest a tagged Pectoral Sandpiper traveled was 5,465 km starting at Lake Red Rock and landing in Venezuela with no stops (Figure 2; 439). The last tagged Pectoral Sandpiper left Lake Red Rock on 7 October. Multiple individuals were tracked to South America.

Objective 3 – Twelve orders and 22 families of invertebrates were identified. The most abundant family by count was Chironomidae (67.6%) followed by Corixidae (18.5%) (Appendix C). The average site richness was 0.68 (SD = 0.97) for 0 cm samples, 0.74 (SD = 0.98) for 3 cm samples, and 0.87 (SD = 1.02) for 6 cm samples. The site richness ranged from 0 to 4 in all water depths. The average site abundance was 2.1 (SD = 4.3) for 0 cm samples, 3.8 (SD = 8.5) for 3 cm samples, and 4.0 (SD = 9.5) for 6 cm samples. Site abundance ranged from 0 to 32 in 0 cm samples, 0 to 55 in 3 cm samples, and 0 to 76 in 6 cm samples.

Future Plans:

Plans are to complete the second of two field seasons by early September 2024. During the 2024-2025 academic year Victoria will complete her remaining coursework, finalize data entry and analyses, and complete her M.S. thesis in spring 2025.

Effects of Experimental Reservoir Releases on Downstream Riverine Aquatic Biota Sustainable Rivers Program: Downstream Ecological Responses to Experimental Flow Releases From Red Rock Dam

| | |
|---------------------------------|--------------------------------------|
| Principal Investigators: | Michael J. Weber |
| Student Investigator: | Erik Griffen |
| Collaborators: | Iowa DNR, US Army Corps of Engineers |
| Duration: | April 2021 - December 2023 |
| Funding Source(s): | US Army Corps of Engineers |

Goals and Objectives:

Assess fish reproduction in the Des Moines River in relation to experimental flows from Red Rock Dam.

Completion Report:

We found Catostomidae larval presence was positively influenced by water temperature whereas larval density was positively associated with both water temperature and discharge. Sciaenidae and Clupeidae larval presence and density were positively related to discharge and change in discharge.

Catostomidae feeding success and consumption of copepods increased with prey density. Catostomidae consumption of rotifers increased with prey density but was negatively associated with feeding success on rotifers and foraging on cladocerans. Cladoceran and copepod consumption by Sciaenidae increased with discharge, but feeding success decreased with discharge when foraging on copepods. Cladoceran consumption by Catostomidae increased with discharge, but feeding success on cladocerans, copepods, and consumption of copepods were negatively associated with discharge. Feeding success and consumption of cladocerans by Sciaenidae and Catostomidae decreased with water temperature, but Catostomidae feeding success and consumption of copepods increased with water temperature. Fish length was negatively associated with Catostomidae consuming rotifers but positively associated with Sciaenidae consumption of cladoceran, copepod, and rotifers. Conversely, we found little support of river discharge on growth of either taxa.

Our results have identified environmental factors influencing early life stages of native riverine fishes. Our results also provide insights into the benefits of experimental flows and environmental conditions in rivers for native fish reproduction, environmental factors influencing larval fish foraging, and the importance of zooplankton prey for larval fish growth. Our results highlight possible positive benefits of experimental flows for fish reproduction and larval fish prey consumption and suggests zooplankton densities may be a significant limiting factor for larval fish growth in lotic systems.

Acoustic Monitoring of Iowa Bats

| | |
|---------------------------------|---|
| Principal Investigator: | Julie Blanchong |
| Student Investigator(s): | Tayah Lande, Kristi Brede |
| Collaborators: | Kelly Poole, Stephanie Shepherd, Michael French |
| Duration: | Continuing, contracts below end 12-31-2023 |
| Funding Source(s): | Iowa DNR (USFWS flow through) |
| Worktag #: | # GR-025454-00001, GR-027038-0001 |

Goals and Objectives:

1. Develop new drive transect and stationary survey sites in accordance with the North American Bat Monitoring Program (NABAT) design framework.
2. Conduct acoustic surveys for bats in Iowa to document bat activity, abundance, and distribution.

Progress:

White-Nose Syndrome (WNS), a devastating disease associated with the mortality of millions of bats, was first documented in New York during the winter of 2005-2006, and is now confirmed in Iowa. The loss of large numbers of bats due to WNS is expected to have enormous economic impacts to agriculture. Knowledge of the abundance and distribution of bat species in Iowa is critically needed to understand the potential ramifications of WNS to Iowa. To gather data on bat abundance and distribution in Iowa, acoustic monitoring has been conducted for several summers along transects in eastern, central, northwest, and southern Iowa.

As in previous summers, the Iowa Department of Natural Resources (IDNR) will recruit volunteers to conduct the acoustic surveys. We will train volunteers to collect bat acoustic data. Relying on well-trained local volunteers to conduct drive transects and survey stationary sites is efficient and cost effective. It also increases public engagement with the project and public awareness of bats and the threat of WNS. In July, citizen scientists will collect bat echolocation calls on >25 drive transects and at >20 stationary survey sites on public and private land in central, eastern, southern, and northwest Iowa. We will process bat echolocation calls using automated bat call identification software and analyze the data for spatial and temporal trends in bat activity across Iowa.

Future Plans:

We will upload bat echolocation calls and associated species identification data to the North American Bat Monitoring Program (NABAT) database, provide a final report of findings to the Iowa DNR, and prepare summary reports to all volunteers and landowner participants.

Monitoring Iowa's Grey Fox Populations

| | |
|---------------------------------|----------------------------|
| Principal Investigator: | Robert W. Klaver |
| Student Investigator(s): | |
| Collaborators: | Vince Evelsizer, Iowa DNR |
| Duration: | April 2022 – December 2025 |
| Funding Source(s): | Iowa DNR |
| Worktag #: | N/A |

Goals and Objectives:

Gray fox are a valuable and understudied furbearer in North America. Since the 1980s, several indices strongly suggest a dramatic decline in the gray fox population throughout the Midwest, although, little research has been conducted in the region. The cause of this decline is unknown, but may be linked to habitat loss and fragmentation, changing mesocarnivore (e.g., coyote) community structure, disease, and other factors. It could also be a combination of these factors. We propose to implement a large-scale, comprehensive study at multiple study sites in Iowa, Illinois, and Ohio. This study would be a collaborative effort between the Iowa Department of Natural Resources (Iowa DNR), the Ohio Department of Natural Resources (Ohio DNR), and the Illinois Department of Natural Resources (Illinois DNR). The goals of this project are to determine causes for the regional population decline of gray fox in the Midwest and provide management recommendations that can be applied as part of this multi-state effort to promote gray fox conservation in the region. Specific objectives are as follows:

Objectives:

1. Determine factors influencing survival and cause-specific mortality of gray fox.
2. Develop landscape-scale spatial habitat models of resource selection for gray fox in 3 Midwest states.
3. Determine the prevalence of various canid diseases using GPS-collared and uncollared foxes.
4. Determine the genetic structure of the gray fox population and identify potential barriers to gene flow in the Midwest

Progress:

Iowa DNR biologist captured an adult male grey fox and fitted it with a GPS collar. We have downloaded 290 location between November 2023 and April 2024 in residential Keokuk, Iowa.

Future Plans:

We will continue monitoring the grey fox currently fitted with a GPS collar. Iowa DNR biologist will continue to both trap and work with Iowa trappers to capture additional foxes.

Density of White-tailed Deer in Iowa

| | |
|---------------------------------------|--|
| Principal Investigator: | Stephen J. Dinsmore |
| Post-Doctoral Investigator(s): | David M. Delaney |
| Collaborators: | Tyler M. Harms, Iowa Department of Natural Resources |
| Duration: | 10/1/2022-6/30/2024 (Extended to 6/30/25) |
| Funding Source(s): | Iowa Department of Natural Resources |
| Worktag #: | GR-026785-00001 |

Goals and Objectives:

The project has three primary goals as follows:

1. Evaluate spotlight survey design considerations for estimating county-specific densities of white-tailed deer.
2. Investigate approaches for integrating multiple available data sets for estimating long-term population trends of white-tailed deer in Iowa.
3. Evaluate the economic and environmental impact of white-tailed deer on various stakeholder interests in Iowa.

Progress:

Post doc David Delaney began work on 27 February 2023 and his work mainly focused on objectives 1 and 2. He has developed robust county-level estimates of deer abundance from the Iowa DNR spotlight data and continues to explore ways to refine estimates of detection probability by adjusting the viewshed and through other approaches. This led to our decision to conduct a drone study better define road avoidance by deer and adjust detection probability estimates. David sampled 12 nights during April and collected 18 hours of thermal video over 10 square miles. He is 41% of the way through extracting deer location data from videos and has identified 290 deer locations. He will finish processing and analyzing data to quantify the shape and magnitude of road avoidance and availability bias by mid-July. Formal description in a peer-reviewed manuscript will follow preparation of the final report. A paper on this aspect of the project is under peer-review at *Methods in Ecology and Evolution*. David presented our analytic framework at the Applied Statistics in Agriculture and Natural Resources conference and received positive feedback. A full draft of the temporal replication aspect of the project is in review with the deer study tech team and will be submitted to a peer-reviewed journal soon. Finally, Dr. Tyndall (ISU) has established an assessment protocol for estimating the cost of deer-vehicle collisions (DVC) in the state of Iowa based on methodologies utilized by the Federal Highway Administration and various state Departments of Transportation. Relevant secondary data has been compiled and is in the process of being refined based on recent data provided by the Iowa DOT and the Iowa Department of Insurance and Financial Services. Costs being accounted for in this assessment includes the weighted average cost per DVC of human injuries, fatalities, property damage, towing, emergency services, carcass removal and disposal, and the lost value of deer. Preliminary data (subject to refinement) suggest that DVCs (including aviation runway accidents) and roadkill deer in Iowa cost about \$128,000,000 per year. This work relates to study objective 3 and will be peer reviewed by an outside consultant to verify assumptions utilized and data interpretations.

Future Plans:

Plans are to continue to finalize models of deer density at the county level by including covariates such as viewshed, environmental conditions, and road avoidance (objective 1) and explore additional data integration techniques (objective 2). We will also meet later in summer 2024 to finalize the economic impacts aspect of this project (objective 3) in time to submit a final report by the 1 October 2024 deadline.

Completed Projects

Developing Capture Techniques and Monitoring the Movement of Sandhill Cranes Breeding in Iowa

Principal Investigator: Robert W. Klaver
Student Investigator(s):
Collaborators: Orrin Jones
Duration: July 2019 – December 2023
Funding Source(s): PR funds through Iowa DNR
Worktag #: GR-021711-00001

Goals and Objectives:

Sandhill cranes (*Antigone canadensis*) are recolonizing Iowa; however, their population affinity is uncertain. Sandhill cranes are assumed to be affiliated with the Eastern Population, which are primarily found in the Great Lakes states of eastern Minnesota, Wisconsin and Michigan. However, recent research in Minnesota discovered that cranes on the western periphery of the EP might overlap with mid-continent population sandhill cranes (MCP) thereby calling into question the affiliation of Iowa's cranes. It is increasingly important to improve our understanding of Iowa's breeding cranes. The most direct way to do so is through a field research project. However, cranes are a novel species in the modern-day Iowa landscape and there is very little previous work to rely upon. This is a pilot project to assess the feasibility of capturing sandhill cranes in Iowa.

Progress:

We have captured 36 sandhill cranes and fitted them with GPS/GSM leg-mounted transmitters. We have gathered > 750,000 during the study.

One of the cranes migrated to Texas as part of the Midcontinent Population and spend time along the Platt River. All of the other cranes migrated as part of the Eastern Population.

Future Plans:

We are in the process of preparing a manuscript on crane biology in Iowa

Conclusions and Recommendations:

Sandhill cranes are part of both the Midcontinent Population and the Eastern Population, with the majority moving as the Eastern Population. Young sandhill cranes move throughout Iowa as part of their exploring biology in their pre-breeding years.

Ecology of Canada Geese in Urban Areas of Iowa

Principal Investigator: Robert W. Klaver
Student Investigator(s):
Collaborators: Orrin Jones, Iowa DNR
Duration: June 2018 – April 2024
Funding Source(s): PR funds through Iowa DNR
Worktag #:

Goals and Objectives:

- Evaluate the movement of Canada geese captured in urban areas. Compare movements of the urban geese to the movements of geese captured in rural locations where the goose hunting season is closed.
- Determine the susceptibility of Canada geese captured in urban areas to hunting during the Special September Canada Goose season and the conventional Canada goose hunting season.
- Estimate annual harvest and survival rates for Canada geese captured in urban areas.
- Evaluate a three age-class model to estimate harvest and survival rates of Canada geese in Iowa.
- Where possible incorporate both live recaptures and dead recoveries to improve statistical precision and accuracy to band recovery models

Progress:

We fitted with GPS/GSM neck collars 101 female Canada geese and have collect > 4 million locations on these geese.

Future Plans:

We are in the process of preparing a manuscript on molt migration

Conclusions and Recommendations:

Data from this study was used in the Iowa Canada Goose Management Plan.

Historical Assessment of Invasive Carp Reproduction Upstream of Lock and Dam 19 in the UMR

Principal Investigator: Dr. Michael J. Weber
Dr. Michael J. Moore

Post-Doctoral Investigator(s): Dr. Jimena Golcher-Benavides

Collaborators: Kim Bogenschutz (IDNR)
Dr. Gregory Whitledge (Southern Illinois University)
Dr. Jim Lamer (Illinois Natural History Survey, INHS)
Zachary Witzel (INHS)
Emily Szott (INHS)
Dominique Turney (INHS)
Shaley Valentine (Southern Illinois University and INHS)

Duration: October 2022 – Present

Funding Source(s): Iowa Department of Natural Resources
US Fish and Wildlife Service

Worktag #: GR-026356-00001

Goals and Objectives:

Goal: To assess the historical occurrence and magnitude of invasive carp recruitment upstream of LD 19 in relation to environmental conditions.

Objective 1: To determine age and annual variation in natal origins of Silver Carp using otolith microchemistry and stable isotope techniques.

Objective 2: To assess annual variation in recruitment dynamics of invasive Silver Carp in association with environmental conditions.

Progress:

We collected otoliths from a total of 505 Silver Carp (664-1088 mm TL), 16 Bighead Carp (925-1300 mm TL), and 5 morphologically distinguishable hybrids between Silver Carp and Bighead Carp (831-1100 mm TL). Otoliths were sectioned for age determination and microchemistry analyses. In May, 2023 elemental composition analyses were performed using mass spectrometry at Southern Illinois University- Carbondale and carbonate samples extracted from the otolith core of each fish were sent to the Environmental Isotope Laboratory at University of Arizona for additional oxygen isotope analyses. After delays in processing at University of Arizona, we received oxygen isotope data for the rest of the samples in May 2024, which allowed us to classify natal origins of 480 Silver Carp in our sample. Our data on natal origin suggested that ~18% of Silver Carp captured in the UMR had early life environments upstream of Lock and Dam 19 in the UMR. Aging of otoliths indicated that twelve age classes between 2007 (15 years old) and 2018 (4 years old) were present among individuals with UMR natal origins. This suggests that although most fish are colonizing the UMR by passing Lock and Dam 19 sometime during their lives, recruitment levels upstream of Lock and Dam #19 may be increasing since the last assessment during the 2015-2017 sampling period (~12% of Silver Carp representing five age classes had an early life environment upstream of LD 19) as the invasion front shifts northward. The strongest year classes in our sample according to catch curves were 2012 and 2016 and the weakest were 2015 and 2015. Strong year classes generally occur during years with warm temperatures and low spring-summer discharges.

Future Plans:

Next, we will finish modeling studentized residuals from updated catch curve analyses as a function of environmental variables to determine conditions associated with strong and weak year classes. A manuscript and a final report are currently being prepared.

Evaluation of Forest and Wildlife Responses to Aerial Applications of Glyphosate

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|---------------------------------|--|
| Principal Investigator: | Miranda Curzon |
| Student Investigator(s): | Katrina Fernald Anne-Utelie Poicon |
| Collaborators: | Tyler Harms (IDNR) |
| Duration: | November, 2018- September, 2023 |
| Funding Source(s): | U.S. Fish and Wildlife Service's Wildlife Restoration Program The Iowa DNR Fish and Wildlife Trust Fund |
| Worktag #: | GR-019981-00001 DD07617 |

Goals and Objectives:

Objective 1. Quantify forest vegetation response to fall aerial glyphosate application and invasive honeysuckle removal. This will include an assessment of impacts to understory herbaceous plants, shrub species, tree seedlings and saplings, and mature overstory trees.

Objective 2. Evaluate the impact of spray timing on the effectiveness of aerial glyphosate treatment of invasive honeysuckle.

Progress:

We established permanent plots and completed pre-treatment vegetation sampling at all three sites (Red Rock, Rathbun, and Mount Ayr WMAs) during summer 2019. This included sampling herbaceous and woody vegetation in all strata. Additionally, the forest breeding bird community was sampled with bird counts. We also installed deer exclosures to enable assessment of the potential interactive effects of honeysuckle and deer browse on tree regeneration. Weather conditions prevented spray treatments applications in November 2019. In 2020 we sampled vegetation and the forest bird community in additional areas treated in 2014 and 2015 identified within each WMA to allow a more-timely comparison of treated and untreated areas. Aerial treatment of all three sites went as planned in November, 2020.

Vegetation for the first post-treatment growing season was completed June-August, 2021. Katie Fernald defended her MS thesis reporting how aerial treatment influenced forest vegetation, the forest bird community, and individual forest birds. Anne-Ult elie Poincon, PhD graduate student recruited to complete this stage of the project started her program in January, 2022.

A second post-treatment season of vegetation sampling focused on the shrub and seedling layer was completed June-August, 2022. Post-treatment sampling of overstory trees and tree regeneration was conducted May-June 2023.

Analysis of the vegetation data collected in 2022 and 2023 and associated writing concluded the work funded under this grant.

Other funds, including a USDA Forest Service Forest Health Protection Grant are currently being used to leverage the investment made by the Iowa DNR and the USFWS Wildlife Restoration Program to continue the project and supplement the results from this initial work.

Conclusions and Recommendations

Aerial application of glyphosate in the fall following senescence of native plant species offers a cost-effective way to reduce invasive bush honeysuckle for the short-term. Early results suggest positive responses in the understory herbaceous community as well as oak and hickory regeneration; however, follow-up treatment is likely necessary. While honeysuckle biomass and density were both significantly reduced as late as 6 years post-treatment, densities suggest that regeneration is occurring. This is supported by anecdotal field observations made in 2023 after the conclusion of post-treatment vegetation. Based on responses of the forest bird community we also recommend that managers pair honeysuckle removal with native shrub restoration when possible. Breeding birds that may be negatively impacted by honeysuckle removal will readily use native shrubs for nesting and cover instead. The positive impacts of native shrubs are also evident in other parts of the year.

Professional Activities

Graduate Committee Service

Robert W. Klaver

Advisor/Co-Advisor

- Karri Folks (Ph.D., Department of NREM, Iowa State University)
- Bridget Nixon (Ph.D., Department of NREM, Iowa State University)
- Matt Stephenson (Ph.D., Department of NREM, Iowa State University)

Committee Member

- Jordan Giese (Ph.D., Department of NREM, Iowa State University)
- Ámbar Meléndez-Pérez (Ph.D., Department of NREM, Iowa State University)
- Christian Slone (M.S., Department of NREM, Iowa State University)

Anna Tucker

Advisor/Co-Advisor

- Jo Ford (M.S., Department of NREM, Iowa State University)
- Lindsey Gapinski (M.S., Department of NREM, Iowa State University)
- Lizzy Lang (M.S., Department of NREM, Iowa State University)
- Kelsey Shepherd (M.S., Department of NREM, Iowa State University)
- Aaron Yappert (M.S., Department of NREM, Iowa State University)

Committee Member:

- Evangeline von Boeckman (M.S., Department of NREM, Iowa State University)
- Bobby Cope (Ph.D., Department of NREM, Iowa State University)
- Rachel Siller (Ph.D., Department of NREM, Iowa State University)
- Bridie Nixon (Ph.D., Department of NREM, Iowa State University)
- Jordan Giese (Ph.D., Department of NREM, Iowa State University)
- Eli Lagacy (M.S., Department of NREM, Iowa State University)
- Claire Rude (M.S., Department of NREM, Iowa State University)
- Erika Ibarra-Garibay (M.S., Department of EEB, Iowa State University)
- Andres Vargas (M.S., Department of Entomology, Iowa State University)
- Riggs Wilson (M.S., Department of NREM, Iowa State University)

Michael J. Moore

Advisor/Co-Advisor

- Juliana Kaloczi (M.S., Department of NREM, Iowa State University)
- Dalton Clayton (M.S., Department of NREM, Iowa State University)
- Justin Harms (M.S., Department of NREM, Iowa State University)
- Daniel Paulson (M.S., Department of NREM, Iowa State University)
- McKensie Vaske (M.S., Department of NREM, Iowa State University)

Committee Member:

- Maddie Lewis
- Brandt Boekhout
- Eli Legacy
- Erik Griffen
- Claire Rude
- Seth Renner
- Connor Fiolek

Professional Service & Outreach

Robert Klaver

- Peer review articles for multiple scientific journals
- American Society of Mammalogists, Member, 1996 –present
- Great Plains Natural History Society, Member, 2010 –present
- Iowa Action Plan Implementation Committee, Member, 2012 –present
- Technical Assistance to Grand Portage Band of Lake Superior Chippewa
- The Wildlife Society
 - Member, 1974 - Present
 - Iowa Chapter, Member, 2012 – present
 - North Central Section, Member, 2012 – present

Anna Tucker

- Member, The Wildlife Society and Biometrics Working Group (2018 – present)
- Member, American Ornithological Society (2014 – present)
- Leader, Powell Center Working Group on Time-dependent Decisions
- External reviewer for USFWS Species Status Assessment for the Pinaleño Talussnail (*Sonorella grahamensis*) and the San Xavier Talussnail (*Sonorella eremita*)
- Member, Dept. of Interior Climate Science Applications Coordination Team

Michael J. Moore

- American Fisheries Society Member
- North American Sturgeon and Paddlefish Society Member
- Lead author for chapter on effects of agriculture on inland fish. For AFS's Inland fisheries Managements in North America Fourth Edition (in progress)
- Member Prairie Fishes and Streams Collaborative
- Co-Chair of the Mississippi-Yangtze River Interbasin Symposium for the 2024 Annual Meeting of the American Fisheries Society

Honors and Awards

Graduate Students

- **Lizzy Lang** – Graduate Student Organization Diamond Hitch Award
- **Daniel Paulson & Justin Harms** - 2024 Dr. Keith McNurlen award from the Izaak Walton League of America - Iowa division
- **Lindsey Gapinski** – 2023 LaVon Tostenson Scholarship Award

Presentations

Robert Klaver

Hatch, A.M., E.J. Isaac, M.B. Agee, N. Bosco, L.A.W. Gapinski, S.A. Hoepfner, R.S. Siller, **R.W. Klaver**, and S.A. Moore. 2023. Movement and mortality of GPS collared moose on the Grand Portage Reservation. The 55th North American Moose Conference and Workshop, Grand Portage, Minnesota. 22 – 26 May 2023.

Anna Tucker

- Lang, E.M., S. J. Dinsmore, A.M. Tucker, and K.E. Kinkead. 2024. Blanding's turtles on the move in Iowa: Seasonal movement and home ranges. Oral presentation at the Joint Meeting of the Society for the Study of Amphibians and Reptiles and Partners in Amphibian and Reptile Conservation. Ann Arbor, MI. (Contributed Oral)
- Ford, J.M., A.M. Tucker, A. Janke, and T. Harms. 2024. Grassland bird community benefits from northern bobwhite (*Colinus virginianus*) habitat management. Oral presentation at the Winter Meeting of the Iowa Chapter of The Wildlife Society. Ames, IA. (Contributed Oral)
- Gapinski, L., A.M. Tucker, and K.E. Kinkead. 2024. Tracking occupancy of avian SGCN at restored wetlands in Iowa across 16 years. Oral presentation at the Iowa Chapter of The Wildlife Society Winter Meeting. Ames, IA. (Contributed Oral)
- Lang, E.M., S.J. Dinsmore, A.M. Tucker, and K.E. Kinkead. 2024. Movement Ecology of Blanding's Turtles in Central Iowa. Oral Presentation at the Iowa Chapter of The Wildlife Society Winter Meeting. Ames, IA. (Contributed Oral)
- Shepherd, K., A.M. Tucker, E. Ibarra-Garibay, and A. Toth. 2024. Evaluating occupancy and habitat associations of rusty patched (*Bombus affinis*) and American (*Bombus pensylvanicus*) bumble bees in Iowa. Oral presentation at the Winter Meeting of the Iowa Chapter of The Wildlife Society. Ames, IA. (Contributed Oral)
- Alexander, A., E.M. Lang, J. Tamplin, K. Kinkead, and A.M. Tucker. 2024. Habitat suitability model for wood turtles in Iowa. Poster presentation at the Winter Meeting of the Iowa Chapter of The Wildlife Society. Ames, IA. (Contributed Poster)
- Shepherd, K., A.M. Tucker, and A. Toth. 2023. Evaluating occupancy and habitat associations of rusty patched and American bumble bees. Oral presentation at The Wildlife Society Annual Conference, Louisville KY. (Contributed Oral)
- Ford, J., A. Janke, and A.M. Tucker. 2023. Avian Grassland Community Benefits from Northern Bobwhite-focused Land Management. Oral presentation at the Annual Meeting of The Wildlife Society. (Contributed Oral)
- Wilson, R., A. Janke, A.M. Tucker, and T. Bogenschutz. 2023. Passive Acoustic Monitoring for Northern Bobwhite Occupancy in an Agricultural Landscape. Oral presentation at the Annual Meeting of The Wildlife Society. (Contributed Oral)
- Ashander, J.D., R.E.W. Berl, G.S. Boomer, T.L. Morelli, A. Terando, Tucker, A.M., Q. Zhao, M.A. Rubenstein, T.G. Martin, I. Chadès, R.S. Epanchin-Niell, J.R. Reimer, H. Kujala, J. Dooley, P.K. Devers, J.E. Lyons, and M.C. Runge. 2023. Future climate change and management of waterfowl harvest in North America. Oral presentation at The Wildlife Society meeting, Louisville, KY. (Invited Oral)
- Berl, R.E.W., P.K. Devers, G.S. Boomer, J. Ashander, A.M. Tucker, and M.C. Runge. 2023. Implications of social non-stationarity and changing hunter behaviors for waterfowl harvest. Oral presentation at The Wildlife Society annual meeting, Louisville, KY. (Invited Oral)
- Gapinski, L.A., A.M. Tucker, and K.E. Kinkead. 2023. Breeding bird use of Wetlands Reserve Program properties in Iowa: Assessing restorations across 16 years. Oral presentation at the Annual Meeting of The Wildlife Society. (Contributed Oral)
- Tucker, A.M., M.C. Runge, J. Ashander, R.E.W. Berl, J.R. Reimer, G.S. Boomer, I. Chadès, P.K. Devers, R.S. Epanchin-Niell, H. Kujala, J.E. Lyons, T.G. Martin, T.L. Morelli, M.A. Rubenstein, A. Terando, and Q. Zhao. 2023. Wildlife management under global change: Time-dependent policies for non-stationary systems. Oral presentation at The Wildlife Society Annual Conference, Louisville KY. (Invited Oral)

Michael J. Moore

- Kaloczi, J. M. J. Moore. 2024. Age and growth of Shovelnose Sturgeon in the Cedar River. Oral Ignite Talk, Iowa State Department of Natural Resource Ecology and Management.

- Golcher-Benavides, J., E. A. Szott, D. D. Turney, S.A. Valentine, Z. J. Witzel, J. T Lamer, G. W. Whitley, **M. J. Moore**, and M.J. Weber. Recruitment dynamics of Silver Carp informed by early life environments in the Upper Mississippi River. Poster Presentation. Iowa Chapter of the American Fisheries Society Annual Meeting.
- Clayton, D., **M. J. Moore**, M. J. Weber. Habitat associations and distribution of invasive Rusty Crayfish in a shallow natural lake. Poster Presentation. Iowa Chapter of the American Fisheries Society Annual Meeting.
- Kaloczi, J., **M. J. Moore**, M. J Hamel, G. Jones, R. N. Hupfeld, and R. Krogman. Incremental Growth Rates in a Cedar River population of Shovelnose Sturgeon through a 17-year Mark-Recapture Dataset. Poster Presentation, Iowa Chapter of the American Fisheries Society Annual Meeting
- Golcher-Benavides, J., E. A. Szott, Z. J. Witzel, J. T. Lamer, M. J. Weber, and **M.J. Moore**. Examining drivers of temporal variation in hybridization outcomes in bigheaded carp in the Upper Mississippi River. Poster Presentation. Iowa American Fisheries Society Annual Meeting.
- Umland, L., **M. J. Moore**, and C. Paukert. 2024. Lake Sturgeon Occupancy and Recruitment in Tributaries of a Mainstem River. World Fisheries Congress, Seattle WA. 5 March 2024.
- Golcher-Benavides, J., E. A. Szott, D. D. Turney, Z. J. Witzel, J. T. Lamer, G. W. Whitley, **M. J. Moore**, and M. J. Weber. 2024. Recruitment dynamics of bigheaded carp in the Upper Mississippi River informed by otolith microchemistry. Oral Presentation. Midwest Fish and Wildlife Conference, Sioux Falls, SD
- Kaloczi, J., **M. J. Moore**, M. J. Hamel, G. Jones, and R. N. Hupfeld, 2024. Incremental Growth Rates in a Cedar River population of Shovelnose Sturgeon through a 17-year Mark-Recapture Dataset. Poster Presentation. Midwest Fish and Wildlife Conference 2024. Sioux Falls, South Dakota.
- Clayton, D., **M. J. Moore**, and M. J. Weber. 2024. Habitat Associations and Distribution of Invasive Rusty Crayfish in a Shallow Glacial Lake. Poster Presentation. Midwest Fish and Wildlife Conference 2024. Sioux Falls, South Dakota.
- Moore, M. J.**, A. A. Coulter, J. Golcher-Benavides, F. J. Rahel, A.W. Walters, S. K. Brewer, and M. L. Wildhaber, 2024. A synthesis of the characteristics and drivers of introduced fishes in prairie streams: Can we manage harmful introduced fishes in these dynamic environments? Oral Presentation at the Midwest Fish and Wildlife Conference, Sioux Falls, South Dakota.
- Bouska, K. L., B. D. Healy, **M. J. Moore**, C. G. Dunn, J. J. Spurgeon, and C. P. Paukert. Diverse portfolios: investing in tributaries for restoration of large river fishes. USGS Ecosystem Mission Area Friday Findings Webinar, 15 September 2023. Virtual. IP-157389.
- Umland, L., **M. J. Moore**, and C. Paukert. 2023. Factors affecting Lake Sturgeon reproduction: the next step in recovery and management. Oral presentation at the American Fisheries Society Annual Meeting, Grand Rapids, MI.
- Golcher-Benavides, J., E. Szott, Z. Witzel, J. T. lamer, G. W. Whitley, **M. J. Moore**, and M. J. Weber. Otolith microchemistry to study recruitment of bigheaded carp in the Upper Mississippi River. Oral presentation at the American Fisheries Society Annual Meeting, Grand Rapids, MI.

Publications

Robert Klaver

- Bartelt, P. E., A. T. DeVries, and R. W. Klaver. 2023. Response of tiger salamanders (*Ambystoma t. tigrinum*) to wetland restoration in a midwestern agricultural landscape, USA. *Ichthyology and Herpetology* 111:571-583.
- Ford, J.M.H., Melendez Perez, A.A., Gapinski, L.A.W., Kaloczi, J.M., Rohde, M., Siddons, T., Wilson, R.O., Yappert, A.A. and Klaver, R.W. (2024), Wildlife Stewardship on Tribal Lands: Our Place is in Our Soul. *Journal of Wildlife Management*, 88: e22585

- Giese, J. C., L. A. Schulte, and R. W. Klaver. 2024. Bird community response to field-level integration of prairie strips. *Agriculture Ecosystems & Environment* 374:9075-9075.
- Jacques, C. N., R. W. Klaver, C. S. DePerno, and A. P. Rockhill. 2024. Comparing the efficacy of two immobilization drug combinations for the chemical restraint of bobcats (*Lynx rufus*). *Journal of Wildlife Diseases* 60:86-94.
- Melendez Perez, A. A., D. Camarena, J. M. H. Ford, L. A. W. Gapinski, A. M. Hatch, B. E. Klossing, A. A. Yappert, and R. W. Klaver. 2023. America's Public Lands: From Yellowstone to Smokey Bear and Beyond (2nd edition). *Journal of Wildlife Management* 87:22465-22465.
- Nixon, B. A., V. Evelsizer, and R. W. Klaver. In press. Evaluating Habitat Use and Relative Abundance of Iowa's River Otter with Harvest Data. *Wildlife Society Bulletin*.
- Stephenson, M. D., L. A. Schulte, and R. W. Klaver. 2024. The relative contributions of habitat area, configuration, and vegetative diversity on snake and lizard presence in agricultural landscapes. *Conservation Science and Practice*:16.
- Stephenson, M. D., K. L. Yuza, L. A. Schulte, and R. W. Klaver. 2024. Habitat amount and edge effects, not perch proximity, nest exposure, or vegetation diversity affect cowbird parasitism in agricultural landscapes. *Landscape Ecology* 39:69-69.
- Swearingen, T. C., R. W. Klaver, C. R. A. Anderson, and C. N. Jacques. 2023. Influence of camera model and alignment on the performance of paired camera stations. *Wildlife Society Bulletin* 47:NIL_1-NIL_11.

Anna Tucker

- Terando, A.J., A.M. Tucker, A.N. Runyon, J.A. Miller, J.L. Perkins, S.W. Kimbrel, A.S. Cross, and R.P. Boyles. 2024. Best Practices for Incorporating Climate Change Science into Department of Interior Analyses, Consultations, and Decision Making. Cooperator Publication. — IPDS: IP-166512
- Tucker, A.M., M.C. Runge, J. Ashander, R.E.W. Berl, J.R. Reimer, G.S. Boomer, I. Chadès, P.K. Devers, R.S. Epanchin-Niell, H. Kujala, J.E. Lyons, T.G. Martin, T.L. Morelli, M.A. Rubenstein, A. Terando, Q. Zhao. *In review*. Natural resource management under global change: time-dependent decisions for non-stationary systems. *Nature Sustainability*. — IPDS: IP-149833
- Tucker, A.M., C.P. McGowan, B.L. Nuse, J.E. Lyons, C.T. Moore, D.R. Smith, J.A. Sweka, K.A. Anstead, A. DeRose-Wilson, and N.A. Clark. 2023. Estimating recruitment rate and population dynamics at a migratory stopover site using an integrated population model. *Ecosphere*. — IPDS: IP-139218; BAO Date: October 1, 2022

Software Release:

Tucker, A.M. and M.C. Runge. Optimal harvest of a theoretical population under system change. Version 1.0.0: U.S. Geological Survey Software Release. Reson, VA. <https://doi.org/10.5066/P9GCJAVB>

Michael J. Moore

- Moore M. J.**, R. L. Flitcroft, E. Tucker, K. M. Prussian, and S. M. Claeson. 2024. Same streams in a different forest? Investigations of forest harvest legacies and future trajectories across 30 years of stream habitat monitoring on the Tongass National Forest, Alaska. *PloS one* 19(7), e0301723.
- Moore, M. J.**, and A. A. Hyman, A. A. 2024. What can conservation culturomics tell us about factors driving public interest in aquatic endangered species. *Biological Conservation* 289 110397
- Bourquin, R., **M. J. Moore**, E. Hallerman, and D. J. Orth. 2023. Conservation genetics of Clinch Dace *Chrosomus sp. cf. saylori*. *Fishes* 8(7):365

In Review:

- Coulter, A. A., **M. J. Moore**, J. Golcher-Benavides, F. J. Rahel, A. W. Walters, S. K. Brewer, M. L. Wildhaber. A synthesis of the characteristics and drivers of introduced fishes in prairie streams: can we manage introduced harmful fishes in these dynamic environments? In Review at *Biological Invasions*.



**Iowa Cooperative
Fish and Wildlife
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