2019 Annual Report

Arkansas Cooperative Fish & Wildlife Research Unit

Arkansas Game & Fish Commission

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University of Arkansas

Wildlife Management Institute · Washington, D.C.

ARKANSAS COOPERATIVE
FISH AND WILDLIFE
RESEARCH UNIT

2019 ANNUAL REPORT

Arkansas Cooperative Fish and Wildlife Research Unit
University of Arkansas
Department of Biological Sciences
Science and Engineering Building, Room 601
Fayetteville, AR 72701

The unit is a cooperative program of the:

U.S. Geological Survey
Arkansas Game and Fish Commission
University of Arkansas
Wildlife Management Institute

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INTRODUCTION

Arkansas Cooperative Fish and Wildlife Research Unit first opened its doors in August of 1988 as one of the four units initiated that year, and one of the 40 coop units across the country associated with land grant universities, state fish and wildlife agencies, and the U.S. Geological Survey – Biological Resources Division. The purpose of these units is to train graduate students in scientific methods of fish and wildlife management.

Over the past 31 years, the Arkansas Cooperative Research Unit has become an active part of state and federal research efforts in Arkansas and across the nation. By the end of our thirty-first year, Arkansas Cooperative Research Unit will have initiated many research projects with Arkansas Game and Fish Commission, U.S. Fish and Wildlife Services, U.S. Geological Survey – Biological Resources Division, National Park Services, and other federal, state and private organizations as sponsors. These projects have funded the research of 69 MS and 15 PhD students, most of which are now working as professional biologists. Presently those students are employed by federal, state, and private agencies, colleges and universities, or are continuing their graduate degrees at other schools. Arkansas Cooperative Research Unit leaders and students have published 195 scientific and technical publications listing the unit and our cooperators in byline and acknowledgements, and another three publications have been accepted or submitted for publication. Unit leaders and Assistant leaders have taught many classes in fisheries and wildlife. Finally, including base funds and contracts, Arkansas Cooperative Research Unit has brought more than $19,781,740 directly into the community.

During the past thirty-one years, Arkansas Cooperative Research Unit has gone through a number of changes. We have changed our federal cooperator from U.S. Fish and Wildlife Services to National Biological Survey to National Biological Service, and we now reside within the U.S. Geological Survey – Biological Resources Division. Our university department changed from Zoology to Biological Sciences and then incorporating the departments of Botany and Microbiology. We have seen twelve departmental chairs (Amlaner, Geren, Kaplan, Talburt, Rhoads, Roufa, Davis, Smith, Spiegel, Beaupre, Henry, and McNabb), three unit leaders (Johnson, Krementz, and DeGregorio), six assistant unit leaders (Annette, Martin, Griffith, Kwak, Thompson, and Magoulick), four administrative assistants (Kimbrough, Koldjeski, Parker, and Moler), four post-doctoral assistants (LeMar, Lehnen, Longing, and Fox), and nine research specialist/technicians (Neal, Aberson, Vaughn, Thogmartin, Lichtenberg, Piercey, Bahm, Nault, and Kitterman).

MISSION STATEMENT

The mission of the Arkansas Cooperative Fish and Wildlife Research Unit is to conduct programs of research, graduate education, and technical assistance that address the needs of the State of Arkansas, the region, and the nation. Research programs will pursue both basic and applied scientific questions that are relevant to the management of fish, wildlife, and their habitats. Research topics will be pursued according to cooperator priorities, availability of collaborative expertise from cooperators, and funding opportunities.

The educational mission of the Arkansas Cooperative Fish and Wildlife Research Unit shall focus on graduate and post-graduate students. Activities will include teaching of formal graduate-level classes, chairing and serving on advisory committees, mentoring the professional development of students, and participation by unit scientists in academic programs of the University of Arkansas. Students should be educated, to prepare them for advancement in broad areas of natural resource management to serve as future leaders of resource management in the State of Arkansas, region, and country. Educational programs of the Arkansas Cooperative Fish and Wildlife Research Unit will be consistent with the professional standards and hiring practices of the cooperators, similar agencies elsewhere, and relevant professional societies involved with natural resource management.

Technical assistance will be provided to unit cooperators in the areas of scientific expertise of the unit. This can include assistance with interpretation of data, preparation and review of experimental designs, identification of specific research voids or needs, and rendering professional judgment. Such activities will generally serve to link the scientists' previously established expertise to specific needs of the cooperators or other related agencies.

Front row, left to right: Andrhea Massey, Ellery Lassiter, Brett DeGregorio, and Sarah Sorensen.
Second row, left to right: Leah Bayer, Kayleigh Smith, and Adrienne Ingram.
Third row, left to right: Grace Showalter, Connor Gale, and John Veon.
Fourth row, left to right: Tyler Fox, Diane Moler, Robert Fournier, and Dan Magoulick.
Photo by Becky Harris 2019 (UA BISC Department)

PERSONNELL AND COOPERATORS

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CURRENT GRADUATE STUDENTS

Leah Bayer, (M.S., Fisheries – Magoulick)
Robert Fournier, (Ph.D., Fisheries – Magoulick)
Conner Gale, (M.S., Wildlife – DeGregorio)
Adrienne Ingram, (Ph.D., Fisheries – Magoulick)
Ellery Lassiter, (Ph.D., Wildlife – DeGregorio)
Andrhea Massey, (M.S., Wildlife – DeGregorio)
Grace Showalter, (Ph.D., Wildlife – DeGregorio)
Kayleigh Smith, (M.S., Fisheries – Magoulick)
Sarah Sorensen, (Ph.D., Fisheries – Magoulick)
John Veon, (M.S., Wildlife – DeGregorio and Krementz)

RECENTLY GRADUATED

Auriel Fournier, Ph.D. – Wildlife
Nicole Graham, M.S. – Fisheries
Jacob McClain, M.S. – Wildlife
Christopher Middaugh, Ph.D. – Fisheries
Phillip Stephenson, M.S. – Wildlife
Allyson Yarra, M.S. – Fisheries

HOURLY TECHNICIANS AND VOLUNTEERS

Ms. Leah Bayer – REU
Mr. Brian Becker – General Help
Ms. Cherokee Gott – REU
Mr. Elliot Lassiter – Turtle Harvest
Ms. Amber Maner -REU
Ms. Andrhea Massey – Turtle Harvest
Mr. Nathan Quimbo – Undergraduate Research Fisheries
Ms. Greta Savitsky – REU

RESEARCH AND FACULTY COLLABORATORS

Dr. David Andersen – U.S. Geological Survey, Minnesota Cooperative Fish and Wildlife Research Unit
Mr. Benny Bowers – Arkansas Game and Fish Commission
Dr. Than Boves – Arkansas State University
Dr. Bret Collier – Louisiana State University
Mr. Dan Collins – U.S. Fish and Wildlife Services
Dr. Tom Cooper – U.S. Fish and Wildlife Service
Dr. Jack Cothern – University of Arkansas
Mr. Richard Crossett – U.S. Fish and Wildlife Service
Mr. Robert J. DiStefano – Missouri Department of Conservation
Dr. Marlis Douglas – University of Arkansas
Dr. Michael Douglas – University of Arkansas
Dr. Ashley Dowling – University of Arkansas
Dr. Jeff Duguay – Louisiana Department of Wildlife and Fisheries
Dr. Sarah DuRant – University of Arkansas
Mr. Kevin Eads – National Park Service
Mr. Alan Edmondson – Northwest Arkansas Land Trust
Dr. Michelle Evans-White – University of Arkansas
Dr. James Fetzner – Carnegie Museum of Natural History
Mr. Houston Havens – Mississippi Department of Wildlife, Fisheries and Parks
Mr. Kyle Hedges – Missouri Department of Conservation
Mr. Jeff Hickle – City of Fayetteville, Arkansas
Mr. Mark Hutchings – Arkansas Game and Fish Commission
Mr. Kelly Irwin – Arkansas Game and Fish Commission
Mr. Clifton Jackson – Arkansas Game and Fish Commission
Mr. JA “Buck” Jackson – Arkansas Game and Fish Commission
Dr. Bruce Kingsbury – Purdue University, Fort Wayne
Dr. Sarah Lehnen – U.S. Fish and Wildlife Service
Mr. Frank Loncarich – Missouri Department of Conservation
Mr. Kevin Lynch – Arkansas Game and Fish Commission
Dr. Doreen Mengel – Missouri Department of Conservation
Dr. Christopher Middaugh – Arkansas Game and Fish Commission
Mr. Nolan Moore – National Park Service
Dr. Jennifer Mortenson – University of Arkansas
Dr. Kusum Naithani – University of Arkansas
Mr. Luke Naylor – Arkansas Game and Fish Commission

Dr. Lori Neumann-Lee – Arkansas State University
Mr. Shaun Oldenburger – Texas Parks and Wildlife
Mr. Jeffrey W. Quinn – Arkansas Game and Fish Commission
Dr. Andy Radaeke – Missouri Department of Conservation
Dr. Aaron Rice – Cornell University
Dr. Vaughn Skinner – University of Arkansas
Dr. Jinelle H. Sperry, - US Army Corps of Engineers, ERDC-CERL
Mr. Al Stewart – Michigan Department of Natural Resources
Mr. Brian Wagner – Arkansas Game and Fish Commission
Mr. Andy Weik – Ruffed Grouse Society
Ms. Rhea Whalen – U.S. Forest Service
Dr. J.D. Willson – University of Arkansas
Mr. Patrick J. Wolff – US Army Corps of Engineers, ERDC-CERL

CURRENT FISHERIES PROJECTS

Leah M. Bayer holding Longear Sunfish (Lepomis megalotis) in a local stream of NW Arkansas, photo by Kayleigh A. Smith (AR Coop Unit)

Central stoneroller (Campostoma anomalum),
photo by Robert J. Fournier (AR Coop Unit)

Biological Responses of Ozark Stream Communities to Compounding Stressors: The Convergence of Drought, Nutrient Pollution, and Novel Predation

Funding Source: University of Arkansas, Distinguished Doctoral Fellowship
University of Arkansas, Biological Sciences
Arkansas Cooperative Fish and Wildlife Research Unit
University of Oklahoma
Sigma Xi Research Grant
Project Duration: July 2014 to December 2019
Principal Investigator: DANIEL D. MAGOULICK
Graduate Student: ROBERT J. FOURNIER (Ph.D. Student)

Research Objectives:

1. To determine the effects of drought, nutrient pollution, and invasive species on the structure and functioning of stream communities.
2. To examine if, and how, multiple stressors interact in stream systems.
3. To construct and parameterize a model that explores stream fish metapopulation dynamics under various disturbance scenarios as they relate to life history strategy.

Management Implications:

1. Little is known regarding the combined ecological effects of common anthropogenic and natural stressors on aquatic communities. Information gained from this research will help managers to establish regulations or mitigate factors negatively affecting fish populations in severely impacted streams.
2. Information gained through this study will help assess the potential invasion impacts of an apex predator on Ozark stream communities.

Project Summary:

Anthropogenic degradation of freshwater ecosystems represents a severe threat to global aquatic biodiversity. Three of the most detrimental ecological disturbances to stream systems—drought, nutrient pollution, and invasive species—have profound and diverse impacts on aquatic communities and are often some of the most pervasive threats to biodiversity in developed countries. Increasing

demand for freshwater resources and the increased frequency of extreme climatic events can exacerbate the biological effects of drought conditions in streams. Anthropogenic introduction of bioavailable nutrients to freshwater systems is increasing globally with dramatic, bottom-up effects on ecosystem structure and functionality. Introduced predators might destabilize food webs with extreme hunting pressure and naïve prey might not possess adequate defenses to increased predatory threats. While the individual effects of drought, nutrient pollution, and invasive predation have been studied across multiple systems, little work has been done regarding their combined effects on freshwater communities. This research will continue to explore the dynamics of severely impacted ecosystems by exposing cross sections of Ozark stream communities to combinations of common ecological disturbances.

We examined the effects of drought, nutrient enrichment, and introduced predators across a series of mesocosm experiments. The results of these experiments showed that each of the individual stressors can impact several aspects of stream community structure and function. Additionally, we saw several instances of stressor interactions. These interactions could be additive or antagonistic, and the relative strength and directionality often depended on trophic position. We also constructed a metapopulation model that examined the effects of drought and invasive species across several life history classifications of stream fishes. The models demonstrated that metapopulation dynamics responded differentially to both types of disturbance based on life history strategy. We also found that models that incorporate additive effects of multiple stressors interact synergistically to dramatically increase extinction rates.

As stressors can interact in ecologically meaningful ways, management or conservation plans that only account for one stressor might be inadequate to protect aquatic resources. The results of this study can provide managers with tools to make more informed decisions regarding the effects of drought, nutrient enrichment, and novel predation as well as their interactive effects in stream systems.

Rainbow Darter (Etheostoma caeruleum), photo by Kayleigh A. Smith (AR Coop Unit)

The Impact of Hydrologic Disturbance on the Body Condition and Assemblage Composition of Fish in the Ozarks

Funding Source: University of Arkansas, Biological Sciences
Arkansas Cooperative Fish and Wildlife Research Unit
Project Duration: June 2018 to September 2019
Principal Investigator: DANIEL D. MAGOULICK
Graduate Student: KAYLEIGH A. SMITH (M.S. Student)

Research Objectives:

1. Evaluate body condition of adult fish at different levels of hydrologic disturbance.
2. Compare fish assemblage composition among flow regimes and along a spectrum of hydrologic disturbance within each flow regime.

Management Implications:

1. This study will provide greater insight into the impact of hydrologic disturbance on native fish species.
2. This information on the impact of land and water use on fish assemblages can be used in conservation efforts.

Project Summary:

Previous studies on fish communities and flow alteration compared unaltered streams to altered streams, and the common finding is that as streams are more altered or disturbed, the body condition of endemic species decreases, and the community structure changes, typically favoring generalist cosmopolitan species over endemic specialists. Several fish species have been identified as

strong predictors of hydrologic disturbance. Four species are likely to be found throughout my study area and occupy different habitat and temporal niches: Rainbow Darters, Longear Sunfish, Central Stonerollers, and Bigeye Shiners. These species have different breeding seasons, ranging from early spring to late summer, utilize different habitats within the same stream, and have different feeding strategies including herbivory, insectivory, and piscivory. All have demonstrated sensitivity to decreased water clarity, and Bigeye Shiners are endangered in other jurisdictions. This study will also compare communities in different natural flow regimes, and then compare communities in altered streams to communities in streams that share the same natural flow regime as the altered stream. I will collect fish from each site by blocking off microhabitats with seine nets and then sampling each microhabitat with a backpack electrofisher. To examine body condition of the four target species, we will weigh and measure twenty fish from each species at each site.

Fisheries

Lollars Creek, photo by Leah Bayer (AR Coop Unit)

Influences of Landscape- and Local-scale Factors on Occupancy and Detection Probability of Crayfish Communities in Ozark Streams

Proposed Funding Source:	University of Arkansas, Distinguished Doctoral Fellowship University of Arkansas, Biological Sciences Arkansas Cooperative Fish and Wildlife Research Unit
Project Duration:	August 2019 to May 2023
Principal Investigator:	DANIEL D. MAGOULICK
Graduate Student:	LEAH M. BAYER (Ph.D. Student)

Research Objectives:

1. Determine occupancy of five crayfish species in the Ozark highlands.
2. Examine landscape- and local-scale factors on the occupancy of these species.

Management Implications:

1. Crayfish are often keystone species in freshwater ecosystems and act as important producers and consumers of biomass within aquatic food webs. As consumers, crayfish use food items

across multiple trophic levels including: fishes, macroinvertebrates, algae, macrophytes, and detrital material. Furthermore, crayfish strongly influence benthic community structure and function, and in some systems, annually convert 18 times the amount of coarse particulate organic matter (CPOM) to fine particulate organic matter (FPOM) as all other shredders combined. Additionally, crayfish serve as an important prey item for a variety of aquatic and terrestrial predators.

2. At least 382 species of crayfish are native to North America, accounting for 75% of the world's total crayfish. Despite their importance in aquatic systems, 48% of these species are at risk (i.e. extinct, endangered, threatened, or vulnerable). Despite being ecologically important and of conservation concern, crayfish are often hard to detect due to their cryptic morphology and benthic behaviors. While studies have looked at crayfish detection and occupancy on a population-level, crayfish occupancy studies at the community-level remain rare. Additionally, while herpetofauna occupancy studies are relatively frequent, knowledge of occupancy of many stream species is little known.
3. According to studying influences of landscape- and local-scale factors on crayfish community occupancy is important for conservation of imperiled species. Several endemic species in the Ozark highlands are of conservation concern: Mammoth Spring Crayfish, *F. marchandi*, the Coldwater Crayfish, *F. eupunctus*, and the Hubbs' Crayfish, *C. hubbsi*. The Spothanded Crayfish, *F. punctimantus*, and the Ozark Crayfish, *F. ozarkae*, are also common stream species in the Ozarks.

Project Summary:

We will use a dataset gathered to examine species-level detection and occupancy of Ozark crayfish. We will sample 75 randomly selected stream segments in northern Arkansas and southern Missouri. Sampling will occur over two consecutive summer seasons (May – September). We will employ the quantitative kickseine method to sample crayfish presence with ten surveys (five riffle, five run) per site. Landscape-level covariates include factors involving soils, geology, land cover, hydrology, agriculture, urbanization, mining, and water quality. Local-scale covariates include water temperature, pH, conductivity, velocity, and depth.

We will use a hierarchical Bayesian framework approach to create a multi-species occupancy model. We will use a principal components analysis (PCA) to combine covariates and reduce complexity of the model. We will create species-specific matrices for sampling occasions at each site where detection is represented as 1 and non-detection as 0. We will model species occupancy state and detection as Bernoulli random variables. We will assume species-specific occupancy probability and detection probability both follow a linear-logit function of the model covariates.

Lollars Creek, Arkansas, photo by Sarah Sorensen (AR Coop Unit)

Impact of Flow Regime on Food Chain Length

Potential Funding Source:	University of Arkansas, Doctoral Academy Fellowship University of Arkansas, Biological Sciences Arkansas Cooperative Fish and Wildlife Research Unit
Project Duration:	May 2019 to May 2021
Principle Investigator:	DANIEL D. MAGOULICK
Graduate Student:	SARAH F. SORENSEN (Ph.D. Student)

Research Objectives:

1. Determine food chain length in groundwater flashy and runoff flashy streams.
2. Determine the impact flow regime has as a disturbance on food chain length.
3. Determine how land use impacts food chain length and if that differs with disturbance.

Management Implications:

1. This study will provide information about how different levels of disturbance due to different flow regimes and land use effect food chain length and energy flow through streams.

2. This information could be useful for the long term management of streams as patterns shift and land uses change or become more intensive.

Project Summary:

The length of food webs is theorized to be determined by energy or resource availability, ecosystem size, and the stability of the system. The basis of the dynamical stability hypothesis is that systems with frequent or extreme disturbances should have shorter food webs, as systems with longer food webs are less stable. Streams are a dynamic system with varying amounts of disturbance. Based on the dynamic stability hypothesis, streams with less stable flow regimes should have shorter food chain lengths than more stable flow regimes. McHugh et al. (2010) found that mean trophic position of large and small fish decreased with increased disturbance. They believe that this is due to reduced availability of predatory invertebrates and a disturbance induced shift to omnivory. However, the disturbance index investigated by McHugh et al. (2010) was quantified using stage height as an indicator of flow variation, temperature, and the Pfankuch river index. Additionally, not all streams sampled by McHugh et al. (2015) contained fish. These variables do not account for major players in stream disturbance that flow regimes do, such as variability in daily flow, constancy of flow, frequency of low flow spells, and flood frequency. Other researchers found that high flow and low flow events reduced food chain length and that the impact ecosystem size has on food chain length is dominated by the indirect path that links area to food chain length via hydrologic variation. However, the intermittent streams studied by this group did not have piscivorous fish and top predators were invertebrates or small bodied fish. In contrast, others found that while the trophic base of food webs shifted, food chain length did not differ due to flow intermittency. This group sampled alpine streams in the Val Roseg, which do not have fish.

This research will examine food chain length in runoff flashy and groundwater streams along a gradient of land uses. Runoff flashy and groundwater flashy streams have similar mean daily flows, keeping ecosystem size similar. However, runoff of flashy streams are characterized by having a greater variability in daily flow, a higher maximum 30-day mean flow, and a greater flood frequency. All sampled streams have piscivorous fish.

Basal resources, invertebrates, and fish have been collected from 10 sites (5 groundwater flashy and 5 runoff flashy) throughout Northern Arkansas, Western Oklahoma, and Southern Missouri. Stable isotope analysis will be performed on samples to determine food chain length and determine the impact disturbance due to flow regime has on food chain length. In addition, food chain length will be analyzed in relation to land use in order to determine if land use impacts food chain length and if that impact differs with hydrologic disturbance.

Fisheries

Middle fork of the Whiter River, photo by Adrienne Ingram (AR Coop Unit)

Fish Metapopulations During Drought: The Effects of Flow Regime on Colonization and Extinction Dynamics During Seasonal Stream Drying.

Funding Source:	University of Arkansas, Doctoral Academy Fellowship University of Arkansas, Biological Sciences Arkansas Cooperative Fish and Wildlife Research Unit
Project Duration:	May 2018 – May 2022
Principal Investigator:	DANIEL D. MAGOULICK
Graduate Student:	LEIGH ADRIENNE INGRAM (Ph.D. Student)

Research Objectives:

1. Use occupancy of refugia before, during, and after seasonal stream drying to assess the role of refugia on stream fish metapopulations during drought. Which habitats act as refugia during drought and estimate colonization and extinction in habitat units.
2. Determine whether streams that experience intermediate levels of drying disturbance have higher diversity than streams that experience lower or higher levels of drying disturbance.
3. Study population connectivity in relation to metapopulations in dendritic stream networks using otolith microchemistry.
4. Determine what factors influence fish's decisions to move to refuge habitats from areas that are drying.

Management Implications:

1. Drought plays a role in structuring aquatic communities. It is important to understand how populations and communities persist in variable environments. Refuge habitats are important to fish during disturbance events, particularly seasonal drying. Water scarcity is increasingly

becoming an issue around the globe due to anthropogenic influences. How fishes deal with hydrologic changes will be important to conservation efforts. Stream habitats that buffer the effects of perturbation may be referred to as refugia, thus it is important to preserve these areas in order to maintain biotic diversity.

Project Summary:

While the importance of refugia as well as how fishes use refugia have been studied, which habitats act as refugia for fish, and whether the habitats that act as refugia change during seasonal drying remain undetermined. Different habitat types are affected by drought differently.

This project commenced in May 2019. Ten streams across AR, OK, and MO that are classified as either Groundwater Flashy or Runoff Flashy Flow Regimes were sampled. Two pools, two riffles, and two runs were sampled at each location using block nets and a Smith-Root backpack electro-fisher. Fish and crayfish were identified on site and released. Habitat was assessed using EPA Rapid Habitat Assessment protocol. Data was collected from 30 May 2019 – 6 September 2019, and was analyzed in R. Simpson's Diversity was calculated for each habitat sampled and analyzed using two-factor ANOVA. All abundance data was Log-transformed before running two-factor ANOVA. Fish diversity showed no significant interaction between Flow Regime and Habitat ($F_{1,2}$=0.341, p=0.7124). Simpson's diversity was significantly greater in RF than GF ($F_{1,1}$=5.278, p<0.05), but diversity among habitats did not differ significantly ($F_{1,2}$=0.342, p=0.7119). Flow Regime by Habitat interaction was not significant for fish abundance ($F_{1,2}$=0.367, p=0.693). Total fish abundance was significantly greater in GF than RF ($F_{1,1}$=11.44, p<0.001) and significantly greater in riffles and runs than pools ($F_{1,2}$=10.47, p<0.001).

Due to extreme rain and flooding, sites could not be sampled before, during, and after drought. We intend to incorporate use of refuge habitats during drought and to assess the potential of refugia as a driver of metapopulation dynamics. Increased diversity in Runoff Flashy streams may be due to increased disturbance in these systems.

Fisheries

East fork of the White River, photo: J.T. Fox (AR Coop Unit)

Identifying Important Hydrologic and Environmental Factors Influencing the Structure of Local Fish Assemblages in Ozark and Ouachita Highlands and Gulf Coastal Plains Streams

Funding Source:	Arkansas Game and Fish Commission
Project Duration:	October 2016 – March 2020
Principal Investigator:	DANIEL D. MAGAOULICK
Postdoctoral Fellow:	J. TYLER FOX

Research objectives:

1. Determine flow ecology relationships for fish and macroinvertebrates to aid the development of environmental flow needs for aquatic communities.
2. Expand our use of long-term biological data for examining environmental flows
3. Provide essential information and tools for dealing with water use issues

Management Implications:

1. Results from this work will form the basis for setting regional environmental flow standards and understanding impacts of land use and climate change on aquatic species and ecosystems.
2. Project provides flow-ecology information for numerous SGCN species

Project Summary:

The hydrologic characteristics of rivers and streams play a central role in aquatic ecosystem structure and function and act as an important environmental filter in determining the distribution of stream biota on a global scale. In addition to shaping channel geomorphology, aquatic habitat availability, sediment and nutrient transport and deposition flow regimes exert a strong influence on

numerous aspects of aquatic organisms' life histories, including timing of reproduction, recruitment and migration. At the ecoregion scale, similar geomorphic, hydrologic, climatic, and floristic conditions typically exist along the longitudinal progression of the river network. However, as opposed to a steady linear gradient, stream hydrology tends to operate in a discontinuous nature where transition zones in flow and substrate are influential determinants of changes in aquatic species assemblages.

Fish assemblages are strongly influenced by the flow regimes of rivers and streams, leading to the evolution of different morphological, physiological and behavioral modes of adaptation in response to natural hydrologic variation, including the magnitude, frequency, timing and duration of high and low flow events. As human consumptive demands for freshwater have increased, freshwater biodiversity and ecological condition have declined as the natural flow regimes of rivers and streams have been partially or completely altered by humans. Seasonal flow amplitude has decreased significantly in rivers covering one sixth of the global land surface, while interannual variability has increased across one quarter of the land, mainly due to water impoundment, diversion, and extraction mainly for agricultural irrigation. Disturbance at the watershed scale can impact have a very different impact on rivers and streams with different flow regimes. For example, the effect of a large dam on the fish assemblage of a stable groundwater stream will be quite different from that on a flashy run off stream.

Beta diversity is defined as the extent to which community composition changes in an entire region or between groups of sites within a region, and is driven by two inter-related processes: spatial turnover leading to species replacement from one site to another (turnover) and the degree to which species are lost or gained from one site to another (nestedness). Understanding how aquatic community composition and patterns of beta diversity vary across space and time and respond to hydrologic alteration and watershed-scale disturbance is an important element of developing effective conservation planning approaches. In addition, measuring freshwater community dissimilarity across environmental and disturbance gradients using a flow regime perspective can provide valuable insight into the range of conditions that a species can tolerate and identify nonlinearities and thresholds in flow-ecology relationships. Long-term biological datasets from the USGS Aquatic GAP initiative and other sources represent an extensive source of high-quality georeferenced species datasets that can be a powerful tool for characterizing ecological responses to changes in flow and other environmental variables across varying spatial and temporal scales.

In this study, we are using long-term biological datasets from the USGS Aquatic GAP initiative and other sources to quantify fish community dissimilarity across environmental and disturbance gradients using a flow regime perspective to provide insight into the range of conditions that a species can tolerate and identify nonlinearities and thresholds in flow-ecology relationships. Analysis of high-quality georeferenced species datasets represents a powerful tool for characterizing ecological responses to changes in flow and other environmental variables across varying spatial and temporal scales. Results of this study will be used to inform best management strategies to mitigate the impacts of watershed disturbance and flow alteration on stream communities.

Top to bottom: Cardinal Shiner, Southern Redbelly Dace, Orangethroat Darter, photo by Dustin Lynch (AR Coop Unit)

Exploring the Importance of Hydrologic and Environmental Gradients and Thresholds on Patterns of Fish Biodiversity and Community Composition Using a Gradient Forest Approach

Funding Source:	Arkansas Game and Fish Commission
Project Duration:	October 2016 – March 2020
Principal Investigator:	DANIEL D. MAGOULICK
Postdoctoral Fellow:	J. TYLER FOX

Research objectives:

1. Determine flow ecology relationships for fish and macroinvertebrates to aid the development of environmental flow needs for aquatic communities.
2. Expand our use of long-term biological data for examining environmental flows
3. Provide essential information and tools for dealing with water use issues

Management implications:

1. Results from this work will form the basis for setting regional environmental flow standards and understanding impacts of land use and climate change on aquatic species and ecosystems.
2. Project provides flow-ecology information for numerous SGCN species

Project Summary:

Riverine ecosystems face increasing pressure from human activities and the growing demand for freshwater resources resulting in widespread alteration of the natural flow regimes of rivers and streams. Local and watershed-scale disturbance from dams, diversions, roads and artificial canals can

impact the composition of aquatic communities by pushing stream flow outside of the bounds of normal function. To model nonlinear threshold responses and investigate the role of environmental factors driving patterns of fish biodiversity and community composition across different flow regimes, we are applying a 'gradient forest' approach, an extension of the random forest statistical model. Gradient forests extend the random forest methodology to examine species assemblages and identify environmental thresholds where important community compositional changes occur. Using long-term, georeferenced species occurrence data compiled by the USGS Aquatic Gap and other sources, we are working to quantify multispecies responses along environmental and hydrologic gradients in streams in the Ozark and Ouachita Highlands and Gulf Coastal Plains. The results of our analysis will provide detailed information on environmental and disturbance thresholds driving patterns of compositional change in fish communities supporting management and conservation of freshwater systems.

NEW FISHERIES PROJECTS

Leigh Adrienne Ingram holding a Redhorse,
photo by Leah M. Bayer (AR Coop Unit)

Yellowcheek Darter, photo: D.T. Lynch (AR Coop Unit)

Effect of Current and Future Climate on Endangered Yellowcheek Darter (*Etheostoma moorei*) Growth, Survival and Refuge Use

Funding Source:	U.S. Geological Survey
Project Duration:	August 2020 – May 2023
Principal Investigator:	DANIEL D. MAGOULICK
Graduate Student:	TBD

Research objectives:

1. Determine effects of drought on growth and survival of Yellowcheek Darter.
2. Examine refuge selection and use strategies of Yellowcheek Darter during drought.
3. Forecast effects of climate change on Yellowcheek Darter growth and survival.

Management implications:

1. This project will directly relate to an important FWS priority, namely the recovery plan for the endangered Yellowcheek Darter.
2. This project addresses specific aspects of research suggested in the recovery plan such as examining habitat use during drought and examining effects of climate change on Yellowcheek Darter population dynamics.

Project Summary:

Yellowcheek Darter (*Etheostoma moorei*) is a fish endemic to the Little Red River watershed in Arkansas. As a result of threats, geographic isolation and declining abundance, the species was listed as

endangered in 2011. Populations have declined, in part, due to intense seasonal stream drying and inundation of lower stream reaches. It is hypothesized that in headwater streams where periodic drying is common, habitat selection influences Yellowcheek Darter distribution and abundance. Seasonal drought is typical in this region, and as drying occurs, individuals must move from riffles into neighboring pools, move into the hyporheic zone, migrate large distances to a persistent riffle, or perish. It is well-established that other darter species take refuge in pools during riffle drying. However, Yellowcheek Darter has only been collected in riffles, and hence has been identified as an obligate riffle-dweller. We seek to determine the patterns of Yellowcheek Darter refuge selection and how this may effect bioenergetics and population dynamics. Additionally, we propose to examine effects of current and future climate on Yellowcheek Darter population dynamics. This information will help conserve this endangered species. Our approach could also be readily transferable to other aquatic species in the Southeast Region and nationally.

CURRENT WILDLIFE PROJECTS

Nesting Brown Thrasher (Toxostoma rufum), photo by Brett DeGregorio (AR Coop Unit)

Wildlife

Juvenile Brown Treesnake (Boiga irregularis) on Guam,
photo by Brenna Levine (UA BISC Department)

Genetically Identify Which Snakes are Producing Offspring During Automated Delivery System (ADS) Suppression

Funding Source:	U.S. Geological Survey, Invasive Species Science, US Department of Interior
Project Duration:	July 2019 – May 2020
Principle Investigators:	MARLIS R. DOUGLAS and MICHAEL E. DOUGLAS
Postdoctoral Fellow:	BRENNA A. LEVINE (University of Tulsa)
Graduate Student:	ZACHERY D. ZBINDEN (Ph.D. Student)

Research Objectives:

1. Determine individual genotypes for all ADS-survivors (N=75) using a genomic approach
2. Derive a pedigree and identify parent-offspring couplets
3. Quantify individual reproductive success based on pedigree and parentage data
4. Evaluate ecological parameters as covariate to parentage reproductive output

Management Implications:

1. Relatedness, parentage, and reproductive success will be determined for all ADS-survivors for which samples are available. By understanding the reproductive drivers in BTS, control can be tailored towards:
2. Removing individuals with high reproductive success.
3. Reducing conditions that promote successful reproduction.
4. Avoiding inadvertent bounce back that large-scale control efforts can promote.

Project Summary:

Invasive species represent major threats to biodiversity, global economies, and human health, and their control requires an understanding of life history processes that facilitate their persistence and spread. This includes *Boiga irregularis* (BTS: Brown Tree Snake*)*, a 'World's Worst' invasive species.

The highly invasive BTS has caused the extinction or extirpation of 10 of the 13 species of birds native to the US territory of Guam since its introduction circa 1949. Furthermore, BTS is detrimental to Guam's economy, causing extensive damage to electrical infrastructure and decimating the local poultry industry. Improvement of Brown Treesnake control is consequently of profound importance.

Control efforts of the BTS population can be made more effective if reproduction of this invasive species is understood in more detail, as production of offspring is directly related to a population's ability to persist. However, the secretive behavior of BTS limits studies of its reproduction in the wild. Monitoring of BTS reproduction post-control can provide an important check-up on the long-term success of control methods, and in particular, to address concerns that the BTS population may evolve over time to become resistant to current control methods.

Fortunately, advances in genomic sequencing make it possible to quantify individual reproductive output from DNA samples, even in species with secretive behaviors like BTS. DNA can be sequenced from BTS tissue samples, yielding a unique genomic profile specific for each individual. These profiles can then be compared among individuals to facilitate the construction of a population-wide 'family tree' (pedigree) from which reproductive output of each individual can be quantified. A previous dissertation (Levine 2018) established such a multi-generational pedigree for BTS in the Closed Population (CP) on Guam. This pedigree represents a baseline to assess potential selection for control-resistant individuals. If selection occurs, control methods would ultimately be rendered ineffective.

The central goal of this research is to quantify individual reproductive output in BTS after ADS (Automated Delivery System) suppression. The study will determine if individuals refractory to ADS control produce a greater number of offspring that are also refractory to ADS applications following long term (> 2 years) ADS treatment. We address 4 main questions germane to the improvement of BTS control:

1. Do key individuals resistant to ADS suppression exhibit high reproductive output?
2. Is resistance to ADS control heritable?
3. Are there particular ecological traits correlated with resistance to ADS control?
4. Are there particular control tools that are highly effective on those individuals, thus allowing control tool refinement?

BTS tissue sampling for DNA sequencing (photo by Brenna Levine, May 2016)

To answer these questions, relatedness amongst ADS-survivors will be determined to derive a pedigree and determine parentage from these data. Individual genotypes will be generated for each snake and compared to a multi-generational family tree constructed from 475 BTS samples collected from the same 5 hectare population on Guam over the previous 12 years.

Assignment of offspring and determination of kinship are key analytical parameters in parentage analyses. Genetic data allow calculating relatedness amongst individuals and hence determining reproductive output, but many (100+) highly polymorphic loci are required to assign offspring-parent pairs with high confidence. A genomic approach that derives individual genotypes from thousands of single nucleotide polymorphisms (SNPs) will be employed to determine relatedness in ADS-survivors.

SNP genotypes will be derived using a reduced-representation genomic approach (ddRAD sequencing). The process entails extraction of genomic DNA, followed by an enzymatic digest to 'cut' the DNA into small fragments. A subset of these fragments common to all individuals is selected and samples are prepared for Next-Generation Sequencing (NGS) in the form of a 'library' (barcoded individuals pooled into a single sample). Sequencing results in millions of short 'reads' of DNA data per individual, which then are processed and mined for SNPs using bioinformatics tools and computational resources at the High Performance Cluster Computing Center (AHPCC) at the University of Arkansas.

Using a combination of bioinformatics programs and custom computer code, familial relationships among the BTS are then inferred via comparisons of the genomic profiles. The number of offspring produced by each individual over time can then be quantified from the multi-generational family tree. Long-term ecological data for each individual are overlaid onto the family tree to (1) facilitate identification of traits associated with high reproductive output, (2) evaluate whether current control methods target the most reproductive individuals, and (3) determine whether traits related to high reproductive output and 'controllability' are heritable and likely to evolve in response to control methods.

DNA has been extracted from 75 individuals (= 100% of post-ADS samples). A ddRAD library comprising barcoded fragments of all 75 samples has been prepared and was submitted end of September to the GC3F (=Genomics and Cell Characterization facility) lab at the University of Oregon for NGS data production. Data are expected to become available by mid-November (6-week turn-around) and will be bioinformatically processed to identify SNPs, derive individual genotypes, estimate relatedness and incorporate the post-ADS samples to the existing pedigree of 475 BTS.

Parent-offspring couplets can be inferred from the pedigree and used to quantify individual reproductive output. A variety of analytical approaches will be used to identify the ecological correlates, including partial Mantel test correlations, generalized linear modeling, and regression tests.

Ellery Lassiter holds an unmarked spotted turtle (Clemmys guttata) in Virginia, photo by Ellery Lassiter (AR Coop Unit)

Spotted Turtle Movement and Population Dynamics

Funding Source:	U.S. Army Corps of Engineers: ERDC – CERL and University of Illinois University of Arkansas, Doctoral Academy Fellowship University of Arkansas, Biological Sciences Arkansas Cooperative Fish and Wildlife Research Unit
Project Duration:	May 2016-March 2020
Principle Investigator:	BRETT A. DEGREGORI
Graduate Student:	ELLERY RUTHER-LASSITER (Ph.D. Student)

Research Objectives:

1. Quantify spotted turtle occupancy and abundance patterns across an urban military installation, Fort Belvoir, VA.
2. Examine the influence of seasonal, climatic, wetland, and turtle intrinsic characteristics on spotted turtle intra- and inter-wetland movements and home-range size.
3. Across the geographic range of the species, assess the influence of landscape composition and climate on the number of wetlands used by individual spotted turtles during a given year.
4. Quantify genetic relatedness of individuals across four sub-populations to better understand landscape connectivity and isolation.

Management Implications:

1. Understand status, distribution, and ecology of spotted turtles in an urbanized setting.
2. Develop management recommendations to update and enhance current environmental regulations at the U.S. Fort Belvoir army installation, so that Fort Belvoir and other Department of Defense installations may better balance training requirements and land stewardship, particularly if the species is listed under the Endangered Species Act.

Project Summary:

Wetland ecosystems are often spatially patchy across a landscape and exhibit seasonal patterns in water levels, resulting in the need for aquatic wildlife to use several different wetland patches across a season. The ecology of semi-aquatic freshwater turtles is especially complex because individuals often make long distance movements among a variety of habitats for mating, foraging, basking, aestivating, and overwintering purposes. These habitat requirements often differ across a season, in response to variation in resource availability, wetland hydroperiod, precipitation, and temperature. Spotted turtles (*Clemmys guttata*) are a species of semi-aquatic turtles that inhabit ephemeral wetland systems and are currently experiencing range-wide declines. This is in part due to habitat loss and fragmentation, which spotted turtles are particularly vulnerable to due to their reliance on multiple wetlands, and therefore connectivity between those wetlands. Understanding the temporal and spatial scale at which spotted turtles use and move between habitats is vital, particularly for a species that relies on connectivity for population stability.

Field work was conducted on and adjacent to the U.S. Fort Belvoir army installation in northern Virginia starting in 2016. From May-November 2016, we conducted a preliminary field season on the Fort Belvoir installation. We equipped six adult turtles with VHF radio transmitters (6 or 10 g from Holohil Systems Ltd) and radio-located them two times a week. GPS location, weather, behavior, and surrounding habitat characteristics were collected for each location.

During subsequent field seasons in 2017-2019, field work was limited to the primary spotted turtle active season, which is from March-August. During these three field seasons, we 1) radio-located turtles; 2) trapped for turtles; 3) conducted visual surveys for turtles; and 4) collected genetic samples from turtles. Limited trapping, visual surveys, and genetic sample collection was conducted at seven locations adjacent and/or near to the installation. Spotted turtles were only detected at two of seven locations and generally persist in the region due to the large population on Fort Belvoir.

At the Fort Belvoir installation, we equipped adult turtles with the same VHF transmitters as noted above and smaller VHF units (3.5 g from Holohil Systems Ltd) to juvenile turtles. We tracked turtles every 48 hours and collected the same information (gps location, weather, behavior, and habitat) as described above. Three Auto Telemetry Units were also placed at one location on the installation to collect fine scale activity data on a subset (24) of turtles. To date, 77 turtles have been tracked, including 57 adults (27 F; 30 M) and 20 juveniles. Turtle occupancy and abundance was sampled via aquatic traps and aquatic visual surveys. For trap sampling, we placed ProMar TR-502 36” x 12” collapsible hoop-net trap transects into wetlands. Traps were baited with sardines in soybean oil and left in place for three trap nights. This was conducted three times per transect per season (total of 9 trap nights per season) and repeated once in a subsequent season. Thus, each transect was sampled for a total of 18 trap nights. We have trapped 85 wetlands to date, including a total of 209 traps placed. For visual sampling, each survey was comprised of a combination of passive and active visual survey time throughout the site. To start, we would stand at vantage points and record turtle presence. We would then walk through the entire wetland to collect turtles seen from the vantage points and collect other additional encounters. Total survey time, surveyors, and survey location were recorded for each survey. To date, we have conducted 159 visual encounter surveys.

Upon collection by either visual sampling or trapping, we removed each turtle from the water, and obtained measurements of size and weight (Haglöf Mantax Calipers, SPI 2000 Plastic Dial Calipers, Pesola® Medio-Line Spring Scales). We also gave turtles a unique identification code by filing a notch using a triangular file in one or more marginal scutes using a modified Ernst (1974) numbering scheme. Measurements were collected upon first capture and during subsequent recaptures, only ID and gps location were recorded. To date, we have captured and marked 421 individual turtles. A genetic sample was also collected from a subset of individuals turtles. We collected genetic samples by blood-withdrawal from the sub-carapacial sinus. To date, blood has been collected from 245 individual turtles.

Andrhea Massey checking a turtle trap, Dixie Farm, Arkansas
photo by Elliot Lassiter (AR Coop Unit)

Assessing the Density, Demography, and Resilience to Commercial Harvest of Aquatic Turtles in the Mississippi Delta Region of Arkansas

Funding Sources:	Arkansas Game and Fish Commission Arkansas Cooperative Fish and Wildlife Research Unit
Project Duration:	May 2019 to December 2021
Principal Investigators:	BRETT A. DEGREGORIO AND J. D. WILLSON
Graduate Student:	ANDRHEA MASSEY (M.S. Student)

Research Objectives:

1. Examine the effects of commercial harvest on population demographics of ten aquatic turtle species in private land aquatic systems in the delta region of Arkansas.
2. Determine what level of harvest is sustainable for each species of turtle.
3. Estimate current populations for each species of turtle.
4. Assess habitat availability in the region.

Management Implications:

1. Understanding the effects of commercial harvest will be critical in effectively managing this resource. Our results should help the AGFC evaluate different harvest regimes for a sustainable resource.

Project Summary:

Due to their unique life history strategies (low juvenile survival, delayed sexual maturity, and adult lifespans of considerable length), turtles may be particularly vulnerable to overharvesting or other catastrophic mortality events, suggesting that unregulated harvest of aquatic turtles may cause irreversible damage to their populations. With many states (e.g., Missouri, Mississippi, Georgia, Texas) closing or otherwise strictly regulating harvest of aquatic turtles, harvest pressure on Arkansas turtles may significantly increase. Currently, once a harvest permit is obtained, ten species of aquatic turtles can be legally collected with no bag limits, size restrictions, or specified harvest season. In order to implement the best management strategies, research is needed to understand the status of turtle populations in Arkansas and the effects of commercial harvest on each species of harvested aquatic turtles. This project was funded in order to provide managers with the foundation for developing and implementing regulations needed for sustainable harvest in Arkansas. Research efforts began on May 13, 2019 and will continue through the summer of 2021. This report summarizes our results to date following the first field season of the study.

We are using a stratified capture-mark-recapture approach across multiple harvested and unharvested sites with a combination of Closed and Robust CMR analytical approaches to rigorously estimate density and capture probability parameters for each of the ten species of aquatic turtles for which harvest is currently allowed in the region. We then plan to extrapolate these estimates to the entire region by using GIS and remote sensing data to delineate the extent of available aquatic habitat, stratified by habitat type, within the region. Finally, we will use stage-based demographic models, parameterized based on our own data and the literature, to evaluate the sensitivity of population dynamics to different harvest levels and conduct simulations to determine sustainable harvest levels and the efficacy of proposed regulatory frameworks, such as different size limits, for each species.

In order to achieve our goals, the research team has been working with AGFC officials (Mr. Kelly Irwin and Dr. Chris Middaugh), local turtle trappers (Mr. Marcus Balch), fish farm managers (Mr. Jason Miller and Mr. Mike Freeze), and local citizens to identify and effectively trap at numerous wetland sites. Our goal in year 1 was to conduct capture-mark-recapture at approximately 20 different sites comprising protected agricultural ditches (on AGFC WMAs), protected fish farms (AGFC properties such as Joe Hogan Fish Hatchery), agricultural ditches with known harvest histories, and finally, fish farms with known turtle harvest histories. During the summer of 2019, we conducted capture-mark-recapture at 24 sites comprising 3 protected ditches, 13 protected fish farm ponds, 3 known harvest ditch sites, and 9 known harvest fish farms. In total, we captured 1800 individuals of nine species (*Apalone spinifera, Trachemys scripta, Chelydra serpentina, Kinosternon subrubrum, Sternotherus odoratus, Chrysemys dorsalis, Graptemys kohnii, Pseudemys concinna, and Macrochelys temminckii*). The most commonly captured turtles were *Trachemys scripta* (n = 1116), *Apalone spinifera* (n = 370), and *Sternotherus oderatus* (n =215). More importantly than overall captures, we were able to recapture over 300 individual turtles, providing the required data for robust estimates of population density.

Our goals for next field season are to initiate trapping earlier in the season for a longer trapping season (April-July 2020). Our goals are to sample at least 20 additional sites as well as to increase the distribution of sites with a focus on adding more known-harvest ditch habitats and sampling a third fish farm. In addition to this, we will be revisiting 5-10 sites in order to collect recapture data for a robust-

design population estimation approach as well as other important demographic parameters. Each of these robust-design sites will be trapped 3 additional times during the summers of 2020 and 2021.

In addition to next season's trapping plans, we have initiated GIS and remote sensing analysis to determine the acres of ditch and pond sampled thus far and the extent of available aquatic habitat in the region.

NEW WILDLIFE PROJECTS

Andrhea Massey and Elliot Lassiter use calipers to measure the plastron length of a Common Snapping Turtle (Chelydra serpentina), one of the most heavily harvested turtles in the state, photo by Brett DeGregorio (AR Coop Unit)

Student John Veon

Mallard Body Mass Variation Within and Among Winters in the Lower Mississippi Alluvial Valley of Arkansas

Funding Source:	Ducks Unlimited University of Arkansas, Biological Sciences Arkansas Cooperative Fish and Wildlife Research Unit
Project Duration:	August 2019 – August 2021
Principal Investigator:	BRETT A. DEGREGORIO, DAVID KREMENTZ
Graduate Student:	JOHN T. VEON (M.S. Student)

Research Objectives:

1. To determine how body mass and body condition of overwintering mallards in Arkansas' LMV vary across time (as compared to historical data from 1979-2004), land management, and by other intrinsic and extrinsic factors.

2. Determine how body mass and body condition vary by age and sex of mallards as well as environmental factors such as temperature and precipitation.
3. Attempt to correlate duck body mass to habitat management performed for waterfowl in the vicinity of their harvest site to better evaluate the management actions of AGFC and other land management agencies.

Management Implications:

1. This study will provide direct feedback to land managers attempting to improve waterfowl fitness by increasing food availability through habitat management.

Project Summary:

Long-distance migrations exert enormous stresses upon wildlife and individuals attempting such feats without adequate resources may not survive. Studies on the effects of body condition in migrating organisms have often focused on birds because they are a taxonomic group that expends considerable energy to migrate between wintering and breeding grounds. Most North American waterfowl overwinter in southern North America before migrating back to breeding grounds in the northern US and Canada. These species face the unique challenge of needing to maintain or increase their body mass during an environmentally difficult time. Body mass can affect the survival of waterfowl during the winter season. Body mass can also affect breeding behaviors in waterfowl such as the timing of which a male and female pair and their nesting behaviors. Researchers have demonstrated that a higher body mass in waterfowl can lead to higher productivity the following winter season. Because body condition is driven by food availability, management agencies such as the Arkansas Game and Fish Commission (AGFC) and US Fish and Wildlife Service (USFWS) expend considerable resources to manage habitat for overwintering waterfowl.

Although food availability is likely the biggest driver of overwinter body condition of waterfowl, other environmental factors likely contribute and several studies have documented large-scale variation in body mass over time. For example, Guillemain et al. (2010) showed that body mass in mallards (*Anas platyrhynchos*) and teal (*Anas crecca*) in Europe increased from the 1950's to the 2000's. Guillemain et al. (2010) suggested that factors such as global warming and local habitat management could be the key factors that influenced the increase in body mass. However, other researchers suggest that these changes are due to a shift in wintering areas. Additional research looking at long-term changes in waterfowl body mass are needed to better understand these patterns.

The sport of hunting generates a large amount of revenue for the state of Arkansas. The Arkansas House of Representatives estimated in 2013 that about $100 million was collected from state and local tax revenue in sales related to hunting products. These sales support up to 17,000 jobs. The House of Representatives reports that one third of that money and 4,500 of those jobs are supported by the sport of duck hunting alone. Within the Lower Mississippi Valley (LMV), the popular duck hunting town of Stuttgart alone is estimated to generate $1 million a day in sales of food, lodging, and duck hunting supplies during the duck hunting season. Due to the importance of waterfowl in this area, and the investments made by the AGFC, we need to understand how body mass of waterfowl varies across the area over time and in relation to management. The body mass of mallards in the LMV of the Arkansas Delta has not yet been assessed. This presents an opportunity to not only analyze the current state of wintering waterfowl body conditions over the course of winter in Arkansas, but will assist in understanding the individual factors that may affect mallard body mass over time. In addition, the North American Waterfowl Management Plan (NAWMP) goals state that Arkansas should provide 219.4 million Duck Energy Days (DEDs) annually during a 110-day wintering period. Arkansas currently supplies

117.5-128.3 million DEDs. Because Arkansas is below its target objective for providing DEDs, the Lower Mississippi Valley Joint Venture (LMVJV) Waterfowl Working Group (2015) developed a plan to help managers reach the target objective of DEDs in Arkansas. This objective is planned to be met by a series of land acquisition, habitat enhancement or restoration on public lands, and conservation opportunities on private lands through cooperative efforts by state, federal and private partners. The resources used in enhancing habitat and increasing food supply for ducks in the MAV should be reflected in the body mass of mallards when using managed lands. These findings will aid in quantifying and understanding the success of the LMVJV plan to date and/or the development of new and effective management plants to provide wintering waterfowl with the necessary resources for breeding and survival before, during, and after their migrations.

My study area will be the LMV of Arkansas. I will select field sites stratified by the relative (low, medium, high) amount of wetland habitat that is managed by public agencies targeting waterfowl.

I will collect samples by visiting duck cleaning businesses, duck hunting lodges and public waterfowl hunting areas. I plan to conduct my study over the next two duck hunting seasons in Arkansas (November 2019 through January 2020 and November 2020 through January 2021). Each day, I will arrive at one site after hunters have completed their hunts. I will measure wing length (mm) using a "wing ruler" for each bird as well as age the birds by observing key features in the mallard wings (Carney 1992). I will determine the sex of the mallards via plumage dimorphism. I will record the body mass (g) of each mallard by using a battery powered electronic balance. I will then use body mass, age, and sex to determine a body condition index (BCI) for each of the birds. I will calculate BCI by using the residuals from a mass by wing length linear regression. I will use aerial photos of the field sites that the mallards were harvested from to determine the proportion of area that is flooded, covered in rice, wooded, or actively managed by AGFC and other entities. Previous research suggests that mallards travel up to 30 km in day while they forage (Beatty et al. 2014). For this reason, I will draw a circle with a 30 km radius where each mallard is harvested to determine our proportions of land cover. I will also note daily winter weather variables for each site mallards are sampled such as precipitation and temperature. Kenneth Reinecke, a former researcher affiliated with the United States Geological Survey (USGS), has provided me with body mass data from over 3000 mallards in the LMV harvested between 1979 and 2004.

Upon completion of data collection, I will analyze mallard body condition and study area environmental factors. Because mallard body mass is known to fluctuate over the winter season, I will examine body mass variation during three periods of time: early winter (mid-November – mid-December), mid-winter (mid-December – mid-January), and late-winter (mid-January – late-January). Similarly, I will explore body mass variation over time from 1979 through 2021. I will develop a set of models to explain body mass (Bm) variation in mallards during the winter. I will use a generalized linear model to observe the interactions of age, sex, period (early, middle, late), precipitation, and temperature on body mass over time. The results of this study will be presented at regional and national meetings (e.g. Arkansas Chapter of the Wildlife Society Annual Meeting, LMV Joint Venture, Ecological Society of America), and then written up in a manuscript for submission to a refereed journal.

This study will address whether mallard body mass is related to food availability at the landscape level as implemented by public land wetland managers. By understanding the link between body mass and land cover, I can provide valuable information to land managers to help them refine their management approach. Knowing the variables that may cultivate a positive mallard BCI could help in developing management implications for the AGFC to restore and/or effectively design successful waterfowl habitat that provide the proper resources for mallards to survive the winter season and spring migrations. Furthermore, this study will address gaps in the literature regarding large-scale changes in waterfowl body mass over time.

Wildlife

Loggerhead shrikes (Langius ludovicianus) are predatory passerines that are in sharp decline across the United States and Canada. The Arkansas CRU is exploring how pesticides may effect the health and behavior of shrikes living in agricultural landscapes, Photo by Brett DeGregorio (AR Coop Unit)

Assessing occurrence and effects of neonicotinoid pesticides on Loggerhead Shrike body condition, immunocompetence, survival, and reproduction

Funding Source:	Arkansas Game and Fish Commission (State Wildlife Grant) University of Arkansas, Doctoral Academy Fellowship University of Arkansas, Biological Sciences Arkansas Cooperative Fish and Wildlife Research Unit
Project Duration:	August 2019-May 2023
Principle Investigator:	BRETT A. DEGREGORIO
Graduate Student:	CONNOR GALE (Ph.D. Student)

Research Objectives:

1. Quantify and characterize neonicotinoid pesticide concentrations in adult and juvenile shrikes across habitats and seasons that we expect to vary in the application/presence of neonicotinoid pesticides.
2. Assess the relationship between neonicotinoid concentrations in shrikes and their: a) immunocompetence, b) adult survival, and c) egg and nestling survival.

Management Implications:

1. This study will begin to fill a critical knowledge gap. We propose to evaluate the potential role of neonicotinoid pesticides in the decline of eastern Loggerhead Shrikes in Arkansas. This research will also have implications for the species range-wide as this species is among the fastest declining and most vulnerable avian species in Arkansas, the US, and in Canada, where it is listed as federally endangered in the eastern provinces and threatened in the western provinces. Although we will be focusing on the Loggerhead Shrike in this study, our results could have implications for many other species that occupy similar grassland/farmland habitats in Arkansas

(and the central United States), including many declining species such as Northern Bobwhite, Henslow's Sparrow, Bachman's Sparrow, and Eastern Meadowlark.

Project Summary:

The Loggerhead Shrike is a grassland (and now cropland) associated avian species that is one of the fastest declining passerines in both Arkansas and North America. To improve our ability to conserve this species of greatest conservation need, we propose to evaluate the occurrence and impact of neonicotinoid pesticides on the species, particularly in the highly agricultural Lower Mississippi Alluvial Valley ecoregion. To do so, we will capture and collect blood and fecal samples from adult and nestling shrikes that inhabit: 1) a variety of row-crop habitats that vary in dominant crop types and likely vary in concentrations of pesticide application, and 2) grassland and pasture habitats with relatively low potential for pesticide presence. We will also catch adult birds across seasons in the same habitat types to assess how pesticide concentrations and potential impacts vary between growing and non-growing seasons; we will also monitor marked birds (including a subset of birds with telemetry) to better estimate survival and monitor nests to assess reproduction. Finally, we will model neonicotinoid concentrations as a predictor of body condition, immunocompetence, survival, and reproduction.

Field work will initiate in November of 2019 where we will begin by conducting fixed radius point count surveys within a 45 km radius of Fayetteville. We will correlate shrike presence with a variety of landscape level and site specific variables. We will conduct surveys at an estimate 120 points and will survey each point at least 3 times during the overwintering season (Nov 15 – Feb 15). We will conduct the same surveys during the breeding season. These surveys will be an important first step in determining the presence, abundance, and distribution of Loggerhead Shrikes in Northwest Arkansas.

Starting in May 2020, we will visit breeding pairs and attempt to 1) capture and band them using baited, spring loaded wire traps, and 2) locate and monitor their nests. Our goal is to capture, band, and locate the nests of 10 pairs of Loggerhead Shrikes in Northwest Arkansas each summer. We will calculate nest survival and fecundity of each pair. We will also collect feather and blood samples from adults and nestlings to test for concentrations of pesticides. These values will be compared to data collected from the heavily agricultural Northeast Arkansas, where pesticide levels are predicted to be much higher. We will review video to quantify nesting behaviors and compare these behaviors with shrikes monitored in the Jonesboro area.

Wildlife

American Robin (Turdus migratorius) nesting in window. This species is particularly well-suited to nesting in anthropogenically modified landscape. However bird species moving to such areas are exposed to an entirely new suite of nest predators and must adapt by making suitable nest site selection choices, Photo by Shutterstock

Nest Site Selection and Predation in Rural, Transitional, and Suburban Avian Communities

Funding Source:	University of Arkansas Distinguished Doctoral Fellowship University of Arkansas, Biological Sciences Arkansas Cooperative Fish and Wildlife Research Unit
Project Duration:	March 2020 – August 2024
Principal Investigator:	BRETT A. DEGREGORIO
Graduate Student:	H. GRACE SHOWALTER (Ph.D. Student)

Research Objectives:

1. Document nest predator identity at avian nests along a suburban to rural gradient.
2. Calculate relative predator density at each study site.
3. Explore correlations between relative predator density and daily predation risk from that predator.
4. Identify nest site selection mechanisms along a suburban to rural gradient.

Management Implications:

1. The goal of this research is to identify the mechanistic basis for rural and suburban population differences, understand predator-prey interactions in novel environments, and shed insight as to the effects of urbanization on wildlife populations. Results from this research can label human dominated landscapes as either sources or sinks for particular bird species and will be an important part of management or recovery plans.

Project Summary:

For decades, ornithologists have recognized that the process of nest site selection is crucial to the maintenance of avian populations; it has been repeatedly demonstrated that nest predation is the most common cause of reproductive failure, indicating that predation is likely a strong selective force with the ability to shape community dynamics and life histories. The nest site selection process is nuanced; birds must take into consideration territory structure, microhabitat structure, and predation risk. Being such a complex problem, the underlying mechanisms of nest site selection are elusive. While the influence of broad-scale habitat has been long-studied, the current understanding of nest predation is lacking. Previously, the identity and composition of nest predators have been little investigated, with nest predation being treated as an incident without an identified culprit. Without understanding the identity of nest predators, the mechanisms behind nest site selection remain elusive, as responses to nest predation are dependent upon the diversity and density of species involved. Though the use of camera monitoring has improved the situation, there is much work left to be done.

When considering the identity of nest predators for a given prey species, one must also consider the range in which said species occurs. Evidence suggests that avian communities in rural and urban areas are subject to different nest predation pressures, likely due to anthropogenic influence. Though that basic observation has been made, only recently have the mechanisms behind differential predation pressures in rural and urban communities been investigated and they remain little understood.

This study will be conducted at three different sites within Northwest Arkansas, each representative of either a rural, transitional, or suburban habitat. The rural sites chosen for this study are located at Kessler Mountain and Wilson Springs, which are Northwest Arkansas Land Trust protected areas. The transitional location, meant to emulate areas of anthropogenic disturbance with lower housing densities (i.e. agricultural edge habitat and restored prairies) is located at Woolsey Wet Prairie Sanctuary, a 46-acre wetland mitigation site adjacent to Fayetteville's West Site Wastewater Treatment Facility. Finally, suburban sites will be located opportunistically through community outreach within Fayetteville neighborhoods and requests for information of nests sighted on a given individual's yard or in neighborhood parks.

Focal prey species whose nests will be monitored were chosen on the basis of known incidence, habitat preference, and life history traits. Data from Cornell Ornithology's All About Birds and Birds of North America, the Breeding Bird Survey, and NWA Audubon Society were used to identify species occurring in Northwest Arkansas during the study season that would be expected to occur in any or all habitat types. Given the framework of examining habitat effects on predation and nest success, the goal was to identify species known to utilize suburban structures as part of their habitat whilst still being seen in less disturbed areas, species that are cosmopolitan (but partial to woodlands), and species that are more common in less disturbed areas, often occurring in pastures or grasslands.

My objectives in this study are to: 1) Use miniature nest cameras to document nest predator identity at avian nests located along a suburban to rural gradient, 2) Use motion-triggered cameras and point count surveys to calculate relative predator density at each study site, and 3) To explore correlations between relative predator density and daily predation risk from that predator. Objective #1 will inform how predator communities change along a suburban to rural gradient whereas objective #2 will allow me to test the predator proliferation hypothesis (i.e. are certain predators more abundant in developed areas). Finally, objective #3 will allow me to explore the urban nest predator paradox (i.e. are densities of certain predators correlated with higher risk from that predator?).

The Eastern Collared Lizard (Crotaphytus collaris) relies upon open canopy glade habitat for persistence, Casey L. Brewster

Glade Restoration and Conservation Management of Eastern Collared Lizards in Northern Arkansas.

Funding Source:	Arkansas Game and Fish Commission, State Wildlife Grant
Project Duration:	March 2020 – March 2023
Principal Investigator:	STEVEN J. BEAUPRE
Project Partners:	BRETT A. DEGREGORIO, MARLIS R. DOUGLAS, KELLY IRWIN, MCREE ANDERSON
Graduate Student:	CASEY L. BREWSTER (Ph.D. Student)

Research Objectives:

1. Improve glade habitat quality and connectivity within the focal sites of this project, and to initiate *C. collaris* population recovery at restored sites by developing a *C. collaris* reintroduction program in Arkansas.
2. Objectives will include habitat restoration though cedar removal and fire management, and *C. collaris* population recovery through population management.

Management Implications:

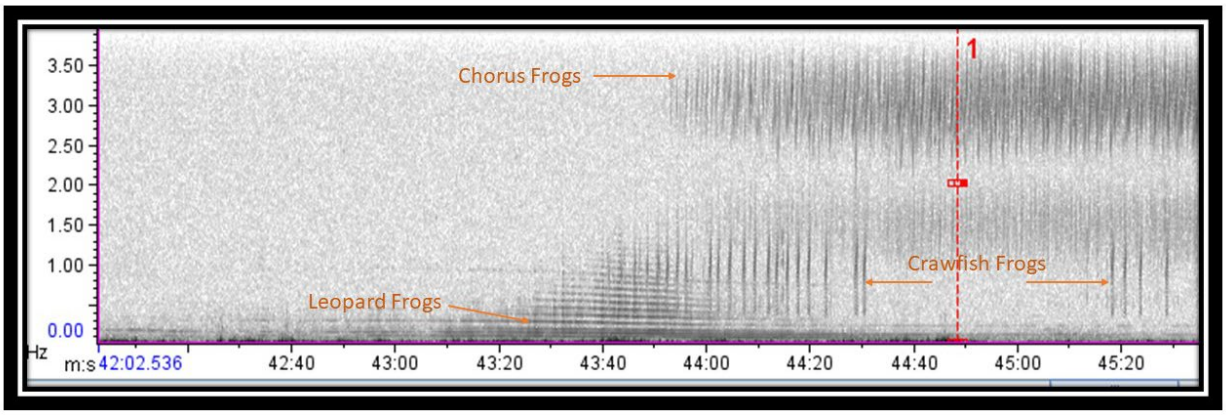
1. Habitat restoration efforts will decrease woody vegetation density and increase abundance/diversity of grasses and glade plants, resulting in improved habitat quality and connectivity.
2. Reintroductions of *C. collaris* will increase glade SGCN diversity and improve the stability of glade communities. Establishing a *C. collaris* reintroduction program will ensure the availability of source animals for future reintroductions of restored glade habitats in Arkansas.

Project Summary:

A growing number of glade species are becoming imperiled in the state, including *C. collaris*. As a key predator in Ozark-glade habitats, *C. collaris* plays an important role in stabilizing species richness of insect communities, many of which are also glade endemics and SGCN. Additionally, *C. collaris* is an important prey species to other glade predators, including several birds of prey, snakes and road runners. Thus, a critical component to restoring and conserving glade-ecosystems and associated SGCN in Arkansas includes conservation efforts aimed at population recovery of *C. collaris*.

The most important variable contributing to the majority of SGCN declines is loss and degradation of habitat. This is especially true for glade SGCN, as glade habitats have experienced extensive woody vegetation encroachment over the past century. For example, glade encroachment has resulted in reduced growth and reproduction of *C. collaris* in Arkansas, likely driving the observed population declines of the species throughout the Ozarks. Thus, the recent emphasis of glade habitat restoration in Arkansas is a major step to improving this situation. In fact, a large number of glade-sites have recently been restored or are currently in the process of restoration. However, *C. collaris* are already extirpated from the vast majority of glade sites in Arkansas. Research suggests that as little as 50m of dense woody vegetation can prohibit dispersal between two populations of *C. collaris*, resulting in the loss of gene flow. Thus, for most of the glade-sites in Arkansas – restored or not - the odds that *C. collaris* will recolonize these sites naturally is highly unlikely. Conservation and restoration of glade ecosystems and associated communities in Arkansas requires two critical components: 1) continued glade-habitat management and 2) active reintroductions of *C. collaris* to restored glade-sites.

The goal of this project is to improve glade-habitat quality and connectivity, and to conduct *C. collaris* population recovery efforts at nine glades-sites within the Ozark Highlands including: Madison McIlroy –Wildlife Management Area (MM-WMA; 4 glade-sites) Hobbs State Park Conservation Area (HSP-CA; 2 glade-sites) and 3 private land glade-sites. Project objectives include: a) restore glade quality and connectivity (cedar removal of 200+ acres and prescribed fire of 2,000+ acres), b) develop a *C. collaris* population management program (for reintroductions), c) reintroduce *C. collaris* to all restored sites within the project, and d) monitor *C. collaris* populations at all restored sites. Project efforts will improve glade ecosystem stability, glade connectivity, initiate *C. collaris* population recovery, and increase the number of *C. collaris* populations in Arkansas.



Spectrograms for Cajun chorus frogs (*Pseudacris foquettei*), southern leopard frogs (*Lithobates sphenocephalus*), and crawfish frogs (*Lithobates areolatus*) calls detected underwater by a hydrophone deployed at Woolsey Wet Prairie in Fayetteville, AR.

Using Hydrophones to Survey for Underwater-calling Frogs

Funding Source:	US Department of Defense – SERDP-ESTCP
Project duration:	March 2018 – December 2020
Principal Investigator:	BRETT A. DEGREGORIO, J.D. WILLSON
Research Technician:	ELLIOT LASSITER

Research Objectives:

1. Compare effectiveness of hydrophones, microphones, and human observers to detect the presence of Gopher Frogs, Crawfish Frogs, and Chiricahua Leopard Frogs.
2. Quantify the effects of wetland characteristics on detection probability.
3. Assess the utility of hydrophone recordings for calculating density of calling frogs.

Management Implications:

1. Emerging research indicates that several species of frogs exclusively or primarily call underwater and that traditional survey techniques may be insufficient for documenting their presence and abundance. Hydrophones may be a cost-efficient, effective method for surveying for these imperiled frog species.

Project Summary:

Management and recovery of threatened and endangered species (TES) necessarily relies upon an understanding of their abundance and distribution. Conservation practitioners spend considerable time and effort surveying for amphibians because they are one of the most imperiled taxa worldwide. Fortunately, anurans (frogs and toads) can be relatively easily surveyed because males make audible mating vocalizations during the breeding season that can be identified to specific species level by trained observers. Currently, the most widely used method for monitoring vocalizing anurans are manual calling surveys. Generally, manual surveys involve observers simply listening to the vocalizations

of male frogs and recording all species detected for the duration of the survey at a specific location. In many surveys, observers may also attempt to roughly estimate abundances of each species heard vocalizing by evaluating the "strength" of the chorus. If sites are repeatedly sampled over time using the same methods, estimates of detection probability and occupancy (i.e., presence or absence of a species) can be generated. However, this method has inherent limitations and emerging research on the ecology of some frog species show that they primarily or even exclusively call while submerged underwater and biological sounds produced underwater do not effectively radiate into the air. Thus, manual surveys are unreliable for surveying for submerged species, all of which are at-risk species

Despite the widespread use of manual surveys, passive acoustic monitoring (PAM) can be used to detect anuran vocalizations and have shown to be particularly useful for intensive monitoring of many anuran populations and this is also true for a variety of terrestrial and marine acoustically active taxa and ecosystems. Typically, PAM (using recorders such as "frogloggers" or "songmeters") is used to collect data intensively at a single or multiple locations, whereas manual surveys provide more superficial data but typically for a larger number of sites. Passive acoustic recorders can be used to survey for anuran species in places or conditions difficult to access for manual surveys (such as during inclement weather or in areas of restricted access) and can be left in the field for extended periods of time, thus greatly increasing the probability of detecting a given species. PAM may be the only practical way to reliably detect species that have very short or unpredictable breeding seasons, such as gopher frogs (*Lithobates capito*), when only 3-10 min of observation at a location (typical manual survey duration) will not be sufficient for detection. Despite its substantial improvements over manual survey methods, PAM recording with airborne microphones has the same limitations when applied to frog species that vocalize primarily or exclusively underwater, they simply are not the proper tool for documenting the presence and abundance of such species including the gopher frog, Chiricahua leopard frog (*Lithobates chiricahuensis*), Crawfish frog (*Lithobates areolatus*), or Oregon spotted frog (*Lithobates pretiosa*).

The ability to record animal underwater vocalizations does exist. Cornell University's Bioacoustics Research Program has used PAM for nearly 30 years to document the occurrence, phenology, and movement of protected species in relation to military training exercises, industry activities, and protected species management efforts. This technology can be transferred to freshwater systems to survey for cryptic or rare, underwater calling, at-risk anuran species. We are currently using paired microphone and hydrophone arrays to survey for Crawfish frogs in Arkansas, Gopher frogs in Georgia, and Chiricahua leopard frogs in Arizona. Our goal is to demonstrate the use of subsurface PAM to survey for three cryptic, at-risk anuran species and to validate the utility of hydrophones in direct comparison with both terrestrial PAM and traditional manual survey methods.

A southern flying squirrel occupies a bluebird nest box – this common nest predator often takes over nest boxes in forested habitats, photo by Brett DeGregorio (AR Coop Unit)

Nesting Ecology of Eastern Bluebirds Across Land Cover Types: Are Agricultural Landscapes Suitable Habitat for This Charismatic Cavity Nester?

Funding Source:	University of Arkansas, Biological Sciences University of Arkansas, Doctoral Academy Fellowship
Project duration:	September 2019 – December 2023
Principal Investigator:	SARAH DURANT, BRETT A. DEGREGORIO,
Graduate Student:	WILLIAM KIRKPATRICK

Research Objectives:

1. Compare nest box occupancy and density across land cover types in Arkansas.
2. Compare growth, health, parental care patterns, and survival of nestlings in relation to land cover and thermal environments.
3. Quantify predator identity and intensity in relation to land cover types.

Management Implications:

1. Common species that occur across numerous land cover types can provide valuable insight into the health of ecosystems. By examining bluebird growth, survival, and behavior we can assess the suitability of different land cover types as wildlife habitat and identify areas in need of management help or mitigation.

Project Summary:

As human population continues to grow, so does our reliance on large-scale intensive agriculture. Agriculture can result in drastic changes to landscapes that have varied effects on local wildlife populations. These lands often differ from the surrounding landscape in insect abundance and diversity, thermal properties, refugia, and abundance of nest-sites. While many species of wildlife cannot persist in agricultural landscapes, others have adapted well to life in these altered areas. Both agriculture and wildlife can benefit from practices that improve suitability of agricultural lands for wildlife populations. Many wildlife species inhabiting agricultural lands can provide important services to agricultural lands such as the consumption of insect or mammalian pests, pollinating plants, and restoring stable nutrient cycles. For instance, birds can benefit from high insect abundance and the warmer thermal properties associated with some agricultural habitat and can provide important services to agricultural efforts like reducing insect pest abundance. Warmer temperatures in agricultural fields could affect avian reproduction by affecting the timing of breeding in birds nesting in this habitat. Warmer temperatures can advance the timing of breeding in birds, which is associated with high reproductive output and success. Further, access to abundant food resources can promote nestling growth rates, reduce stress hormones, and increase nestling survival. Many simple farming practices (e.g., hedgerows, no-till, cover crops) have drastically increased the suitability of agricultural land to beneficial wildlife. For some avian species, improving suitability could be as simple as providing high quality nest-sites for insectivorous, cavity-nesting birds by installing nest boxes. The goal of this project is to explore whether agricultural land provides high quality nesting habitat for Eastern Bluebirds (*Sialia sialis*), an insectivorous, cavity nesting bird.

We are studying whether insect abundance and thermal attributes of agricultural lands promote breeding success of Eastern Bluebirds relative to reference sites such as remnant or restored prairies and woodland savannah. This system is ideally suited to evaluating the effects of landcover on wildlife health for several reasons. First, bluebirds are easy to capture and manipulate in the field, in part because they breed in nest boxes allowing easy tracking of many individuals throughout reproduction. Bluebird nest box arrays are easy to set-up and maintain and allow researchers to monitor large colonies of birds without expending effort nest searching. Nests laid in artificial nest boxes are easily monitored and researchers can ascertain nestling growth rates, nest success, and parental provisioning rates relatively easily. Furthermore, this charismatic, insectivorous bird can occur in high densities in agricultural landscapes. Second, long-term studies demonstrate that bluebird nesting responds to local temperatures, and warmer temperatures can advance lay dates by 4 days (0.6 day advance/°C) and birds that bred earlier laid larger clutches in years with warmer temperatures. In most parts of their range, bluebirds lay 2-3 clutches per season, but only birds that initiate breeding early in the season produce more than one successful brood per season. Clutches produced later in the summer are also significantly smaller than clutches produced earlier. Thus, birds that breed, hatch, and fledge offspring earlier should have higher reproductive output and success, but only if temperatures are warm and food abundance is high. Third, closely related species, including the western bluebird (*S. mexicana*), are declining across their ranges. Our research may provide mechanisms to improve population status of

declining species that use agricultural lands. Thus, information gained from studies of Eastern Bluebirds will be broadly applicable to current and future species of management concern.

To date, we have built and deployed 100 bluebird nest boxes in agricultural areas (n = 2), restored prairie (n = 1), woodland savannah (n = 1), and suburban neighborhoods (n = 2). If colonized by bluebirds, we will monitor the progress and survival of nests every 2-3 days. Upon hatching, we will weigh and measure nestlings every 4 days until fledging to assess growth and development rates between environments. Each nest box will be equipped with temperature data loggers to assess how the thermal environment influences colonization and use by birds and how the thermal environment influences nestling health and growth. We will also use nest cameras to quantify parental provisioning rate, predator identity, and predation intensity for each nest in relation to the land cover type in which it exists.

A Virginia Opossum (left) and a White-tailed Deer (right) recorded at Woolsey Wet Prairie as part of Project Snapshot: USA in 2019.

Project Snapshot: USA – Arkansas

Funding Source:	Arkansas Cooperative Fish and Wildlife Research Unit
Project duration:	September 2019 – December 2020
Principal Investigator:	BRETT A. DEGREGORIO
Graduate Student:	N/A

Research Objectives:

1. Researchers from all 50 states will concurrently collect camera trap data (400 trap nights: Oct 4 – Dec 1) on mammal abundance and distribution and upload it to a central repository to make nation-wide comparisons of mammal community composition and activity patterns.

Management Implications:

1. An understanding of density, occupancy, and habitat associations of mammals across the nation can inform managers about how communities in their state compare to those of other states and give important baseline information for assessing population trends in the future.

Project Summary:

Snapshot USA's goal is to facilitate the collaboration of cooperators to contribute to a national database of public wildlife data. Representatives from all 50 states across the national have concurrently deployed motion-triggered game cameras in an assigned habitat type. Each contributor will collect between 400 – 500 camera nights of data using between 7 and 40 cameras. Each camera has particular deployment variables standardized across the project. All data will be uploaded by December 1 into eMammal database to facilitate collaboration. This nationwide data will be used to examine nationwide trends in mammal community assembly rules associated with natural environmental and anthropogenic filters. Collaborators for all 50 states will contribute camera trap data from a standardized camera trap array at the same time from each site.

The Arkansas Cooperative Research Unit is contributing data from Arkansas collected at Woolsey Wet Prairie Reserve in Fayetteville, AR. A set of 10 Bushnell game cameras were deployed on October 13, 2019 and picked up on Nov 26. We collected 80,000 photos. We went through every photo taken and identified all mammals captured as well as age and sex data when available. These data have been uploaded to eMammal. We recorded data on bobcat, white-tailed deer, coyote, American raccoons, virginia opossum, nine-banded armadillo, eastern cottontail, and various rodents. The CRU will be an author on at least two papers emerging from the use of these data looking at nationwide trends in mammal community composition and activity patterns of common mammals.

PRODUCTIVITY

Kayleigh Smith, Adrienne Ingram, Sarah Sorensen, Leah Bayer, with advisor Dan Magoulick, photo by Dan Magoulick (AR Coop Unit)

HONORS AND AWARDS:

Bayer, L.M. – University of Arkansas Graduate School, Distinguished Doctoral Fellowship, 2019-2023.
Fox, J.T. – Ecological Society of American-National Ecological Observatory Network Early Career Scholars Award – 2019.
Gale, C.W. – University of Arkansas Graduate School, Doctoral Academy Fellowship, 2019-2023.
Ingram, L.A. – University of Arkansas Graduate School, Doctoral Academy Fellowship, 2018-2022.
Ingram, L.A. – Conservation Scholarship, Arkansas Game and Fish Commission, 2019-present.
Lassiter, E.R.V. – University of Arkansas Graduate School, Doctoral Academy Fellowship, 2019-2023.
Lassiter, E.R.V. – University of Arkansas Graduate School and International Education Travel Grant for $1,261: October 2019.
Magoulick, D.D. – U.S. Geological Survey performance award, 2018.
Magoulick, D.D. – U.S. Geological Survey STAR award, 2018.
Showalter, H.G. – University of Arkansas Graduate School, Distinguished Doctoral Fellowship, 2019-2023.
Sorensen, S.F. – University of Arkansas Graduate School, Doctoral Academy Fellowship, 2018-2022.
Sorensen, S.F. – Johnson Endowed Scholarship for Outstanding First Year Graduate Student, University of Arkansas, 2018.
Sorensen, S.F. – Conservation Scholarship, Arkansas Game and Fish Commission, 2019-present.

COURSES TAUGHT:

Bayer, L.M. – Principles of Biology Laboratory, University of Arkansas – Fall 2019.
Fournier, R.J. – Fish Biology Laboratory, University of Arkansas – Spring 2019.
Fournier, R.J. – Honors Principles of Biology Laboratory, University of Arkansas – Fall 2019.
Fournier, R.J. – Principles of Biology Laboratory, University of Arkansas – Fall 2018, 2019.
Fournier, R.J. – Biometry Laboratory, University of Arkansas – Spring 2018.
Fox, J.T. – 2019 International Study Special topics: Sustainable Development, Department of Biology, University of Arkansas, Fort Smith – Summer 2019.
Fox, J.T. – Spatial Ecology Graduate Seminar, Department of Biology, University of Arkansas, Fayetteville – Spring 2019.
Gale, C.W. – Human Physiology Laboratory, University of Arkansas – Fall 2019.
Ingram, L.A. – Biology for Majors Laboratory, University of Arkansas – Fall 2018, 2019, Spring 2019.
Lassiter, E.R.V. – Principles of Biology Laboratory, University of Arkansas – Fall 2019.
Magoulick, D.D. – Biometry: Experimental Design & Data Analysis for Biologists, University of Arkansas – Spring 2018
Showalter, H.G. – human Anatomy Laboratory, University of Arkansas – Fall 2019.
Smith, K.A. – Principles of Biology Laboratory, University of Arkansas – Fall 2018, 2019, Spring 2018.
Smith, K.A. – Principles of Biology Laboratory Prep Team, University of Arkansas – Fall 2018, 2019, Spring 2018.
Sorensen, S.F. – Biology for Majors Laboratory, University of Arkansas – Fall 2018, 2019, Spring 2019.
Veon, J.T. – Principles of Biology Laboratory, University of Arkansas – Fall 2019.

PUBLICATIONS AND PROFESSIONAL PAPERS PRESENTED:

Scientific Publications:

Tetzlaff, S.J., J.H. Sperry, B.A. Kingsbury, and **B.A. DeGregorio**. 2019. Captive rearing duration may be more important than environmental enrichment for enhancing turtle head-starting success. Global Ecology and Conservation 20:1-11.

Tetzlaff, S.J., J.H. Sperry, and **B.A. DeGregorio**. 2019. Effects of antipredator training, environmental enrichment, and soft release on wildlife translocations: A review and meta-analysis. Biological Conservation 236:324-331.

DeGregorio, B.A., J.H. Sperry, D.G. Kovar, and D.A. Steen. 2019. Southern flying squirrels (Glaucomys Volans) as major predators of avian nest boxes in Conecuh National Forest, Alabama. Southeastern Naturalist 18:476-488.

Tetzlaff, S.J., J.H. Sperry, and **B.A. DeGregorio**. 2019. Tradeoffs with growth and behavior for captive box turtles headstarted with environmental enrichment. Diversity 40:1-12.

Fox, J.T., and **D.D. Magoulick**. 2019. Predicting hydrologic disturbance of streams using species occurrence data. Science of the Total Environment 686:254-263. DOI.org/10.1016/j.scitotenv.2019.05.156

Herbert, J.A., A. Chakraborty, L.W. Naylor, W.S. Beatty and **D.G. Krementz.** 2018. Effects of landscape structure and temporal habitat dynamics on wintering mallard abundance. Landscape Ecology 33:1329-1334.

Stephenson, P.L., T.L. Griswold, M.S. Arduser, A.P.G. Dowling and **D.G. Krementz**. 2018. Checklist of bees (Hymenoptera: Apoidea) from managed emergent wetlands in the lower Mississippi Alluvial Valley of Arkansas. Biodiversity Data Journal 6:e24071. Doi: 10.3897/BDJ.6.e24071.

Fournier, A.M.V., D.C. Mengel, E. Gbur, A. Raedeke, and **D.G. Krementz**. 2019. Evaluating tradeoffs in the response of Sora and waterfowl to the timing of early autumn wetland inundation. Waterbirds 42:168-178.

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

Lynch, D.T., D.R. Leasure, and **D.D. Magoulick**. 2019. Flow alteration-ecology relationships in Ozark Highland streams: Consequences for fish, crayfish and macroinvertebrate assemblages. Science of the Total Environment 672:680-697. DOI.org/10.1016/j.scitotenv.2019.03.383.

Rodman, A., K.R. Brye, **D.D. Magoulick**, and S. Todd. 2019. Population characteristics of Ozark Bass (*Ambloplites contellatus*) in the Upper White River Basin of Northern Arkansas. Natural Resources 10:121-138. DOI: 10.4236/nr.2019.105009.

Bruckerhoff, L.A., D.R. Leasure, and **D.D. Magoulick.** 2019. Flow-ecology relationships are spatially structured and differ among flow regimes. Journal of Applied Ecology 56:398-412. DOI:10.1111/1365-2664.13297.

Middaugh, C.R., and **D.D. Magoulick.** 2019. Changes in Body Condition and Diet of Lotic Smallmouth Bass across Two Flow Regimes during Summer Months at the Southern Extent of Their Native Range. Pp. 93-110 in M.J. Siepker and J.W. Quinn, editors. Managing Centrarchid Fisheries in Rivers and Streams. American Fisheries Society, Symposium 87, Bethesda, Maryland.

Yarra, A.N., and **D.D. Magoulick.** 2019. Modeling effects of invasive species and drought on crayfish extinction risk and population dynamics. Aquatic conservation: Marine and Freshwater Ecosystems 29:1-11. DOI:10.1002.aqc.2982.

Middaugh, C.R., and **D.D. Magoulick**. 2018. Forecasting effects of angler harvest and climate change on smallmouth bass abundance at the southern edge of their range. PLoS ONE 13 (8) DOI:e0202737.https://doi.org/10.1371/journal. Pone.0202737

Lynch, D.T., D.R. Leasure, and **D.D. Magoulick**. 2018. The influence of drought on flow-ecology relationships in Ozark Highland streams. Freshwater Biology 63:946-968. DOI:10.1111/fwb.13089.

Yarra, A.N., and **D.D. Magoulick**. 2018. Stream permanence is related to crayfish occupancy and abundance in the Ozark Highlands, USA. Freshwater Sciences 37:54-63. DOI:10.1086/696020

Middaugh, C.R., B. Kessinger, and **D.D. Magoulick**. 2018. Climate-induced seasonal changes in smallmouth bass growth rate potential at the southern range extent. Ecology of Freshwater Fish 27:19-27. DOI:10.1111/eff.12320.

Scientific Publications In-Process:

Tetzlaff, S.J., J.H. Sperry, and B.A. DeGregorio. Using 3D printed turtles to assess predation risk on juvenile Eastern Box Turtles. (In review).

Bayer, L.M., **R.J. Fournier**, and **D.D. Magoulick**. 2019. Modelling effects of disturbance on population dynamics of generalized crayfish life history strategies. (in press)

Fournier, R.J., and **D.D. Magoulick**. 2019. Effects of multiple stressors on stream ecosystem structure and function: drought and nutrient pollution. (in press)

Fournier, R.J., N.R. Bond and **D.D. Magoulick**. 2019. Modeling effects of disturbance across life history strategies of stream fishes (in review)

Fournier, R.J., and **D.D. Magoulick**. 2019. Effects of multiple stressors on stream ecosystem structure and function: drought and predation. (in prep)

Fox, J.T., and **D.D. Magoulick**. 2019. A gradient forest approach for exploring hydrologic and environmental thresholds. Ecological Applications. (in press)

Fox, J.T., and **D.D. Magoulick.** 2019. Examining aquatic community diversity and dissimilarity along hydrologic gradients using a flow regime perspective. Ecohydrology. (in press)

Moore, J.D., T.R. Cooper, R. Rau, D.E. Andersen, J.P. Duguay, C.A. Stewart, and **D.G. Krementz**. 2019. Assessment of the American woodcock singing-ground survey zone timing and coverage. Pages xx-xx. In (Krementz, D.G. et al., eds) Proceedings of the Eleventh American Woodcock Symposium. Roscommon, MI. University of Minnesota Press. Minneapolis, MN. (in press).

Yarra, A.N., and **D.D. Magoulick**. 2019. Effect of stream permanence on predation risk of lotic crayfish by riparian predators. (in revision)

Leasure, D.R., and **D.D. Magoulick.** 2019. Simulated water withdrawals emphasize stream monitoring to conserve natural flow regimes. Water Resources Research (in revision)

Magoulick, D.D., S.W. Hodges, M.P. Dekar, M.K. Scott, M.R. Rabalais, and C.M. Bare. 2019. Relationship between hydrologic variation, temporal variation and fish assemblage structure in natural flow regimes of the Ozark Plateau. (in revision)

Leasure, D.R., and **D.D. Magoulick**. 2019. A new Bayesian assessment of hydrologic alteration. (in revision for Ecological Applications)

Graham, N.E., and **D.D. Magoulick.** 2019. Effects of invasive species sources population and drought on crayfish populations and ecosystem structure and function. (in revision)

Flinders, J.A., A. Clement, and **D.D. Magoulick**. 2019. Effects of prey and tissue type on δ13C and δ15N discrimination and turnover rates of rainbow trout. (in revision)

Bruckerhoff, L.A., D.R. Leasure, and **D.D. Magoulick.** 2019. Trait Composition of fish assemblages across hydrologic regimes (in prep)

Magoulick, D.D., and D.R. Leasure. 2019. Flow alteration of intermittent and perennial streams in the Interior Highlands, USA. (in prep)

Sayre, K.R., P.R. Lind, M.A. Evans-White, **D.D. Magoulick**, and T. Scott. 2019. Effect of macro grazers on periphyton in Ozark streams. (in prep)

Graham, N.E., and **D.D. Magoulick**. 2019. Assessing spatial variation in morphology and traits related to invasiveness in an introduced crayfish species. (in prep)

Longing, S.D., T. Hayashi, and **D.D. Magoulick**. 2019. Observations of aquatic beetle flight, responses to microhabitat drying, and morphology of ecologically-segrated, endemic congeners. (in prep)

Longing, S.D., J. Flannery, D.R. Leasure, and **D.D. Magoulick**. 2019. Multi-habitat associations and predictive habitat modelling of *Heterosternuta sulphuria* (Coleoptera: Dytiscidae) in Ozark streams. (in prep)

Wynne, K.C., J. Clark, and **D.D. Magoulick**. 2019. Morphological traits related to the invasiveness of two subspecies of *Faxonius neglectus.* (in prep)

Clark, J., K.C. Wynne, and **D.D. Magoulick**. 2019. Predicting probability of occurrence and factors affecting distribution and abundance of an invasive crayfish. (in prep)

Magoulick, D.D. 2019. Predation and drought effects on native and invasive crayfish species growth and survival. (in prep).

Koenigbauer, S.T., C.R. Middaugh, A.N. Yarra, N.E. Graham, and **D.D. Magoulick**. 2019. Lotic habitat influences on predation of crayfish. (in revision)

Fetzner, Jr., J.W., R.J.DieStefano, **D.D. Magoulick** and B.K. Wagner. 2019. Mitochondrial phylogeography of the imperiled Coldwater Crayfish *Faxonius eupunctus* (Decapoda: Cambaridae): High levels of divergence and its taxonomic and conservation implications. (in prep)

Fetzner, Jr., J.W., R.J. DiStefano, **D.D. Magoulick**, and B.K. Wagner. 2019. Mitochondrial phylogeography of the imperiled Mammoth Spring Crayfish *Faxonius marchandi* (Decapoda: Cambaridae): Taxonomic and conservation implications. (in prep)

Flinders, J.A. and **D.D. Magoulick**. 2019. Assimilation efficiency of rainbow trout. (in revision)

Magoulick, D.D., and **R.J. Fournier**. 2019. Factors influencing movement of a stream fish assemblage: Spatial and temporal variation. (in prep)

DiStefano, R.J., and **D.D. Magoulick**. 2019. Validation of crayfish species distribution model. (in prep)

Scott, M.K., and **D.D. Magoulick.** 2019. Land use raelationships with flow regime and fish assemblage structure: A species and trait-based approach. (in revision)

Bare, C.M. and **D.D. Magoulick**. 2019. Smallmouth bass environmental history and movement in a freshwater lotic system determined by otolith microchemistry. (in revision)

Flinders, C.A., ad **D.D. Magoulick.** 2019. Partitioning variance within a spatial scale hierarchy: relative contributions to lotic crayfish community structure. (in revision)

Leasure, D.R., and **D.D. Magoulick**. 2019. Predicting climate change effects on flow metrics and community structure in Interior Highland streams. (in prep)

Magoulick, D.D., J.P. Ludlam and G.R. Huxel. 2019. Effects of disturbance, predation and omnivory in structuring a stream food web. (in prep)

Magoulick, D.D. 2019. Resistance and resilience of fishes to flow disturbance. (in prep)

Bare, C.M., and **D.D. Magoulick**. 2019. Movement, Habitat Use, and Survival of Smallmouth Bass in Tributary and Mainstem Ozark Streams. (in prep)

Graham, C., and **D.D. Magoulick.** 2019. Relationship between larval fish drift and discharge during a flood event in an Ozark stream. (in prep)

Cushing, A.W., and **D.D. Magoulick**. 2019. Effects of catch-and-release areas on movement and survival of rainbow trout in Arkansas tailwaters. (in prep).

Technical Publications:

DeGregorio, B.A. J.H. Sperry, and B.A. Kingsbury. 2019. Transferring "translocation science" to wildlife conservation on DoD installations: demonstration of environmental enrichment and soft release technology. Report ID: RC201616. DoD SERDP-ESTCP program.

Yarra, A.N., J.W. Fetzner, Jr. and **D.D. Magoulick**. 2018. Invasive species effects, population status and population genetics of crayfish species of greatest conservation need (*Faxonius marchandi, Faxonius eupunctus,* and *Cambarus hubbsi)* in the Ozark Highlands of Arkansas and Missouri. Final Report prepared for the State Wildlife Grant program and the Arkansas Gram and Fish Commission, Little Rock, Arkansas. SWG-T52.

Papers Presented:

Bayer, L.M., **R.J. Fournier**, and **D.D. Magoulick.** July 2018. Modelling effects of crayfish invasion and drought on crayfish population dynamics of generalized crayfish life history strategies. International Association of Astacology, Pittsburgh, PA.

Bayer, L.M., **R.J. Fournier**, and **D.D. Magoulick.** July 2018. Modelling effects of crayfish invasion and drought on crayfish population dynamics of generalized crayfish life history strategies. National Conference for Undergraduate Women in Mathematics, Linclon, NE.

Bayer, L.M., **R.J. Fournier**, and **D.D. Magoulick.** July 2018. Modelling effects of crayfish invasion and drought on crayfish population dynamics of generalized crayfish life history strategies. Joint Mathematics Meetings, San Diego, CA.

DeGregorio, B.A., J.H. Sperry, J.D. Willson, and P.J. Wolff. December 2018. Innovative methods of surveying for imperiled species on DoD installations. DOD SERDP-ESTCP Symposium.

Tetzlaff, S.J., E. Astrada, **B.A. DeGregorio**, and J.H. Sperry. July 2019. 3D Printed Models Aid in Identifying Factors Affecting Predation Risk for Juvenile Box Turtles. Joint Meeting of Ichthyologists and Herpetologists, Snowbird, UT.

Ingram, L.A., H.L. Helks, B. Tate, and Jordan F. October 2019. Effects of Riparian Cannopy cover on the Imperiled Okaloosa Darter. 149th Meeting of American Fisheries Society, Reno, NV.

Magoulick, D.D., and **J.T. Fox**. 2019. Predicting hydrologic disturbance of streams using species occurrence data. Symposium on *Habitat and Distribution Modeling Across Terrains and Disciplines: Addressing Common Challenges in Fisheries and Wildlife,* American Fisheries Society/The Wildlife Society Joint Conference, Reno, NV.

Savitsky, G. and **D.D. Magoulick**. 2019. Headwater Stream Algal Response to Nutrient Increase Across Flow Regimes. Arkansas Water Resources Conference, Fayetteville, AR.

Magoulick, D.D. and **J.T. Fox**. 2019. Predicting hydrologic disturbance of streams using species occurrence data. Society for Freshwater Science, Salt Lake City, UT.

Ruther-Lassiter, E.V., J.H. Sperry, and **B.A. DeGregorio**. October 2019. Regional Trends in Spotted Turtle (Clemmys guttata) Movement Patterns. The Wildlife Society, Reno, NV.

Ruther-Lassiter, E.V., J.H. Sperry, and **B.A. DeGregorio**. July 2019. Regional Trends in Spotted Turtle movement. Joint Meeting of Ichthyologists and Herpetologists, Snowbird, UT.

Ruther-Lassiter, E.V., **B.A. DeGregorio**, and J.H. Sperry. October 2018. Spotted turtle (Clemmys guttata) movement and occupancy dynamics across an urbanized landscape. The Wildlife Society Annual Conference.

Ruther-Lassiter, E.V., **B.A. DeGregorio**, and J.H. Sperry. August 2018. Spotted turtle (Clemmys guttata) movement and occupancy dynamics across an urbanized landscape. Ecological Society of America Annual Conference.

Maner, A., **K.A. Smith,** and **D.D. Magoulick**. 2018. The Effect of Flow Regime on Rainbow Darter (*Etheostoma caeruleum)* Body Condition in the Ozark Highlands. Arkansas Water Resources Conference, Fayetteville, AR.

Gott, C., **K.A. Smith,** and **D.D. Magoulick**. 2018. Examining Body Condition of Ringed Crayfish *Faxonius neglectus* Across Streams. Arkansas Water Resources Conferences, Fayetteville. AR.

Posters Presented:

Bayer L.M., **R.J. Fournier**, and **D.D. Magoulick**. February 2019. Modeling effects of crayfish invasion and drought on population dynamics of generalized crayfish life history strategies. Emerging Researchers National (ERN) Conference in STEM, Washington D.C.

Tetzlaff, S.J., B.A. Kingsbury, J.H. Sperry, and **B.A. DeGregorio**. December 2018. Effects of environment on translocation success for eastern box turtles. SERD-ESTCP Annual Symposium, DoD. Washington, D.C.

DeGregorio B.A., Wolff, P.J., and A. Rice. December 2018. Demonstration of Subsurface Passive Acoustic Monitoring (SPAM) to Survey for Underwater-Calling Frogs. SERDP-ESTCP Symposium, DoD. Washington, D.C.

DeGregorio B.A., S.J. Tetzlaff, B.A. Kingsbury, and J.H. Sperry. October 2019. Does Environmental Enrichment Improve Head Starting for Easter Box Turtles?

Tetzlaff, S.J., E. Astrada, **B.A. DeGregorio**, and J.H. Sperry. 3D Printed Models Aid in Identifying Factors Affecting Predation Risk for Juvenile Box Turtles.

B.A. DeGregorio, Wolff, P.J., and J.D. Willson. December 2018. Demonstrations of a novel method for estimating the density of secretive snakes. SERDP-ESTCP Symposium, DoD. Washington, D.C.

Ingram, L.A., and **D.D. Magoulick.** September 2019. Effects of Flow Regime on Fish Assemblage Structure. 149th Meeting of the American Fisheries Society. Reno, NV.

Ruther-Lassiter, E.V., **B.A. DeGregorio**, and J.H. Sperry. November 2019. Why did the turtle cross the wetland? Spotted, Blanding's, and Wood Turtle Symposium, Berkeley springs, WV.

COMMITTEES/TASK FORCES/RECOVERY TEAMS:

Bayer, L.M. – Pi Mu Epsilon (PME) National Mathematics Honor Society

Bayer, L.M. – Member – American Fisheries Society. 2019-present.

DeGregorio, B.A. – Faculty Advisor – Student Chapter, The Wildlife Society – University of Arkansas. 2019-present.

DeGregorio, B.A. – Graduate Student Advisory Committee – Pooja Panwar, M.S. Department of Biological Sciences, University of Arkansas. 2019-present.

DeGregorio, B.A. – Graduate Student Advisory Committee – Anant Deshwal, Ph.D. Department of Biological Sciences, University of Arkansas. 2019-present.

DeGregorio, B.A. – Graduate Student Advisory Committee – Sasha Tetzlaff, Ph.D. Department of Natural Resources, University of Illinois. 2015-present.

Fournier, R.J. – Member – Biology Graduate Student Association, University of Arkansas. 2015-present.

Fournier, R.J. – Member – American Fisheries Society, University of Arkansas Student Chapter. 2015-present.

Fox, J.T. – Member – Ecological Society of America – 2014-present.

Fox, J.T. – Member – American Association for the Advancement of Science – 2009-present.

Fox, J.T. – Member – Society for Conservation Biology – 2008-present.

Fox, J.T. – Member – American Fisheries Society – 2008-present.
Fox, J.T. – Reviewer – Science for the Total Environment – 2018-present.
Fox, J.T. – Reviewer – Freshwater Biology – 2017-present.
Ingram, L.A. – President – University of Arkansas Student Chapter – American Fisheries Society. 2019.
Ingram, L.A. – Member – American Fisheries Society. 2019-present.
Ingram, L.A. – Member – American Fisheries Society – Education Section of the American Fisheries Society. 2019.
Ingram, L.A. – Member – American Fisheries Society – Student and Early Career Professionals Section of American Fisheries Society. 2019.
Ingram, L.A. – Member – University of Arkansas Student Chapter – American Fisheries Society. 2019-present.
Ingram, L.A. – Member – University of Louisiana – American Fisheries Society. 2018-present.
Ingram, L.A. – Member – University of Arkansas Student Subunit of American Fisheries Society. 2018-present.
Ingram, L.A. – Member – University of Arkansas Association of Women in Science. 2019-present.
Ingram, L.A. – Member – University of Arkansas Biological Sciences Graduate Student Association. 2018-present.
Krementz, D.G. – Graduate Student Advisory Committee – Maxwell Carnes-Mason, M.S., Department of Biological Sciences, University of Arkansas. 2016-present.
Krementz, D.G. – Graduate Student Advisory Committee – Alexis Hilario, Ph.D., Department of Biological Sciences, University of Arkansas. 2017-present.
Krementz, D.G. – Member – The Wildlife Society. 1998-present.
Krementz, D.G. – Member – Midwest Marshbird Monitoring Group. 2012- present.
Krementz, D.G. – Associate Editor, Southeastern Naturalist Journal. 2016-present.
Krementz, D.G. – Member – Lower Mississippi Alluvial Valley Joint Venture Waterbird Science Team. 2010-present.
Lassiter, E.V. – Member – Society for the Study of Amphibians and Reptiles – National 201?-present.
Lassiter, E.V. – Member – The Wildlife Society – National. 201?-present.
Lassiter, E.V. – Member – The Wildlife Society, University of Arkansas State Chapter. 2019.
Lassiter, E.V. – Member – The American Fisheries Society, University of Arkansas State Chapter. 2019.
Magoulick, D.D. – Member – North American Benthological Society. 1986–present.
Magoulick, D.D. – Member – American Fisheries Society. 1990–present.
Magoulick, D.D. – Member – Sigma Xi Scientific Research Society. 1984-present.
Magoulick, D.D. – Member – Project Kaleidoscope Faculty for the 21st Century. 1999-present.
Magoulick, D.D. – Graduate Student Advisory Committee – Zachory Tipton, Ph.D. Department of Biological Sciences, University of Arkansas. 2019 – present.
Magoulick, D.D. – Graduate Student Advisory Committee – Samuel Dais, Ph.D. Department of Biological Sciences, University of Arkansas. 2019 – present.
Magoulick, D.D. – Graduate Student Advisory Committee – Brianna Hillebrand, M.S. Department of Biological Sciences, University of Arkansas. 2019 – present.
Magoulick, D.D. – Graduate Student Advisory Committee – Alexandria Peterson, Ph.D. Department of Biological Sciences, University of Arkansas. 2018 – present.
Magoulick, D.D. – Graduate Student Advisory Committee – Maggie Hoang, M.S. Department of Biological Sciences, University of Arkansas. 2018 – present.
Magoulick, D.D. – Graduate Student Advisory Committee – Chelsea Kross, Ph.D. Department of Biological Sciences, University of Arkansas. 2015 – present.
Magoulick, D.D. – Graduate Student Advisory Committee – Allyn Dodd, Ph.D. Department of Biological Sciences, University of Arkansas. 2015 – 2018.

Magoulick, D.D. – Graduate Student Advisory Committee – Kayla Sayre, M.S. Department of Biological Sciences, University of Arkansas. 2015 – 2018.

Magoulick, D.D. – Graduate Student Advisory Committee – Brooke Howard-Parker, M.S. Department of Biological Sciences, University of Arkansas. 2015 – present.

Magoulick, D.D. – Graduate Student Advisory Committee – Kyler Hecke, M.S. Department of Biological Sciences, University of Arkansas. 2014 – 2017.

Magoulick, D.D. – Graduate Student Advisory Committee – Jacqueline Guzy, Ph.D. Department of Biological Sciences, University of Arkansas. 2014 – 2019.

Magoulick, D.D. – Graduate Student Advisory Committee – Melissa Welch, M.S. Department of Biological Sciences, University of Arkansas. 2013 – present.

Magoulick, D.D. – Graduate Student Advisory Committee – Whitney Nelson, Ph.D. Department of Biological Sciences, University of Arkansas. 2013 – 2018.

Magoulick, D.D. – Graduate Student Advisory Committee – Kapil Khadka, Ph.D. Department of Biological Sciences, University of Arkansas. 2012 – 2017.

Magoulick, D.D. – External Reviewer for Dissertation and Thesis – Griffith University, Brisbane, Australia. 2019.

Magoulick, D.D. – Review Committees and Panels – U.S. Geological Survey, Research Grade Evaluation Panel. 2018.

Magoulick, D.D. – Chair, Unit Leader and Assistant Professor, Arkansas Cooperative Fish and Wildlife Research Unit, Department of Biological Sciences, University of Arkansas. 2017 – 2018.

Magoulick, D.D. – Yellowcheek Darter Recovery Plan Team – U.S. Fish and Wildlife Services. 2013-present.

Magoulick, D.D. – Crayfish Species Status Assessment team (7 species) – U.S. Fish and Wildlife Services. 2017-present.

Magoulick, D.D. – Adaptation Science Management Team for Gulf Coastal Plain Ozarks Landscape Conservation Cooperative – U.S. Fish and Wildlife Services. 2012 – 2018.

Magoulick, D.D. – Fish Taxa Team – Arkansas Wildlife Action Plan. 2010-present.

Magoulick, D.D. – Crayfish Taxa Team – Arkansas Wildlife Action Plan. 2010-presnt.

Magoulick, D.D. – Aquatic Habitat Team – Arkansas Wildlife Action Plan. 2010-present.

Magoulick, D.D. – International Union for Conservation of Nature (IUCN) Australia Freshwater Fish Conservation Work Group. 2009-present.

Magoulick, D.D. – U.S. Fish and Wildlife Service Aquatic Nuisance Species Task Force. 2007-present.

Magoulick, D.D. – Arkansas Invasive Species Task Force. 2007-present.

Magoulick, D.D. – Arkansas Zebra Mussel Task Force. 1997-present.

Magoulick, D.D. – Regional Science Fair Judge. 2008-present.

Smith, K.A. – Member – Biology Graduate Student Association, University of Arkansas. 2017-present.

Smith, K.A. – Member – The Wildlife Society, University of Arkansas Student Chapter. 2017- present.

Smith, K.A. – Member – American Fisheries Society, University of Arkansas Student Chapter. 2017-present.

Smith, K.A. – Treasurer – American Fisheries Society, University of Arkansas Student Chapter. 2017-2018.

Smith, K.A. – President – American Fisheries Society, University of Arkansas Student Chapter. 2018-2019.

Sorensen, S.F. – Member – American Fisheries Society, University of Arkansas Student Subunit. 2018-present.

Sorensen, S.F. – Secretary – American Fisheries Society, University of Arkansas Student Subunit. 2018-2019.

Sorensen, S.F.- Treasurer, American Fisheries Society, University of Arkansas Student Subunit. 2019-present.
Veon, J.T. – Member – Biology Graduate Student Association, University of Arkansas. 2019.
Veon, J.T. – Member – The Wildlife Society Student Chapter, University of Arkansas. 2019.
Veon, J.T. – Member – Ducks Unlimited. 2019.
Veon, J.T. – Member – Delta Waterfowl. 2019.

TECHNICAL ASSISTANCE:

Training Offered:

Magoulick, D.D. – Experimental Design for Biologists. Presented as a webinar to Arkansas Game and Fish Commission – June 11, 2018.

Training Received:

Bayer, L.M. – Adult and pediatric First Aid/CPR/AED Training – American Red Cross – 2017.
Bayer, L.M. – Adult and Pediatric First Aid/CPR/AED – American Red Cross – 2019.
Bayer, L.M. – Envorimental Health & Safety:Hazardous Waste & Communication – University of Arkansas – 2017.
Bayer, L.M. – Dr. Dan Magoulick – Over the water Safety Training – U.S. Department of Interior – 2018.
Bayer, L.M. – U.S. Geological Survey – Electrofishing Safety Training – U.S. Department of Interior – 2017.
DeGregorio, B.A. – U.S. Geological Survey – Supervisory Training, U.S. Department of Interior – 2019.
DeGregorio, B.A. – U.S. Geological Survey – Intro to Industrial Hygiene – U.S. Department of Interior – 2019.
DeGregorio, B.A. – U.S. Geological Survey – Bloodborne Pathogens – U.S. Department of Interior – 2019.
DeGregorio, B.A. – U.S. Geological Survey – Basic Laboratory Training – U.S. Department of Interior – 2019.
DeGregorio, B.A. – U.S. Geological Survey – Safety 1300 – U.S. Department of Interior – 2019.
DeGregorio, B.A. – U.S. Geological Survey – Safety and Occupational Health Program Overview – U.S. Department of Interior – 2019.
DeGregorio, B.A. – U.S. Geological Survey – Authorities, Roles, and Responsibilities – U.S. Department of Interior – 2019.
DeGregorio, B.A. – U.S. Geological Survey – Anti-harassment training – U.S. Department of Interior - 2019.
DeGregorio, B.A. – U.S. Geological Survey – Defensive Driving – National Security Council – 2019.
DeGregorio, B.A. – Adult first aid/CPR/AED – American Red Cross – 2019.
DeGregorio, B.A. – GSA SmartPay Travel Card Training – U.S. Department of Interior – 2019.
DeGregorio, B.A. – GSA SmartPay Purchase Card Training – U.S. Department of Interior – 2019.
DeGregorio, B.A. – The Humane Card and Use of Laboratory Animals – University of Arkansas – 2019.
DeGregorio, B.A. – U.S. Geological Survey Supervisor Training – U.S. Department of Interior – 2019.
Ingram, L.A. – Adult First Aid/CPR/AED – American Red Cross – 2019.
Ingram, L.A. – U.S. Geological Survey – Defensive Driving – U.S. Department of Interior – 2019.
Ingram, L.A. – U.S. Geological Survey – FWS Electrofishing Principles and Techniques – U.S. Department of Interior – 2019.

Ingram, L.A. – U.S. Geological Survey – FWS Electrofishing Safety – U.S. Department of Interior – 2019.

Ingram, L.A. – U.S. Geological Survey – Fundamental Science Practices, Release of U.S. Geological Survey Scientific Data – U.S. Department of Interior – 2019.

Ingram, L.A. – U.S. Geological Survey – Industrial Hygiene Program Requirements – U.S. Department of Interior – 2019.

Ingram, L.A. – U.S. Geological Survey – Safety and Occupational Health Program Overview – U.S. Department of Interior – 2019.

Ingram, L.A. – U.S. Geological Survey – Safety Program Requirements – U.S. Department of Interior – 2019.

Ingram, L.A. – U.S. Geological Survey – Authorities, Roles, and Responsibilities – U.S. Department of Interior – 2019.

Ingram, L.A. – U.S. Geological Survey – Safety and Occupational Health Overview – U.S. Department of Interior – 2019.

Ingram, L.A. – Louisiana Department of Wildlife and Fisheries – Boater Education Certificate & License – 2018.

Lassiter, E. – U.S. Geological Survey – NSC Defensive Driving Course 10th Edition R3 – U.S. Department of Interior – 2019.

Lassiter, E. – Adult and Pediatric First Aid/CPR/AED – American Red Cross – 2019.

Massey, A. – Adult First Aid/CPR/AED – American Red Cross – 2019.

Massey, A. – U.S. Geological Survey – Defensive Driving – U.S. Department of Interior – 2019.

Massey, A. – U.S. Geological Survey – Fundamental Science Practices, Release of U.S. Geological Survey Scientific Data – U.S. Department of Interior – 2019.

Massey, A. – U.S. Geological Survey – Safety:1304 USGS Industrial Hygiene Program Requirements – U.S. Department of Interior – 2019.

Massey, A. – U.S. Geological Survey – Safety and Occupational Health Program Overview – U.S. Department of Interior – 2019.

Massey, A. – U.S. Geological Survey – Safety: 1300 USGS Safety Program Requirements – U.S. Department of Interior – 2019.

Massey, A. – U.S. Geological Survey – Safety: 1339 USGS Safety Program Requirement for Administrative Personnel – U.S. Department of Interior – 2019.

Massey, A. – U.S. Geological Survey – Safety: 1338 USGS Authorities, Roles, and Responsibilities – U.S. Department of Interior – 2019.

Massey, A. – U.S. Geological Survey – Safety and Occupational Health Overview – U.S. Department of Interior – 2019.

Massey, A. – Collaborative Institutional Training Initiative: Working with the IACUC (Curriculum Group & Course Learner Group) & 1- Basic Course (Stage) – University of Arkansas – 2019.

Massey, A. – Collaborative Institutional Training Initiative: Wildlife Research (Curriculum Group & Course Learner Group) & 1- Lab Animal Research (Stage) – University of Arkansas – 2019.

Ruther-Lassiter, E.V. – Adult First Aid/CPR/AED – American Red Cross – 2019

Ruther-Lassiter, E.V. – U.S. Geological Survey – NSC Defensive Driving Course 10th Edition R3 – U.S. Department of Interior – 2019.

Ruther-Lassiter, E.V. – U.S. Geological Survey – Safety Program Requirements – U.S. Department of Interior – 2019.

Ruther-Lassiter, E.V. – U.S. Geological Survey – Industrial Hygiene Program Requirements – U.S. Department of Interior – 2019.

Ruther-Lassiter, E.V. – U.S. Geological Survey – Safety and Occupational Health Program Overview – U.S. Department of Interior – 2019.

Ruther-Lassiter, E.V. – U.S. Geological Survey – Authorities, Roles, and Responsibilities – U.S. Department of Interior – 2019.

Ruther-Lassiter, E.V. – U.S. Geological Survey – Bloodborne Pathogens – U.S. Department of Interior – 2019.

Ruther-Lassiter, E.V. – University of Arkansas – Working with the IACUC – 2019.

Ruther-Lassiter, E.V. – University of Arkansas – Wildlife Research – 2019.

Showalter, H.G. – Adult First Aid/CPR/AED – American Red Cross – 2019.

Showalter, H.G. – U.S. Geological Survey – Safety: 1300 USGS Safety Program Requirements – U.S. Department of the Interior – 2019.

Showalter, H.G. – U.S. Geological Survey – Safety:1304 USGS Industrial hygiene Program Requirements – U.S. Department of Interior – 2019.

Showalter, H.G. – U.S. Geological Survey – Safety:1315 USGS Safety and Occupational Health Program Overview – U.S. Department of Interior – 2019.

Showalter, H.G. – U.S. Geological Survey -Safety:1338 USGS Authorities, Roles, and Responsibilities – U.S. Department of Interior – 2019.

Showalter, H.G. – U.S. Geological Survey – Safety:1553 USGS Bloodborne Pathogens – U.S. Department of Interior – 2019.

Smith, K.A. – U.S. Geological Survey – Principles and Techniques of Electrofishing – U.S. Department of Interior – 2018.

Smith, K.A. – U.S. Geological Survey – Safety: 1300 USGS Safety Program Requirements – U.S. Department of Interior – 2018.

Smith, K.A. – U.S. Geological Survey – NSC Defensive Driving Course 9th Edition – U.S. Department of Interior – 2018.

Smith, K.A. – Adult and Pediatric First Aid/CPR/AED – American Red Cross – 2018.

Smith, K.A. – U.S. Geological Survey – Safety:1428 USGS Introduction to Industrial Hygiene – U.S. Department of Interior – 2017.

Smith, K.A. – Safety: DOI Safety and Occupational Health Overview – U.S. Department of Interior – 2017.

Smith, K.A. – Dr. Dan Magoulick – Over the water Safety Training – U.S. Department of Interior – 2019.

Sorensen, S.F. – Adult First Aid/CPR/AED – American Red Cross – 2019.

Sorensen, S.F. – U.S. Geological Survey – Defensive Driving – U.S. Department of Interior – 2019.

Sorensen, S.F. – U.S. Geological Survey – FWS Electrofishing Safety – U.S. Department of Interior – 2019.

Veon, J.T. – Collaborative Institutions Training Initiative – Working with IACUC (Curriculum Group & Course Leaner), & 1-Basic Course Stage, University of Arkansas – 2019.

Veon, J.T. – Collaborative Institutions Training Initiative – Wildlife Research (Curriculum Group & Course Learner Group), & 1 Lab Animal Research Stage, University of Arkansas – 2019.

Veon, J.T. – U.S. Geological Survey – Safety: 1338 USGS Authorities, Roles, and Responsibilities – U.S. Department of Interior – 2019.

Veon, J.T. – U.S. Geological Survey – Safety: 1553 Bloodborne Pathogens – U.S. Department of Interior – 2019.

Veon, J.T. – U.S. Geological Survey – Safety: 1315 USGS Safety and Occupational Health Program Overview – U.S. Department of Interior – 2019.

Veon, J.T. – U.S. Geological Survey – Safety: 1304 USGS Industrial hygiene Program Requirements – U.S. Department of Interior – 2019.

Veon, J.T. – U.S. Geological Survey – Safety: 1300 USGS Safety Program Requirements – U.S. Department of Interior – 2019.

Veon, J.T. – U.S. Geological Survey – NSC Defensive Driving Course 10th Edition R3 – U.S. Department of Interior – 2019.

Outreach:

Bayer, L.M. – Volunteer – Stroll the Atols Marshallese Event – American Fisheries Society – July 2019.
Ingram, L.A. – Volunteer – Stroll the Atols Marshallese Event – American Fisheries Society – July 2019.
Sorensen, S.F. – Volunteer – Stroll the Atols Marshallese Event – American Fisheries Society – July 2019.