ARKANSAS COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

ANNUAL REPORT 2013

Arkansas Cooperative Fish and Wildlife Research Unit
Department of Biological Sciences – SCEN 523
University Of Arkansas
Fayetteville, AR 72701

Arkansas Cooperative
Fish & Wildlife Research Unit

The Unit is a Cooperative Program of the:

US 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 40 coop units across the country associated with Land Grant universities, state game and fish 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 25 years, the Arkansas Coop Unit has become an active part of state and federal research efforts in Arkansas and across the Nation. By the end of our twenty-second year, Arkansas Coop Unit will have initiated many research projects with Arkansas Game and Fish Commission, U.S. Fish and Wildlife Services, U.S. Geological Survey, National Park Services, and other federal, state, and private organizations as sponsors. These projects have funded the research of 55 MS and 9 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 Coop Unit leaders and students have published 147 scientific and technical publications listing the unit and our cooperators in byline and acknowledgements, and another six publications have been accepted or submitted for publication. Unit leaders and Assistant unit leaders have taught many classes in fisheries and wildlife. Finally, including base funds and contracts, Arkansas Coop Unit has brought more than $17,802,689 directly into the community.

During the past quarter of a century, Arkansas Coop Unit has gone through a number of changes. We have changed our federal cooperator from the U. S. Fish and Wildlife Services to National Biological Survey to National Biological Service, and we now reside within the U.S. Geological Survey. Our University department changed from Zoology to Biological Sciences and then incorporating the departments of Botany and Microbiology. We have seen ten Departmental Chairs (Amlaner, Geren, Kaplan, Talburt, Rhoads, Roufa, Davis, Smith, Spiegel and Beaupre), two Unit Leaders (Johnson and Krementz), six Assistant Unit Leaders (Annette, Martin, Griffith, Kwak, Thompson, and Magoulick), four Administrative assistants (Kimbrough, Koldjeski, Parker, and Moler), three Post-Doctoral Assistants (LeMar, Lehnen, and Longing), 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 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 for advancement in broad areas of natural resource management and to serve as future leaders of resource management in the State of Arkansas, region and country. Educational programs of the 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 to Back, Right to Left: E. Ronke, C. Sebright, L. Bruckerhoff, K. Sayre, A. Fournier, D. Magoulick, D. Lynch, D. Krementz, C. Reddin, R. Fournier, D. Leasure, J. Herbert, C. Middaugh, D. Moler, & T. Pittman

PERSONNEL AND COOPERATORS

COORDINATING COMMITTEE MEMBERS

US GEOLOGICAL SURVEY

Dr. Kevin Whalen
US Geological Survey
12201 Sunrise Valley Drive
Reston, VA 20192
Telephone: (703) 269-7711
Fax: (703) 648-4269
Email: kwhalen@usgs.gov

AR GAME AND FISH COMMISSION

Mike Knoedl, Director
AR Game and Fish Commission
2 Natural Resources Drive
Little Rock, AR 72205
Telephone: (501) 223-6305
Fax: (501) 223-6448
Email: mwknoedl@agfc.state.ar.us

WILDLIFE MANAGEMENT INSTITUTE

Steve Williams, President
Wildlife Management Institute
1440 Upper Bermudian Road
Gardners, PA 17324
Telephone: (717) 677-4480
Email: swilliams@wildlifemgt.org

US FISH & WILDIFE SERVICES

Emily Jo Williams, Chief
Migratory Bird Program
1875 Century Blvd, Suite 240
Atlanta, GA 30345
Telephone: (404) 679-7206
Fax: (404) 679-4006
Email: Emily_Jo_Williams@fws.gov

UNIVERSITY OF ARKANSAS

Dr. Jim Rankin, Vice Provost for Research
& Economic Development
ADMN 205
University of Arkansas
Fayetteville, AR 72701
Telephone: (479) 575-2470
Fax: (479) 575-3846
Email: rankinj@uark.edu

Dr. Fred Spiegel
Department of Biological Sciences
University of Arkansas
SCEN 601
Fayetteville, AR 72701
Telephone: (479) 575-4248
Fax: (479) 575-4010
Email: fspiegel@uark.edu

UNIT STAFF

UNIT LEADER

Dr. David G. Krementz
Telephone: (479) 575-7560
Fax: (479) 575-3330
Email: krementz@uark.edu

ASSIST. UNIT LEADER, FISHERIES

Dr. Daniel D. Magoulick
Telephone: (479) 575-5449
Fax: (479) 575-3330
Email: danmag@uark.edu

OFFICE MANAGER

Diane Moler
Telephone: (479) 575-6709
Fax: (479) 575-3330
Email: dmoler@uark.edu

CURRENT GRADUATE STUDENTS

Lindsey Bruckerhoff (M.S., Fisheries – Magoulick)
Phillip Costello (M.S., Fisheries – Magoulick)
Auriel Fournier (PhD., Wildlife – Krementz)
Robert Fournier (PhD., Fisheries – Magoulick)
John Herbert (M.S., Wildlife – Krementz)
Doug Leasure (PhD., Fisheries – Magoulick)
Dustin Lynch (Ph.D., Fisheries – Magoulick)
Christopher Middaugh (M.S., Fisheries – Magoulick)
Tyler Pittman (Ph.D., Wildlife – Krementz)
Christopher Reddin (M.S., Wildlife – Krementz)
M. Eliese Ronke (M.S., Wildlife – Krementz)
Cari Sebright (M.S., Wildlife – Krementz)

HOURLY TECHNICIANS

Ms. Kimberlian L. Beasley – General help
Mr. Thomas C. Boersig III – E-Flow
Mr. Matthew E. Boone – Rails
Ms. Leslie C. Brinkman – Rails
Ms. Lindsey A. Bruckerhoff – E-Flow
Mr. Alan J. Edmondson – E-Flow & General help
Mr. Jonathan H. Fournier – General
Ms. Alexandra P. Hooks – E-Flow
Mr. Justin A. Lehman – Rails
Ms. Brianna K. Olsen – E-Flow

Ms. Kayla R. Sayre – E-Flow
Ms. Charity E. Woolsey – Turkey

VOLUNTEERS

Mr. J. Alex Baecher – E-Flow
Ms. Brooke Beckwith – E-Flow
Mr. Ross Suiery – E-Flow
Ms. Kaitlyn S. Werner – E-Flow
Ms. Shannon Wiley – E-Flow

RESEARCH AND FACULTY COLLABORATORS

Dr. Tom Cooper – U.S. Fish and Wildlife Service
Mr. Robert J. DiStefano – Missouri Department of Conservation
Mr. Jacob Westoff – Ph.D. Student, University of Missouri
Mr. Jeffrey W. Quinn – Arkansas Game and Fish Commission
Dr. Sarah Lehnen – Consultant
Dr. John Jackson – Department of Biological Sciences, Arkansas Tech University
Mr. Josh Duzan – Biohydrologist, The Nature Conservancy
Dr. Jim Petersen – Hydrologist Study Unit Chief, Ozark Plateaus Study Unit USGS Arkansas Water Science Center
Mr. Richard Crossett – U.S. Fish and Wildlife Service
Ms. Rhea Whalen – U.S. Forest Service
Mr. Kevin Lynch – Arkansas Game and Fish Commission
Mr. Benny Bowers – Arkansas Game and Fish Commission
Mr. Luke Naylor – Arkansas Game and Fish Commission
Mr. Houston Havens – Mississippi Department of Wildlife, Fisheries, and Parks
Dr. Andy Radaeke – Missouri Department of Conservation
Dr. Doreen Mengel – Missouri Department of Conservation
Mr. Nolan Moore – National Park Service
Mr. Kevin Eads – National Park Service
Mr. Kwasi Asante – University of Arkansas
Dr. Marlis Douglas – University of Arkansas
Dr. Michael Douglas – University of Arkansas
Dr. Jack Cothern – University of Arkansas

COMPLETED FISHERIES PROJECTS

Spavinaw Creek

Orconectes eupunctus

The Imperiled Coldwater Crayfish (*Orconectes eupunctus*) in the Black River Drainage of Missouri and Arkansas: Factors Affecting Distribution and Abundance

Funding Source:	Missouri Department of Conservation
Project Duration:	July 2010 to May 2013
Principal Investigators:	DANIEL D. MAGOULICK, ROBERT J. DISTEFANO, BRIAN WAGNER, JAMES FETZNER
Graduate Student:	MATTHEW NOLEN (M.S. Student)

Research Objectives:

1. Determine how anthropogenic and natural factors influence the observed distribution and densities of coldwater crayfish populations at multiple spatial scales.
2. Determine the probability of occurrence at any given stream segment within the known distribution of the coldwater crayfish.

Management Implications:

1. Results will allow managers and policy makers to access the importance of various landscape factors to coldwater crayfish.
2. Results will prioritize target streams and stream reaches for conservation and mitigation.
3. Results will identify potential streams and habitats that may contain and continue to support viable coldwater crayfish populations.

Project Summary:

We determined distribution and abundance of populations of coldwater crayfish in the Black River drainage by sampling stream segments. A minimum of four riffle habitats or “sites” (*sensu* MacKenzie et al., 2006) and four run sites were identified within each sampling reach. Riffles and runs were delineated by qualitatively assessing depth and flow rate of the stream. We used a quantitative kicknet method to determine densities of crayfish in each stream segment. Crayfish were dislodged from a randomly chosen 1-m^2 quadrat “sub-sample” area by thoroughly kicking and disturbing the substrate directly upstream of a 1.5 x 1.0-m seine net (3-mm mesh). Replicate kicknet surveys consisting of multiple sub-samples were collected from each riffle or run site. At all sampling reaches, physical characteristics of riffle and run sites were collected. Decision tree analysis (CART) was used to produce probability-based models of *O. eupunctus* occurrence and densities within the Eleven Point River, Spring River, Strawberry River, and lower Black River watersheds, collectively. Both the presence/absence data and the density data served as the two primary response variables for use in CART, while the natural and anthropogenic variables served as explanatory variables.

CART models indicated that *O. eupunctus* presence was positively associated with factors related to stream size, current velocity, and spring discharge. These associations were observed at both a finer, riparian-zone scale and at a larger, local catchment scale. Predictive models correctly classified presence/absence about 98% of the time, but only predicted *O. eupunctus* presence (defined as >0.5 probability) at one unsampled site. Subsequent sampling at that site failed to collect *O. eupunctus*, suggesting that the nine known stream segments containing *O. eupunctus* may represent the entire distribution of the species. Classification trees modeled this rare species well and consistently out-performed random models. Protection of groundwater resources could be considered in conservation plans, as the data indicate that spring flow volume is important to the species.

CURRENT FISHERIES PROJECTS

Fieldwork at South Fork Dry Sac River, MO

Fisheries

Sager Creek, Delaware Co., OK

Ecological Limits of Hydrologic Alteration (ELOHA)

Funding Source:	Arkansas Game and Fish Commission
Project Duration:	September 2010 to July 2014
Principal Investigator:	DANIEL D. MAGOULICK
Graduate Research Assistant:	DOUG R. LEASURE (Ph.D. Student)
Graduate Research Assistant:	DUSTIN T. LYNCH (Ph.D. Student)

Objectives:

1. Classify stream types within Arkansas based on hydrology and geomorphology.
2. Develop regional-level hydrology-biology response relationships for a portion of the Ozarks.

Management Implications:

1. Products of this study, including a statewide river classification system and regional ecological-flow relationships, will form the scientific framework for environmental flow standards and aid studies involving the impacts of global climate change on Arkansas's unique streams and rivers.

Project Summary:

Providing adequate water quantity and quality in streams and rivers is a pressing issue worldwide. It is crucial to determine appropriate environmental flows in streams. This proposal develops the first phase in a multi-year study, involving many partners and a series of steps towards the goal of producing the scientific basis for environmental flow standards within Arkansas. Products of this study, including a statewide river classification system and regional ecological-flow relationships will form the scientific framework for setting environmental flow standards and understanding impacts of global climate change. These ecological-flow response relationships will help determine instream flow needs in the Ozarks and will provide the basis for conservation of at least 9 fish species, 11 crayfish species, and 11 insect species of greatest conservation need, including yellowcheek darter, Arkansas darter, Ozark shiner, longnose darter, silver redhorse, stargazing darter, Ozark chub, and current darter. This work will positively impact many species and ecosystems statewide, those of greatest conservation need and otherwise.

Hydrologic classification has been widely adopted in ecohydrology, often with the goal of characterizing flow-ecology relationships and crafting appropriate water management for individual types of rivers or streams. We have now completed a regional river classification and quantitative descriptions of each natural flow regime for the Ozark-Ouachita Interior Highlands region of Arkansas, Missouri, and Oklahoma. Sixty-four reference streams in relatively undisturbed condition were identified based on the hydrologic disturbance index and by screening GIS databases for potential sources of hydrologic alteration such as dams, water discharge sites, urbanization, and agriculture. Based on daily flow records from 64 reference streams, seven natural flow regimes were identified using mixture model cluster analysis: Groundwater Stable, Groundwater, Groundwater Flashy, Runoff, Runoff Flashy, Intermittent, and Intermittent Flashy. Sets of flow metrics were selected that best quantified nine ecologically important components of each natural flow regime. An uncertainty analysis was performed to avoid selecting metrics strongly affected by measurement uncertainty that can result from short periods of record. Measurement uncertainties (bias, precision, and accuracy) were quantified for 170 commonly used flow metrics produced by the USGS Hydrologic Index Tool. The ranges of variability expected for select flow metrics under natural conditions were quantified for each flow regime to provide a reference for future assessments of hydrologic alteration. A random forest model was used to predict the natural flow regimes of all stream segments in the study area based on climate and catchment characteristics and a map was produced. The geographic distribution of flow regimes suggested distinct eco-hydrological regions that may be useful for conservation planning. This classification system provides a hydrologic foundation for future examination of flow-ecology relationships in the region, including our own study of ecological communities in Groundwater streams of the Springfield Plateau.

Our second field season was conducted from May to August 2013 at 26 sites in the Ozark Highlands of Arkansas, Oklahoma and Missouri. To facilitate biological comparisons, we selected sites belonging to a single flow regime, groundwater streams, within a single ecoregion, the Ozark Highlands, and confined to a single physiographic region, the Springfield Plateau. All 21 sites from the 2012 field season were revisited, along with 5 additional sites. At each site, the reach was stratified by habitat into pools, runs, and riffles (9 habitat units total). Benthic macroinvertebrates, water samples, and detailed stream geomorphology measurements were taken at all sites. Sampling for fish and crayfish was conducted at 17 of the 26 sites. At sites where fish and crayfish were sampled, habitat variables such as wetted width, depth, current velocity, substrate size, and percent canopy cover were recorded along multiple transects for each habitat unit. All sampling was conducted at least 100 m away from bridge abutments, culverts, or any man-made structures that could influence stream habitat. Fish were collected using three-pass backpack electrofishing with block-nets at the upstream and downstream ends of each habitat unit, identified to species and size class, and released in the field. Crayfish were also collected on each pass and identified to species, classed as either juvenile or adult, and released in the field. Benthic macroinvertebrates were collected using two different methods: a richest-targeted habitat (RTH) collection consisting of sampling from three riffles using a 0.25 m^2 quadrat and then combining samples, and a qualitative multi-habitat (QMH) collection consisting of timed collection from all habitat types along the reach. Physical-chemical water quality parameters such as temperature, pH, dissolved oxygen, conductivity, and salinity were recorded on site. A rapid habitat assessment was carried out at each site. 20 sites were located at USGS stream gauges from which long-term hydrological data could be obtained.

Analyses were conducted on the data collected during the 2012 field season. Hydrologic metrics based on magnitude, frequency, duration, and timing of flow were calculated from USGS gauge data, along with a hydrologic disturbance index (HDI) for all sites. Community metrics such as richness, diversity, and trait-based metrics were calculated for fish and crayfish samples. In fish communities, we found significant negative relationships between Simpson's diversity and percent intolerant species and HDI, and a significant positive relationship between number of intolerant species and rapid habitat assessment score. Multiple regression was used to test competing models incorporating 6 variables relating to hydrology, geomorphology and water quality in predicting species richness, diversity, percentage of intolerant species, and total fish density. We found the best model for predicting both Simpson's diversity and percent intolerant individuals to be a single variable model consisting of total phosphorus, while the best model for predicting total density was the full model (flow variability, variability in recession rate, total P, substrate size, current velocity and incision ratio). We found a positive relationship between crayfish density and HDI, potentially driven by the fact that a high proportion of crayfish samples at most sites consisted Ringed Crayfish (*Orconectes neglectus*), a highly tolerant species, which showed positive relationships between components of the HDI, including water withdrawals, road density, and fragmentation.

Orangethroat (AR Coop Unit/Dustin Lynch)

Effects of Drought on Behavior, Growth, and Survival of *Etheostoma spectabile* and *Etheostoma flabellare* in Stream Mesocosms

Funding Source:	Arkansas Game and Fish Commission
Project Duration:	May 2013 to May 2014
Principal Investigator:	DANIEL D. MAGOULICK
Graduate Student:	DUSTIN LYNCH (Ph.D. Student)
Undergraduate Student:	KAITLYN SMITH WERNER (Student)

Objectives:

1. Determine effect of drought on growth, survival and refuge use behavior of orangethroat and fantail darter.

Management Implications:

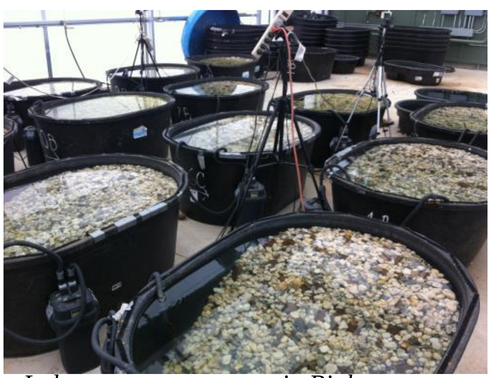
1. This study will provide greater insight into the populations of two Arkansas darter species.
2. With this information, an understanding of anthropogenic effects on the species could be described and monitored closely in conservation efforts as well as water withdrawl.
3. The study will give conservation ecologists and those attempting to preserve darter habitats more knowledge as to what factors improve or degrade these species chance of survival and recolonization.

Project Summary:

Both the orangethroat (*E. spectabile*) and fantail darter (*E. flabellare*) are small, benthic species that cohabitate similar aquatic environments in the northwest Arkansas portion of the Illinois River tributaries (Robinson and Buchanan, 1988). The orangethroat darter prefers small headwater creeks where it is found in shallow riffles of slow to moderate current, and it has also been reported to occupy marginal regions of pools (Pflieger, 1975). Multiple authors have reported the orangethroat's lack of presence in large, deep streams having deep riffles (Robinson and Buchanan, 1988). The polytypic fantail darter is also found in small stream riffles, but seem to prefer a swift current (Robinson and Buchanan, 1988). The orangethroat darter and the fantail darter have overlapping spawning seasons and similar feeding preferences.

Fantail, Dustin Lynch

It is suspected that in headwater streams where periodic drying is common, habitat selection influences the distribution and densities of darter species. As a riffle dries, the occupants of the riffle have limited options. The inhabitants must move into neighboring pools, move into the hyporheic zone, migrate large distances to a persistent riffle or perish. It is not well established how specific darter species like the orangethroat and fantail survive during these drying events. Given observed presence of orangethroat darters in marginal regions of pools, we suspect that these species will move from the riffle to a nearby pool, and occupy the marginal or hyporheic zone until the riffle is restored. Fantail darters have been observed in pools, but usually in juvenile stages. It is unclear how these darters will seek refugia in the absence of a swift riffle, but we hypothesize that the adult fantail darters used for this experiment will occupy the marginal hyporheic zone alongside the orangethroat darters.


Indoor mesocosm setup in Biology Greenhouse, Kaitlyn Werner

In this experiment we will be using indoor mesocosms to examine the survivorship, growth, and behavioral patterns of the fantail and orangethroat darters in a drought situation. We suspect that both species will show reduced growth and survival under drought conditions. It will be interesting to quantify if one species is less inhibited by a drying event than the other, while also examining and comparing the refugia strategies between the selected species.

In the future, this experiment could prove to be a model for examining the refugia strategies and survivorship of the federally endangered yellowcheek darter in response to an induced drying event. This study could also prove to be useful in understanding how anthropogenic drying events, caused by dams or through agricultural water withdrawal, can inhibit the growth and survivorship of two common Ozark darter species.

Perennial groundwater stream, Yocum Creek

Population Genetics of Orangethroat Darter and Cardinal Shiner: Effect of Flow Regime

Funding Source:	Arkansas Game and Fish Commission & Arkansas Department of Higher Education
Project Duration:	May 2013 to May 2014
Principal Investigator:	DANIEL D. MAGOULICK
Graduate Student:	DOUGLAS R. LEASURE (Ph.D. Student)
Undergraduate Student:	BROOKE BECKWITH (Student)

Research Objectives:

1. Examine gene flow and genetic structure of *Etheostoma spectabile squamosum* and *Luxilis cardinalis* in both perennial groundwater streams and intermittent streams.

Management Implications:

1. Little is known about the influence of flow regime on gene flow and genetic structure of stream fishes. This study will provide vital information about how different flow regimes affect gene flow and dispersal.
2. This data could be useful for the long-term management of streams and species that inhabit them, including endangered species.

Project Summary:

Understanding the population dynamics of freshwater stream fish species is of growing significance due to the environmental pressures that affect these systems (Huey et al., 2011). Connectivity, drought and drying, landscape, and flow regime are important natural factors that can affect population dynamics (Huey et al., 2011; Hodges & Magoulick, 2011; Huey et al., 2008). In this study, we will be focusing on the relationship between population genetics and flow regimes. Currently, knowledge about the dispersal of freshwater fish is limited due to difficulties with direct demographic measurements (Lamphere & Blum, 2012). However, combining demographic and genetic approaches could provide crucial information to understanding the population dynamics of fish (Lamphere & Blum, 2012). This data could be used to create relationships between gene flow and flow regime that could be applied to fish assemblages in the region, including imperiled species.

Poff et al. (2010) defines environmental flows as the quantity, timing, and quality of stream flows required to maintain particular organisms in a system or overall ecosystem function. The classification of flow regimes is based on the hydrology of the system (Poff et al., 2010). In this region, examples of stream classification types include perennial groundwater stable, perennial groundwater, perennial runoff, and intermittent. The two flow regimes that we will be concerned with are perennial groundwater and intermittent.

The orangethroat darter, *Etheostoma spectabile,* is a benthic species known to live a relatively sedentary lifestyle. *E. spectabile* inhabits primarily small headwater creeks and spring-runs where it mainly occupies shallow riffles (Robinson & Buchanan, 1988). This species is highly variable geographically in Arkansas and has been divided into five subspecies. The subspecies we will focus on is the Arkansas River scaly orangethroat darter, *Etheostoma spectabile squamosum* (Figure 1). This subspecies is more robust than other subspecies found in Arkansas.

Figure 1. Arkansas River scaly orangethroat darter, Etheostoma spectabile squamosum.

The cardinal shiner, *Luxilus cardinalis,* is found in northwest Arkansas in clear, north bank tributaries of the Arkansas River. *L. cardinalis* (Figure 2) is a schooling species that lives in small, clear, gravel-bottomed streams or small rivers. It is found in deep riffles or pools with moderate current (Robinson & Buchanan, 1988). The dispersal potential of this minnow is likely much greater than that of *E. spectabile squamosum.*

Figure 2. Cardinal Shiner, Luxilus cardinalis.

In this study, our main goal is to compare the gene flow of *E. spectabile squamosum* and *L. cardinalis* in both a perennial groundwater stream and an intermittent stream. These particular species were chosen for the study for two main reasons: 1) *E. spectabile squamosum* and *L. cardinalis* will probably be affected by flow regime and 2) the population genetic structure and gene flow of the two species are likely to differ greatly based on life history traits. We hypothesize that there will be greater gene flow in the perennial groundwater flow class for both species due to the greater connectivity throughout a perennial groundwater stream. Between species, we hypothesize that *L. cardinalis* will have much greater gene flow than *E. spectabile squamosum* due to the differences in habitat use, swimming ability, and dispersal potential.

NEW FISHERIES PROJECTS

Top to bottom: Cardinal Shiner, Southern Redbelly Dace, Orangethroat Darter

Honey Creek, Arkansas

Quantification of Hydrologic Alteration and Relationships to Biota in Arkansas Streams: Development of Tools and Approaches for Un-Gaged Streams

Proposed Funding Source: Arkansas Game and Fish Commission
Project Duration: July 2013 to June 2015
Principal Investigator: DANIEL D. MAGOULICK
Graduate Student: DOUGLAS R. LEASURE (Ph.D. Student)

Research Objectives:

1. Develop the capability to predict natural flow conditions in the absence of daily discharge data. Natural flow conditions would be expected in the absence of anthropogenic flow alteration.
2. Develop the capability to predict actual flow conditions in the absence of daily discharge data. Flow alteration will be quantified as the ratio of actual flow to natural flow.
3. Quantify hydrologic alteration in streams with existing biological community data and establish key relationships between flow alteration and the integrity of stream communities.
4. Assess potential biological impact of hydrological alteration for streams of conservation interest, such as the Little Red River.

Management Implications:

1. Results from this work will provide the scientific foundation for ultimately producing environmental flow standards within Arkansas.
2. Developing methods to determine hydrologic alteration in un-gaged streams will dramatically improve our ability to examine issues of flow alteration in Arkansas, particularly in areas that have been heavily modified such as the Arkansas delta region.

3. Relationships developed in these objectives can then form the basis for setting state and regional environmental flow standards and understanding impacts of climate change.
4. This work will positively impact many species and ecosystems statewide, those of greatest conservation need and otherwise.
5. Information from this study will also be useful for dealing with water use issues, such as those from natural gas development.

Project Summary:

Providing adequate water quantity and quality in streams and rivers is a pressing issue in Arkansas and worldwide. For this reason, it is crucial to determine appropriate flows in streams to protect fish and wildlife needs (environmental flows). A crucial component of determining environmental flows is determining hydrologic alteration. Additionally, the ability to determine hydrologic alteration for sites where discharge data does not exist (i.e. un-gaged sites) is crucial to examining environmental flows for most streams in Arkansas and the U.S. A new method has been proposed by Carlisle *et al.* (2010) to assess hydrologic alteration at gaged sites by comparing observed flow characteristics to expected natural flow characteristics predicted based on catchment and climate characteristics using random forest models. Currently, only a small portion of existing biological data are from stream sites where USGS stream gages are in operation, making it difficult to relate stream flow and flow alteration to biological communities. We propose initiating a project with the goal of determining hydrologic alteration at un-gaged stream sites by using random forest models to quantify expected natural flow as well as current flow conditions based on catchment and climate characteristics. Knowledge of hydrologic alteration at un-gaged stream sites will allow us to, 1) map flow alteration throughout Arkansas, 2) relate flow alteration to biological data at multiple spatial scales and for multiple stream types and sizes, and 3) relate flow alteration to land use/land cover. Flow alteration will be assessed at all sites statewide for which suitable biological community data exists allowing specific degrees and types of flow alteration to be associated with biological communities. This flow alteration assessment tool will be applied to the Little Red River drainage to provide information relevant to the conservation of this ecologically sensitive drainage. The flow alteration tool will also be available for future flow alteration assessments at any stream site in the state. This proposal adds an important component to our current research in which we have completed a statewide hydrologic classification of rivers, as well as conducting aquatic community sampling at sites within a single flow class and ecoregion, in order to develop ecological-flow relationships within a portion of the Ozarks. Products of this study will form the scientific framework for setting environmental flow standards and understanding impacts of global climate change. This work will positively impact many species and ecosystems statewide, those of greatest conservation need and otherwise.

Literature Cited:

Carlisle DM, Falcone J, Wolock DM, Meador RM, Norris RH. 2010. *Predicting the natural flow regime: Models for assessing hydrological alteration in streams.* River Research and Applications **26**:118-136.

Longear sunfish (Lepomis megalotis)(AR Coop Unit/Dustin Lynch)

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

Proposed Funding Source:	Arkansas Game and Fish Commission
Project Duration:	July 2014 to July 2016
Principal Investigator:	DANIEL D. MAGOULICK
Graduate Student:	ROBERT J. FOURNIER (Ph.D. Student)

Research Objectives:

1. To determine the effects of drought and nutrient pollution on the growth and survival of a cross section of stream community's fauna.
2. To examine the effects of a novel predator (largemouth bass) and native predator (smallmouth bass) on the growth and survival of stream fauna, and to assess ecosystem structure and function in normal and drought conditions.
3. To examine the ecological dynamics of apex predation and nutrient enrichment in streams.
4. To construct and parameterize a model that explores community dynamics under varying predation pressures and drought conditions.

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 (Benke 1990). Three of the most detrimental ecological disturbances to stream systems—hydrological alteration, 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 might exacerbate the biological effects of drought conditions in streams (Beniston et al. 2007). Anthropogenic introduction of bioavailable nutrients to freshwater systems is increasing globally (Vitousek et al. 1997) with dramatic, bottom-up effects on ecosystem structure and functionality (Woodward et al. 2012). 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 attempt to explore the dynamics of severely impacted ecosystems by exposing cross sections of Ozark stream communities to combinations of common ecological disturbances.

We will explore the compounded effects of drought, nutrient enrichment, and introduced predators across a series of experiments. First, we will use indoor mesocosms to examine survivorship and growth of fish and crayfish species exposed to combinations of drought and nutrient enrichment treatments with and without a native apex predator (smallmouth bass). Second, we will perform an indoor mesocosm experiment which compares growth and survivorship of communities exposed to combinations of drought, native apex predation (via smallmouth bass), or novel apex predation (via largemouth bass). Third, we will perform a manipulative field experiment in the Boston Mountains ecoregion of northwestern Arkansas by adding either a single smallmouth or largemouth bass to an enclosed stream habitat with and without nutrient enriching substrata and comparing community dynamics to unmanipulated habitats within the system. Finally, we will construct a mathematical model which explores predatory impacts of native and novel predation on metacommunity dynamics in normal and drought conditions.

We anticipate that the results of this study will provide managers with tools to make more informed decisions regarding both the levels of the individual disturbance factors we explore as well as helping to create disturbance management plans which take into effect the compounded effects of multiple stressors within one system.

Crooked Creek, Arkansas

Hindcasting and Forecasting Effects of Angler Harvest, Land Use and Climate Change on Smallmouth Bass Growth and Survival at the Southern Edge of Their Range

Potential Funding Source: Arkansas Game and Fish Commission, U.S. Geological Survey

Project Duration: January 2014 to January 2017
Principal Investigator: DANIEL D. MAGOULICK
Graduate Student: CHRISTOPHER R. MIDDAUGH (Ph.D. Student)

Research Objectives:

1. Determine relative influence of angler harvest, land use, and climate change on smallmouth bass *Micropterus dolomieu* abundance in Crooked Creek, AR at historical, present, and future time periods.
2. Incorporate bioenergetics modeling to examine effects of angler harvest, land use, and climate change on smallmouth bass growth in Crooked Creek, AR.
3. Compare Crooked Creek model with other rivers along a latitudinal gradient.

Management Implications:

1. The relative effects of harvest, land use, and climate change on smallmouth bass abundance and growth will be compared and managers could use this information in future regulation changes.

2. Regulation strategies to maximize growth and/or abundance could be examined.
3. Results could better prepare managers for future challenges that may be presented by climate change.

Project Summary:

Many rivers ecosystems have been extensively altered by anthropogenic influences such as channelization, riparian vegetation removal, and urbanization. Many of these land use factors are interrelated and can affect river ecosystems in complex ways including altering flow regimes and increasing water temperatures. Further, climate change could exacerbate the effects of altered land use on discharge and water temperature by increasing precipitation stocasticity and increasing air temperatures. River discharge and temperature are particularly influential factors on fish populations such as smallmouth bass *Micropterus dolomieu*, especially at larval and juvenile stages. Better understanding of how abiotic factors structure smallmouth bass populations is critical for better management of this species, especially as climate change alters lotic habitats.

In this study, we will create an age-structured model exploring the influences of climate change, land use, and angler harvest on smallmouth bass abundance and growth using three time periods: historical, present, and future (similar to Peterson and Kwak 1999). Smallmouth bass data for present time will come from long-term AGFC Crooked Creek sampling. Life history parameters such as size at age, recruitment, and mortality will be calculated from this data. We will use USGS river gauges and NOAA climate data to model historical and present river discharge and temperature. We will use existing climate models to extrapolate precipitation and temperature to future conditions. For each time period, smallmouth bass seasonal growth and abundance will be examined. The model will also be used to simulate different regulation scenarios under present and future conditions. These simulations will provide managers with recommendations on how to best manage the Crooked Creek smallmouth bass in regards to abundance and size structure especially in regards to future climate change. Eventually, this Crooked Creek model will be compared with similar models created for other rivers along a latitudinal gradient to examine differences in smallmouth bass response to climate change.

Literature Cited:

Peterson, J. T., and T. J. Kwak. 1999. *Modeling the effects of land use and climate change on riverine smallmouth bass.* Ecological Applications 9:1391-1404.

Central Stoneroller (AR Coop Unit/Dustin Lynch)

Trait Composition of Fish Assemblages along Hydrologic Gradients

Funding Source:	Arkansas Game and Fish Commission
Project Duration:	August 2013 –May 2015
Principal Investigator:	DANIEL D. MAGOULICK
Graduate Student:	LINDSEY A. BRUCKERHOFF (M.S. Student)

Research Objectives:

1. Characterize the fish assemblages of different hydrologic regimes in Arkansas based on the relationship between hydrologic metrics and fish traits.
2. Compare trait based and taxonomic based approaches for describing changes in fish assemblages in response to hydrologic variation.
3. Test for morphological variation between fish inhabiting different hydrologic regimes.
4. Determine the relative roles of genetic divergence and phenotypic plasticity driving morphological variation.

Management Implications:

1. This study contributes to the knowledge of ecological-flow relationships to aid in determining environmental flow standards.
2. Identification of traits useful for monitoring changes in fish assemblages will help predict consequences of alterations to natural flow patterns due to climate change, as well as anthropogenic influence.
3. Understanding the roles of phenotypic plasticity and genetic divergence may provide insight into the evolutionary consequences of flow alteration.

Project Summary:

In lotic systems, environmental pressures are largely determined by the hydrologic regime (Naiman et al. 2008). Ecologically important components of the hydrologic regime include the magnitude of discharge and frequency, duration, timing, and rate of change of flow events (Poff and Ward 1989, Richter and Baumgartner 1997, Poff et al. 1997). These components influence habitat volume, current velocity, channel geomorphology, substratum stability, suspended sediments, temperature, chemistry, and channel connectivity (Poff and Ward 1989, Jowett and Duncan 1990), which are all important habitat characteristics influencing which species are present (Poff 1997). Because hydrology controls so many attributes of the physical environment in streams, organisms adapt and evolve in response to maintained variation of hydrologic regimes (Lytle and Poff 2004).

Traits can be used to describe patterns of community assemblages along hydrological gradients (Poff and Allan 1995, Mims and Olden 2012). Trait based approaches assume that species traits converge when environmental pressures are similar (Southwood 1988). Based on this theory, categorizing species by different traits allows for the study of community assemblages across biogeographic boundaries (Schluter 1986). This study aims to determine the relationship between trait compositions of fish assemblages and hydrological variability.

In addition to trait variation between fish assemblages, hydrologic factors may also influence intraspecific and interspecific phenotypic variation. Adaptations in response to hydrologic variation may be apparent by examining morphological variation of fish between different hydrologic regimes. Observed morphological variation may be the result of phenotypic plasticity or genetic divergence. This study aims to determine what morphological features of fish vary across hydrologic gradients. Further, this study will address whether phenotypic plasticity or genetic divergence is predominantly driving morphological variation.

I will examine the trait composition of fish assemblages by using hydrological and fish survey data from Arkansas streams within the Ozark Highland, Arkansas Valley, Boston Mountains, and Mississippi Alluvial Plains ecoregions. Hydrologic variability will be described by nine flow metrics measuring the magnitude of flow events at average, low, and high flow conditions, the frequency and duration of low and high flow conditions, and the timing and rate of change of flow events. A combination of RLQ and four-corner analysis will be used to determine the relationship between the nine flow metrics, overall hydrologic variability, single traits, and suites of traits (trait syndromes). This analysis will determine how fish trait compositions change across hydrologic gradients, as well as how individual components of the hydrologic regime affect fish assemblages.

Variation in morphology between fish occupying different hydrologic regimes will be investigated using geometric morphometrics. Fish will be sampled from stable groundwater streams and intermittent streams that experience extremely low flows. Photographs of individual fish will be used to digitize landmarks representing major features of fish morphology. A suite of morphometric software programs will be used to digitize landmarks, obtain shape variables using Procrustes analysis, and determine shape variation within and between hydrologic regimes.

I will determine if phenotypic plasticity or genetic divergence is driving morphological variation by conducting a 20 week long, fully factorial mesocosm experiment. I will rear young of the year from two natural populations, one from a stable high flowing groundwater stream (population 1) and the other from an intermittent stream that experiences seasonally extreme low flows (population 2). There will be four treatment groups: population 1 young reared in low flow conditions, population 1 young reared in high flow conditions, population 2 young reared in low flow conditions, and population 2 young reared in high flow conditions. At the end of the experiment, fish will be photograph and geometric morphometrics analysis will be completed using the same methods used in the comparative field study. Morphological variation due to genetic predisposition will be indicated by differences in shape variables between populations. Phenotypic plasticity will be indicated by differences in shape variables between treatments in each of the populations.

CURRENT WILDLIFE PROJECTS

C. Reddin setting up pit trap array at Pea Ridge National Military Park

Adult and young King Rail – Greg Page

King Rail Breeding and Brood Ecology

Funding Source: U.S. Fish and Wildlife Service
Project Duration: May 2011 to September 2014
Principal Investigator: DAVID G. KREMENTZ
Graduate Student: AURIEL M.V. FOURNIER (Ph.D. Student)

Research Objectives:

1. Identify habitat characteristics of locations used by sora, Virginia rails, and king rails in the autumn on four wetland complexes in Missouri.
2. Evaluate sora, Virginia rail, and king rail occupancy and abundance relative to water level management and wetland habitat management regimes during autumn migration.

Project Summary:

King Rails north of the Gulf Coast in the central and Mississippi flyways are endangered, threatened or a species of concern. Breeding and brood rearing habitat use of King Rails were identified as Priority Information needs for Rails and Snipe at the FWS King Rail Conservation Plan Workshop. This project was originally funded to look at the breeding and brood ecology of King Rails but because of the drought that greatly reduced King Rail numbers in Oklahoma we changed the scope of the project.

We expanded the scope of this project so we could perform a series of randomized management experiments to better understand the habitat use and timing of King Rails during fall migration by looking at this managed wetland impoundments.

By expanding the scope of this project we will be able to better inform the management of water level change and disturbance manipulation of wetland impoundments which are predominantly being managed for waterfowl habitat during migration. The change of scope of this project would allow us to take an additional year to do experimental manipulation of wetland impoundments across the state of Missouri and better understand the role of management in the occupancy and use of these impoundments by King Rails and other secretive marsh birds.

We will work closely with managers from the Missouri Department of Conservation and the U.S. Fish and Wildlife Service to identify a series of wetland impoundments in each of our four regions and randomly select units each year to be managed under different levels of water level management and disturbance. This randomized management will also allow us to better fulfill the current autumn project's objectives.

During the 2012 season of Effects of Wetland Management Strategies on Habitat Use of Autumn Migrating Rails on Intensively-Managed Wetland Complexes in Missouri we detected 6 King Rails across our 12 study sites. The change of scope in this project funded the 2013 season of this project, and the results of that can be found in the summary for Effects of Wetland Management Strategies on Habitat Use of Autumn Migrating Rails in Missouri, in this report.

Sora at Nodaway Valley Conservation Area, Missouri, autumn 2013 (AR Coop Unit/Nick Seeger)

Effects of Wetland Management Strategies on Habitat Use of Autumn Migrating Rails on Intensively-Managed Wetland Complexes in Missouri

Funding Source:	U.S. Fish and Wildlife Service
Project Duration:	July 2012 to September 2015
Principal Investigator:	DAVID G. KREMENTZ
Graduate Student:	AURIEL M.V. FOURNIER (Ph.D. Student)

Research Objectives:

1. Identify habitat characteristics of locations used by Sora, Virginia, Yellow and King Rails in the autumn on four wetland complexes across Missouri.
2. Estimate Sora, Virginia, Yellow and King Rail occupancy rates and abundance in relation to water level management and wetland habitat management regimes during autumn migration.
3. Determine timing, location, and sample size necessary to conduct a telemetry study to evaluate survival during autumn migration.

Management Implications:

1. Understanding how management of impoundments for waterfowl impacts rails will allow managers to better manage wetlands for all waterbirds during autumn migration.

Project Summary:

The Migratory Shore and Upland Game Bird Support Task Force for rails and snipe identified four priority information needs of which one, estimate vital rates to support population modeling, targeted the estimation of survival rates of rails. While autumn may provide an opportune time to capture Sora for a telemetry study, it first will be necessary to determine characteristics of habitat most likely to support rails during autumn migration.

We are using an occupancy based approach to survey managed wetland impoundments at night using ATVs and spotlights between 15 August and 31 October 2012-2014. From this data set, we will be able to estimate detection probabilities, occupancy rates and abundances. We will relate those estimates to habitat measurements taken at those sites. Relating the estimates to habitat and management covariates at local and landscape levels will assist managers in determining the trade-offs necessary to make better decisions to meet the life history needs of a variety of wetland species. We are surveying impoundments in four different regions of Missouri, each containing two Missouri Department of Conservation (MDC) Conservation Areas (CA) and one U.S. Fish and Wildlife Service (USFWS) National Wildlife Refuge (NWR).

In addition to our main objectives are collecting data for many side projects. We are also collecting feathers for stable isotope analysis to estimate the origin of captured rails. We are collecting body measurements from Yellow Rails for inclusion in a statistical model to predict their sex and blood samples for genetic analysis. We attached VHF transmitters to rails so we can better understand how the rails are responding to ATVs during surveys. We used a remote-controlled helicopter to take near-infrared images of a variety of different wetlands across the study area. We flew the copter on programmed transects over wetlands to take a series of photos. We will merge together and analyze these photos to determine the interspersion of the plants and water in an impoundment using FRAGSTATS.

During 279 surveys (one person surveying in one impoundment = one survey), we detected 1,592 rails: 44 rails during round 1 (14-29 August), 482 rails during round 2 (31 August – 19 September), 1017 rails during round 3 (21 September – 14 October) and 49 rails in Round 4 (18-29 October 29). Rail detections increased until 26 September. Survey effort was not the same across regions and rounds because of equipment break-down and the federal shutdown. We conducted the most surveys in the first round and in the north central region.

We detected 1 King Rail (KIRA, *Rallus elegans*) at Otter Slough CA in the third round. No KIRA were documented on eBird in the mid-latitude states after August making our October observation the latest recorded KIRA this year north of the gulf coast.

We detected 1,562 Sora during the 2013 survey period, 44 during the first round, 481 during the second, 990 during the third round and 47 in the fourth round. Soras (SORA, *Porzana carolina*) were found on every CA/NWR surveyed and in 70% of impoundments surveyed (29 of 41). We detected SORA in 80% of impoundments surveyed (29 of 36). SORA migration began in late August (10-24 SORA/hour) and peaked in late September (23-30 September, 60-200
SORA/hour) with most birds departing by 20 October. We detected fewer SORAs in the southeast region during all rounds as compared to the numbers of SORA detected at the northern regions in both 2012 and 2013. We first detected fewer SORA later in 2013 than in 2012 despite a 50% increase in survey effort. Our visual assessment of smoothed splines of the SORA detections do not suggest a difference in migration timing between years.

We detected 24 Virginia Rails (VIRA, *Rallus limicola)* during the 2013 survey period during all 3 rounds. We detected Virginia Rails more often during the latter half of the season, especially the third round. Our visual comparison of the 2012 versus 2013 VIRA distributions suggests the peak of VIRA migration was slightly later in 2013 than in 2012.

We detected 5 Yellow Rail (YERA, *Coturnicops noveboracensis*) during the 2013 survey period. We compared the timing of our YERA detections against eBird detections across mid-latitude states in the United States, and found the timing of our detections was similar to eBird records. Qualitatively we believe, based on both eBird and our distribution of YERA detections, that YERA migration through Missouri was later in 2013 than in 2012. No Black Rails (*Laterallus jamaicensis*) were detected during the 2013 survey period.

In 2013, we detected the most rails in the northwestern region and the fewest in the southeast region across all rounds. We detected a similar number of SORA/hour in the northwest and north central regions during the third round. In 2012 the north central region had more birds than any other region, a pattern we did not observe in 2013. Unlike 2012, as the fall progressed, rails were not evenly distributed across the 4 regions. We detected the most birds at Swan Lake NWR in 2012 and at Squaw Creek NWR in 2013.

We were able to complete detection probability surveys on 10 SORA. We determined SORAs are moving an average of 3 meters but no more than 8 meters from the ATV. Our observations suggest that SORA are not being pushed outside of the transect strip. These observations suggest that our survey method is adequately detecting available SORA and that our vegetation sampling is at the correct scale.

We intend to survey 15 August - 31 October, 2014 using the same methods. We will conduct surveys on state land from 15 August – 15 October 2014 and on federal land for the entire study period. We would like to work with managers to set up some management experiments across the state so we can better understand the role of management in creating the habitats these birds use. The photos from the helicopter have been processed and are being prepared for publication

C. Reddin processing a fulvous harvest mouse, Pea Ridge National Military Park, Arkansas (AR Coop Unit)

Small Mammal Baseline Inventory Survey of Pea Ridge National Military Park, Benton County, Arkansas

Funding Sources:	U.S. National Park Service
Project Duration:	August 2012 to August 2013
Principal Investigator:	DAVID G. KREMENTZ
Graduate Student:	CHRISTOPHER REDDIN (M.S. Student)

Research Objectives:

1. To produce a baseline estimate of small mammal abundance, diversity, and species richness for the six main habitat types that occur at Pea Ridge National Military Park, Benton County, Arkansas.
2. To assess Texas mouse (*Peromyscus attwateri*) habitat use.

Management Implications:

1. To determine what species of small mammal may be lost from Pea Ridge National Military Park due to anticipated habitat management actions, especially removal of eastern red cedar (*Juniperus virginiana* var. *virginiana*).

Project Summary:

The goal of resource management at Pea Ridge National Military Park (PERI), Benton County, Arkansas is to interpret the civil war battle that occurred there on 7-8 March 1862. One management objective of the National Park Service is for the landscape to reflect the natural range of conditions present at the time of the battle. As the landscape has gone through a number of changes since that battle (James 2008), vegetation management practices including burning and mechanical thinning will be needed to return the landscape to its former state. Altering the vegetation landscape may cause changes in the species composition of small mammals that currently occur there. Further, one of the species out at PERI, the Texas mouse, is known to inhabit red cedar stands along cliffs and bluffs. Since red cedar tends to be found in the marginal soils around cliffs and bluffs, we also wanted to see if the Texas mouse is responding to the vegetation, the substrate, or both.

At PERI are found six habitat types including: 1) cool season grassland dominated by tall fescue (*Festuca arundinacea*) and redtop (*Agrositis gigantea*), 2) warm season grassland dominated by indiangrass (*Sorghastrum nutans*) and big bluestem (*Andropogon gerardii*), 3) oldfield sites, 4) post oak-blackjack oak (*Quercus stellata, Q. merilandica*) forest, 5) oak-hickory (*Q.* spp., *Carya* spp.) forest, and 6) red cedar forest. In August 2012 we positioned two small mammal trapping lines in each of the five main habitat types for a total of ten lines. At each site we set out 21 Sherman traps (8 x 9 x 23 cm) and four Tomahawk traps (#202) in a line as well as a Moultrie motion-activated game camera near a likely spot to observe larger animal movements. Where available, the Tomahawk traps were placed on the bole of a tree at ~3 m to catch squirrels. Trapping occurred for five consecutive nights at each location. Captured animals were given an individually numbered #1005-1 monel ear tag to identify recaptures and we recorded species, weight, and sex. Trapping began in September 2012 and continued through August 2013. We divided the 12-month time frame into four seasons: autumn (Sep-Nov), winter (Dec-Feb), spring (Mar-May), and summer (Jun-Aug). From the winter session onward we added 1 additional trap line in each forested habitat. We ran each trapping line for one 5-day session each season, for a total of 125 trap-nights per season and 500 for the year. This allowed us to determine changes in small mammal community structure among seasons. We also trapped at 7 additional trap lines divided between locations along rock-strewn, dolomite bluffs in red cedar and post oak forest to gauge Texas mouse use of rocky substrate.

To quantify the habitat relationships of the animals we caught, each season we measured vegetation at the start of each trapping line, at 9 randomly selected points within the habitat patch each line was in, and within the three woodland habitat types, and at trap locations where an animal was caught. At each point we recorded canopy cover, tree basal area, average ground cover, and average vertical obstruction.

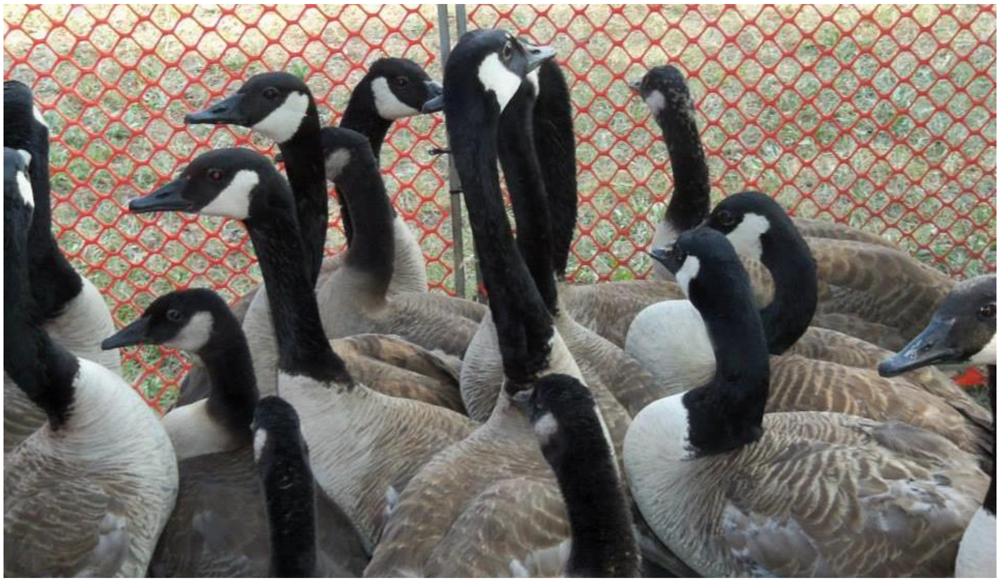
We captured 289 animals a total of 544 times belonging to 9 species: 270 captures of 129 individual *Peromyscus* spp. (due to difficulty in distinguishing deer mice [*P. maniculatus*] from white-footed mice[*P. leucopus*] we lumped them together), 119 captures of 44 individual Texas mice, 76 captures of 57 individual fulvous harvest mice (*Reithrodontomys fulvescens*), 23 captures of 23 individual least shrews (*Cryptotis parva*), 33 captures of 20 individual hispid cotton rats (*Sigmodon hispidus*), 14 captures of 8 individual golden harvest mice (*Ochrotomys nuttalli*), 5 captures of 4 individual prairie harvest mice (*R. montanus*), 1 capture of 1 individual southern flying squirrel, and 2 captures of 1 individual unknown *Reithrodontomys*. We captured 156 animals in post oak-blackjack oak woodlands, 131 in red cedar woodlands, 125 in oldfields, 75 in warm season grassland, 44 in oak-hickory, and 13 in cool season grasslands. We captured 73 animals in the autumn session, 99 in winter, 199 in spring, and 173 in summer.

Oldfields were the most species rich habitat with 7 species caught there while oak-hickory forest was the least species rich habitat with only *Peromyscus* spp. and Elliot's short-tailed shrew being caught there. We caught the fulvous harvest mouse, hispid cotton rat, and least shrew only in grassland habitats while the southern flying squirrel and Elliot's short-tailed shrew we only captured in forests. We trapped the Texas mouse, golden harvest mouse, and *Peromyscus* spp. in both grasslands and forested habitats, though in larger numbers in forests. We only caught the southern flying squirrel and plains harvest mouse in one habitat each, red cedar forest and cool season grassland, respectively. *Peromyscus* spp. is the only animal we found in every habitat.

Using multiple permutational ANOVA tests on every pairwise comparison of habitats by season and species abundance, we found that all three forested habitats had similar small mammal communities, while the small mammal communities in oldfield and warm season grasslands were unique. Cool season grassland had a similar small mammal community compared to oak-hickory forest. The similarity between small mammal communities in forested habitats results from the dominance of *Peromyscus* spp. in those communities (34%, 90%, and 92% of the total abundance in red cedar, post oak, and oak-hickory forest, respectively).

Away from rocky substrate, we estimated Texas mouse abundance to be six times higher in red cedar than post oak, though one trap line skewed the data as it contributed 82% of all Texas mice caught in red cedar. When we trapped along rocky bluffs, we estimated 11 Texas mice among 4 post oak trap lines but did not catch a single Texas mouse across 3 red cedar trap lines. Since our results are conflicting, we will conduct three more lines of trapping in rocky, red cedar habitat at Devil's Eyebrow State Recreation Area in March to collect additional data.

Except for a single southern flying squirrel, which are difficult to catch and common in many types of forests, we did not find any threatened, endangered, or even unique small mammals in our red cedar forest transects. As such, we do not foresee that red cedar removal will result in the extirpation of any small mammal species from PERI. Further, all three grassland habitats, which red cedar invades and converts into woodland, have higher diversity estimates than red cedar. From a small mammal community perspective, removal of red cedar would likely be benefit the small mammal biodiversity at PERI. Cool-season grassland does have a state listed species of special concern, the plains harvest mouse. Further research is needed to understand this species' ecology and response to different habitat management practices, especially prescribed fire, as we found it in small numbers.



Temperate-nesting Canada geese being rounded up for banding in Hot Springs, Arkansas, July 2013

Survival, Abundance, and Distribution of Temperate-nesting Canada Geese (*Branta Canadensis*) in Arkansas

Funding Source:	Arkansas Cooperative Fish & Wildlife Research Unit University of Arkansas- Fayetteville
Project Duration:	August 2012 – May 2014
Principle Investigator:	DAVID G. KREMENTZ
Graduate Student:	M. ELIESE RONKE (M.S. Student)

Research Objectives:

1. To estimate annual survival and hunter recovery rates in Arkansas from 2005-2011 and to determine whether annual survival rates have decreased with liberalized hunting regulations.
2. To determine the abundance of temperate-nesting Canada geese in Arkansas from 2002-2011 and to project future abundance.
3. To estimate the annual geographic range of temperate-nesting Canada geese in Arkansas from 2004-2012 and predict future range.

Management Implications:

1. The temperate-nesting population of Canada geese in Arkansas has grown since the reintroduction of Canada geese in Arkansas. To better manage this population, the Arkansas Game and Fish Commission must have an understanding of the past, present, and predicted future patterns of survival, recovery, abundance, and distribution of temperate-nesting geese within the state.

Project Summary:

Management of Canada geese (*Branta canadensis*) has evolved over the past decades, especially with the reintroduction of the giant Canada goose (*B. c. maxima*) throughout the central and eastern United States. Canada goose hunting in Arkansas is meant to provide opportunities for as many interested hunters as possible. The Arkansas Game and Fish Commission (AGFC) has liberalized Canada goose hunting regulations over the past decade and instituted an early season in September 2007 to harvest temperate-nesting geese before migratory populations arrive. Identifying the effects of time and varying hunting regulations on the temperate-nesting population in Arkansas will help determine best potential strategies for meeting of the Canada goose management goals.

The AGFC bands temperate-nesting Canada geese in Arkansas annually during flight-feather molt, typically the last week of June and first week of July at locations in the Arkansas River Valley and Southwestern and Northwestern Arkansas. From 1999-2012 approximately 13,000 geese received federal aluminum leg bands. Hunters reported recoveries of banded geese to the U.S. Geological Survey Bird Banding Laboratory (BBL) in Laurel, Maryland.

We retrieved banding and recovery data for the years 2001 to 2011 from BBL in October 2012 for analysis. In addition to BBL data, we retrieved data on live recaptures of banded geese for the years 2006 to 2011 from the AGFC in August 2012. We also retrieved completed birder checklists in Arkansas during the breeding season for the years 2004-2012 from eBird, a website Audubon and Cornell Lab of Ornithology organize, for species distribution modeling.

Survival

We estimated annual survival rates for 2006-2011 using the Burnham joint live-dead capture-mark-recapture model in Program MARK. We incorporated the effects of potential hunting pressure in survival models by assigning two categories, pre-liberalization (2005-2006) and post-liberalization (2007-2011) based on the introduction of the September hunting season in 2007. We incorporated the effects of age in survival models using the standard 2-age approach and the 3-age approach Heller (2010) described, which accounts for molt migrant geese post-sampling.

We used quasi-likelihood Akaike's Information Criterion (QAIC) to select among candidate models. We ranked models using the resulting ΔQAIC values, and we selected the model with the lowest QAIC as the model most plausible given the data. We considered all models within $\Delta QAIC \leq 2.00$ acceptable models for the data to account for model-selection uncertainty. We determined model averages for annual survival rates of adult and young geese. We then calculated the annual hunter recovery rate using the model averages of annual survival.

Two models, incorporating the 2-age approach and the 3-age approach, were equally plausible while neither harvest regulations nor year were important in explaining variation in survival rates. In the top models, young survival rate confidence intervals were higher than adult survival rate confidence intervals. Model averaged annual adult survival rates were 0.761 (SE=0.0103) while young survival rates were 0.847 (SE=0.0143). Model averaged hunter recovery rates (*f*) were 0.078 (SE=0.0067) for adults and 0.050 (SE=0.0066) for young.

Abundance

We used the Lincoln Index to determine temperate-nesting Canada goose abundance in Arkansas. We fit a best fit power curve using the exponential population growth formula to the Lincoln abundance estimates from 2002-2011 to predict the growth of goose populations in Arkansas. Initial abundance estimates using a harvest rate derived from the Arkansas direct recovery rate of banded geese produced a statewide abundance estimate for 2011 of over 500,000 individuals, nearly one third of the 1.6 million temperate-nesting Canada geese estimated for the Mississippi Flyway. One possible explanation of the high initial estimate relates to the harvest rate of Arkansas Canada geese. The harvest rates derived from the Arkansas direct recovery rate ($\bar{x}$=0.054, SE=0.007) is well below the Mississippi Flyway average harvest rate ($\bar{x}$=0.17, SE=0.008) for giant Canada geese. Therefore we created an adjusted Lincoln estimate using a regional estimate of harvest rate based on the average direct recovery rates of Arkansas, Kentucky, Missouri Oklahoma, and Tennessee, states with similar temperate-nesting Canada goose populations.

The unadjusted Lincoln Index for temperate-nesting Canada Geese in Arkansas in 2011 was 189,861 (SE=30,007). The trendline index for 2011 was 333,678 (SE=198,299) and using this trendline index, we project over 460,000 geese by 2020. The Lincoln Index adjusted with the regional average harvest rate for temperate-nesting Canada Geese in Arkansas in 2011 was 138,268 (SE=19,433). The trendline index for 2011 was 200,783 (SE=91,063) and using this trendline index, we project over 260,000 geese by 2020.

Distribution

We created maps of the distribution of temperate-nesting Canada geese in Arkansas for 2004 to 2012 using coordinates of Canada goose hunter recoveries from BBL and sightings during the breeding season from eBird, a website Audubon and Cornell Lab of Ornithology organize. We produced shapefiles of the encounter points in ArcGIS for each year. We then created kernel density estimations and volume estimates with contour lines in R using the home range estimation package, adehabitatHR. We used the series of resulting images to display the change in temperate-nesting Canada goose distribution over time. Volume contour maps show an increase in Canada goose encounters in northwestern Arkansas and along the Arkansas River Valley. Pockets of geese also occurred in southwestern and northeastern Arkansas. The highest concentrations of temperate-nesting Canada geese occurred in the center and northwestern corner of the state.

We created a wind rose diagram of temperate-nesting Canada goose dispersal in Arkansas from 2001-2011 using the coordinates of the banding location and final recovery or live recapture location of 1,417 geese encountered greater than 15km from their original banding location. The wind rose diagram of dispersal in Arkansas shows movement in the east and west directions. Forty-two percent of geese dispersed along the east-west axis, 25% east and 17% west. The average dispersal distance was 50km (SE=1.13km). The first quartile, median, and third quartile distances were 24km, 31km, and 63km, respectively. The maximum dispersal distance was 344km, the path stretching from the Fort Smith area in western Arkansas to the Dumas area in the southeastern corner of Arkansas along the Mississippi River.

We will also examine 137 geese banded in Arkansas and recovered outside of Arkansas to determine if the distance traveled is a function of sex or age.

Hatched turkey nest from a radio-marked wild turkey in the White Rock Ecosystem Restoration Area

The Effects of Prescribed Fire on Female Eastern Wild Turkey on the White Rock Ecosystem Restoration Project

Funding Sources:	Arkansas Game and Fish Commission, U.S. Forest Service, National Wild Turkey Federation (State and National Chapters)
Project Duration:	January 2011 to January 2014
Principal Investigator:	DAVID G. KREMENTZ
Graduate Research Assistant:	TYLER PITTMAN (Ph.D. Student)

Research Objectives:

1. Examine habitat selection of female wild turkeys at multiple spatial scales and seasons with respect to burn regimes. We will pay particular attention to nest site selection.
2. Document pre-nesting movements of hens and relate those movements to nest and hen breeding success.
3. Estimate period and annual hen survival, and productivity.
4. Compare our habitat use, movements and vital rate estimates against those same comparable values for radio-marked wild turkey hens monitored at the same site in 1992 and 1993 before large scale growing season prescribed burns were used.
5. Develop management recommendations to enhance nesting habitat availability, hen survival and recruitment in the Central Hardwoods Region.

Management Implications:

1. Reexamination of the prescribed fire management regimes in the central hardwood region in relation to providing habitat suited to supporting an eastern wild turkey population
2. Examination of possible forest management alternatives to better suit the eastern wild turkey population and the goals of the U.S. Forest service in the region

Program Summary:

The eastern wild turkey (*Meleagris gallopavo silvestris*) was almost extirpated from Arkansas, but with help of restocking and significant changes to the management regulations, the subspecies has rebounded to >100,000 birds statewide (Widner 2007). This statewide success has however not been sustained in all areas of the state, especially White Rock Wildlife Management Area (WMA) on the Ozark-St. Francis National Forest. In this region of the western Ozark Mountains, steady decreases in harvest numbers have been observed over recent years causing concern for the wild turkey population. One possible cause of this decline in population numbers could be the extensive and intensive prescribed fire regime that the U.S. Forest Service employs.

During late winter (Mid-January to 1 April 2011-2013) we trapped eastern wild turkey females in the White Rock WMA using rocket nets at trap sites baited with cracked corn. After capture, females were each fitted with a 90-100g Platform Transmitter Terminals (PTTs) satellite transmitter using a modified backpack harness. The PTTs were capable of transmitting Global Positioning System (GPS) coordinates along with other sensor data via the Argos-Trios Satellite system every 48-120 hrs. Despite extensive trapping effort, only 5 females were captured and marked in 2011. After approximately 6 months all PTTs deployed in 2011 had malfunctioned and ceased transmitting GPS coordinates. In 2012 we captured and marked 34 females, of which 31 survived to the breeding season. In 2013 we captured 33 adult females and 18 juvenile females of which we deployed 33 PTTs, 20 on adult females and 13 on juvenile females. We monitored every female deployed with a PTT until either mortality or transmitter failure. Currently 5 PTTs from 2012 and 15 PTTs from 2013 are still functioning.

We identified 39 initial nest attempts and 7 renest attempts during the 2012 field season. During the 2013 field season we identified 33 initial nest attempts and 12 renest attempts. To examine nest-site selection we collected habitat covariates at pre-nesting locations, 40m and 300m from nest-sites, and nest-sites. At these locations we collected vegetation covariates such as visual concealment, stem counts, and canopy cover. We also collected topographic covariates and covariates derived from USDA Forest Service geographic information system (GIS) data such as mechanical treatments, distance to roads, and time since prescribed fire. We then used mixed effects logistic regression to determine what habitat covariates best explained the discrimination between nest-sites and non-nest-sites. We developed a candidate model set (n=16) that consisted of micro-habitat models, covariates collected at <10m scale, macro-habitat models, covariates collected at >10m scale, and hybrid-habitat models that included covariates collected at both scales. We used Akaike Information Criterion (AIC_c) to select among models. Our results suggest that nest site selection is a multi-scale process. We found that nest sites had higher values of visual concealment (0-1m), were more steep, and had higher amounts of woody ground cover (woody vines & oak regeneration <2 years in age) than non-nest-sites. We also found that nest-sites had fewer stems of small shrubs (ground level diameter <5cm) and fewer stems of medium trees (15-30cm dbh). We also observed a significant interaction term between the percent visual concealment (0-1m) and time since fire suggesting visual concealment increases with increasing time since fire. We also examined nest patch selection and found that females selected patches smaller than 40m in size which potentially could be a result of small disturbance, such as tree fall gaps and/or the patch dynamics of large disturbance such as prescribed fire.

We monitored and determined the ultimate fate, hatched or destroyed, of 49 initial nest attempts and 16 renest attempts over 2012 and 2013. We used this information and habitat covariates collected at each of these nest sites to estimate nest survival, nest success rates, and hen success rates. The daily nest survival rate (DSR) is the probability a nest will survive to the next day and the nest success rate (NSR) is the probability that a nest will be successfully incubated to hatch. Hen success is the proportion of available females that successfully incubate and hatch at least one nest that year. DSR and NSR were best explained by differences in age over four weekly periods of incubation. No top models included habitat covariates as predictors of DSR and NSR. The NSR from the top model was 0.286 (SE=0.062) for adults and 0.007 (SE=0.019) for juveniles over the entire study. Hen success was 26% for adults in 2012 and 23% in 2013 compared to 20% hen success found previously on White Rock WMA (Badyeav 1994).

We estimated period and annual survival rates for females using GPS location data and sensor data transmitted from the PTTs. We used the known fate and nest survival models in program MARK to estimate survival rates. We estimated annual survival rates on a monthly basis over 2012 and 2013. The top explanatory model indicated that survival varied on a seasonal basis. The model suggested that survival was lower during the breeding season (Mar-Jun) and during the fall season (Oct-Nov). The annual survival rate was 0.65 (95%CI=(0.616,0.684)) for 2012. We plan to complete this analysis when birds captured in 2013 have been on the landscape for a full year. Breeding season survival rates were 0.802 (95%CI=(0.692, 0.879)) in 2012 and 0.769 (95%CI=(0.652, 0.855)) in 2013.

We are currently estimating female home ranges using dynamic Brownian bridge movement models (dBBMM). We will use the dBBMMs to examine prenesting habitat selection and brood habitat selection for those individual that successfully hatched a nest. We are analyzing vegetation data collected under a repeated measures sampling design to assess the response of vegetation to the current prescribed fire regime. We will examine vegetation patch dynamics in response to prescribed fire using remotely sensed data. These two analyses in combination with our nest-sites selection results should provide more insightful into the role prescribed fire plays in the availability of nest habitat. In 2013 we initiated a trail camera survey to estimate pre-harvest abundance on White Rock WMA. We are currently collecting a second year of survey data and plan to evaluate and hopefully develop a survey method for statewide implementation.

Literature Cited:

Chandler, R. B., Royle, J. A. *Spatially explicit models for inference about density in unmarked or partially marked populations*. The Annals of Applied Statistics. Vol. 7, No. 2, pp.936-954, 2013.

Damm, P. E. *Using Automated Cameras to Estimate Wildlife Populations.* Auburn University, December 13, 2010.

Royle, J. A. *N-Mixture models for estimating population size from spatially replicated counts*. Biometrics Vol. 60, pp. 108-118, 2004.

NEW WILDLIFE PROJECTS

Bald Knob NWR during flooding

American woodcock captured and transmitter attached, Wedington WMA, 2014
(AR Coop Unit/Tyler Pittman)

Spring Migration Ecology of American Woodcock (*Scolopax minor*) in the Central Management Region of the United States

Funding Source:	University of Arkansas and Arkansas Cooperative Fish and Wildlife Research Unit
Project Duration:	August 2013 to May 2015
Principal Investigator:	DAVID G. KREMENTZ
Graduate Student:	CARI SEBRIGHT (M.S. Student)

Research Objective:

1. Document habitat use of American woodcock during spring migration in Arkansas, Missouri, Iowa and Illinois.

Management Implications:

1. To better manage American woodcock across the Central Management Region it is necessary to better understand habitats being used during spring migration.

Project Summary:

The American woodcock (*Scolopax minor*) is an elusive and sought after game bird. However American woodcock (hereafter called woodcock) populations have been in steady decline since 1968 in the Central and Eastern Management Regions in the United States (Cooper and Rau 2013). In 2006 a Migratory Shore and Upland Game Bird Support Task Force was established to develop research priorities to better manage woodcock habitat (Case et al. 2010). One of the priority information needs listed by the Task Force is to document habitat use during migration (Case et al. 2010). Most studies to date have focused on both the northern breeding grounds and the southern wintering grounds while little to no research has been conducted on the migration routes.

We will solicit both citizen scientists and volunteers from federal and state agencies to conduct surveys on woodcock in Arkansas, Missouri, Iowa and Illinois which are located between the breeding and wintering grounds of the Central Region. We will conduct surveys from 15 January to 20 April during the spring migration in 2014 and 2015. We will conduct surveys in a wide variety of habitat types to collect abundance data and location information. We will investigate potential habitats used by these birds using a GIS analysis. First, we will need to estimate the average distance a woodcock flies from a nocturnal roosting field to the surrounding diurnal habitat. We hope to accomplish this by capturing a sample of woodcock in Arkansas and fitting them with VHF transmitters. We will determine locations for each marked bird at least twice a day during the diurnal period to determine distances traveled from nocturnal to diurnal habitat. Once we have an estimate of these distances, we will use the distance estimates to describe the habitat surrounding the singing grounds using large scale vegetation GIS layers like LANDFIRE data.

Currently, we have over 190 volunteers participating in the study. This number does not include the individuals that are working with local volunteer coordinators such as local Audubon chapters, nature centers, and similar organizations. It is our hope that participation will increase for the second survey season. We also hope to attach radio transmitters to woodcock in other parts of the study areas the second season to get a better idea of distances moved between diurnal and nocturnal habitats. We hope that the information gained from this study will help managers to better understand the habitats being used during spring migration. Such information can then be used by managers to make more informed decisions on habitat types to manage for in the future.

Waterfowl at a flooded field in Bald Knob NWR

The Role of Surface Water and Food Availability on the Abundance and Distribution of Wintering Waterfowl in the Arkansas Mississippi Alluvial Valley

Funding Source:	USGS
Project Duration:	August 2013-May 2015
Principle Investigator:	DAVID G. KREMENTZ
Graduate Student:	JOHN HERBERT (M.S. Student)

Research Objectives:

1. Relate waterfowl distributions and abundances to environmental and habitat covariates.
2. Analyze the temporal and spatial changes in waterfowl abundance during a single season and among years.

Management Implications:

1. This study will provide land managers with information to improve waterfowl conservation strategies during the winter months in Arkansas. Since we will be using agriculture and flood data, this information can better inform farmers in the Mississippi Alluvial Valley (MAV) on how they can contribute to waterfowl conservation. Further cooperative measures with farmers and land managers in the MAV can contribute to higher waterfowl abundances during the winter.

Project Summary:

Arkansas winters large numbers of dabbling ducks, diving ducks and geese (Reinecke et al. 1989). In particular, Arkansas is the primary wintering area for mallards (*Anas platyrhynchos*) in North America (Bellrose 1976, Reinecke et al. 1989). Arkansas consistently has the highest mallard harvest per year of any state, and the Arkansas Delta contains the majority of those harvested mallards (Green and Krementz 2008). For this reason, studying the factors that influence winter distribution and abundance of mallards will help biologists better manage this species and likely other dabbling ducks. This research will address the effect that surface water and food availability has on the spatial movements and abundance of mallards over time.

The Arkansas Game and Fish Commission (AGFC) conducts aerial waterfowl surveys four times each winter. In 2009, the AFGC initiated surveys using a stratified random design by separating the MAV into five strata. The AGFC further advanced the survey design by developing a new stratified random sampling design based on U.S. Geological Survey watersheds, which separated the MAV into eleven separate strata. This new sampling design increased the precision and accuracy of the survey results. We will use data obtained by the AGFC aerial winter waterfowl surveys from November 2009 through January 2014. We will use remotely sensed data, and agriculture data through a Geographic Information System to investigate how habitat type and resource availability affect waterfowl distribution and abundance over time.

We predict that waterfowl abundance will be greatest in bottomland forests, managed waterfowl management units with moist-soil plots and agricultural fields with high amounts of waste product, conditioned on the availability of surface water. We also predict that the range of suitable habitat will drive waterfowl distributions. These findings should provide land managers with information to improve waterfowl conservation strategies during the winter months in Arkansas.

PRODUCTIVITY

C. Sebright with an American Woodcock

HONORS AND AWARDS

Fournier, A.M.V. – University of Arkansas Graduate School, Distinguished Doctoral Fellowship, 2012-2016
Fournier, R.J. – University of Arkansas Graduate School, Doctoral Academy Fellowship, 2013-2017
Leasure, D.R. – University of Arkansas Graduate School, Doctoral Academy Fellowship, 2009-2013
Leasure, D.R. – Outstanding Paper of the Year, Coleopterist Bulletin, 2012
Lynch, D.T. – University of Arkansas Graduate School, Distinguished Doctoral Fellowship, 2011-2015
Ronke, M.E. – Harold and Margaret Hedges Memorial Scholarship in Ornithology, 2013
Ronke, M.E. – Arkansas Audubon Society Annual Trust Award Recipient, 2013
Ronke, M.E. – Southeastern Regional Wildlife Conclave, 2nd Place Essay Competition, 2013

COURSES TAUGHT

Krementz, D.G. – Wetlands Ecology and Management – Spring 2013
Magoulick, D.D. – Conservations Biology – Spring 2013

PUBLICATIONS AND PROFESSIONAL PAPERS PRESENTED

Scientific Publications

Fournier, A.M.V., M.C. Shieldcastle, A.C. Fries, and J.K. Bump. 2013. A Morphometric Model to Predict the Sex of Virginia Rails (*Rallus limicola*). Wildlife Society Bulletin 37, 881-886.

Berdeen, J.B., and **D.G. Krementz.** 2013. Unusual Courtship Behaviors by Male American Woodcock. Southeastern Naturalist 12:N1-N5. – IPDS: IP-038611; BAO Date: June 12, 2012.

Lehnen, S.E., and **D.G. Krementz.** 2013. Use of Aquaculture Ponds and Other Habitats by Migrating Shorebirds along the Lower Mississippi River. Environmental Management 52:417-426. – IPDS: IP-038382; BAO Date: May 31, 2012.

Dekar, M.P. and **D.D. Magoulick.** 2013. Effects of predators on fish and crayfish survival in intermittent streams. Southeastern Naturalist 12:197-208.

Papers Presented

Fournier, A.M.V., D.G. Krementz, D.C. Mengel, A.H. Raedeke. 2013. Phenology, Habitat Use of Fall Migrating Rails in Missouri. Missouri Department of Conservation.

Fournier, A.M.V., D.G. Krementz, D.C. Mengel, A.H. Raedeke. 2013. Phenology, Habitat Use and Co-Occurrence of Fall Migrating Yellow Rails on Intensively-Managed Wetland Complexes in Missouri. Research In Progress. Yellow Rail Virtual Symposium.

Krementz, D.G., K. Asante, and L.W. Naylor. 2013. Autumn Migration of Mississippi Flyway Mallards as Determined by Satellite Telemetry. Ecology and Conservations of North American Waterfowl Meeting. Jackson, MS.

Naylor, L.W., **D.G. Krementz,** and S.E. Lehnen. 2013. A Watershed-based Aerial Survey to Estimate Wintering Duck Abundance. Ecology and Conservation of North American Waterfowl Meeting. Jackson, MS.

Krementz, D.G., J.R. Bolenbaugh, T. Cooper, R.S. Brady, and K.L. Willard. 2012. Population Status of the King Rail in the Midwestern United States. 73rd Midwestern Fish and Wildlife Conference, Wichita, KS.

Bolenbaugh, J.R., T. Cooper, R.S. Brady, K.L. Willard, and **D.G. Krementz.** 2012. Status and Breeding Season Distribution of the Migratory King Rail Population. The Wildlife Society 19th Annual Conference, Portland, OR

Lynch, D.T., and **D.D. Magoulick.** 2013. Ecological Flow-Relationships in the Ozark Highlands. American Fisheries Society, Little Rock, AR.

Lynch, D.T., and **D.D. Magoulick.** 2013. Distribution and Abundance of the Endangered Yellowcheek Darter in the Little Red River Drainage of Arkansas. Joint Meeting of Ichthyologists and Herpetologists, Albuquerque, NM.

Lynch, D.T., and **D.D. Magoulick.** 2013. Distribution and Abundance of the Endangered Yellowcheek Darter in the Little Red River Drainage of Arkansas. Meeting of the American Fisheries Society, Arkansas Chapter, Conway, AR.

Magoulick, D.D., and **P. Costello.** 2013. Comparison of Demographic and Individual Based Models Examining Effects of Drought on Fish Population Dynamics, Refuge Use and Species Persistence at Multiple Spatial Scales. Special session on Finding Simplicity in Complexity; Matching Models To Data, American Fisheries Society, Little Rock, AR

Magoulick, D.D. and R. Reese. 2013. Effect of Nutrient Enrichment and Large Benthic Consumers on Stream Ecosystem Structure. Special session on Nutrients, Aquatic Food Webs, and Fisheries Management, American Fisheries Society, Little Rock, AR

Magoulick, D.D. and M.S. Nolen. 2013. Influence of spatial scale on factors affecting three endemic crayfish species. Special session on Progress and challenges in scaling pattern and process in aquatic ecosystems, Society for Freshwater Science, Jacksonville, FL

Pittman H.T., D.G. Krementz, R.S. Whalen, B. Bowers, and K. Lynch. 2013. Survival of Eastern Wild Turkey in the Ozark Highlands, Arkansas. 2013. Arkansas State Chapter of the Wildlife Society. Russellville, AR.

Reddin, C.J., and **D.G. Krementz.** 2013. Small Mammal Community Associations at Pea Ridge National Military Park, Benton County, Arkansas. Arkansas State Chapter of the Wildlife Society. Russellville, AR

Ronke, M.E., D.G. Krementz, L.W. Naylor. 2013. Survival and Recovery of Temperate-nesting Canada Geese Banded in Arkansas. Arkansas State Chapter of the Wildlife Society. Russellville, AR

Posters Presented

Fournier, A.M.V., D.G. Krementz, D.C. Mengel, A.H. Raedeke. 2013. Ecology of Fall Migrating Sora in Missouri. 20th Annual Wildlife Society Conference, Milwaukee, WI

Pittman, H.T., D.G. Krementz, B. Bowers, K. Lynch, R. Whalen. 2013. Nest Site Selection of Eastern Wild Turkey with Relation to Early Growing Season Prescribed Fire in the Ozark Highlands, Arkansas, USA. 20th Annual Wildlife Society Conference, Milwaukee, WI

Ronke, M. E., L.W. Naylor. 2013. Abundance and Geographic Distribution of Temperate-nesting Canada Geese in Arkansas. 20th Annual Wildlife Society Conference, Milwaukee, WI

Committees/Task Forces/Recovery Teams

Fournier, A.M.V. – Member of the Yellow Rail Working Group, 2013 -present
Fournier, A.M.V. – Member of the Student Professional Development Working Group of the Wildlife Society, 2008 -present
Fournier, A.M.V. – Regional Science Fair Judge, 2012 -present
Fournier, A.M.V. – Treasurer, University of Arkansas Student Chapter of the Wildlife Society, 2013 -present
Fournier, A.M.V. – Vice President, Biology Graduate Student Association, University of Arkansas, 2013 -present
Krementz, D.G. – Facilities committee, Department of Biological Sciences, University of Arkansas 2008 -present
Krementz, D.G. – Graduate studies committee, Department of Biological Sciences, University of Arkansas 2012 -present
Krementz, D.G. – Faculty Advisor Student Chapter, The Wildlife Society, University of Arkansas 2005 -present
Krementz, D.G. – National Resources Conservation Service Arkansas Wildlife Sub-committee on Marsh Birds 2011-present
Krementz, D.G. – member, West Gulf Coastal Plain JV landbird technical group August 2009 -present

Krementz, D.G. – Chairman, Webless Committee, Mississippi Flyway Game Bird Technical Section February 2006 -present

Krementz, D.G. – USGS representative to the Mississippi Flyway Game Bird Technical Section 2011 -present

Krementz, D.G. – Webless Migratory Game Bird Proposal Review Committee 2011 - present

Krementz, D.G. – Chairman Donald H. Rusch Memorial Game Bird Research Scholarship Committee, The Wildlife Society, 2012 -present

Krementz, D.G. – member, The Wildlife Society, August 1998 – present

Krementz, D.G. – Graduate Committee for Ford, Hanna, M.S. Student – 2012 -present

Krementz, D.G. – Graduate Committee for Kristensen, Thea, Ph.D. Student – 2008 -present

Magoulick, D.D. – Graduate Committee for Ganguly, Shrijeeta, Ph.D. Student – 2013

Magoulick, D.D. – Graduate Committee for Nelson, Whitney, Ph.D. Student – 2013

Magoulick, D.D. – Graduate Committee for Vogrinc, Philip, M.S. Student – 2013

Magoulick, D.D. – Graduate Committee for Smartt, Ayla, Ph.D. Student – 2013

Magoulick, D.D. – Graduate Committee for Ronke, M. Eliese, M.S. Student – 2012 -present

Magoulick, D.D. – Graduate Committee for Fournier, Auriel, Ph.D. Student – 2012 -present

Magoulick, D.D. – Graduate Committee for Halvorson, Hal, Ph.D. Student – 2012 -present

Magoulick, D.D. – Graduate Committee for Khadka, Kapil, Ph.D. Student – 2012 -present

Magoulick, D.D. – Graduate Committee for Chesbro, Cameron, Ph.D. Student – 2012 -present

Magoulick, D.D. – Graduate Committee for Willard, Karen, Ph.D. Student – 2011 -present

Magoulick, D.D. – Graduate Committee for Pittman, H. Tyler, Ph.D. Student – 2011 -present

Magoulick, D.D. – Graduate Committee for Dyer, Robert, M.S. Student 2011 -present

Magoulick, D.D. – Adaptation Science Management Team for Gulf Coastal Plain Ozarks Landscape Conservation Cooperative 2012 –present

Magoulick, D.D. – Intra-agency Climate Change Working Group 2010 –present

Magoulick, D.D. – Natural Conservancy Science Advisory Board 2010 –present

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

Magoulick, D.D. – Crayfish Taxa 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. – Nature Conservancy In-Stream Flows team 2009 –present

Magoulick, D.D. – Upper White River Basin Foundation Technical Advisory Group 2008 –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. – Science fair advisory panel for Haas Hall Academy 2011 –present

Ronke, M.E. – Judge, Northwest Arkansas Regional Science and Engineering Science Fair, 2013-present

Ronke, M.E. – President, University of Arkansas Wildlife Society, 2013-present

Ronke, M.E. – Secretary, University of Arkansas Biology Graduate Student Association, 2013-present

TECHNICAL ASSISTANCE

Training Offered

Krementz, D.G. – Advising the Arkansas Game and Fish Commission wildlife division Region VII on how to better manage some of their wildlife management areas for American woodcock – 2013

Training Received

Baecher, J.A. – Electrofishing Safety – U.S. Department of the Interior – 2013
Boersig, T.C. – NSC Defensive Driving II – U.S. Department of the Interior – 2013
Boersig, T.C. – FWS-CSP2202-OLT-Electrofishing Safety – U.S. Department of the Interior - 2013
Boone, M.E. – NSC Defensive Driving II – U.S. Department of the Interior – 2013
Boone, M.E. – ATV Safety E-Course – The ATV Safety Institute – 2012
Brinkman, L.C. – AAA Driver Improvement Program – Arkansas Cooperative Research Unit – 2012
Brinkman, L.C. – ATV Safety E-Course – The ATV Safety Institute – 2012
Bruckerhoff, L.A. – Safety: Field Employee Orientation – U.S. Department of the Interior – 2013
Bruckerhoff, L.A. – NSC Defensive Driver II – U.S. Department of the Interior – 2013
Bruckerhoff, L.A. – Electrofishing Safety – U.S. Department of the Interior – 2013
Fournier, A.M.V. – Basic First Aid and CPR – American Red Cross – 2012
Fournier, A.M.V. – 'Adehabitat' R Package Workshop – The Wildlife Society/James Shepard – 2013
Fournier, A.M.V. – Occupancy Modeling Course – Humboldt State University - 2013
Fournier, A.M.V. – Principles of Modeling with Spreadsheets – National Conservation Training Center – 2013
Fournier, A.M.V. – NSC Defensive Driver II – U.S. Department of the Interior – 2013
Fournier, A.M.V. – The Humane Care and Use of Laboratory Animals – University of Arkansas – 2013
Fournier, A.M.V. – U.S. Geological Survey Department of the Interior Safety and Occupational Health Program Overview – U.S. Department of the Interior – 2013
Fournier, A.M.V. – U.S. Geological Survey Safety: Introduction to Industrial Hygiene – U.S. Department of the Interior – 2013
Fournier, A.M.V. – U.S. Geological Survey Safety: Safety Program Requirements – U.S. Department of the Interior – 2013
Fournier, A.M.V. – U.S. Geological Survey Safety: Authorities, Roles and Responsibilities – U.S. Department of the Interior – 2013
Fournier, R.J. – NSC Defensive Drivers II – U.S. Department of the Interior – 2013
Fournier, R.J. – Safety: Field Employee Orientation – U.S. Department of the Interior – 2013
Fournier, R.J. – Electrofishing Safety – U.S. Department of the Interior - 2013
Herbert, J.A. – Safety: Field Employee Orientation – U.S Department of the Interior – 2013

Krementz, D.G. – Boat U.S. Foundation's Online Boating Safety Course, Boat U.S. Foundation
Krementz, D.G. – NSC Defensive Drivers II – U.S. Department of the Interior – 2012
Krementz, D.G. – Veteran Employment Training for Hiring Managers – U.S. Department of the Interior – 2013
Krementz, D.G. – GSA SmartPay Travel Card Training – U.S. Department of the Interior - 2013
Krementz, D.G. – The No FEAR Act – U.S. Department of the Interior - 2013
Krementz, D.G. – Department of the Interior Charge Card Refresher Course – U.S. Department of the Interior – 2013
Krementz, D.G. – Federal Information Systems Security Awareness + Privacy and Records Management – U.S. Department of the Interior – 2013
Krementz, D.G. – Authorities, Roles and Responsibilities for Executives – U.S. Department of the Interior – 2013
Krementz, D.G. – U.S. Geological Survey Safety and Occupational Health Program Overview – U.S. Geological Survey – 2013
Krementz, D.G. – U.S. Geological Survey Sustainability and Environmental Management System Awareness – U.S. Geological Survey – 2013
Krementz, D.G. – Federal Information Systems Security Awareness + Privacy and Records Management – USDI
Krementz, D.G. – The Humane Care and Use of Laboratory Animals – University of Arkansas
Krementz, D.G. – U.S. Geological Survey Ethics Training – U.S. Geological Survey – 2013
Krementz, D.G. – Policy and Procedures, University of Arkansas – 2013
Krementz, D.G. – Discrimination and Whistleblowing in the Workplace – U.S. Geological Survey – 2013
Leasure, D.R. – Safety: Field Employee Orientation – U.S. Department of the Interior – 2013
Lehman, J.A. – AAA Driver Improvement Program – Arkansas Cooperative Research Unit – 2012
Lehman, J.A. – ATV Safety E-Course – The ATV Safety Institute – 2012
Lynch, D.T. – Safety: Field Employee Orientation – U.S. Department of the Interior – 2013
Lynch, D.T. – Laboratory Safety – U.S. Department of the Interior – 2013
Lynch, D.T. – NSC Defensive Driver II – U.S. Department of the Interior – 2013
Lynch, D.T. – Safety: Authorities, Roles, and Responsibilities – U.S. Department of the Interior – 2013
Lynch, D.T. – Safety: DOI Safety and Occupational Health Overview – U.S. Department of the Interior – 2013
Lynch, D.T. – Safety: U.S. Geological Survey Industrial Hygiene Program – U.S. Department of the Interior – 2013
Lynch, D.T. – Safety: U.S. Geological Survey Safety and Occupational Health Program Overview – U.S. Department of the Interior – 2013
Lynch, D.T. – Safety: U.S. Geological Survey Safety Program Requirements – U.S. Department of the Interior – 2013
Magoulick, D.D. – Safety: Supervisor Orientation – U.S. Department of the Interior – 2013
Magoulick, D.D. – NSC Defensive Driver II – U.S. Department of the Interior – 2013
Moler, D. – NSC Defensive Driver II – U.S. Department of the Interior – 2013

Moler, D. – Safety: Administrative Employee Orientation – U.S. Department of the Interior – 2013
Moler, D. – I-9 Training – University of Arkansas – 2012
Moler, D. – Sexual Harassment Training: Fulbright College – University of Arkansas – 2012
Pittman, H.T. – Safety: Field Employee Orientation – U.S. Department of the Interior – 2013
Pittman, H.T. – First Aid, CPR and AED – American Red Cross – 2013
Pittman, H.T. – Oregon Online ATV Safety Education Course – Oregon ATV Safety Institute – 2012
Pittman, H.T. – NSC Defensive Driver II – U.S. Department of the Interior – 2013
Pittman, H.T. – Blasting Training – Arkansas Department of Labor Safety Division – 2013
Pittman, H.T. – Wildlife Rocket Netting Safety – Arkansas Game and Fish Commission – 2013
Reddin, C.J. – Safety: Field Employee Orientation – U.S. Department of the Interior – 2012
Reddin, C.J. – NSC Defensive Driving II – U.S. Department of the Interior - 2013
Ronke, M.E. – Safety: Field Employee Orientation – U.S. Department of the Interior – 2013
Ronke, M.E. – NSC Defensive Driver II – U.S. Department of the Interior – 2013
Ronke, M.E. – ATV Rider Certification – ATV Safety Institute, 2013
Sebright, C.E. – ATV Rider Certification – ATV Safety Institute, 2013
Sebright, C.E. – Adult CPR, Basic First Aid and AED – American Red Cross, 2013
Sebright, C.E. – Safety: Field Employee Orientation – U.S. Department of the Interior – 2013
Wiley, S. – Electrofishing Safety – U.S. Department of the Interior – 2013
Woolsey, C.E. – NSC Defensive Driving II – U.S. Department of the Interior – 2013

FORMER GRADUATE STUDENTS can be found under the title 1988 – 2012 Former Graduate Students at ULR: http://www.coopunits.org/Arkansas/Documents/