2012 Annual Report
Arkansas Cooperative Fish

& Wildlife Research Unit

25th Anniversary

Arkansas Game & Fish Commission
USGS science for a changing world
University of Arkansas
Wildlife Management Institute Washington D.C.

ARKANSAS COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

ANNUAL REPORT 2012

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

USGS Arkansas Cooperative
Fish and 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 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 Cooperative Research Unit has become an active part of state and federal research efforts in Arkansas and across the Nation. By the end of our twenty-fifth year, Arkansas Cooperative Research Unit has 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 56 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 Cooperative Research Unit leaders and students have published 147 scientific and technical publications listing the unit and our cooperators in byline and acknowledgements, and other 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 Cooperative Research Unit has brought more than $17,747,689 directly into the community.

During the past quarter of a century, Arkansas Cooperative Research 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 incorporated 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 Arkansas Cooperative Research Unit shall focus on graduate and post-graduate students. Activities will include teaching of formal graduate-level classes, chairing and serving on advisory committees, mentoring the professional development of students, and participation by Unit scientists in academic programs of the University of Arkansas. Students should be educated to prepare 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 Arkansas Cooperative Research Unit will be consistent with the professional standards and hiring practices of the Cooperators, similar agencies elsewhere, and relevant professional societies involved with natural resource management.

Technical assistance will be provided to Unit Cooperators in the areas of scientific expertise of the Arkansas Cooperative Research 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.

PERSONNEL AND COOPERATORS

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CURRENT GRADUATE STUDENTS

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Auriel Fournier (Ph.D., Wildlife – Krementz)
Doug Leasure (Ph.D., Fisheries – Magoulick)
Dustin Lynch (Ph.D., Fisheries – Magoulick)
Tyler Pittman (Ph.D., Wildlife – Krementz)
Christopher Reddin (M.S., Wildlife – Krementz)
M. Eliese Ronke (M.S., Wildlife – Krementz)
Karen Willard (Ph.D., Wildlife – Krementz)

CURRENT UNDERGRADUATE STUDENTS

Brooke Beckwith (Fisheries – Magoulick)
Kaitlyn Smith Werner (Fisheries – Magoulick)

RECENTLY GRADUATED GRADUATE STUDENTS

Jon Flinders (Ph.D., Fisheries – Magoulick)
Matt Nolen (M.S., Fisheries – Magoulick)

HOURLY TECHNICIANS

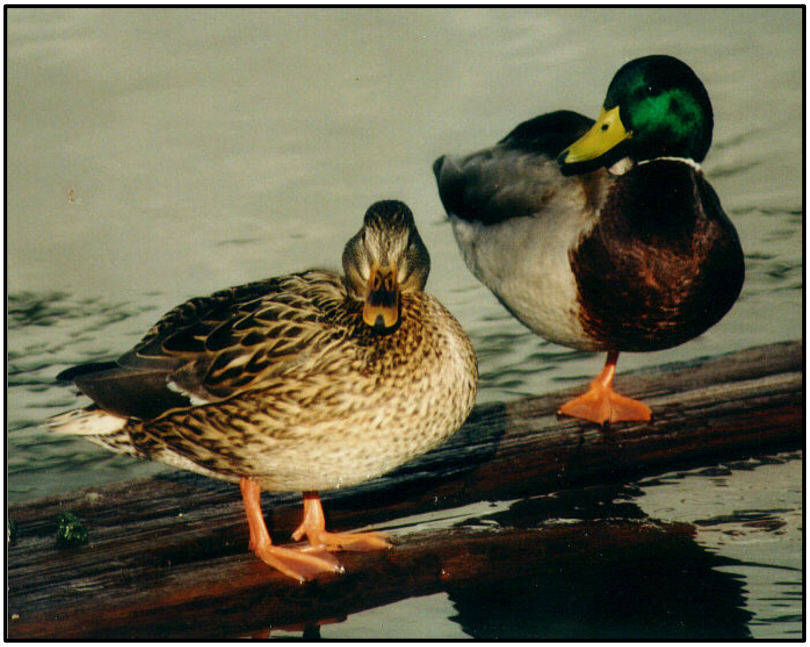
Ms. Kimberlian L. Beasley – General help
Mr. Jacob A. Coulter – Turkey
Mr. Alan J. Edmondson – Crayfish
Mr. Brett Garrison – Crayfish
Mr. Toshiki Hayashi – E-Flow
Ms. Brianna K. Olsen – E-Flow
Ms. Annamarie U. Saenger – King Rail

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. 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
Mr. Robert Bastarache – U.S. Forest Service
Ms. Rhea Whalen – U.S. Forest Service
Mr. David Arbor – Oklahoma Department Wildlife Conservation
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. Dennis Daniel – National Wild Turkey Federation
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

COMPLETED WILDLIFE PROJECTS

Yellow Rail observed during nocturnal spotlight surveys, Swan Lake NWR, 2012
(AR Coop Unit/Justin Lehman)



Mallards

Monitoring the Effects of Climate Change on Waterfowl Abundance in the Mississippi Alluvial Valley: Optimizing Sampling Efficacy and Efficiency

Funding Source:	U.S. Fish and Wildlife Service
Project Duration:	November 2011 to September 2012
Principal Investigator:	DAVID G. KREMENTZ
Postdoctoral Follow:	SARAH E. LEHNEN

Research Objectives:

1. Reduce staff time associated with design and analysis of aerial surveys for winter waterfowl.
2. Generate comparable estimates of waterfowl abundance for multiple regions (Arkansas, Louisiana, and Mississippi).
3. Increase precision of estimates of waterfowl abundance by redesigning strata boundaries (Arkansas).
4. Increase accuracy of waterfowl estimates by estimating effects of canopy cover and observer on waterfowl detection probabilities (Arkansas).
5. Relate estimated waterfowl abundance to local (transect level), landscape (strata level), and weather (temperature and snow cover) characteristics.

Management Implications:

1. Increases the speed of dissemination by reducing processing time, thus allowing for faster management responses in the event of declines or shifts in abundance.

2. Increases the accuracy and precision of estimates, thus increasing the probability that changes in abundance will be detected.

Project Summary:

Given the potential for dramatic changes to wildlife distribution and abundance under various climate change scenarios, there is a great need to quickly collect and process reliable information on wildlife populations. Wintering waterfowl, in particular, provide an excellent bellwether for the effects of climate change as changes in their abundance and distribution reflect both a direct response to climatic variables (e.g., temperature and precipitation) and an indirect response to climate change mediated through habitat alterations. The Mississippi Alluvial Valley (MAV) is a continentally important region for migrating and wintering waterfowl in North America, and the single most important region for wintering mallards.

Beginning in 2005, the Mississippi Department of Wildlife, Fisheries, and Parks, in cooperation with Dr. Pearse and Mississippi State University, has annually conducted aerial surveys using a stratified random design and estimated abundance and distribution of mallards and other waterfowl four times each winter. Based on that success, in 2009 the Arkansas Game and Fish Commission (AGFC) adopted the same protocol for its aerial surveys of the Arkansas portion of the MAV. However, implementation of these protocols in Arkansas was time consuming for AGFC staff (e.g., three weeks of staff time to select randomized transects for one survey). Summarizing and geospatial processing of the data collected was also time consuming. To overcome these issues, we developed a user-friendly graphical user interface in program R. This interface randomly selects transects, stratified by region, for aerial surveys and outputs the selected transects into a format that can be read by the software used for the aerial surveys. Additionally, this tool rapidly processes the collected data to generate estimates of duck abundance with standard errors and bootstrapped 95% confidence intervals and generates a kernel density map illustrating the spatial distribution of the surveyed waterfowl. This increases the speed of dissemination by reducing processing time, thus allowing for faster management responses in the event of rapid declines or shifts in abundance.

In addition, we increased the precision of the surveys in Arkansas by reconfiguring the strata boundaries, resulting in a reduction of the estimate of total standard error of 39%. We also wanted to increase the accuracy of waterfowl abundance estimates by addressing factors known to effect detection in aerial surveys of waterfowl, namely canopy cover and observer. To this effect, we used a double observer approach to estimate of visibility correction factor for observer and canopy cover (open or closed). Using these corrected estimates of waterfowl abundance, future analysis will relate waterfowl abundance to local (transect level), landscape (strata level), and weather (temperature and snow cover) characteristics.

American Woodcock

Assessment of Open Habitat Types Used at Night by American Woodcock on Fall Migration through National Wildlife Refuges in the Arkansas Delta to Integrate Woodcock and Migratory Bird Management in a Decision Making Context

Funding Sources:	U.S. Fish and Wildlife Service
Project Duration:	October 2010 to May 2012
Principal Investigator:	DAVID G. KREMENTZ
Co-Principal Investigator:	RICHARD CROSSETT

Research Objectives:

1. Document the relative use of open habitat types in waterfowl impoundments at night by woodcock and shorebirds on fall migration through the Arkansas Delta.
2. Estimate important habitat covariates that explain among and within habitats use by fall migrating woodcock and shorebirds.
3. Document woodcock migration chronology.
4. Document waterfowl habitat types, juxtaposition, and flooding regimes (current mgmt.) within these impoundments.

Management Implications:

1. To determine which crop types and harvest practices are most attractive to migrating woodcock.
2. To determine if current harvest regulation season dates are appropriate.
3. To determine if timing of impoundment flooding can be integrated to meet the needs of woodcock, shorebird and waterfowl.

Project Summary:

The American woodcock (*Scolopax minor*) is a species of high concern not only to the U.S. Fish and Wildlife Service, but to other working groups like the U.S. Shorebird Conservation Plan (working group) where the woodcock has a priority score of 4 (out of 5). Recently a group of recognized experts in woodcock biology met and developed a priority information needs for the woodcock. One of four priority information needs identified was to improve the understanding of migration, breeding, and wintering habitat quality for woodcock. These experts also identified that information for most aspects of woodcock biology are largely lacking for migration periods, and that identification of important habitats used during migration is considered a key area for additional research. Finally, they identified that habitat and habitat management is critical to woodcock conservation. With additional information about habitat use by woodcock during migration, uncertainty in current management practices might be reduced. Our proposed study will document what types of open habitats are used at night during fall migration through the Arkansas Delta. We are focusing on nocturnal habitat because it is during the night that woodcock primarily forage and a substantial proportion of mortality is thought to occur in these habitats. A large portion of the open habitats used at night on NWRs in the Arkansas Delta are in impoundments that are managed specifically for waterfowl. Waterfowl management directly affects woodcock use through habitat management within those impoundments (e.g. planting & moist-soil mgmt.) and through fall flooding. Waterfowl impoundment flooding typically impacts woodcock because woodcock cannot tolerate any flooding. Flooding regimes often begin in November when woodcock are still migrating. Not only do woodcock vacate these impoundments upon flooding but also late migrating shorebirds like Wilson's snipe (*Gallinago delicata*), dunlins and dowitchers do to. Thus with better information on types of nocturnal fields (waterfowl habitat & juxtaposition) used and better understanding how woodcock and other shorebirds respond to current flooding regimes, we should be able to better integrate woodcock and shorebird (later migrating species) habitat management with waterfowl management. Finally, recent research on migration chronology of birds has indicated that spring migration has shifted later in response to changing climate patterns but the impacts of changing climate on fall migration patterns of birds are not well known. If fall migration chronology of woodcock is shifting, such timing might affect management schedules and activities.

Preliminary surveys of nocturnal open habitat types used in the Arkansas Delta at Cache River National Wildlife Refuge by one of us (Richard Crossett) indicated that a variety of field types are used by woodcock. Field types include both harvested and unharvested soybeans, moist-soil units, and fallow fields. Several field types not used by woodcock were corn, and milo. Rice fields were not surveyed. We propose to survey all field types previously surveyed as well as rice, but we will reduce our survey effort in corn and milo fields. We will survey woodcock beginning no sooner than 1 hr after dark until no later than midnight during all phases of the moon except for 5 days either side of the full moon. Woodcock tend not to use nocturnal fields during the full moon. Surveys will be conducted from ATVs traveling at slow speeds while systematically searching fields using a hand-held spotlight. We will use $\geq$2 ATVs per night to cover a larger area and for safety reasons. During each survey, we will record time in each field, # ATVs, average speed, distance traveled (kms), air temperature, cloud cover, moon phase, precipitation, management treatment (harvested, disked, burned, etc.) general habitat description of the vegetation in the field, and at each woodcock capture/sighting location, coordinates of birds, soil moisture and other micro habitat information. Migration chronology in our study will be compared to woodcock migration chronology from woodcock band recovery and parts collection records. The study area will include Wapanocca, Bald Knob, Cache River, and White River NWR's.

We surveyed transects in 91 fields of 8 field types. We detected woodcock from the first week in November through the third week in December but in low numbers. No woodcock were detected in millet or rice fields whereas woodcock were most frequently detected and has the highest estimated densities in unharvested soybeans. All other crop type/post-harvest management combinations had lower woodcock densities. No woodcock were detected in fields < 8 ha or > 40 ha. Woodcock in the lower Mississippi Alluvial Valley may benefit from management for unharvested soybean fields of moderate size (~8-40 ha). On private lands where leaving unharvested soybeans is not very practical, then the use of ridge and furrow seed bed preparation might be considered. When field disking is necessary, it should be delayed until spring. Future research should assess the relative attractiveness of strip intercropping on field use by woodcock.

CURRENT WILDLIFE PROJECTS

Habitat occupied by King Rail pair, Red Slough Wildlife Management Area
(AR Coop Unit/K.Willard)

A rocket net being deployed over eastern wild turkey, White Rock Wildlife Management Area (AR Coop Unit/Tyler Pittman)

The Effects of Prescribed Fire on the Nesting Ecology of the Eastern Wild Turkey in the White Rock Wildlife Management Area, Arkansas

Funding Sources:	U.S. Forest Service, Arkansas Game and Fish Commission
Project Duration:	January 2011 to January 2014
Principal Investigator:	DAVID G. KREMENTZ
Graduate Student:	H. TYLER PITTMAN (Ph.D. Student)

Research Objectives:

1. To determine the cause(s) for the decline of the eastern wild turkey population on White Rock Wildlife Management Area.
2. To assess the effect of the prescribed fire management regime on nesting habitat and ecology of eastern wild turkeys.
3. To estimate the population and vital rates of eastern wild turkeys on White Rock Wildlife Management Area.

Management Implications:

1. To determine if the prescribed fire management regime is appropriate for supporting a population of eastern wild turkeys or the cause of their decline.
2. To determine if an alternative forest management regimes or technique can satisfy the requirements of the eastern wild turkey and the U.S. Forest Service.

Project Summary:

The eastern wild turkey (*Meleagris gallopavo silvestris*) has been one of the most sought after gallinaceous birds in North American. In the early 20th century, the wild turkey had almost been extirpated from Arkansas, but with help of a major restocking effort and significant changes to the harvest 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 numbers harvested have been observed over recent years causing concern for the wild turkey population there. 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. This burning method may be reducing availability of nesting habitat and destroying early nests. Our study is designed to investigate the relationship between prescribed fire practices and the nest ecology of turkeys at the White Rock WMA using satellite transmitters.

At the beginning of the 2012 nesting season, 29 of the original 34 females captured and fitted with 90-100g Platform Transmitter Terminals (PTTs) with GPS capability were still alive. We recovered 4 transmitters from capture mortalities and one from predation mortality before nesting. Of the 29 females that were alive at the initiation of nesting, 27 attempted to nest. Two juvenile females apparently did not nest. During the nesting season we sampled vegetation at 35 nest sites of which 27 were first nest attempts. Of these 27 first nest attempts, 6 hatched. We detected 8 second nest attempts of which only 1 hatched. We monitored the brood success of the 7 successful females with brood counts at 2 and 4 weeks. We collected vegetation measurements for females during prenesting movements and at nest sites. We also resampled the 75 random vegetation plots that we sampled in 2011. At the end of the 2012 field season, 26 of the original 34 females were still alive.

During the 2012 field season PTT performance was satisfactory but VHF performance was marginal. In August and September, we observed a drop in performance and reliability of the PTTs and almost complete failure of the VHF units. After investigation, we determined that the poor performance was due to a manufacturing error. The manufacturer replaced 33 PTTs for the 2013 field season. Of 26 deployed PTTs at the end of the 2012 field season, we have recovered 4 units from suspected turkey mortalities and 4 recaptures of non-functioning units. Of the remaining 18 deployed PTTs, 3 have stopped transmitting and 15 are providing limited data on the status of the female (alive or dead) and periodic locations. These 15 could potentially be used in 2013 to collect nest data.

In December 2012, we began scouting potential flocks and trap locations for the 2013 field season. Currently we have captured 30 adult females and 13 juvenile females. We have deployed all 33 replacement PTTs at least once and are currently attempting to redeploy any units recovered before the end of the trapping season. We plan to sample vegetation for prenesting movements and nest site selection for the 33 females captured this season. We will use any data from the partially working PTTs from 2012. Vegetation will be sampled again for the 75 random vegetation plots that were previously sampled. We initiated a trail camera survey in 2013 to estimate turkey abundance on White Rock WMA and supplement our habitat selection and use data.

In winter 2011 we began a population genetics project to investigate if there is any evidence of genetic abnormalities in turkeys across Arkansas. Our project stems from concerns that in all 5 physiographic regions in Arkansas, turkey indices have declined in parallel suggesting that the potential cause of this decline is something other than habitat or harvest management reasons. We sent 350 mailers to Arkansas sportsmen and women beginning in spring 2011 asking them to provide us with a sample of feathers from each turkey they shot as well as the date and location of the kill. We received 186 individual feather samples of which we identified 181 individual turkeys. We then analyzed these samples for evidence of population structure at the physiographic regions and for heterozygosity at the state level. We will again send feather mailers for the 2013 turkey season and are exploring possible expansions to include other states across the Southeast.

Trying to capture king rails at Red Slough WMA, 2011

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: KAREN WILLARD (Ph.D. Student)

Research Objectives:

1. Document nesting habitat, clutch size, nest success rate, and source of nest loss for king rails (*Rallus elegans*) under various water level management options at Red Slough Wildlife Management Area (WMA), Grassy Slough WMA, and privately owned WRP wetlands in Oklahoma.
2. During the brood rearing period, document brood movements, habitat use, sources of fledgling loss and estimate fledgling survival rates for king rails under various water level management options at Red Slough Wildlife Management Area (WMA), Grassy Slough WMA, and privately owned WRP wetlands in Oklahoma.

Management Implications:

1. Knowing how king rails respond to water level management during the breeding season will allow managers to better manage wetlands for rails and other secretive marsh birds as a trade-off to managing wetlands for waterfowl and other taxa.

Project Summary:

King rails, north of the Gulf Coast, in the Central and Mississippi Flyways are endangered, threatened or a species of concern. One estimate of the current population size of the migrant king rails in the Upper Mississippi River Valley and Great Lakes Waterbird Region is between 137 and 443 breeding pairs. The precipitous decline of the once 'common' king rail, at least in the Mississippi Flyway, over the past 50 years has been attributed to several causes including wetland loss and degradation, rice habitat loss, harvest and other threats. At the FWS king rail Conservation Plan Workshop and at the Priority Information Needs for Rails and Snipe, experts determined that the brood survival and brood habitat use were considered major unknowns and warranted immediate research. Recent work on secretive marsh birds, including the king rail, have all suggested that water level management may play a critical role in the survival of marsh birds from fledging to fall flight.

We intend to use radio telemetry to investigate both breeding and brood ecology of king rails with respect to water level management during both nesting and brood rearing periods. This study revolves around the capture and marking of both adult and fledgling king rails with VHF transmitters. VHF marked birds will be relocated every day and at different times of the day. To sample unused habitats, survey points will be randomly selected with the study site for habitat measurement. Water depth (cm) will be measured at the center and at 5 m in the 4 cardinal directions at each point to calculate the mean water depth. Dominant plant species (covering the greatest area) will be determined within a 30-m radius. Marsh birds appear to select habitat based on emergent plant structure rather than species composition, thus for analysis, emergent vegetation species will be lumped into three groups based on predominant habitat association and the height of each species at maturity: short emergents, tall emergents, and woody vegetation.

We will estimate habitat selection using resource selection functions as well as using logistic regression. Nest success, and fledgling and brood survival can all be estimated using Program MARK. For nests, we will make nest fate observations at a low frequency (~6 days) to reduce the probability of disturbing the nesting adults. For fledglings, we will make daily observations to determine fate.

During 2012, 9 nests were located. Nest were located in both tall and short emergent vegetation but were never located in impoundments that were burned or disked the previous year.

During both 2011 and 2012, capturing king rails proved very difficult. In 2011, we captured 3 king rails, 1 adult and 2 juveniles, while in 2012, 1 adult king rail was captured. Juvenile birds either lost their transmitters or were killed within a few days. One adult was tracked for 22 days while the other was tracked 51 days. The former adult was not paired and moved (3 Km) from the impoundment where captured because of drought. The latter adult was paired and made 3 nesting attempts, the first of which was successful. This bird avoided areas that were burned or disked the previous year.

Only two broods were observed in 2012 and they used shallow standing water or saturated soil with dense emergent cover nearby. Broods avoided wetland units burned or disked the previous year.

The steady decline in king rails using Red Slough has forced us to reconsider the direction of this project.

NEW WILDLIFE PROJECTS

Removing turkeys from net to place in National Wild Turkey Federation boxes after capture, White Rock Wildlife Management Area, Arkansas (AR Coop Unit/T. Pittman)

Temperate-nesting Canada geese being rounded up for banding in Arkansas

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

Funding Source:	Arkansas Game and Fish Commission
Project Duration:	August 2012 – May 2014
Principle Investigator:	DAVID G. KREMENTZ
Graduate Student:	M. ELIESE RONKE (M.S. Student)

Research Objectives:

1. To estimate the abundance and survival rate of temperate-nesting Canada geese in Arkansas and the changes in abundance and survival from 2001 to the present.
2. To estimate the effects of changing hunting regulations on survival and recovery of temperate-nesting Canada geese in Arkansas.
3. To estimate the geographic distribution of temperate-nesting Canada geese in Arkansas from 2000 to the present.

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 abundance, survival, recovery, and distribution of temperate-nesting geese within the state.

Project Summary:

Throughout most of the lower 48 United States, Canada geese (*Branta canadensis*) have established breeding populations, and groups of these "temperate-nesting" geese are becoming increasingly common in their range. Temperate-nesting populations do not participate in a yearly migration; rather they reside in single location year-round, occasionally performing molt migrations in their lifetime. These temperate-nesting geese are associated with an increasing number of negative human-goose interactions. The Arkansas Game and Fish Commission (AGFC) has managed Arkansas's Canada geese for the past several- years through hunting regulations, such as early seasons aimed specifically at the temperate-nesting populations. AGFC also manages nuisance geese by offering suggestions of control measures for private citizens, such as vegetation management, the use of dogs or scare crows. In order to determine whether AGFC methods are meeting management goals, we will examine the abundance, survival, and movement patterns of the Arkansas's temperate-nesting Canada geese.

From 1999 to 2011, AGFC banded more than 13,000 temperate-nesting Canada geese during the breeding season at yearly goose roundups. AGFC captured geese at locations throughout the Arkansas Valley and parts of Southwestern and Northwestern Arkansas and banded the geese with standard aluminum leg bands. In the years 1999-2004 and 2009-2010, AGFC also attached neck collars to a portion of the banded geese. In addition to band ID codes, AGFC recorded the banding location, age (local or after-hatch-year) and gender of the bird. Goose hunters reported recoveries of banded geese to the USGS Bird Banding Laboratory (BBL). We obtained recovery data from BBL in October 2012 for analysis. In addition to BBL data, AGFC provided data on live recaptures of banded geese.

We estimated preliminary survival and recovery rates using a 2-age Brownie recovery analysis in Program MARK for geese with leg bands only and for geese with neck bands. We compared the rates in Program CONTRAST, and while survival rates were similar, recovery rates were significantly different. We are deliberating on how to handle the neck collard geese. One option is to use the Barker's model of joint live- and dead-recovery to adjust for band type. We will examine the effects of some or all of the following variables: gender, age at banding, year of recovery, hunting effort in year of recovery, and banding and recovery location (urban vs. rural).

To determine goose abundance, we will use the Lincoln Index which is derived from harvest and recovery rates. We will use a best fit curve of the abundance estimates from 1999-present to approximate the trajectory of goose populations in Arkansas. In addition, we hope to map the future expansion of geese in Arkansas using ArcGIS.

We anticipate that the results of our study will provide AGFC with better information to make more informed harvest regulations and additional management strategies for temperate-nesting Canada geese in Arkansas.

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 five main habitat types that occur at Pea Ridge National Military Park, Benton County, Arkansas.
2. To assess small mammal habitat relationships.

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 redcedar (*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.

At PERI are found five habitat types including: 1) tall fescue (*Festuca arundinacea*) grassland, 2) warm-season grassland, 3) post oak-blackjack oak (*Quercus stellate, Q. merilandica*), 4) oak-hickory (*Q.* spp., *Carya* spp.), and 5) redcedar woodlands. 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 bough 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 their species, weight, and sex. Trapping began in September 2012 and will continue through August 2013. This 12-month time frame is divided into four seasons: autumn (Sep-Nov), winter (Dec-Feb), spring (Mar-May), and summer (Jun-Aug). Each trapping line will be run for one 5-day session each season, for a total of 125 trap-nights per season and 500 for the year, to determine changes in small mammal community structure among seasons.

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 is in, and within the three woodland habitat types, 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 will begin analyzing the data to look for habitat associations of the small mammals in March.

To date we have captured 123 individual animals a total of 172 times belonging to 8 species: 45 captures of 39 individual fulvous harvest mice (*Reithrodontomys fulvescens*), 31 captures of 17 individual white-footed mice (*Peromyscus leucopus*), 30 captures of 14 individual Texas mice (*P. attwateri*), 27 captures of 17 individual deer mice (*P. maniculatus*), 18 captures of 18 individual least shrews (*Cryptotis parva*), 17 captures of 15 individual hispid cotton rats (*Sigmodon hispidus*), 3 captures of 2 individual golden harvest mice (*Ochrotomys nuttalli*), and 1 prairie harvest mouse (*R. montanus*). We have captured 86 animals in warm-season grassland, 38 in post oak-blackjack oak woodlands, 33 in redcedar woodlands, 12 in oak-hickory, and 3 in tall fescue grasslands. We captured 73 animals in the autumn session and 99 animals in the winter session. Once trapping is complete in August, we will estimate species richness by habitat and for PERI as a whole using program SPECRICH2.

To date, fulvous harvest mice, hispid cotton rats, and least shrews make up the bulk of the animals captured in the warm season grasslands. The only prairie harvest mouse we encountered was from the tall fescue grassland, along with a least shrew and a fulvous harvest mouse. Texas mice occupy redcedar woodlands almost exclusively, white-footed mice occupy the two hardwood woodlands almost exclusively, and deer mice are found in small numbers in all woodland habitats. Our results are consistent with Brown (1964), who documented the habitat associations of these three closely related *Peromyscus* species in the Missouri Ozark region.

Brown (1964) suggested that the different habitat preferences of the three species of *Peromyscus* cannot be explained by different diets because their diets are nearly identical. As this conclusion is based only on stomach content analysis of eleven mice between *P. attwateri*, *P. leucopus,* and *P. maniculatus*, we will examine the diet of all individual deer, Texas, and white-footed mice we catch using stable isotope analysis of the carbon (δ^{13} C) and nitrogen (δ^{15} N) composition of their feces to determine if each species' diets differ. Only one fecal sample will be analyzed per individual per season. We will also collect five samples of acorns or juniper cones from each trapping line to analyze their δ^{13} C/δ^{15} N ratio and compare it to the fecal samples from that line to see if the primary mast crop is a major food source.

Sora observed during nocturnal spotlight surveys,
Swan Lake NWR, 2012 (AR Coop Unit/Justin Lehman)

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 2014
Principal Investigator:	DAVID G. KREMENTZ
Graduate Student:	AURIEL 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, using the Sora (*Porzana carolina*) as a surrogate. Fall was targeted because rails are easier to capture when water availability is limited on the landscape because of climate and management decisions. While fall 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 fall migration.

We will use an occupancy approach to survey managed impoundments at night using ATVs and spotlights for 2 consecutive nights on 3 occasions between 15 August and 15 October 2012 and 2013. From this data set, we should be able to estimate detection probabilities, occupancy rates, abundances, and 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 water birds.

We will survey 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). We will select 1-2 managed impoundments at each management area, stratified based on habitat type (perennial emergent, moist-soil unit or upland (crops and grasslands). At each rail detection site we will record the UTM coordinates and return the next day to collect local habitat measurements that relate to wetland habitat management practices, including water depth, water-vegetation interspersion, and persistent, non-persistent, woody, upland, and crop cover. We will also collect habitat information at 20 random sites within the impoundments to relate local use to available habitat. These analyses will be conducted only on each 2-day survey as we recognize that the assumption of a closed population in the study area will be violated among survey periods.

In 2012 during 109 nights of surveying (1 person surveying for 2 hours = 1 survey night), we detected 1,964 rails: 192 rails during round 1 (15-30 August), 550 rails during round 2 (2-19 September), and 1,222 rails during round 3 (21 September- 7 October). We detected 7 King Rails (*Rallus elegans*), 3 during survey periods and 4 during diurnal impoundment scouting. We only detected King Rails in the first two rounds. We detected 1,895 Sora during the 2012 survey period, 185 during the first round, 538 during the second and 1,172 during the third round. Soras were found on every CA/NWR surveyed and in 92% of impoundments surveyed (36 of 39). We detected 33 Virginia Rails (*Rallus limicola)* during the 2012 survey period during all 3 rounds. We detected Virginia Rails more often during the latter half of the season, especially the third round. We detected 36 Yellow Rail (*Coturnicops noveboracensis*) during the 2012 survey period, 33 during surveys and 3 during diurnal impoundment scouting. Yellow Rail detections increased in the third round. No Black Rails (*Laterallus jamaicensis*) were detected during the 2012 survey period.

We intend to survey again in a similar manner in the fall of 2013 (Aug-October). We hope to include some additional but related studies including factors affecting detection probability of rails, collecting feathers for stable isotope analysis to try and estimate the origin of the detected rails, and also collecting measurements on Yellow Rails in collaboration with a series of other projects to develop a morphometric model to predict gender based on these measurements.

COMPLETED FISHERIES PROJECTS

Southern Redbelly Dace (Chrosomus erythrogaster) (AR Coop Unit/Dustin Lynch)

Yellowcheek Darter(Etheostoma moorei)(AR Coop Unit/Dustin Lynch)

Distribution and Abundance of the Yellowcheek Darter in the Little Red River Drainage of Arkansas

Funding Source:	U.S. Fish and Wildlife Services
Project Duration:	August 2011
Principal Investigator:	DANIEL D. MAGOULICK
Graduate Student:	DUSTIN LYNCH (Ph.D. Student)

Research Objectives:

1. To determine current status of yellowcheek darter populations in the upper Little Red River watershed.
2. To estimate the distribution (occupancy rate and probability of detection) and abundance of yellowcheek darters in streams of the Little Red River drainage of Arkansas.

Management Implications:

1. Assess importance of various landscape factors to yellowcheek darter.
2. Prioritize target streams and stream reaches for conservation and mitigation.
3. Identify potential streams and habitats that may contain and continue to support viable yellowcheek darter populations.

Project Summary:

The yellowcheek darter (*Etheostoma moorei*) is a rare and imperiled species with a geographically restricted and fragmented range in the Little Red River drainage of north-central Arkansas. Populations of the yellowcheek darter are limited to the Middle, South, Archey, and Devils Forks of the Little Red River (Robison and Buchanan, 1988). A dam on the Little Red River to create Greers Ferry Reservoir in 1962 greatly reduced the range of the yellowcheek darter, which no longer occurs in the mainstem Little Red River (Robison and Buchanan, 1988). Populations are now isolated in upstream tributaries due to the reservoir, with no gene flow possible between branches (Johnson, 2009). Yellowcheek darters appear to be poorly adapted to drought conditions, with severe drought events in 1998 and 2000 having eliminated the species from many previously inhabited riffles and subsequent recolonization having only been partially successful (Wine et al., 2008). Additionally, the species faces a number of anthropogenic threats in the region, ranging from gas well development to gravel mining and feedlot pollution. Populations of yellowcheek darter have declined approximately 80% in the past twenty years (Mitchell et al., 2002). The species was federally listed as endangered, effective September 8, 2011.

While some research has been done on the yellowcheek darter, given the potential threats and its status, much more needs to be done. Major questions that need to be addressed include: Are the populations of yellowcheek darters continuing to decline? What is the current distribution and abundance of yellowcheek darters? How do anthropogenic and natural factors influence the observed distribution and densities of yellowcheek darter populations at multiple spatial scales? Therefore, we conducted a study to address some of these questions.

We sampled for yellowcheek darter at 12 sites in the Middle Fork and South Fork Little Red River. Six were sites sampled for yellowcheek darter in previous studies, and seven were newly selected sites. Darters were dislodged from a 1-m^2 area by thoroughly kicking and disturbing the substrate directly upstream of a 1.5 x 1.0-m seine net (3-mm mesh). Darters dislodged from the substrate were washed into the seine net with the aid of the current and by pulling the seine through the sample area. Darters were sampled from three riffles per site when possible and either 5 or 10 randomly selected replicates per riffle, depending on the size of the riffle. At all sampling locations physical habitat characteristics were collected for each replicate. Substrate size composition within the habitat was quantified by visually estimating percent area of silt (<0.02 cm diameter), sand (0.02-0.1 cm), gravel (0.1-3 cm), pebble (3-6 cm), cobble (6-25 cm), and boulder (≥ 26 cm) within the 1m^2 sample area. Following collection of darters, stream depth and mean (0.6 depth) current velocity in front of the sample area were determined using a meter stick and Marsh-McBirney® flow meter. We used program PRESENCE to estimate occupancy rates (psi) and detection probability (p) and examined relationships between yellowcheek darter density and environmental variables. We developed a priori candidate models and selected the best models using Akaike Information Criterion corrected for small sample size (AIC_c). We compared darter densities among sites with non-parametric ANOVA and used non-parametric correlation to examine associations between density and environmental variables. We also used PRESENCE to determine detection probability (r) on the Royle and Nichols (2003) heterogeneity model, based on detection per individual.

We captured a total of 47 yellowcheek darters. The species was present at 7 of 12 sites, for a naive occupancy estimate of 0.583. Yellowcheek darters were found at 4 sites on the South Fork and 3 on the Middle Fork. They were found at 5 of the 6 previously sampled sites and at 2 new sites. The best model was one in which occupancy is constant but detection probability is positively related to current velocity. Occupancy rates were high for a rare and endemic species (>0.6) but this estimate is likely inflated relative to a true random sample within the Little Red River drainage. Densities were highly variable within and among streams, but on the lower end of those found in previous studies. The average abundance per riffle based on repeated counts was 1.318 ± 0.871. Detection probability per individual was low (0.375) and variable. Relative abundances were low compared to other darter species, as found in other recent studies (Wine et al. 2008). Yellowcheek darter had the lowest relative abundance of all darter species at all sites except three on the South Fork. Capture probability per individual (r) was low but variable. Detection probability and density were both positively related to current velocity. We suggest that because of its small, fragmented range and the isolated nature of remaining populations, the yellowcheek darter would benefit from regular monitoring and active management.

CURRENT FISHERIES PROJECTS

Golden Crayfish (Orconectes luteus) (AR Coop Unit/Dustin Lynch)

Matt Nolen, Identifying and sexing crayfish

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.

Chamber Springs, Benton County, Arkansas
(AR Coop Unit/Dustin Lynch)

Classification of Arkansas Flow Regimes, Regional Ecological-Flow Response Relationships and Environmental Flows assessment for the Ozark Region

Funding Source:	Arkansas Game and Fish Commission
Project Duration:	March 2011 to July 2014
Principal Investigator:	DANIEL D. MAGOULICK
Graduate Student:	DOUGLAS R. LEASURE (Ph.D. Student)
Graduate Student:	DUSTIN LYNCH (Ph.D. Student)

Research 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' 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 project develops the first phase in a multi-year study, involving many partners working towards the goal of establishing a 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.

State-wide River Classification System

Regional differences in hydrologic regimes can be thought of as representing eco-hydrological regions, akin to ecoregions, likely to have corresponding differences in aquatic and riparian biological communities favoring those species best adapted to the natural hydrologic conditions dominant on the landscape. We identified seven *natural* hydrologic regimes in the Ozark and Ouachita Mountain region: Groundwater stable, groundwater, groundwater flashy, runoff perennial, runoff flashy, intermittent, and intermittent flashy (Fig. 1). The geographic distribution of hydrologic regimes among our reference streams appeared somewhat clustered, suggesting distinct eco-hydrological regions within the study area. The Ozark Highlands were dominated by groundwater streams. The Boston Mountains, Arkansas Valley, and South Central Plains were dominated by flashy runoff streams. The Ouachita Mountains had a mixture of runoff and groundwater streams. Each flow regime had unique characteristics in terms of nine ecologically-relevant aspects of flow regimes: Magnitude of average flow, magnitude of high flow, magnitude of low flow, duration of high flow, duration of low flow, frequency of high flow, frequency of low flow, timing of flow events, and rate of change of flow (Fig. 2). The ranges of hydrologic conditions expected in the absence of anthropogenic disturbance were quantified to provide a baseline for assessing hydrologic alteration in disturbed streams throughout the study area. The next steps will be to develop predictive models that use landscape characteristics such as topography, soils, current climate, and future climate scenarios to identify natural hydrologic regimes and degrees of hydrologic alterations at un-gaged streams under pressure from human development and climate change.

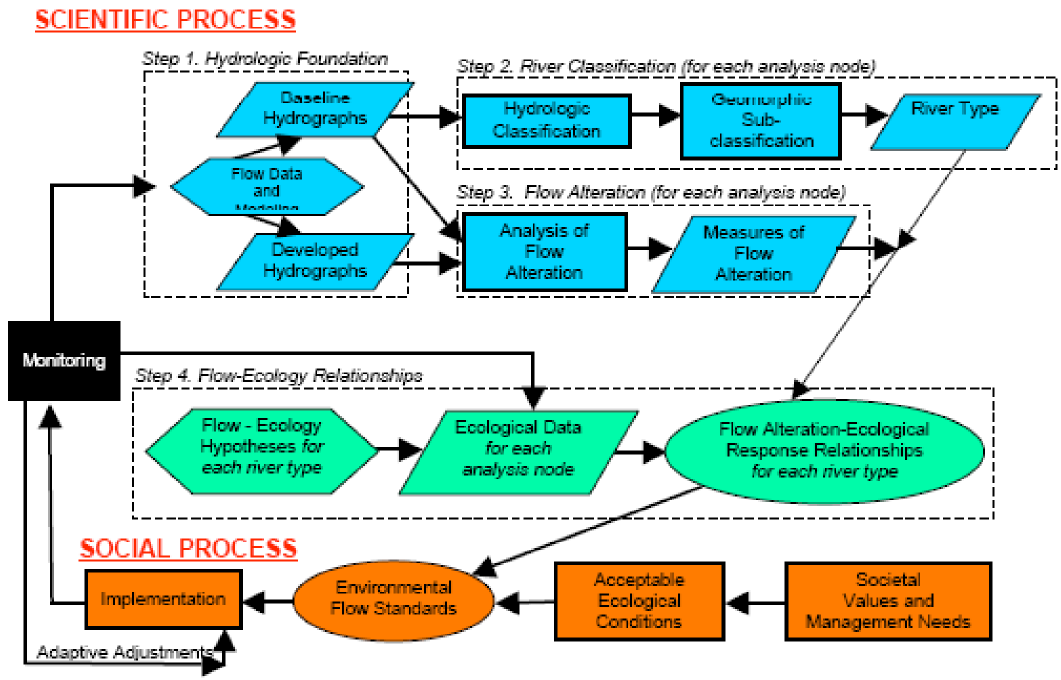
To produce the state-wide river classification system, we selected 67 streams with USGS gaging stations that represented least disturbed hydrological conditions in the Ozark Highlands, Boston Mountains, Arkansas Valley, Ouachita Mountains, and South Central Plains ecoregions of Arkansas, Missouri, and Oklahoma. Hydrologic disturbance screening was based on Falcone's hydrologic disturbance index (HDI) which is a composite index reflecting quantity of water withdrawals, density of major dams, change in dam storage from 1950 to 2009, percent canals in the watershed, EPA monitored discharge locations, road density, and land cover fragmentation. All reference streams used in our analysis had HDI values below the median HDI for both the study area and nationally. Stream gages were only included if their records contained at least 15 complete years of daily flow data within the temporal window of 1955-2010. Flow metrics were calculated for all reference streams using the USGS Hydrologic Index Tool (HIT) which produced 171 flow metrics categorized into nine categories to represent the nine ecologically-relevant aspects of flow regimes. Metrics were standardized by average discharge or catchment area to minimize the effect of river size on the final classification. Ten metrics were selected using principal components analyses to characterize all nine aspects of flow regimes. Guassian mixture model clustering was used to cluster reference streams into groups with distinct natural hydrologic regimes based on the ten selected flow metrics. After the flow regimes of reference streams were identified, principal components analyses were used to select a custom set of flow metrics to best characterize each natural hydrologic regime.

Percentiles of all flow metrics were used to quantify hydrologic conditions and natural variation expected in the absence of anthropogenic disturbance.

Regional Ecological-Flow Relationships

Our first of two field seasons was conducted from May 2012 to August 2012 at 22 sites in the Ozark Highlands of Arkansas, Oklahoma and Missouri. To facilitate biological comparisons between sites, we selected sites within a single flow regime (stable groundwater streams) and confined to a single ecoregion (the Ozark Highlands). 20 of the 22 sites were at USGS stream gauges from which long-term hydrological data could be obtained. Sampling was stratified by habitat at each site to include three units each of riffles, pools, and runs with all units at least 100 m away from road crossings to avoid the hydrologic influence of bridge abutments, culverts, or any other man-made structures that could influence physical stream habitat characteristics or create artificial habitat. We sampled fish, crayfish, and benthic macroinvertebrates. 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 processed separately, 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 collecting from all habitat types along the reach for a standardized time of one hour. Biological community response metrics were calculated based on fish and crayfish community sampling, including densities, species richness and evenness, diversity indices, and trait-based metrics derived from an Index of Biotic Integrity developed specifically for Ozark Highland streams.

At each unit, habitat variables such as wetted width, depth, current velocity, substrate size, and percent canopy cover were recorded along multiple transects. Additionally, stream geomorphology variables such as bankfull width, mean and max bankfull depth, low bank height, and 39 other geomorphological variables were recorded, along with a rapid habitat assessment score for each reach. Water quality data such as temperature, pH, dissolved oxygen, conductivity, and salinity were recorded using a hydrolab unit. Temp-loggers were installed at each field site. Water samples were collected for analysis at the Arkansas Water Resources Center Water Quality Lab at three different times - late spring, summer, and winter. Water was tested for fluoride, chloride, organophosphates, nitrate, phosphate, total N, total P, total suspended solids, conductivity and turbidity. We calculated 171 flow metrics based on USGS gauge data that incorporated magnitude, frequency, duration, timing, and rate of change. Currently, macroinvertebrate samples are being processed in the lab using a grid subsampling method and analyses are being conducted on fish and crayfish community data. Our second field season will be conducted beginning in May 2013, during which all sites from the previous season will be re-sampled, along with the addition of new sites



SCIENTIFIC PROCESS
Step 1. Hydrologic Foundation
Baseline Hydrographs
Flow Data and Modeling
Developed Hydrographs
Step 2. River Classification (for each analysis node)
Hydrologic Classification
Geomorphic Sub-classification
River Type
Step 3. Flow Alteration (for each analysis node)
Analysis of Flow Alteration
Measures of Flow Alteration
Monitoring
Step 4. Flow-Ecology Relationships
Flow - Ecology Hypotheses for each river type
Ecological Data for each analysis node
Flow Alteration-Ecological Response Relationships for each river type
SOCIAL PROCESS
Implementation
Environmental Flow Standards
Acceptable Ecological Conditions
Societal Values and Management Needs
Adaptive Adjustments

Figure 1. Map of natural flow regimes found at 67 USGS stream gaging stations considered to be streams representing the least-disturbed hydrologic conditions regionally.

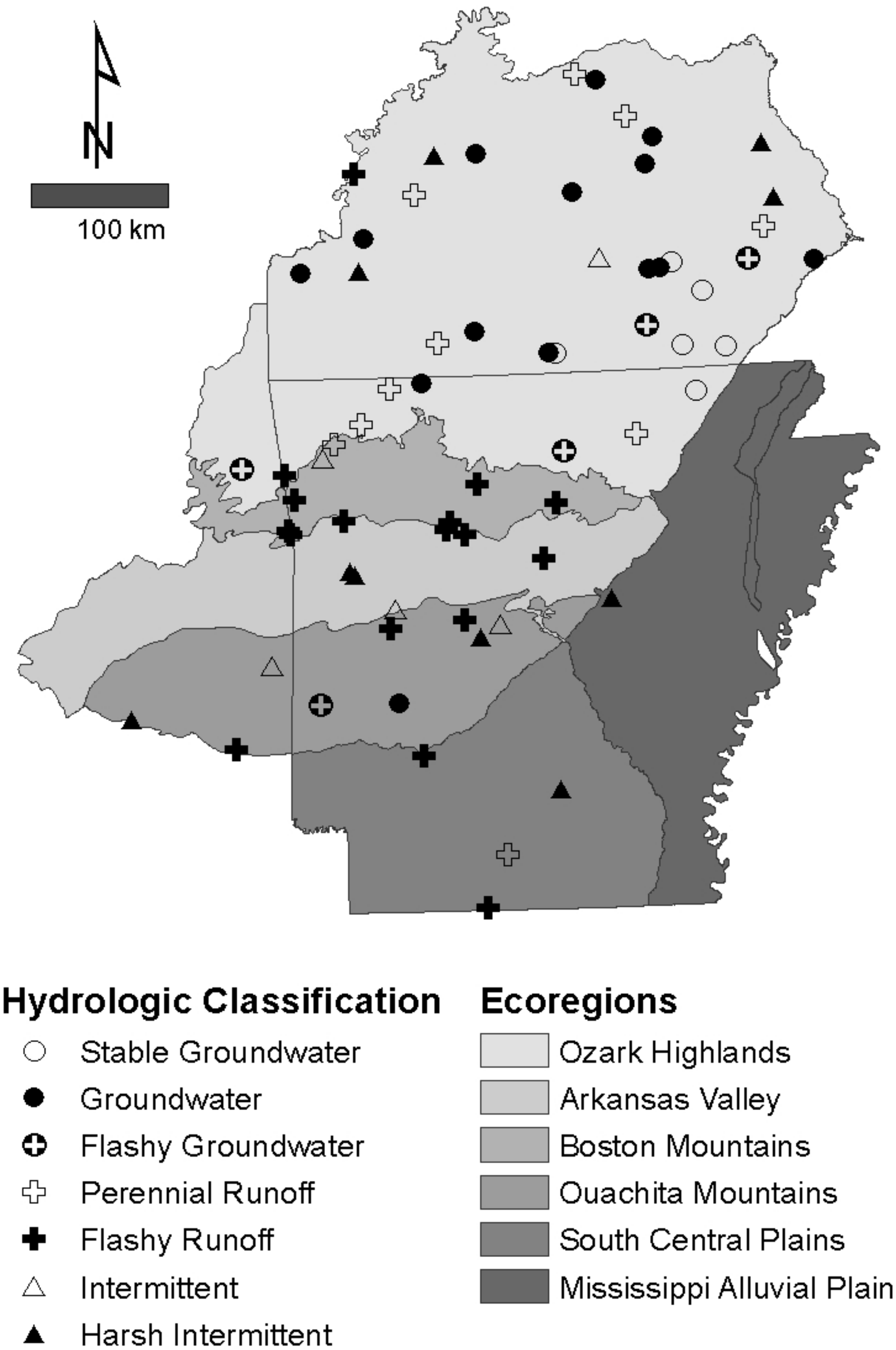
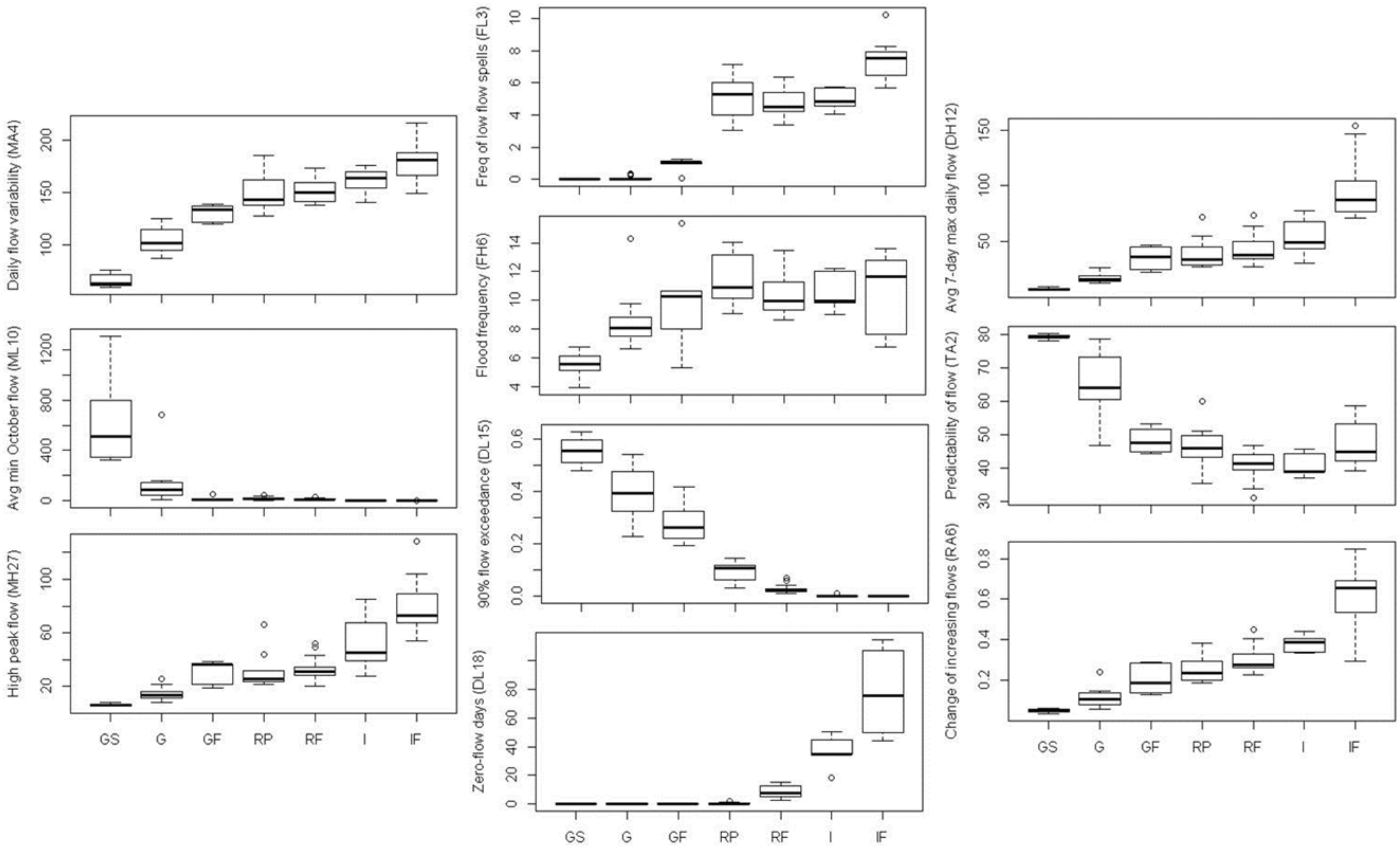


Figure 2. Boxplots showing among-class differences in flow metrics used for clustering hydrologic regimes: Groundwater stable (GS), groundwater (G), groundwater flashy (GF), runoff perennial (RP), runoff flashy (RF), intermittent (I), and intermittent flashy (IF).



NEW FISHERIES PROJECTS

E-Flow Crew Collecting Data on Little Sugar Creek, Benton County, Arkansas (AR Coop Unit/Dustin Lynch)

Crooked 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. 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. 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 (Figure 1), 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.

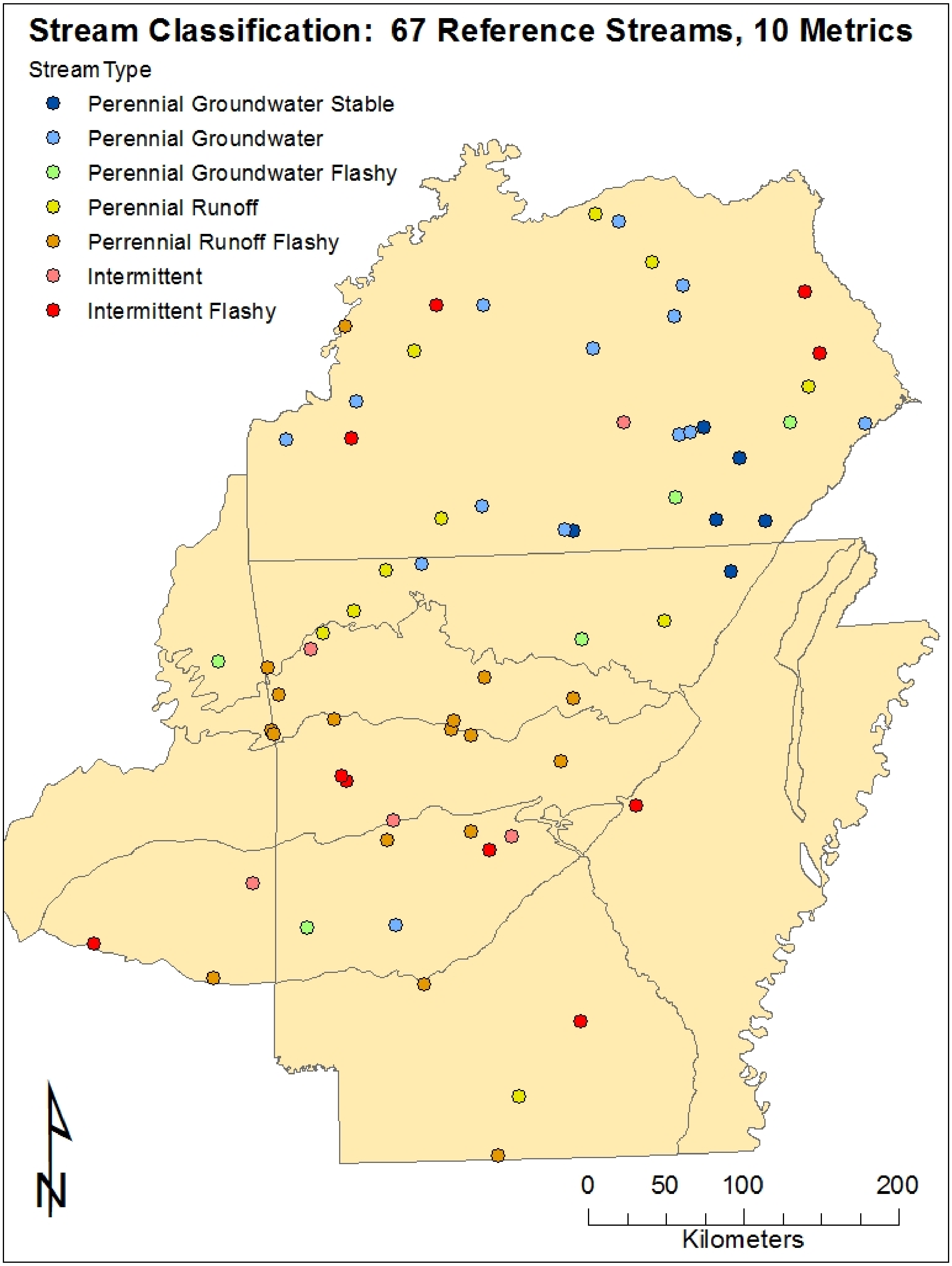


Figure 1. Flow classes in Arkansas and surrounding region for 67 reference gages with >15 years period of record. Class determinations were done using a Gaussian mixture model clustering algorithm based on 10 hydrologic metrics related to magnitude, frequency, duration, timing and rate of change.

Orconectes marchandi

Population Status and Population Genetics of the Imperiled Mammoth Spring Crayfish, *Orconectes marchandi*, in the Spring River Drainage

Proposed Funding Source: Arkansas Game and Fish Commission
Project Duration: June 2013 to July 2015
Principal Investigator: DANIEL D. MAGOULICK
Graduate Student: TBD

Research Objectives:

1. Examine population status of *Orconectes marchandi* in the Spring River drainage.
2. Determine the extent of gene flow evolutionary significant units and compare current and historical genetic diversity of *Orconectes marchandi.*
3. Examine population structure of *Orconectes marchandi* and determine potential for invasion impacts by *Orconectes neglectus.*

Management Implications:

1. It is vital for managers to understand the status and threats to the Mammoth Spring crayfish, given that it is one of our most geographically restricted stream crayfish and an invasive species is spreading within the basin where it is found.
2. Monitoring and population genetics of the Mammoth Spring crayfish will help determine the status of this imperiled crayfish and potential for evolutionary significant units among sub-populations.
3. Additionally, this study will allow us to determine population structure of the Mammoth Spring crayfish and potential threats to this population, including population bottlenecks, an invasive crayfish and habitat loss.
4. Information gained here will ultimately be used to make decisions regarding the conservation of the Mammoth Spring crayfish, and will inform decisions regarding at least two other species that are potentially at risk from similar threats (*Orconectes eupunctus* and *Cambarus hubbsi*).

5. Data collected will also significantly enhance our understanding of crayfish distributions in Arkansas and will be incorporated into databases maintained by the Arkansas Game and Fish Commission and the Arkansas Natural Heritage Commission.

Project Summary:

The Mammoth Spring crayfish, *Orconectes marchandi*, is one of our most geographically restricted stream crayfish and is considered imperiled in Arkansas, Missouri and globally, and a candidate for listing by the USFWS. Crayfish are extremely important in most freshwater systems, typically acting as keystone or dominant species in these systems. The threat of an advancing invasive species, along with potential habitat loss and fragmentation, makes determining *O. marchandi* population status and population genetics extremely important. We propose to determine *O. marchandi* population status by comparing abundance and occupancy rates from 1998-1999 to those from a recent study in 2010-2011, and by comparing current and historical genetic diversity. We will also use genetic data to examine population structure, gene flow among sub-populations, and potential ESU's. Simulation models will be used to determine potential effects of an invasive crayfish on *O. marchandi* populations.

Yellowcheek (AR Coop Unit/Dustin Lynch)

Effects of Drought on Behavior, Growth, and Survival of *Etheostoma moorei* and *Etheostoma caeruleum* 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 yellowcheek and rainbow darter

Management Implications:

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

Project Summary:

Yellowcheek darter (*Etheostoma moorei*) are small, benthic fish that have undergone substantial decline in the past 30 years (Robinson and Harp, 1981), resulting in the species being federally listed as an Endangered Species in September 2011. The species range was endemic to the Little Red River drainage, but following the construction of Greers Ferry Reservoir in 1964 a large area of yellowcheek darter downstream habitat range was destroyed, leaving only four isolated populations in upstream tributaries: the South Fork, Middle Fork, Archey Fork, and Beech Fork (Robinson and Buchanan, 1988). Headwater streams in this region undergo seasonal drought, which can lead to extensive drying of aquatic habitats. It is thought that the Greers Ferry Dam may be exacerbating effects of natural climatic cycles, including drought, in the tributaries (Wine et al., 2008). Headwater stream fishes, like the yellowcheek darter, have evolved in hydrologic systems subject to periodic drying, but joint effects of drying and isolation by anthropogenic structures may be partly responsible for their decline (Wine et al., 2008).

Other sympatric darters that occupy riffles alongside *E. moorei* include *E. caeruleum* (rainbow darter), *E. blennoides* (greenside darter), and *E. zonale* (banded darter) (Wine, 2004). Yellowcheek darter was formerly the most abundant riffle dwelling fish in the Little Red River drainage (Robinson and Harp, 1981), but after years of riffle drying and rewetting, the rainbow darter became the most abundant riffle fish while yellowcheek darter had declined to fifth most abundant (Wine, 2004).

It is suspected that in headwater streams where periodic drying is common, habitat selection influences the distribution and densities of the stenotypic *E. moorei* (Raney and Suttkus) and the eurytypic *E. caeruleum*. Despite the two species having similar preferences for prey and substrate, there is evidence that the relationship lacks interspecific competition because of their differing behavior and microhabitat selection (Weston et al., 2010). The Middle Fork tributary is occupied by both of these species and is subject to periodic drying. Rainbow darter and yellowcheek darter were both observed to be present simultaneously in riffles, although it was observed that yellowcheek darter were located in the crevices between the substrate, sometimes with only their heads visible, while the rainbow darter was found to be exposed on the surface of the substrate (Weston et al., 2010).

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 well established that the rainbow darter takes refuge in pools during riffle drying (Wine, 2004). However, the yellowcheek darter has only been collected in riffles, and hence has been identified as an obligate riffle dweller (Robinson and Harp, 1981; Wine, 2004). If the yellowcheek darter does not occupy the hyporheic zone during riffle drying then they are required to migrate over large distances for refuge. Although extirpation at certain areas suggested that the yellowcheek darters were using the hyporheic zone (Weston et al., 2010), more study is needed to determine the patterns of yellowcheek darter refuge selection.

In this experiment we will be using indoor mesocosms to examine the survivorship, growth, and behavioral patterns of the yellowcheek darters in the presence of the rainbow darters in a drought situation. We suspect that the yellowcheek darters will show reduced growth and survival under drought conditions. We also hypothesize that yellowcheek darters will attempt to use the hyporheic zone during drying, whereas rainbow darters will move into pools during drying.

Perennial groundwater stream, Yocum Creek

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

Funding Source:	Arkansas Game and Fish Commission
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.

Figure 2. Cardinal Shiner, Luxilus cardinalis.

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.*

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.

Smallmouth bass, Crooked Creek, AR

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, National Park Service, U.S. Geological Survey
Project Duration:	September 2013 to August 2016
Principal Investigator:	DANIEL D. MAGOULICK
Graduate Student:	TBD

Research Objectives:

1. Determine effects of angler harvest, land use and climate change on smallmouth bass growth and survival.

Management Implications:

1. Information from this study will allow managers to determine whether angler harvest, land use or climate are more important to smallmouth bass growth and survival at the critical southern edge of the species range.
2. This knowledge will allow managers to establish regulations or mitigate factors negatively affecting smallmouth bass populations.

PRODUCTIVITY

L. Brinkman, M. Boone, A. Fournier, and J. Lehman preparing to survey rails at Otter Slough Conservation Area 2012

HONORS AND AWARDS

Fournier, A.M. – University of Arkansas Graduate School, Distinguished Doctoral Fellowship, 2012-2016
Leasure, D.R. – University of Arkansas Graduate School, Doctoral Academy Fellowship, 2009-2013
Lynch, D.T. – University of Arkansas Graduate School, Distinguished Doctoral Fellowship, 2011-2015
Magoulick, D.D. – U.S. Geological Survey, Cooperative Research Units, Science Excellence Award, 2011
Ronke, M. E. – University of Arkansas Hedges-Ferguson Award, 2011

COURSES TAUGHT

Magoulick, D.D. – Biometry: Experimental Design & Data Analysis – Spring 2012
Magoulick, D.D./Krementz, D.G. – Habitat Use and Selection – Fall 2011
Krementz, D.G. – Wildlife Management Techniques – Spring 2012

PUBLICATIONS AND PROFESSIONAL PAPERS PRESENTED

Scientific Publications

Dekar, M.P. and **D.D. Magoulick**. 2012. Effects of predators on fish and crayfish survival in intermittent streams. Southeastern Naturalist (In Press)

Westhoff, J.T., R.J. DiStefano and **D.D. Magoulick**. 2012. Do environmental changes or juvenile competition act as mechanisms of species displacement in crayfishes? Hydrobiologia 683:43-51

Bolenbaugh, J.R., **D.G. Krementz**, and S. E. Lehnen. 2011. Secretive marsh bird species co-occurrences and habitat association across the Midwest, USA. Journal of Fish and Wildlife Management 2:49-60

Budd, M.J., and **D.G. Krementz**. 2011. Status and distribution of breeding secretive marshbirds in the Delta of Arkansas. Southeastern Naturalist 10: 687-702

Krementz, D.G., **K. Asante**, and L.W. Naylor. 2011. Spring Migration of Mallards from Arkansas as Determined by Satellite Telemetry. Journal of Fish and Wildlife Management 2:156-168.

Krementz, D.G., **S.E. Lehnen**, and **J.D. Luscier**. 2012. Habitat use of woodpeckers in the Big Woods of Eastern Arkansas. Journal of Fish and Wildlife Management 3:89-97

Bolenbaugh, J.R., T. Cooper, R S. Brady, **K.L. Willard**, and **D. G. Krementz**. 2012. Population status and habitat associations of the king rail in the Midwestern United States. Waterbirds 35:535-545

Krementz, D.G., **K. Asante**, and L.W. Naylor. 2012. Autumn Migration of Mississippi Flyway mallards as determined by satellite telemetry. Journal of Fish and Wildlife Management 3:238-251

Technical Publications

Nolen, M. and **D.D. Magoulick**. 2011. The Imperiled Coldwater Crayfish (*Orconectes eupunctus*) in the Black River Drainage of Missouri and Arkansas: Distribution, Population Genetics and Factors Affecting Distribution and Decline. Annual Report, MDC Account 8104; WPI 720. Fiscal Year 2011, Columbia, Missouri.

Theses and Dissertations

Flinders, J.M. 2012. Stable Isotope Analysis and Bioenergetic Modeling of Spatial-Temporal Foraging Patterns and Consumption Dynamics in Brown and Rainbow Trout Populations within Catch-and-Release Areas of Arkansas Tail Waters. Ph.D. Dissertation, University of Arkansas.

Nolen, M.S. 2012. Habitat Modeling of Three Endemic Crayfish Species in the Black River Drainage of Missouri and Arkansas: Factors Affecting Distribution and Abundance. M.S. Thesis, University of Arkansas.

Papers Presented

Magoulick, D.D. 2012. Environmental flows in Arkansas. Water Law and Policy Conference, Little Rock, Arkansas.

Magoulick, D.D. 2012. Impacts of drying and crayfish invasion on stream ecosystem structure and function. TEMPRIV: Ecohydrology and ecological quality in temporary rivers, University of Évora, Portugal.

Magoulick, D.D. 2012. Classification of Arkansas flow regimes to assist environmental flows assessment for the Ozark region. Ozark Summit, Springfield, Missouri.

Magoulick, D.D., J.W. Fetzner Jr., R.J. DiStefano, B.K. Wagner, E.M. Imhoff and M.S. Nolen. 2012. Gene flow and phylogeographic patterns in imperiled Coldwater Crayfish populations in the Ozarks. Special session on *Recent advances in crayfish biology, ecology, and conservation,* Society for Freshwater Science, Louisville, Kentucky.

DiStefano,R.J., **D.D. Magoulick**, B.K. Wagner, J.W. Fetzner Jr., E.M. Imhoff and M.S. Nolen. 2012. Distribution, occupancy and detection of the imperiled Coldwater Crayfish in Ozark Streams of Missouri and Arkansas. Special session on *Recent advances in crayfish biology, ecology, and conservation,* Society for Freshwater Science, Louisville, Kentucky.

Magoulick, D.D. 2011. Impacts of drying and crayfish invasion on stream ecosystem structure and function. Special session on *When rivers run dry: temporary streams as coupled aquatic-terrestrial ecosystems*, Symposium for European Freshwater Sciences, Girona, Spain.

Magoulick, D.D. 2011. Fish Harvesting and Management: Approaches and Implications for Sustainable Harvests Using Ecological Theory and Application. Special Session on *Fish Ecology: Sustainability* at the Fulbright Colloquium: Integral Approaches to Knowledge, University of Arkansas, Fayetteville, Arkansas.

Magoulick, D.D. 2012. Classification of Arkansas flow regimes. White River Fisheries Partnership, Branson, Missouri.

Magoulick, D.D. 2012. Classification of Arkansas flow regimes to assist environmental flows assessment for Arkansas and the surrounding region. Arkansas Game and Fish Commission, Little Rock, Arkansas.

Magoulick, D.D. and J.M. Flinders. 2011. Rainbow trout: Are they what they eat? White River Fisheries Partnership, Mountain Home, Arkansas.

Magoulick, D.D., J.M. Flinders, A.W. Cushing. 2011. Effect of catch and release areas on rainbow and brown trout movement, survival and bioenergetics in Arkansas tailwater rivers. Trout Unlimited, Mountain Home, Arkansas.

Magoulick, D.D. 2011. Inter-basin Introductions of Crayfish. Aquatic Nuisance Species Task Force, Little Rock, Arkansas.

Magoulick, D.D. and J.M. Flinders. 2011. Examining assumptions of stable isotope analysis and assimilation efficiency in rainbow trout: Are you what you eat? Trout Unlimited, Fayetteville, Arkansas.

Kusmik, A., **D.T. Lynch** and **D.D. Magoulick**. 2012. Influence of geomorphology and land use on fish community structure in Ozark Highland streams. Arkansas Water Resources Center conference, Fayetteville, Arkansas.

Deal, K., **D.T. Lynch** and **D.D. Magoulick**. 2012. Relationship between crayfish abundance and hydrologic factors in Ozark Highland Streams. Arkansas Water Resources Center conference, Fayetteville, Arkansas.

Reese, R.A., **D.D. Magoulick**, and **J.P. Ludlam**. 2012. Effect of nutrient enrichment and large benthic grazers on stream ecosystem structure. Ozark Summit, Springfield, Missouri.

Lynch, D.T. and **D.D. Magoulick**. 2012. Distribution and abundance of the yellowcheek darter in the Little Red River drainage of Arkansas. Ozark Summit, Springfield, Missouri.

Reese, R.A., **D.D. Magoulick**, and **J.P. Ludlam**. 2012. Effect of nutrient enrichment and large benthic grazers on stream ecosystem structure. Fulbright Colloquium: Integral Approaches to Knowledge, University of Arkansas, Fayetteville, Arkansas.

Magoulick, D.D. and **J.M. Flinders**. 2011. Effects of Prey and Tissue Type on δ13C and δ15N Fractionation and Turnover Rates of Rainbow Trout. American Fisheries Society, Seattle, Washington.

Douglas, M. R., **H.T. Pittman**, W. J. B. Anthonysamy, M. A. Davis, **D. G. Krementz**, R. E. Vernocy Jr., W. Louis, and M. E. Douglas. 2012. Molecular ecology of eastern wild turkey in the interior Highlands of Arkansas and surrounding areas. 73rd Midwest Fish and Wildlife Conference. Wichita, KS.

Lehnen, S.E. and **D.G. Krementz**. 2012. A comparison of shorebird habitat use during fall migration in the Lower Mississippi Alluvial Valley. Proceedings of the Southeastern Association of Fish & Wildlife Agencies Meeting. Hot Springs, AR.

M.R. Douglas, **H.T. Pittman**, W.J.B. Anthonysamy, M.A. Davis, **D.G. Krementz**, R.E. Vernocy Jr, and M.E. Douglas. 2012. New tools for the next generation of wildlife professionals: molecular ecology of wild turkey from the interior highlands of Arkansas. Proceedings of the Southeastern Association of Fish & Wildlife Agencies Meeting Hot Springs, AR

Krementz, D.G., L.A. Scott, and **J.M. Carroll**. 2012. Secretive marsh bird management on public lands along the western Arkansas River. Arkansas State Chapter of the Wildlife Society. Fayetteville, AR.

Krementz, D.G., **K. Asante**, L.W. Naylor. 2012. Geospatial analyses of telemetry data for mallard (Anas playthyrynchos) migration along the Mississippi Flyway. Association of American Geographers Mtg.

Carroll, J.M. and **D.G. Krementz**. 2011. The development of a winter survey for Wilson's snipe in the Mississippi Flyway. Proceedings of the Southeastern Association of Fish and Wildlife Agencies.

Carroll, J.M., and **D.G. Krementz**. 2011. Wilson's snipe winter survey development in the Mississippi Flyway. Mississippi Flyway Technical Section Meeting - Webless Committee

Posters Presented

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 & 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.

Krementz, D.G. 2012. King rail breeding ecology. Red Slough Birding Convention

Committees/Task Forces/Recovery Teams

Magoulick, D.D. – Ecologist, Department of Biological Sciences, University of Arkansas 2011-2012

Magoulick, D.D. – Global Change Ecologist, Department of Biological Sciences, University of Arkansas 2003 – 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

Magoulick, D.D. – Regional Science Fair Judge 2011

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

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. – Research Grade Evaluation Panel October 2012

Krementz, D.G. – Member, Arkansas State Wildlife Action Group September 2008 - September 2011

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

TECHNICAL ASSISTANCE

Training Offered

Training Received

Fournier, A. – ATV Rider Certification – ATV Safety Institute – 2012
Fournier, A. – CPR and First Aid Training – American Red Cross – 2012
Olsen, B. – AAA Driver Improvement Program – University of Arkansas – 2011
Olsen, B. – Electrofishing Safety – US Department of the Interior – 2012
Olsen, B. – Adult CPR/AED/First Aid Training – University of Arkansas – 2012
Beasley, K. – AAA Driver Improvement Program – University of Arkansas – 2011
Coulter, J. – AAA Driver Improvement Program – University of Arkansas – 2011
Coulter, J. – ATV Safety E-Course – ATV Safety Institute – 2011
Coulter, J. – Wildland Chainsaw Training S-212 – US Forestry Services 2011
Boone, M. – ATV Safety E-Course – ATV Safety Institute – 2012
Boone, M. – AAA Driver Improvement Program – University of Arkansas – 2012
Brinkman, L. – AAA Driver Improvement Program – University of Arkansas – 2012
Brinkman, L. – ATV Safety E-Course – ATV Safety Institute – 2012
Lehman, J. – AAA Driver Improvement Program – University of Arkansas – 2012
Lehman, J. – ATV Safety E-Course – ATV Safety Institute – 2012
Willard, K. – Safety: Introduction to Industrial Hygiene – US Department of the Interior – 2012
Willard, K. – Safety: DOI Safety and Occupational Health Overview – US Department of the Interior – 2012
Willard, K. – Safety: Authorities, Roles, and Responsibilities – US Department of the Interior – 2012
Willard, K. – Safety: USGS Safety and Occupational Health Program Overview – US Department of the Interior – 2012
Willard, K. – Safety: USGS Safety Program Requirements – US Department of the Interior – 2012
Willard, K. – Adult CPR/AED/First Aid Training – American Red Cross – 2012
Nolen, M. – Adult CPR/AED/First Aid Training – University of Arkansas – 2011
Saenger, A. – AAA Driver Improvement Program – University of Arkansas – 2012
Edmondson, A. - AAA Driver Improvement Program – University of Arkansas – 2012
Costello, P. – AAA Driver Improvement Program – University of Arkansas – 2012
Leasure, D. – AAA Driver Improvement Program – University of Arkansas – 2012
Lynch, D. – FWS-CSP2C01-OLT-Principles and Techniques of Electrofishing – US Department of the Interior – 2012
Pittman, H. – Adult CPR/AED/First Aid Training – University of Arkansas – 2011
Reddin, C. – AAA Driver Improvement Program – University of Arkansas – 2012
Ronke, M. – AAA Driver Improvement Program – University of Arkansas – 2012

Magoulick, D. – FWS-CSP2C01-OLT-Principles and Techniques of Electrofishing – US Department of the Interior – 2012

Magoulick, D. – Applied Fluvial Geomorphology course, Wildland Hydrology, Fayetteville 2011

Krementz, D. G. – Adult CPR/AED/First Aid Training – American Red Cross – 2012

Krementz, D.G. – Boat U.S. Foundation's Online Boating Safety Course, 2011

Krementz, D.G. – NSC Defensive Driving II, US DOI, 2012

Krementz, D.G. – Authorities, Roles and Responsibilities for Executives, US DOI, 2012

Krementz, D.G. – USGS Safety and Occupational Health Program Overview, USGS, 2012

Krementz, D.G. – USGS Sustainability and Environmental Management System Awareness, USGS 2012

Krementz, D.G. – Federal Information Systems Security Awareness + Privacy and Records Management, USDI, 2012

Krementz, D.G. – The Humane Care and Use of Laboratory Animals, University of Arkansas, 2011

Krementz, D.G. – USGS Ethics Training, USGS, 2011

Krementz, D.G. – Policy and Procedures, University of Arkansas, 2012

Krementz, D.G. – Discrimination and Whistleblowing in the Workplace, USGS, 2012

Krementz, D.G. – Veteran Employment Training for Hiring Managers, DOI, 2012

Krementz, D.G. – USGS Ethics Training, USGS, 2012

RECENTLY GRADUATED STUDENTS
(name, degree, date, theses/dissteration, current position)

James M. Carroll (M.S. 2011 University of Arkansas) Dr. David G. Krementz (Wildlife)
The Development of a Winter Survey for Wilson’s Snipe in the Mississippi Flyway
Ph.D. Oklahoma State University

Jon M. Flinders (Ph.D. 2012 University of Arkansas) Dr. Daniel D. Magoulick (Fisheries)
Stable Isotope Analysis and Bioenergetic Modeling of Spatial-Temporal Foraging Patterns and Consumption Dynamics in Brown and Rainbow Trout Populations within Catch-and-Release Areas of Arkansas Tail Waters
Resident Fisheries Biologist, Idaho Department of Fish and Game, Salmon, ID

Matthew Nolen (M.S. 2012 University of Arkansas) Dr. Daniel D. Magoulick (Fisheries
Habitat Modeling of Three Endemic Crayfish Species in the Black River Drainage of Missouri and Arkansas: Factors Affecting Distribution and Abundance
Para-Professional, Union Public Schools, Tulsa, OK