Annual Report
2007-2008

Arkansas Cooperative Fish and Wildlife Research Unit

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University of Arkansas

Wildlife Management Institute, Washington D.C.

Arkansas Game & Fish Commission

ARKANSAS COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

ANNUAL REPORT 2007-2008

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

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

The Arkansas Cooperative Fish and Wildlife Research Unit first opened its doors in August 1988 as one of four units initiated that year, and one of 40 coop units across the country associated with Land Grant universities, state game and fish agencies, Wildlife Management Institute, and the U.S. Geological Survey. The purpose of these units is to train graduate students in scientific methods of fish and wildlife management, conduct fish and wildlife research, and provide technical assistance.

Over the past 20 years the Arkansas Coop Unit has gone through a number of changes. The federal cooperator changed from the U.S. Fish and Wildlife Service to the National Biological Survey to National Biological Service and finally to U.S. Geological Survey. The University department changed from Zoology to Biological Sciences and combined with Botany and Microbiology. We have seen nine Departmental Chairs (Amlaner, Geren, Kaplan, Talburt, Rhoads, Roufa, Davis, Smith, and Spiegel), and five Assistant Unit Leaders move on to other coop or university positions (Annette, Martin, Griffith, Kwak, and Thompson) and one Unit Leader retire (Johnson).

Past research efforts have been broadly funded by state agencies (Arkansas Game and Fish Commission, Louisiana Wildlife and Fisheries, Mississippi Museum of Science), federal agencies (U.S. Fish and Wildlife Service, U.S. Forest Service, U.S. Geological Survey, National Park Service), and non-government organizations (Ducks Unlimited, Rocky Mountain Elk Foundation, Arkansas Audubon Society Trust, Trout Unlimited, Sigma Xi). These funded projects have resulted in many scientific articles.

In 1999, the Unit was reformed under a new Unit Leader, David Krementz, and soon thereafter 2 new Assistant Unit Leaders were hired, Dan Magoulick (fisheries) and Bill Thompson (wildlife). With the full support of all cooperators, this new team began a new era at the Arkansas Coop Unit. The opportunities that exist in Arkansas for the Unit at this time are many and exciting. With the cooperation of all parties, the new Arkansas Coop Unit will excel in producing quality graduate students, solid research and supportive technical assistance.

MISSION STATEMENT

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

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

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

PERSONNEL AND COOPERATORS

COORDINATING COMMITTEE MEMBERS

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RESEARCH TECHNICIANS

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CURRENT GRADUATE STUDENTS

Jason Bolenbaugh (M.S., Wildlife – Krementz)
Matt Carroll (M.S., Wildlife- Krementz)
Matthew Dekar (Ph.D., Fisheries – Magoulick)
Jon Flinders (Ph.D., Fisheries – Magoulick)
John Ludlam (Ph.D., Fisheries – Magoulick)
Leah Scott (M.S., Wildlife – Krementz)

RECENTLY GRADUATED GRADUATE STUDENTS

Michael J. Budd – M.S., (Krmentz)
Aaron Cushing – M.S., (Magoulick)
Abby Darrah – M.S., (Krementz)
Shawn Hodges – M.S., (Magoulick)
Eric Larson – M.S., (Magoulick)

HOURLY TECHNICIANS

Kwasi Asante – Mallard Satellite
Clark Baker – Forage Base & Trout Production – King Rails
Brandon Bolding – Forage Base & Trout Production
Shawn Boomsma – Forage Base & Trout Production
Nedra Brown – Office Help
Ashley Clement – Forage Base & Trout Production
Matthew Dickhut – Forage Base & Trout Production
Nicholas Donaghey – Forage Base & Trout Production
Kyla Ercit – Woodpecker Habitat
Amy Finfera – Woodpecker Habitat
Andrea Green – Sora Rails
Damon Hollis – Woodpecker Habitat
Miller Jarrell – Catch & Release Trout – Forage Base & Trout Production
Blake Jones – Forage Base & Trout Production
Cameron Kovah – Woodpecker Habitat
Dana Krementz – Office Help
William Tyler Lamon – Office Help
Kelly Laycock – Crayfish
Jason Luscier – Woodpecker Habitat
Maureen McClung – Web Design & Update
Andrea Miller – Woodpecker Habitat
Jonathan Mize – Forage Base & Trout Production
Robert Pitts – Forage Base & Trout Production
Breanna Powers – King Rails
Hannah Pruett – Woodpecker Habitat
Angela Rose – King Rails
Jessica Shaw – King Rails
Andrew Spees – Transmitter Harness Study
Ryan Sniegocki – Forage Base & Trout Production
Kayla Steele – Forage Base & Trout Production
John Stewart – Office Help
Paul Tidwell – Woodpecker Habitat
John Urquhart – Forage Base & Trout Production
Kirsten Wert – King Rails
Brandon Banks – Collaboration between Environmental Dynamics Program & Honors College, University of Arkansas

RESEARCH AND FACULTY COLLABORATORS

Dr. Steven Beaupre – Department of Biological Sciences – University of Arkansas
Dr. Johnnie Gentry – Department of Biological Sciences – University of Arkansas
Dr. Jim Peterson – Water Resources Division - USGS
Dr. Larkin Powell – School of Natural Resource Sciences – University of Nebraska
Dr. Fred Spiegel – Department of Biological Sciences – University of Arkansas
David Mott – Buffalo National River, National Park Service
Dr. Bill Uhlein – U.S. Fish and Wildlife Service
Mr. Randy Wilson – U.S. Fish and Wildlife Service
Dr. Sammy King – Louisiana Cooperative Fish and Wildlife Research Unit
Dr. Tom Cooper – U.S. Fish and Wildlife Service
Dr. Mike Plummer – Harding University

COMPLETED PROJECTS

Wildlife

Surveying for woodpeckers in the Big Woods

Woodpecker-Habitat Relationships on Public Lands in the Big Woods of Arkansas

Funding Source:	U.S. Fish & Wildlife Service
Project Duration:	April 2006 to May 2008
Principal Investigator:	DAVID G. KREMENTZ
Graduate Research Assistant:	JASON D. LUSCIER

Research Objectives:

1. To determine the habitat use of woodpeckers in the Big Woods of Arkansas

Management Implications:

1. The information gathered will allow state and federal natural resource agencies to better manage public lands for woodpeckers, and especially the ivory-billed woodpecker.

Project Summary:

The recent rediscovery of the ivory-billed woodpecker (IBWO) in the Big Woods of Arkansas has raised a number of questions regarding how to best manage for this bird in the Mississippi Valley Bird Conservation Region. To begin this process, an understanding of the habitat needs of the IBWO is necessary. Based on historical accounts, we know that IBWO had some habitat affinities including a selection for: 1) extensive continuous forest areas, 2) very large trees, 3) continuing supply of recently dead trees, 4) an open canopy, and 5) an association with some tree species (e.g., sweetgum, Nuttall's oak) along with an avoidance of other tree species (e.g., overcup oak, water hickory). These habitat needs probably met both foraging needs, and nesting/roosting tree requirements. Whether any one or some combination of these variables met some limiting requirement is unknown, but Tanner suggested that forage availability was an important determinant for the presence of IBWO in a particular woodland tract. With these habitat variables known, in theory, it should be possible to survey for IBWO on public lands in the Big Woods of Arkansas and assess which variables are more or less important. Unfortunately there are few IBWO to survey.

However, Tanner mentioned that an indicator of good IBWO habitat was an abundance of any woodpeckers. Thus, we investigated IBWO-habitat relationships on public lands in the Big Woods of Arkansas using woodpecker densities as a surrogate for IBWO use.

The study sites included Dagmar, Trustin Holden, Rex Hancock/Black Swamp, Bayou Meto, Wattensaw, Henry Gray/Hurricane Lake WMAs, and Cache and White River NWR. A recently completed habitat inventory and assessment for IBWO on public lands in the Big Woods of Arkansas (http://www.lmvjv.org/IBWO_habitat_inventory_&_assessment.htm) was the sampling frame. This sampling frame allowed us to select a set of available points to survey. Again, these points were selected based on the five variables above. We recognized that a balanced sample was not be possible for various reasons (logistical, availability), and so we emphasized selecting across variables 2 (large trees), and 3 (continuing supply of recently dead trees) first. Large trees are required by IBWO to produce roost and breeding cavities in. Forage availability for IBWO was considered uncertain across time and space and was thought to directly influence stand occupancy rates.

Point-transect bird surveys were conducted at each site for 2 months during 2007 spring (before leaf out: Feb, Mar) and 2006 & 2007 summer (after leaf out; May, June). We used the bird monitoring protocol for forest interior birds as described by the Lower Mississippi Valley Joint Venture population monitoring group at: http://www.lmvjv.org/library/pop_monitoring/LMVJV_Point_Count_Procedures.doc. The format of data collected allowed analyses to be conducted both in program DISTANCE and program PRESENCE. Program PRESENCE uses a repeated measures approach to better estimate the probability of detecting a woodpecker species at a site. With this better estimate of detection, it was then possible to better estimate the probability of a site being occupied. During this process, we investigated the effects of covariates on both detection and occupancy.

We detected 4047 individual woodpeckers across 3588 detections which varied in number by species and survey season. Thus most detections were of a single individual woodpecker. We had enough detections to estimate densities of downy woodpeckers (DOWO), red-bellied woodpeckers (RBWO), and pileated woodpeckers (PIWO) during all 3 survey seasons. Red-headed woodpeckers (RHWO), yellow-bellied sapsuckers (YBWO), and northern flickers (YSFL) are primarily winter visitors to the Big Woods, thus we were only able to estimate their densities during winter 2007 (i.e., there were not enough detections to estimate densities during either breeding season). In no season were we able to estimate densities for hairy woodpeckers (HAWO).

Although the 95% CI's overlapped, there was a general pattern for PIWO and DOWO densities to be lower during the winter season than during the breeding season. The opposite pattern was true for RHWO, YBSA, and YSFL when densities could only be estimated during the winter. Unlike the other woodpeckers, the RBWO density estimates increased with each successive survey season. DOWO densities were similar each season. DOWO and RBWO densities were higher than PIWO densities each season. PIWO densities were always lower than the other estimable woodpecker densities.

We found that the bottomland hardwood forests of the Big Woods of eastern Arkansas harbor some of the highest densities of woodpeckers in the southeastern United States. Our high woodpecker density estimates for the Big Woods are likely due to the abundance of older-growth hardwoods. In addition, the disturbance resulting from fluctuating water levels in the area provides ample foraging and nest-cavity excavating opportunities. If one accepts Tanner's (1942) hypothesis that high woodpecker densities are indicative of suitable IBWO habitat, then it follows that the Big Woods of eastern Arkansas provide suitable habitat for IBWO. Too, the generally high densities of all woodpeckers in the Big Woods indicates that current

management efforts in conjunction with altered hydrology cycles are appropriate for the woodpecker community in general.

King rail. Photo by Noppadol Paothong of Missouri Dept. of Conservation

Distribution of King Rails (*Rallus elegans*) in the Lower Mississippi Flyway

Funding Source:	U.S. Fish & Wildlife Service
Project Duration:	April 2006 to May 2008
Principal Investigator:	DAVID G. KREMENTZ
Co-Principal Investigator:	SAMMY L. KING
Graduate Research Assistant:	ABBY DARRAH (M.S. Student)

Research Objectives:

1. To determine the distribution of migrant king rails in Missouri during the breeding season.
2. To determine the occupancy rate of migrant king rails across Missouri during the breeding season
3. To better understand the habitat use of migrant king rails in Missouri during the breeding season

Management Implications:

1. The information gathered will allow state and federal natural resource agencies to better assess the current status of king rails throughout the lower Mississippi Flyway.
2. The habitat use information will allow agencies to better manage for king rails throughout the lower Mississippi Flyway.

Project Summary:

The king rail (*Rallus elegans*) is a large rail that associates with both fresh and brackish marshes and is widely distributed across eastern United States, southeastern Canada, eastern Mexico, and Cuba. King rail populations have declined dramatically over the last 30 years, largely due to loss of wetland habitat. Declines have been greatest in the migratory

populations of the midwest, and the species is considered threatened or endangered in some states. However, the king rail is a game bird in many Atlantic and Gulf coast states, where the resident populations are thought to be stable. The migration routes and wintering grounds of the migratory king rails are not well known, thus it is possible that these endangered populations are exposed to harvest in the winter.

Because of this pattern, we initiated a multi-stage series of interrelated projects to better understand the ecology of king rails in the lower Mississippi Flyway. First, we assessed the distribution, occupancy rates, and habitat use of king rails in Missouri during the breeding season. With better knowledge of this, we will then propose to investigate in more depth, the timing and routes followed and habitats used during fall migration, and determine the distribution, occupancy rates and habitat use of wintering king rails in coastal Louisiana.

To assess the distribution and habitat use of king rails along the Upper Mississippi Valley, we conducted repeated call-broadcast surveys at 83 sites in 2006 and 114 sites in 2007. We detected king rails at 8 sites in 2006 and 14 sites in 2007. We found king rails concentrated at Clarence Cannon National Wildlife Refuge, an adjacent private Wetland Reserve Program land, and B. K. Leach Conservation Area; these areas were located in the Mississippi River floodplain in northeast Missouri. Using the program PRESENCE, we estimated detection probability and incorporated habitat covariates into the estimation of site occupancy. We tested the fit of our data across a series of models which included percent cover of tall emergent vegetation (e.g. *Typha latifolia, Sparganium americanum*), short emergent vegetation (e.g. *Eleocharis palustris, Leersia oryzoides*), woody vegetation, and interspersion of water and vegetation (2007 only) within 50 m of the survey location. We found that the top occupancy model for 2006 included woody vegetation while the top occupancy model for 2007 included short emergent vegetation, tall emergent vegetation, interspersion, and woody vegetation. Site occupancy was negatively related to woody vegetation cover in both years and was positively related to interspersion (measured in 2007 only), while there was no consistent relationship between occupancy and tall or short emergent vegetation. To compare the habitat use of nesting and brood-rearing king rails, we randomly sampled 5-m plots within used and unused habitats during the nesting and brood-rearing seasons to measure water depth and determine dominant cover type. We fit logistic regression models to the data and selected among candidate models using AIC_c. We used the regression coefficient of top models to calculate odds ratios for habitat use. Nesting adults were more likely to use sites dominated by short emergent vegetation and deeper water, while broods were more likely to use sites dominated by short emergent vegetation and shallower water, and avoided areas dominated by tall emergent vegetation. During the nesting season throughout our study area, king rails occupied wetlands that were characterized by high coverage of short emergent vegetation, moderate coverage of tall emergent vegetation, high water-vegetation interspersion, and little or no coverage by woody vegetation. Nesting king rails used areas of deeper water, possibly as protection against mammalian predators, while broods may require shallower water for mobility and prey capture. Broods avoided areas with tall emergents, contrary to findings in other studies.

Common Moorhen photo taken at Arkansas Post, Arkansas by Michael J. Budd

Survey of Breeding Secretive Marsh Birds in the Delta Region of Arkansas

Funding Source:	Arkansas Game and Fish Commission
Project Duration:	April 2005 to July 2007
Principal Investigator:	DAVID G. KREMENTZ
Graduate Research Assistant:	MICHAEL J. BUDD (M.S. Student)

Research Objectives:

1. To determine the current breeding status of secretive marsh birds in the Delta of Arkansas.
2. To determine the probability of detecting secretive marsh birds.
3. To understand basic habitat types occupied by secretive marsh birds.

Management Implications:

1. The information gathered will allow the AGFC to assess the current status of secretive marsh birds throughout the rest of Arkansas.
2. Should these marsh birds be located on AGFC WMAs, then the agency would be in better control of its species of concern.
3. Results will provide population surveys that will determine responsible harvest limits.

Project Summary:

The Delta Region of Arkansas was once part of a vast wetland area comprised mostly of bottomland hardwoods as well as emergent, and submergent wetlands, and prairie. Before European settlement, the LMAV was a 10 million-ha, forested-wetland system. Between the 1950s and the 1970s, much of this land was cleared and converted to agriculture and aquaculture facilities. Along with this change in land use has been an unknown change in the use of those wetlands by secretive marsh birds.

The status and distribution of secretive marsh birds in Arkansas is not well known. Most marsh bird populations are in decline and are listed as species of management concern by federal, state, and local agencies. We surveyed the Delta during the summers of 2005 and 2006 using call-playback surveys and multiple repeat visits at each site to determine the current status of secretive marsh birds. We surveyed 190 sites overall for 2005 and 2006 and found that secretive marsh birds were uncommon in this region. All breeding species were detected at less than 22% of sites surveyed. In 2005, 54% of sites had ≥1 species of secretive marsh bird, and 28% of sites had >1 species. The average number of species per occupied wetland was 1.9 (SE = 0.16). The maximum number of marsh bird species found at any one site was 5, which occurred at 1 site. In 2006, 46% of sites had ≥1 species of secretive marsh bird and 56% of sites had >1 species. The average number of species per occupied wetland was 2.3 (SE = 0.21). The maximum number of marsh bird species found at any one site was 6, which occurred at 1 site. We found that most secretive marsh bird species occurred more frequently in the southern region of the Delta. We modeled habitat selection of the least bittern (*Ixobrychus exilis*) and pied-billed grebe (*Podilymbus podiceps*) as they were the only species detected at enough sites to permit analysis. We used program PRESENCE, which accounts for imperfect detection, to model habitat selection. Model selection provided substantial support for the least bittern's selection of wetlands with increasing amounts of emergent vegetation and minimal amounts of forest adjacent to the wetland. Model selection did not provide support for habitat selection by the pied-billed grebe.

Stream cages for crayfish competition experiment in the South Fork Spring River

Effect of the Introduced Crayfish, *Orconectes neglectus*, on Native Crayfish in the Spring River Drainage

Funding Source:	Arkansas Game and Fish Commission, U.S. Fish and Wildlife Service
Project Duration:	15 July 2005 to 15 December 2007
Principal Investigator:	DANIEL D. MAGOULICK
Graduate Research Assistant:	ERIC LARSON (M.S. Student)

Research Objectives:

2. Test the hypothesis that environmental changes do not prevent *O. eupunctus* juveniles from surviving and growing in their former range.
3. Test the hypothesis that *O. neglectus* outcompete *O. eupunctus* at the juvenile life history stage.
4. Compare life histories of *O. neglectus* and *O. eupunctus* in the Spring River drainage.

Management Implications:

1. Information from this study will help determine current impacts and predict future impacts of the introduced crayfish species on native species.

2. Understanding mechanisms of displacement and effects of introduced crayfish on native species will allow managers to develop informed strategies regarding the need for mitigation and potential success of mitigation efforts.
3. Information gained here will be especially important in making decisions regarding the conservation of three species that are potentially at risk from this invasion, *Orconectes eupunctus*, (locally rare and uncommon and globally imperiled) *Orconectes marchandi* (both locally and globally imperiled), and *Cambarus hubbsi*.

Project Summary:

Two native crayfish species, *Orconectes eupunctus* (globally imperiled) and *Cambarus hubbsi*, appear to have been displaced from part of their former range in the Spring River drainage of Arkansas and Missouri by the introduced crayfish *O. neglectus chaenodactylus*. Previous research suggested that *O. eupunctus* have been displaced from their former range by biotic interactions, but interspecific competition between *O. eupunctus* and *O. neglectus* adults during summer does not appear to be the mechanism responsible for this displacement. Therefore, this study seeks to explore other potential mechanisms in the disappearance of *O. eupunctus* from the upper South Fork Spring River watershed.

One objective of this study was to examine competitive interactions at the juvenile, rather than adult, life stage. Juvenile crayfish compose the majority of the crayfish community in Ozark streams and rivers through the summer and fall, and exhibit high growth rates. Consequently, this may be an appropriate life stage at which to detect competition. We used field experiments in stream enclosures and agonistic interactions in the laboratory to test for evidence of competition between *O. neglectus* and *O. eupunctus* juveniles. *Orconectes eupunctus* juveniles grew and survived in their former range, with no significant difference between *O. eupunctus* and *O. neglectus* growth rates ($F=0.004$, $P=0.952$). In laboratory trials, *O. neglectus* was generally dominant in the presence of limited food, while *O. eupunctus* juveniles were more likely to use limited shelter. A field experiment of competition found that *O. neglectus* juveniles did not impair the survival or growth of *O. eupunctus* juveniles ($F=0.632$, $P=0.439$). Results of this study indicate that while biotic interactions rather than habitat degradation seem to be responsible for the displacement of *O. eupunctus* from its former range, competition at the juvenile life stage is an unlikely mechanism for the displacement.

Another objective of this project was to examine the role of life history in the *O. neglectus* introduction and apparent displacement of native Spring River crayfish. Life history has been found to contribute to some crayfish species replacements. Currently, the life history of *O. eupunctus* has not been documented, and life history studies of *O. neglectus* may not apply to the introduced population in the Spring River drainage. Monthly life history sampling of *O. eupunctus* and *O. neglectus* from June 2005 to December 2006 was used to gather information on timing of reproductive events, fecundity, and juvenile growth rates that might provide *O. neglectus* with advantages over *O. eupunctus*. Timing of reproductive events were synchronous and juvenile growth rates comparable between the two species. *Orconectes neglectus* females carried significantly more eggs than *O. eupunctus* females ($F=6.221$, $P=0.016$). While fecundity might favor *O. neglectus* in the invasion, a much higher proportion of *O. eupunctus* individuals were reproductively active (90% of females with eggs compared to

30% of females with eggs) and this may negate the difference in eggs per female between the species.

Finally, additional studies exploring the apparent displacement of *O. eupunctus* are planned for 2007, with an emphasis on investigating the potential role of disturbance (stream drying) in the success of *O. neglectus* as an introduced species.

A rainbow trout receives a transmitter.

Research tech Miller Jarrell tracks a fish.

Effect of Catch and Release Areas on Movement and Mortality of Resident Rainbow Trout in Bull Shoals and Norfork Tailwaters

Funding Source:	Arkansas Game and Fish Commission.
Project Duration:	June 2004 to December 2007
Principal Investigator:	DANIEL D. MAGOULICK
Graduate Research Assistant:	AARON CUSHING (M.S. Student)

Summary:

Special regulations have been instituted on portions of the cold tailwater fisheries in Arkansas. Catch and release (CR) areas have been located along the Bull Shoals and Norfork tailwaters to "exploit" trout "growth potential". In other words, trout should stay in the system longer, and therefore grow larger. This hypothesis assumes that, 1) trout do not move out of the special regulation areas, 2) trout do not suffer high angler mortality rates within the special regulation areas, and 3) the forage base is sufficient for growth within the special regulation areas. In this project, we will address the assumptions one and two and we will address the third assumption in a companion project.

Goal:

Determine effects of catch and release areas on movement and mortality of resident rainbow trout in Bull Shoals and Norfork tailwaters.

Project Objectives:

1. Determine most effective tag retention technique for surgical implantation of transmitters.
2. Determine whether trout maintain home ranges within the tailwater and the relationship between home range size and special regulation areas.
3. Determine movement, mortality and habitat use of rainbow trout prior to installation of planned habitat improvement projects.

Management Implications:

1. This study will determine the effect of catch and release areas on movement and mortality rates of resident rainbow trout in Bull Shoals and Norfork tailwaters.
2. This information will help managers to determine the effectiveness of special regulation areas.
3. Knowledge of movement and mortality rates of resident rainbow trout will help managers determine stocking effectiveness and potential causes for low numbers of trout returned to creel.
4. Knowledge of site fidelity, home range and movement patterns will permit managers to determine effective sizes of special regulation or habitat manipulation areas.

Project Update

A series of tag retention studies using a variety of fish sizes and surgical techniques were conducted at the Jim Hinkle Mammoth Spring Hatchery from the fall of 2004 to the spring of 2005. The most promising technique was then used in a preliminary field study conducted in the Norfork CR area in the summer of 2005 to become familiar with the tracking equipment and determine retention rates. Four weeks after surgery, retention rates were satisfactory and examination of tagged individuals showed complete healing with little or no infection. A total of 124 fish had ≥ 15 weekly tracking locations from July 2005 to October 2006. Home-ranges were determined based on total linear distance and kernel density estimates. The most downstream area, with higher water temperatures, had the greatest proportion of fish moving outside the CR area. There were no significant differences in movement patterns between fish tagged in and out of CR areas. Summer movements in all but the farthest downstream area were limited (0-10 meters). In fall and spring several fish made upstream migrations covering distances ranging from 6-40 kilometers. Overall, most fish did not move outside of the area where they were tagged (70% in CR areas, 54% in non-CR areas). The length of most CR areas in the White River and Norfork River appears to be sufficient to encompass movement and home ranges of most rainbow trout. However, downstream CR areas with high water temperatures may not provide suitable habitat for rainbow trout to remain resident. Knowledge of movement patterns and home ranges will allow managers to more effectively establish the size and location of special regulation areas. Project results support the assumptions that 1) most trout remain within the CR areas, and 2) angler mortality is lower in these areas.

CURRENT PROJECTS

Fisheries

River otter inhabiting experimental pond

Effects of Otter (*Lontra canadensis*) Predation On Stream Communities

Funding Source:	Arkansas Game and Fish Commission
Project Duration:	August 2004 to June 2009
Principal Investigator:	DANIEL D. MAGOULICK
Graduate Research Assistant:	MATTHEW P. DEKAR (Ph.D. Candidate)

Objectives:

1. Quantify aquatic and riparian food webs and investigate spatial and temporal variation in predator-prey dynamics between otters and the aquatic community.
2. Quantify otter diet and investigate abiotic factors regulating the seasonal availability of prey.
3. Estimate daily energy expenditure with doubly labeled water and develop a bioenergetics model to estimate seasonal consumption of aquatic prey.

Management Implications:

1. Results will highlight important interactions and impacts of otters on prey populations, including sport fishes.
2. Bioenergetics models will give insight into ecological and physiological constraints regulating otter populations.
3. Results will enable predictions concerning how predator and prey populations will respond to environmental variation associated with seasonal fluctuations in water levels and temperature.

Project Summary:

River otters (*Lontra canadensis*) are primarily aquatic specialists and foraging in the aquatic environment requires high metabolic rates, with large costs associated with thermo-regulation and swimming. Considering the elevated energetic demand, otters must consume a large portion of local biomass production in order to grow and reproduce, with important consequences to community and ecosystem dynamics. In particular, there is growing concern that otters both prey upon and compete with important sport fishes. Therefore, our objectives are to examine the effects of river otter predation on the abundance and distribution of fish and crayfish in Little Mulberry Creek and the Mulberry River of northwest Arkansas, U.S.A. From 2005 to 2008, we quantified spatial and temporal variation of stream food webs using circular statistics and stable isotopes. In addition, we sampled otter feces for diet analysis seasonally and we obtained stomachs from otter carcasses collected during the winter trapping season. In 2007, we began monitoring crayfish abundance to develop predictive models of otter diet based on prey availability. Finally, in 2008 we began a doubly labeled water experiment with captive otters in an experimental pond to estimate daily energy expenditure. Results indicated that otters consume mostly crayfish but switch to fish during the winter, corresponding to a decrease in crayfish availability. We are currently developing an otter bioenergetics model with diet and metabolism data to estimate seasonal consumption of aquatic prey.

River otter prior to release after blood sampling on Little Mulberry Creek

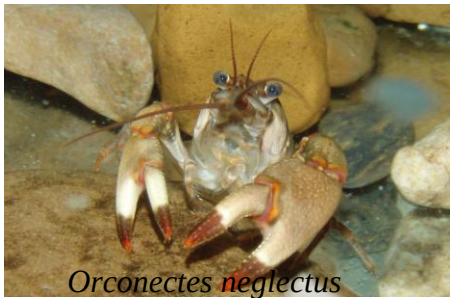
Experimental crayfish and stoneroller grazing exclusions in the Little Mulberry River, AR (left). Mesocosm experiments conducted in a greenhouse laboratory (right).

The Effects of Stream Drying on Grazer-Mediated Processes in Boston Mountain Streams and the Importance of Grazer Identity

Project Duration: June 2005 to December 2008
Principal Investigator: DANIEL D. MAGOULICK
Graduate Research Assistant: JOHN LUDLAM (Ph.D. Student)

Research Objectives:

Identify biotic and abiotic factors that influence grazer-benthos interactions in an intermittent Ozark stream and determine how two dominant grazers differ in response to flow-related disturbance.



Orconectes neglectus

Management Implications:

1. Stream drying is likely to increase in frequency and severity under recent climate projections. Understanding how drying affects stream functioning will inform management decisions for conserving these systems.
2. This research will help in developing predictions for changes in water quality and nutrient dynamics in headwater streams due to stream drying.

Project Summary:

Crayfish and central stonerollers graze algae, consume detritus and invertebrates, resuspend deposited silt and alter substrate characteristics. Through these mechanisms they can have large impacts on functioning of headwater streams. Seasonal drying in Boston Mountain streams reduces water levels in pools, dries riffles, disconnects habitats, increases densities of aquatic organisms, and may alter predation risk for biota. Additionally, it may affect the ability of crayfish and central stoneroller minnows to mediate stream functioning. We are

examining how drying affects grazer-mediated stream functioning (GMSF) and testing how grazer identity affects the responses of GMSF to stream drying. Manipulative field experiments have tested these hypotheses in natural systems using electric fence chargers to control the presence of grazers. We are also using experimental stream mesocosms to simulate drying in a more controlled laboratory setting.

Sign indicating the start of the Norfork C-R

Jon Flinders with a rainbow trout collected in Bull Shoals tailwater, AR

The relationship between forage base and trout production in catch and release areas on Bull Shoals and Norfork tailwaters.

Funding Source:	Arkansas Game and Fish Commission.
Project Duration:	1 January 2004 to 31 December 2008
Principal Investigator:	DANIEL D. MAGOULICK
Graduate Research Assistant:	JON M. FLINDERS (Ph.D. Student)

Research Objectives:

1. Determine proportions of prey items consumed by brown trout and rainbow trout in special regulation areas of Bull Shoals and Norfork tailwaters.
2. Determine relative contributions of various food sorces to trout production.
3. Determine whether the prey base is limiting trout production.
4. Determine effectiveness of gut contents analysis and stable isotope analysis in developing a bioenergetics model.

Management Implications:

1. This study will determine whether the prey base is adequate to support trout production within special regulation areas on Bull Shoals and Norfork tailwaters.
2. This information will help managers to determine if stocking rates are appropriate for the system and whether special regulation areas can achieve their stated goal of exploiting trout "growth potential".
3. An understanding of the relative contribution of prey items, such as sculpins and crayfish, to trout production will provide managers information that will be valuable in determining potential impacts of bait harvest on trout production.
4. All of this information should help fishery biologist to better manage the Bull Shoals and Norfork tailwater trout fisheries.

Project Summary:

Catch-and-release regulations are commonly used in sport fisheries in an attempt to provide increased residence times and survival rates and provide more and/or larger fish. Most catch-and-release studies address factors that affect immediate mortality rates in fish, but rarely evaluate fish growth rates and food resources. We used a bioenergetics modeling approach to examine whether food resources limited brown and rainbow trout production in three catch-and-release areas in Bull Shoals and Norfork tailwaters. We incorporated field data on brown and rainbow trout thermal experience, growth, diet analysis, and abundance from catch-and-release areas into species-specific bioenergetics models to quantify seasonal consumption of benthic fish and drifting invertebrates and compared prey consumption rates to prey availability. Growth rates were reduced in fall and winter for both species, indicating a possible seasonal bottleneck in prey supply. Based on diet analysis, Amphipoda, Chironomidae, Cladocera spp., Decapoda, Gastropoda, Isopoda, and sculpin were commonly ingested by brown and rainbow trout, but varied by species, season, and site. Despite the lack of energetic value to trout, filamentous algae was also found in stomachs of rainbow trout in high proportions at each site across all seasons, indicating epibenthic foraging. Sculpin became more common in the stomachs as brown trout attained larger sizes (>250 mm), indicating a shift to piscivory with size. Abundances of trout in Norfork C-R were nearly twice as high as Bull Shoals. Food limitation for rainbow trout appeared to occur in fall/winter, whereas brown trout were typically not food limited. Norfork CR area supported higher consumption, growth rates and densities than Bull Shoals for both species, and Bull Shoals prey base was adequate to maintain or support brown trout growth. This information will assist managers in determining the effectiveness of the catch-and-release areas in Arkansas tailwaters.

King rail by J. J. Audubon

Assessing an expert-based landscape approach to predict King Rail (*Rallus elegans*) distribution

Funding Source:	U.S. Fish & Wildlife Service
Project Duration:	January 2008 to September 2010
Principal Investigator:	DAVID G. KREMENTZ
Graduate Research Assistant:	JASON R. BOLENBAUGH (M.S. Student)

Research Objective:

1. To evaluate the predictive ability of the king rail Landscape Suitability Index (LSI) model.
2. To determine the distribution of the king rail in the Upper Mississippi River/Great Lakes Region Joint Venture (JV).
3. To identify areas of high king rail abundance within the JV.
4. To provide recommendations that will assist in creating a more reliable LSI model for future king rail management.

Management Implications:

1. The information gathered will allow federal and state agencies to better assess the current status of king rails throughout the JV.
2. The information gathered will also allow the JV to assess the current LSI model and make possible improvements for future king rail management.
3. The habitat use information will allow agencies to better manage for king rails throughout the JV.

Project Summary:

Landscape Suitability Index (LSI) models are predictive models that provide wildlife biologists and managers with a tool to evaluate wildlife habitat quality across large landscapes. The

development of predictive habitat models has rapidly increased in biological sciences with the rise of new powerful statistical techniques and Geographical Information Systems (GIS). GIS, combined with abundant landscape-level data provides new approaches for wildlife managers that are neither labor intensive nor time consuming to develop and evaluate ecological characteristics (e.g. habitat quality, location of habitat) over a large landscape scale.

Severe population declines have been reported in the northern part the king rails (*Rallus elegans*) range. In addition, king rails are listed as either threatened or endangered in 13 states, and is considered a Species of Greatest Conservation Need in 30 of 34 states within its range. LSI models can be especially important when managing for rare species, such as the king rail, and can be used to facilitate protection and restoration of critical habitats.

From 4 May to 12 July we surveyed 264 high, moderate, and low suitability sites in the Upper Mississippi/Great Lakes Joint Venture Region, hereafter referred to as the JV. The JV encompasses all or portions of 10 mid-western states (IA, IL, IN, KS, MI, MN, MO, NE, OH, and WI). Areas of high suitability habitats were characterized as emergent herbaceous or woody wetlands >20ha, and <20km from a known breeding site. Moderate suitability habitats consisted emergent herbaceous or woody wetlands <20ha, and <20km from a known breeding site. Low suitability habitats were classified as having emergent herbaceous or woody wetlands <20ha, within counties of historic presence, or outside counties of historic presence but within the breeding range.

Both high and moderate suitability areas were quite clumped in distribution. Because of this clumped distribution, the high and moderate suitability sites were often located within adjacent wetland complexes on the same management units, and equally vulnerable to the flood events that occurred in 2008. The heavy rainfall resulted in extensive flooding that inundated most of our intended survey sites. As a result of the flooding, we were forced to haphazardly select 114 new sites. We attempted to relocate sites to wetlands nearest the original site. Flooding was sometimes so extensive that low suitability sites were the only nearby replacements for moderate and high suitability sites. We replaced 87 high and moderate sites with low suitability sites. Of the 264 sites that we surveyed, 151 were low, 29 were moderate, and 84 were high suitability sites.

We surveyed each site 3 times and detected 8 king rails at 5 low suitability sites, 3 of which were at Goose Pond Fish & Wildlife Area in Linton, IN. We detected 2 king rails at Goose Pond 10 on 20 May, and another 1 on 7 June. We also detected 1 bird at Goose Pond 6 and 1 at Goose Pond 8 on 7 June. Other king rail detections included a pair at Whiteriver Wildlife Management Area (WMA) in Minnesota City, MN on 7 June, as well as 1 detection at B.K. Leach Conservation Area (Bittern Basin) in Elsberry, MO. One king rail was opportunistically detected at Four Rivers Conservation Area in Horton, MO on 31 May.

We collected habitat data within a 30-m radius centered at the point in which we were standing. Originally, we planned to analyze the response data and the habitat covariates using program PRESENCE to estimate occupancy rates (psi) and detection probabilities(p), however, estimating occupancy rates and detection probabilities will not be possible with our sparse dataset that consists of only 8 king rail detections. We will run other marsh bird data through

program PRESENCE to evaluate the efficiency of our sampling scheme and assess if the habitat variables will be useful in predicting occupancy.

In light of the 2008 flooding, we will reassess our sampling scheme and the distribution of our sampling sites. We feel an adjustment in the selection criteria for the LSI values may be necessary to reduce clumping of high and moderate suitability sites. Doing so will not only increase the number of those sites across the landscape and leave us less vulnerable to flood events.

Wildlife

Pectoral sandpiper at Bald Knob NWR, Arkansas

Concentration Area Demarcation and Abundance Estimation of Fall Migrating Shorebirds through the Lower Mississippi Alluvial Valley

Funding source:	U.S. Fish & Wildlife Service
Project Duration:	September 2008 to January 2010
Principal Investigator:	DAVID G. KREMENTZ
Postdoctoral Researcher:	SARAH E. LEHNEN

Research Objectives:

1. Determine traditional areas of shorebird concentration in the LMAV during fall migration by reviewing surveys conducted 1990-2008.
2. Produce current abundance estimates of shorebirds in the LMAV by conducting surveys during the 2009 fall migration season for targeted shorebirds.

Management Implications:

1. Information on shorebird fall migration concentration areas and timing in the LMAV will allow managers to better manage habitat for maximum shorebird use.
2. With this information, the FWS should be able to rapidly respond to a reported HPAI event in shorebirds in the LMAV should one occur.

Project Summary:

Asian outbreaks of the highly pathogenic avian influenza (HPAI) H5N1 virus in wild birds have created concern over the potential for an outbreak in North America. Several bird species with Alaskan and Siberian breeding habitats freely intersperse with Asian birds during the breeding season before returning to their non-breeding habitats in North and South America. Of particular concern are shorebirds species that regularly migrate through the Lower Mississippi Alluvial Valley (LMAV) as they move between their breeding and wintering grounds via the Mississippi Flyway.

Following the "Early Detection and Response Plan for Occurrence of Highly Pathogenic Avian Influenza in Wild Birds", we plan to assist with the development of an early detection system to determine areas federal and state wildlife agencies should target their search efforts for infected shorebirds during the fall period if and when the virus arrives in the Mississippi Flyway. We are focusing on the fall period because shorebirds do not concentrate during the spring migration in the LMAV. In addition, because shorebirds are at risk of contracting H5N1 on their breeding grounds the chance of an outbreak during fall migration is greater than in spring. The shorebirds targeted by this study are those species identified by the Mississippi Flyway Council as being at high-risk for contracting H5N1: pectoral sandpiper (*Calidris melanotos*), dunlin (*Calidris alpina*), long-billed dowitcher (*Limnodromus scolopaceus*), and to a lesser extent greater yellowlegs (*Tringa melanoleuca*), lesser yellowlegs (*T. flavipes*), and ruddy turnstone (*Arenaria interpres*).

Our plan involves two approaches.
Concentration area demarcation – We will demarcate traditional concentration sites for fall migrating shorebirds through the LMAV by: 1) searching federal and state birding literature, 2) consulting recognized local birding experts and management agencies, and 3) reviewing the LMAV Joint Venture shorebird monitoring database. From these sources, we will compile count data collected from standardized surveys completed during fall migration between 1990 and 2008 and augment this data set with observational data collected during this same time frame. Based on these counts adjusted for survey effort, we will identify areas of high use using kernel estimates of shorebird density by species. Next, we will determine a maximum number of individuals present of each species at each site for each time period. We will then combine these maximum counts across 2º latitudinal bands from 30º - 38º to produce chronology histograms for the fall across the region. We will also develop an index of dispersion from total maximum of each species based on the following categories: broadly dispersed (60% of birds occurred in 10 or more sites), moderately dispersed (3 to 9 sites), or concentrated (1 or 2 sites).

Abundance estimation - To augment the historical data and to produce current abundance estimates, we will conduct surveys during the 2009 fall migration for targeted shorebirds in the LMAV. Because shorebirds move from north to south over the course of fall migration, we will conduct line transect surveys in 3 bands across the LMAV over 3 periods (early, middle, late) during the fall. The 80-km wide bands will run east-west from bluff to bluff across the valley. The bands will be located at approximately 35, 33, and 31 degrees latitude. Each pass of the three bands will take 3 weeks for a sum total of 9 weeks of surveys. We will survey from the western to eastern bluff for shorebirds in predetermined shallow wetland and moist field habitats. As occupied habitats are encountered, we will follow an adaptive cluster sampling design to focus on nearby habitat. For each shorebird or shorebird flock detected we will measure the perpendicular distance from the road or levee using range finders and document the habitat type. We will then estimate shorebird densities using program DISTANCE. We will use these results to demarcate fall migration shorebird concentration sites for the LMAV.

NEW PROJECTS

Wildlife

Wilson's snipe. Photo by Jim Weis. Utah Division of Wildlife Resources

Development of a Winter Survey for Wilson's Snipe in the Mississippi Flyway

Funding Source: U.S. Geological Survey
Project Duration: January 2009 to May 2011
Principal Investigator: DAVID G. KREMENTZ
Graduate Research Assistant: J. MATTHEW CARROLL (M.S. Student)

Research Objectives:

1. To estimate population abundance for wintering Wilson's snipe in the Mississippi Flyway.
2. To determine the need for survey–specific covariates in the survey method.
3. To examine the factors that may affect variation in yearly abundance estimates at individual sites.

Management Implications:

1. To develop a standardized survey method for Wilson's snipe in the Mississippi Flyway.
2. To determine the important survey-specific covariates that need to be recorded in operational surveys.
3. To better understand habitat requirements of wintering Wilson's snipe.
4. Density and population estimates will provide initial data for monitoring Wilson's snipe.

Project Summary:

The Wilson's snipe (Gallinago delicata) is a relatively far ranging migratory species which is also an important game bird. The Wilson's snipe primarily breeds in the marshes, fens and swamps of the North American boreal forests. The remoteness of many of these breeding sites ensures minimal disturbance and the vegetation of the region provides for breeding snipe and their young. The wintering grounds are a stark contrast from the boreal forests. A large portion of the snipe population in North America winters in the southern United States, primarily in the Lower Mississippi Alluvial Valley. The wintering grounds provide nutrient rich soils that contain abundant invertebrate prey species, as well as, relatively mild and stable weather conditions which are conducive to energy conservation.

The population status of snipe is not well known as systematic surveys for this species are not conducted. What surveys are conducted, e.g., Christmas Bird Count, indicate declining populations. Too, harvest of snipe has declined but such trends may reflect a decline in hunter numbers more than a decline in snipe abundance.

Christmas Bird Counts have provided data on snipe populations and are an important source of information on population trends and yearly geographic shifts. However, the surveys are not tailored to snipe and do not provide consistent yearly information that can be used to make specific inferences about the overall population. Nevertheless, the Christmas Bird Counts have shown a significant decline in snipe between 1959 and 1988. To estimate the snipe population and ultimately determine indicators of a possible decline, correct survey methods and the timing of those surveys must be researched. Breeding surveys for snipe have proven difficult and inconsistent for a variety of reasons ranging from the complexity of factors affecting the audible detection of snipe (winnowing), to the logistical problems with visual surveys in the thick and remote breeding habitat. However, between mid January and early March in the southern United States snipe populations are relatively stable and the lack of vegetation at many sites provides better survey conditions.

From 20 January to 24 February 2009, we conducted line transect surveys across 50 townships throughout Arkansas, Mississippi, and Louisiana. The bulk of the sites were located in the Lower Mississippi Alluvial Valley; however, some sites were located in southwestern Louisiana and the Red River region of Louisiana. Twenty townships were picked based on data from the Christmas Bird Counts and thirty townships were chosen randomly within the region of study. Nine 1.8 kilometer line transect surveys were conducted in each township (where feasible) and were selected by a combination of random points and the proximity of those points to suitable roads. The distance to individual and clusters of snipe from the transect line were recorded. Also, habitat type, water depth, vegetation height, percent of vegetation and percent of water in each individual habitat were noted.

We will use program DISTANCE to estimate snipe densities at the township level. We will investigate whether habitat specific snipe densities can be estimated. Ultimately, we will estimate year specific population estimates for Wilson's snipe that winter in the Mississippi Flyway.

PRODUCTIVITY

HONORS AND AWARDS

Darrah, A.J**.** – Accepted into Ph.D. program at University of Arkansas, 2008
Green, A.W. – Accepted into Ph.D. program at Colorado State, 2008
Ludlam, J.P. – NSF GK-12 Graduate Fellowship, University of Arkansas, 2008
Dekar, M.P. – Causey Grant, University of Arkansas, 2008
Ludlam, J.P. – Professor Delbert Swartz Endowed Graduate Fellowship for Outstanding Graduate Student, University of Arkansas, 2008
Ludlam, J.P. – Sigma Xi Grant-in-Aid of Research, Sigma Xi Honor Society, 2008
Ludlam, J.P. – Distinguished Doctoral Fellowship, University of Arkansas, 2004-2008
Dekar, M.P. – Leggett Fellowship, University of Arkansas, 2005-2008
Kitterman, C.L**.** – Accepted into MS program at Tennessee Tech, 2007
Larson, E.R. – Scott D. Shull Award, Department of Biological Sciences, University of Arkansas, 2007

COURSES TAUGHT

Magoulick – Biometry – Spring 2008
Krementz – Wildlife Management – Spring 2008
Krementz – Parameter Estimation – Spring 2008
Magoulick – Fish Ecology – Spring 2007

PUBLICATIONS AND PROFESSIONAL PAPERS PRESENTED

Scientific Publications

Larson, E.R. and D.D. Magoulick. 2008. Comparative life history of native (*Orconectes eupunctus*) and introduced (*Orconectes neglectus*) crayfishes in the Spring River drainage of Arkansas and Missouri. American Midland Naturalist 106:323-341.

Larson, E.R. and D.D. Magoulick. 2008. Does juvenile competition explain displacement of a native crayfish by and introduced crayfish? Biologica Invasions DOI 10.107/s10530-008-9286-2.

Larson, E.R., R.J. DiStefano, D.D. Magoulick, and J. Westhoff. 2008. Efficiency of quadrat sampling for riffle-dwelling crayfish. North American Journal of Fisheries Management 28:1036-1043.

Scott, M.K. and D.D. Magoulick. 2008. Swimming performance of five warmwater stream fish species. Transactions of the American Fisheries Society 137:209-215.

Buchsbaum, R.N., L.A. Deegan, J. Horowitz, R.H. Garritt, A.E. Giblin, J.P. Ludlam, and D.H. Shull. 2008. Effects of regular salt marsh haying on marsh plants, algae, invertebrates and

birds at Plum Island Sound, Massachusetts. Wetlands Ecology and Management DOI 10.1007/s11273-008-9125-3.

Krementz, D.G. and E.E. Gbur, Jr. 2008. American woodcock wingbee reliability. 10th American Woodcock Symposium. In Press.

Plummer, M.V., D.G. Krementz, L.A. Powell and N.E.Mills. 2008. Effects of habitat disturbance on survival rates of softshell turtles (*Apalon spinifera*) in a urban stream. Journal of Herpetology. 42:555-563.

Green, A.W. and D.G. Krementz. 2008. Mallard harvest distributions in the Mississippi and Central Flyways. Journal of Wildlife Management 72:1328-1334.

Flinders, C.A. and D.D. Magoulick. 2007. Effects of depth and crayfish size on predation risk and foraging profitability of a lotic crayfish. Journal of the North American Benthological Society 26:767-778.

Dekar, M.P. and D.D. Magoulick. 2007. Factors affecting fish assemblage structure during seasonal stream drying. Ecology of Freshwater Fish. 16:335-342.

Magoulick, D.D. and R.J. DiStefano. 2007. Invasive crayfish *Orconectes neglectus* threatens native crayfishes in the Spring River drainage of Arkansas and Missouri. Southeastern Naturalist 6:141-150.

Flinders, C.A. and D.D. Magoulick. 2007. Habitat use and selection within Ozark lotic crayfish assemblages: spatial ant temporal variation. Journal of Crustacean Biology 27:242-254.

James, R.A. and D.G. Krementz. 2007. Dispersal patterns of giant Canada geese in the central United States. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 59:144-154.

Collier, B.A. and D.G. Krementz. 2007. Uncertainty in age-specific harvest estimates and consequences for white-tailed deer management. Ecological Modeling 2001:194-204.

Myatt, N.A. and D.G. Krementz. 2007. Fall migration rates, and habitat use of American woodcock in the Central United States. Journal of Wildlife Management 71:1197-1205.

Myatt, N.A. and D.G. Krementz. 2007. American woodcock fall migration using Central Region band recovery and wing receipt data. Journal of Wildlife Management 71:336-344.

Lehnen, S.E. and D.G. Krementz. 2007. The influence of body condition on stopover ecology of least sandpipers in the lower Mississippi Alluvial Valley during fall migration. Avian Conservation and Ecology 2:9.

Collier, B.A. and D.G. Krementz. 2007. Opinions and preferences of Arkansas deer hunters regarding harvest management. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 61:54-59.

Technical Publications

Larson, E.R. and D.D. Magoulick. 2007. Effects of the introduced crayfish *Orconectes negelectus* on a native crayfish *Orconectes eupunctus* in an Ozark stream system. Final Report prepared for the Arkansas Game and Fish Commission, Little Rock, Arkansas.

Cushing, A.W. and D.D. Magoulick. 2007. Effects of catch-and release areas on movement and survival of rainbow trout in Arkansas tailwaters. Final Report prepared for the Arkansas Game and Fish Commission, Little Rock, Arkansas.

Theses and Dissertations

Darrah, A.J. 2008. Distribution, habitat use, and reproductive ecology of the king rail in the Illinois and upper Mississippi River Valleys. M.S. Thesis, University of Arkansas.

Budd, M.J. 2007. Status, distribution, and habitat selection of secretive marsh birds in the Delta of Arkansas. M.S. Thesis, University of Arkansas.

Cushing, A.W. 2007. Effects of catch-and-release areas on movement and survival of rainbow trout in Arkansas tail waters. M.S. Thesis, University of Arkansas.

Hodges, S.W. 2007. Movement, survival and refuge use of three minnow species (*Campostoma Anomalum, Notropis Boops,* and *Semotilus Atromaculatus*) during seasonal drying in an intermittent Ozark Mountain stream. M.S. Thesis, University of Arkansas.

Larson, E.R. 2007. Effects of an introduced crayfish on a native crayfish in and Ozark stream: The role of life history and juvenile competition. M.S. Thesis, University of Arkansas.

Papers Presented

Magoulick, D.D. and C.M. Bare. 2008. Using otolith microchemistry to describe the movements of smallmouth bass in a riverine environment. Symposium on Uses of Otolith Chemistry for Midwest Fisheries Management, Midwest Fish and Wildlife Confernce, Columbus, Ohio.

Magoulick, D.D. and E.R. Larson. 2008. Effects of an introduced crayfish, *Orconectes neglectus,* on native crayfish in the Spring River drainage. Arkansas Wildlife Action Plan Conference, Mt. Magazine, Arkansas.

Magoulick, D.D., G.R. Huxel, M.P. Dekar, S.W. Hodges and C.M. Bare. 2008. Effects of stream drying on fish refuge use and species persistence: forecasting effects of global climate change. Special session on Effects of Climate-Related Drying and Surface Water Loss on Aquatic Ecosystems in Extreme Environments, American Fisheries Society, Ottawa, Ontario, Canada.

Magoulick, D.D. and M.K. Scott. 2008. Influence of land use, flow regime and ecoregion on stream habitat and fish assemblage structure. Arkansas Water Resources Conference, Fayetteville, Arkansas.

Ludlam, J.P., D.D. Magoulick, E.R. Larson, and K.H. Laycock. 2008. Disturbance and predation mediate trophic interactions in an aquatic food web. Ecological Society of America, Milwaukee, Wisconsin.

Magoulick, D.D., E.R. Larson, K.H. Laycock and J.P. Ludlam. 2008. Predation and stream drying differentially affect survival and habitat use of a native and invasive crayfish. North American Benthological Society, Salt Lake City, Utah.

Larson, E.R, D.D. Magoulick, C. Turner and K.H. Laycock. 2008. Disturbance and species displacement: Differential tolerance to stream drying and desiccation between native and invasive crayfishes. North American Benthological Society, Salt Lake City, Utah.

D.D. Magoulick, E.R. Larson, M.R. Rabalais, C. Turner, and K.H. Laycock. 2008. Disturbance and species displacement: Differential effects of stream drying and predation on native and invasive crayfishes. Iowa State University.

D.D. Magoulick, E.R. Larson, M.R. Rabalais, C. Turner, and K.H. Laycock. 2008. Disturbance and species displacement: Differential effects of stream drying and predation on native and invasive crayfishes. Missouri State University.

Darrah, A.J. and D.G. Krementz. 2008. Site occupancy and habitat use of three marsh bird species in the Illinois and Upper Mississippi River Valleys. The Waterbird Society Mtg.

Krementz, D.G., M.J. Budd, A.J. Darrah, and J.R. Bolenbaugh. 2008. A synthesis of research on migratory king rails in the Mississippi Flyway. The Waterbird Society Mtg.

Krementz, D.G. and J.D. Luscier. 2008. Woodpecker densities and habitat use in the Big Woods of Arkansas. Ivory-billed Woodpecker Science Symposium.

Budd, M.J. and D.G. Krementz. 2008. Status, distribution, and habitat selection of secretive marsh birds in the Delta of Arkansas. Arkansas Wildlife Action Plan Conference.

Krementz, D.G. 2007. Survival of sora during fall migration in Missouri. American Ornithologists' Union Mtg.

Ludlam, J.P. and D.D. Magoulick. 2007. Spatial and temporal variation in the effects of grazing fish and crayfish on benthic communities during stream drying. Special session on Ecology and conservation of substrate-oriented fishes, North American Benthological Society, Columbia, South Carolina.

D. Stefan, R.J., D.D. Magoulick, E.M. Imhoff, and E.R. Larson. 2007. Use of an intermittent Ozark stream and hyporheic zone by two imperiled crayfishes. Special session on Crayfish Ecology, North American Benthological Society, Columbia, South Carolina.

Flinders, J.M. and D.D. Magoulick. 2007. Trophic interactions and foraging patterns of rainbow and brown trout in Ozark tail waters: A stable isotope and gut content analysis approach. American Fisheries Society, San Francisco, California.

Cushing, A.W. and D.D. Magoulick. 2007. Comparison of rainbow trout movements using radiotelemetry and otolith microchemistry in Arkansas tailwaters. American Fisheries Society, San Francisco, California.

Dekar, M.P., D.D. Magoulick, and G. Huxel. 2007. Spatial and temporal variation in stable carbon and nitrogen isotopes: implications for aquatic food web analyses. American Fisheries Society, San Francisco, California.

Larson, E.R. and D.D. Magoulick. 2007. Competition among juveniles as a potential mechanism for crayfish species displacement in an Ozark river drainage. North American Benthological Society, Columbia, South Carolina.

Larson, E.R., R.J. DiStefano, D.D. Magoulick, and J. Westhoff. 2007. Efficiency of quadrat sampling for riffle-dwelling crayfish. Southern Division American Fisheries Society, Memphis, Tennessee.

Cushing, A.W. and D.D. Magoulick. 2007. Movement of rainbow trout in the catch and release areas of Arkansas tailwaters. Southern Division American Fisheries Society, Memphis, Tennessee.

Cushing, A.W. and D.D. Magoulick. 2007. Movement of rainbow trout in the catch and release areas of Arkansas tailwaters. Arkansas Chapter American Fisheries Society, Mt. View, Arkansas.

D.D. Magoulick and J.M. Flinders. 2007. Growth and condition of brown and rainbow trout in catch and release areas of Bull Shoals and Norfork tailwaters. Bella Vista Fly Fishers, Bella Vista, Arkansas.

Cushing, A.W. and D.D. Magoulick. 2007. Effects of catch and release areas on movement and survival of resident rainbow trout in Arkansas tailwaters. Trout Unlimited, Springdale, Arkansas.

Magoulick, D.D. 2007. Crayfish Life History and Ecology, American Fisheries Society, Mountain View, Arkansas

Doster, R.H. and D.G. Krementz. 2007. Winter habitat affinities of two grassland bird species in the lower Mississippi River alluvial valley: Sedge Wren and Le Conte's Sparrow. American Ornithologists' Union Mtg.

Posters Presented

Dekar, M.P., D.D. Magoulick and G. Huxel. 2008. Spatial and temporal variation of intermittent stream food webs derived from stable isotopes. American Fisheries Society, Ottawa, Ontario, Canada.

Ludlam, J.P. and D.D. Magoulick. 2008. Effects of crayfish and grazing fish on benthic communities during stream drying: Spatial and temporal variation. Special session on Patterns in Stream Ecosystem Functioning Across Bioclimatic Regions, North American Benthological Society, Salt Lake City, Utah.

Darrah, A.J. and D.G. Krementz. 2008. Habitat use of breeding king rails in the Illinois and Upper Mississippi River Valleys. American Ornithologists' Union Mtg.

Budd, M.J. and D.G. Krementz. 2007. Habitat selection by least bittern in the Delta of Arkansas. American Ornithologists' Union Mtg.

Committees/Task Forces/Recovery Teams

Krementz, D.G. – Priority Information Needs for Rails and Snipe Funding Strategy Workshop, 2008
Bolenbaugh, J.R. – President, The Wildlife Society, University of Arkansas, 2008
Magoulick, D.D. – Grant Proposal Reviewer, National Sciences Foundation proposal, 2008
Krementz, D.G. – Facilities committee, Department of Biological Sciences, University of Arkansas, 2008
Ludlam, J.P. – Treasurer, Biology Graduate Student Association, University of Arkansas, 2007
Darrah, A.J. – President, The Wildlife Society, University of Arkansas, 2007
Magoulick, D.D. – Arkansas Invasive Species Task Force, 2007
Magoulick, D.D. – The Nature Conservancy Science Advisory Board, 2007
Magoulick, D.D. – Northwest Arkansas Conservation Authority, 2007
Magoulick, D.D. – Occupancy Estimation course, Colorado State University, 2007
Magoulick, D.D. – Role of Assessment in Teaching workshop, University of Arkansas, 2007
Krementz, D.G. – King Rail Conservation Plan Workshop – Chairman Research and Monitoring Sections, 2006-2007
Magoulick, D.D. – Faculty Search Committees, Ecologist, University of Arkansas 2006-2007
Magoulick, D.D. – Graduate Studies Committee, University of Arkansas 2005-present, Vice-chair 2006-present

Krementz, D.G. – Planning committee, Department of Biological Sciences, University of Arkansas, 2004-2007
Magoulick, D.D. – Project Kaleidoscope Faculty for the 21st Century, 1999-present

TECHNICAL ASSISTANCE

Training Offered

Ludlam, J.P. – HERMES Program Mentor, Collaboration between Environmental Dynamics Program and Honors College, Undergraduate, Brandon Banks, University of Arkansas, 2008

Training Received

Bolenbaugh, J. R. – Marsh Bird Training Workshop, Mobile, Alabama, 2008
Krementz, D.G. – Short course in Resource Selection Functions, West, Inc., 2008
Krementz, D.G. – Short course in Spatial Statistics, University of Arkansas, 2007
Krementz, D.G. – IACUC Policy and Procedure Certification, 2007