Annual Report

2006

Arkansas Cooperative

Fish and Wildlife

Research Unit

USGS science for a changing world

University of Arkansas

Wildlife Management Institute, Washington D.C.

Arkansas Game & Fish Commission

ARKANSAS COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

ANNUAL REPORT 2006

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

Arkansas Cooperative
Fish & Wildlife Research Unit

The Unit is a Cooperative Program of the:

US Geological Survey
Arkansas Game and Fish Commission
University of Arkansas
Wildlife Management Institute

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INTRODUCTION

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, Biological Resources Division. 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 18 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 eight Departmental Chairs (Amlaner, Geren, Kaplan, Talburt, Rhoads, Roufa, Davis, and Smith), 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, 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 has begun 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. 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

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All photos in this report are from student's research sites

CURRENT GRADUATE STUDENTS

Michael J. Budd (M.S., Wildlife – Krementz)
Aaron Cushing (M.S., Fisheries – Magoulick)
Abby Darrah (M.S., Wildlife – Krementz)
Matthew Dekar (Ph.D., Fisheries – Magoulick)
Jon Flinders (Ph.D., Fisheries – Magoulick)
Adam Green (M.S., Wildlife – Krementz)
Shawn Hodges (M.S., Fisheries – Magoulick)
Eric Larson (M.S., Fisheries – Magoulick)
John Ludlam (Ph.D., Fisheries – Magoulick)

RECENTLY GRADUATED GRADUATE STUDENTS

Christopher Bare – M.S., (Magoulick) Employed by USGS Columbia River Research Laboratory.
Sarah C Coulter – M.S., (Krementz) Employed by Westworth Associates Environmental, Ltd.
Adam W. Green – M.S., (Krementz) Employed by Patuxent Wildlife Research Center.
Mandy K. Scott – M.S., (Magoulick) Employed by Texas parks and Wildlife Department.

HOURLY TECHNICIANS

Brandon Bolding – Forage Base & Trout Production
Andrea Claassen – Marsh Birds
Garrett Clark – Forage Base & Trout Production
Ashley Clements – Forage Base & Trout Production
Amy Clifton – Woodpecker Habitat – Catch & Release Trout – Forage Base & Trout Production
Nick Donaghery – Forage Base & Trout Production
Robin Doss – Forage Base & Trout Production
Jared Flowers – Catch & Release Trout
Benton Gann – King Rails
Matt Hangsleben – Catch & Release Trout
Miller Jarrell – Catch & Release Trout – Forage Base & Trout Production
Blake Jones – Forage Base & Trout Production
Shawn King – Office Help
Scott Longing – Forage Base & Trout Production
Bobby Pitts – Forage Base & Trout Production
Matthew Pumfery – Forage Base & Trout Production
Ryan Sniegocki – Forage Base & Trout Production
Steven Stake – Marsh Birds
Micheal Strauser – Woodpecker Habitat

Arkansas Coop Unit – April 2006

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. Kim Smith – Department of Biological Sciences – University of Arkansas
Dr. Fred Stephen – Department of Entomology – University of Arkansas
David Mott – Buffalo National River, National Park Service
Mr. Josh Cusiomanio – Missouri Department of Natural Resources
Dr. Bill Uhlein – U.S. Fish and Wildlife Service
Mr. Bob Strader – 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

COMPLETED PROJECTS

Mallard (Greg Lavaty)

Harvest Distributions of Mallards in Recent Times

Funding Source:	Arkansas Game and Fish Commission
Project Duration:	January 2005 to December 2006
Principal Investigator:	DAVID G. KREMENTZ
Graduate Research Assistant:	ADAM W. GREEN (M.S. Student)

Research Objectives:

1. Determine whether mallard populations have changed in the Lower Mississippi Flyway over the past 25 years.
2. Determine reasons for changes in wintering mallard distributions if they should occur.

Management Implications:

1. Analyses should help Arkansas Game & Fish Commission respond to hunter concerns.
2. Analyses should help AGFC determine which corrective management actions might be taken if mallard winter distributions have changed.

Project Summary:

A recent topic of debate among hunters, especially those in Arkansas, is the apparent lack of mallards for harvest since about 2000, as compared to the high harvest years of 1998-2000. We examined distributions of mallards in the Mississippi (MF) and Central (CF) Flyways from 1980 – 2004 to determine whether distributions have changed.

We used geographic information systems (GIS) to analyze spatial distributions of band recoveries and U.S. Fish and Wildlife Service Parts Collection Survey (wing receipts) data during the hunting seasons (Sep–Feb) and winters (Dec – Feb), 1980–2003. We calculated the mean latitude for each year for band recoveries and the harvest estimated using wing receipts, which we weighted using values representing the estimated number of mallards harvested for each wing as provided by the USFWS Division of Migratory Bird Management. Because we had such large data sets, we chose a northward shift of 2° latitude as a cutoff for determining biologically significant effects of changes in mallard distributions on harvest availability. We then ran a linear regression of mean latitude for

each data set against year to determine any overall trends. There was high hunter satisfaction from 1998–2000 and low satisfaction from 2001–2003, so we compared the long-term mean latitude (1980–1997) against each of the years 1998–2003 using the 2° cutoff to determine significance. We also calculated the centroid (mean latitude/longitude) of band recovery and harvest distributions for each year. We calculated 50% and 95% kernel density estimates (KDE) for band recoveries. Because of the weights associated with wing receipts we could not use kernel density estimation but created density maps by interpolating estimated mallard harvest between recovery locations.

We found that, during the hunting seasons, mean latitudes of band recoveries ranged from 37.62˚ to 39.55˚ ($\bar{x}$ = 38.63˚, SE = 0.11˚) and harvest ranged from 37.56˚ to 39.56˚ ($\bar{x}$ = 39.48˚, SE = 0.11˚). Mean latitudes for band recoveries and harvest did not show a trend across time. The long-term mean latitude (1980–1997) was 38.69˚ (95% CL $\pm$ 0.03°) for band recoveries and 38.74˚ (95% CL $\pm$ 0.02°) for harvest. Comparison of mean latitudes of recoveries to the long-term average resulted in latitudes during high satisfaction years centered farther south and latitudes during low satisfaction years centered farther north than the long-term average, yet none deviated >1.2° from the long-term average. Centroids for bands and harvest during 2001–2003 were similar to those during the early and mid 1980s, and the years 1998–2000 had centroids located much farther south than all other years.
Size and distribution of band recovery KDEs did not change much from 1980–2000 and core areas (i.e. 50% KDE) for all years included the lower MF, particularly eastern Arkansas and extreme northwest Mississippi. During low satisfaction years, the core extended farther north and included most of the Bootheel of Missouri and extreme western Kentucky but still included the same area as in 1980–2000 (i.e. eastern Arkansas and northwestern Mississippi). Despite the small changes in core areas, 95% KDEs during 2001–2003 expanded to the west and northeast. Density maps of estimated harvest showed patterns similar to those of band recoveries. The magnitude of harvest changed from year to year but the harvest distributions were consistent across the study period.

During the winters, mean latitudes of band recoveries ranged from 34.89˚ to 37.59˚ ($\bar{x}$ = 35.80˚, SE = 0.14˚) and harvest ranged from 34.36˚ to 37.59˚ ($\bar{x}$ = 35.02˚, SE = 0.10˚). Mean latitudes for band recoveries and harvest both showed a positive trend across time.
The long-term mean latitude was 35.56° (95% CL $\pm$ 0.05°) for band recoveries and 34.83° (95% CL $\pm$ 0.02°) for harvest. Mean latitudes for the years 1998–2003, except 2000, were greater (i.e. farther north) than the long-term mean latitude, and 2003 was the only year in which the mean latitude was >2° north than the long-term average. Visual examination of centroids showed that band recovery locations from 2001–2003 were centered farther north than other years and that the harvest centroids from 2001–2003 were similar to those from 1982 and 1984. Core areas of KDEs and density maps showed similar distributions to those during the hunting season, with the highest band recoveries and harvest in the Arkansas and Mississippi Deltas. As seen during the hunting seasons, 95% KDEs expanded northward from 2001–2003. Despite large declines in harvest in the lower MF beginning in 2001, harvests during 2001–2003 were still greater than harvests throughout much of the 1980s and early 1990s. It appears that hunter perceptions and expectations have changed because of the high harvests during the late 1990s. Recent declines in harvest are more likely due to declines in the breeding population.

Conflicting data between the hunting season and winter make it difficult to say with confidence that mallard distributions have changed within the last 25 years. Hunting season data suggests no change in distributions, while winter data suggests a slight shift northward. Northward shifts in winter mean latitudes are most likely due to expansions in the 95% KDEs as core areas remained relatively unchanged.

CURRENT PROJECTS

Wildlife

Ivory-billed woodpecker

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:	

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, I propose to investigate IBWO-habitat relationships on public lands in the Big Woods of Arkansas using woodpecker densities as a surrogate for IBWO use.

The study site will include 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) will be the sampling frame. This sampling frame will allow me to select a set of available points to survey. Again, these points will be selected based on the five variables above. I recognize that a balanced sample will not be possible for various reasons (logistical, availability), and so I will emphasize 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 will be conducted at each site for 2 months during 2007 spring (before leaf out: Feb, Mar) and 2006 & 2007 summer (after leaf out; May, June). I will employ 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 will allow analyses to be conducted both in program DISTANCE and program PRESENCE. I am planning to use the latter program while the former program will be used by Patuxent Wildlife Research Center personnel to address different research questions. 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 is then possible to better estimate the probability of a site being occupied. During this process, it is also possible to investigate the effect of covariates on both detection and occupancy.

I have completed 2 sampling periods (May-June 2006, Jan-Feb 2007). During the first sampling period 195 woodpecker surveys were completed: 87 surveys at 28 sites at WMA locations, 43 surveys at 12 sites at CRNWR locations, and 65 surveys at 53 sites at WRNWR locations. A few sites were surveyed <6 times because of rain, and access issues; 2 sites were eliminated because of road noise. Red-bellied woodpeckers were detected at every repeated site and usually were detected >3 times at each site. The high occurrence of red-bellied woodpeckers at each site will not allow analyzing habitat use for these sites. Pileated woodpeckers were less common than red-bellied woodpeckers as most sites had no or only a couple of sightings. The highest number of sightings of pileated woodpeckers at any one site was 3. Based on these detections, pileated woodpeckers are making choices among sites to frequent. An initial estimate of the probability of occupancy for pileated woodpeckers was 0.64 (0.152 SE) and a probability of detection

was 0.26 (0.66 SE). The second sampling period data are being compiled and analyzed now. One observation of note regarding the winter sampling was a large influx of red-bellied sapsuckers and common flickers.

Expected Products:

By examining woodpecker use across a variety of sites with different combinations of habitat components, I hope to assess if woodpeckers are selecting habitats used based on those variables. The inclusion of season and year in the mix will allow me to assess if biological needs, e.g., reproductive requirements, or weather factors, e.g., drought, influence habitat selection decisions across time. Finally, the examination of landscape level variables should allow a better understanding if large scale variables can influence habitat selection at different scales. With a better understanding of how woodpeckers select habitat in the Big Woods, managers should be able to better manage public lands there for IBWO.

Wildlife

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 are proposing a multi-stage series of interrelated projects to better understand the ecology of king rails in the lower Mississippi Flyway. First, we will assess 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.

From 2 May to 1 July 2006, we surveyed 89 points among 15 refuges along both sides of the Mississippi River between St. Louis and Hannibal, Missouri. We used the protocol described in the North American Standardized Marsh Bird Survey, and surveyed each point 8-10 times in mornings and evenings. We collected habitat data $\leq$ 100 m of each survey point. We will analyze the response data and habitat covariates in the program PRESENCE to estimate the probability of a site being occupied (psi) and the probability of detection (p), as well as to assess the relative importance of habitat or landscape covariates. Preliminary analyses suggest that king rail occupancy is positively correlated with emergent vegetation and negatively correlated with trees and shrubs.

We detected king rails on 2 refuges, BK Leach Conservation Area and Clarence Cannon National Wildlife Refuge. We searched for nests and broods within these 2 refuges by walking transects through entire management cells. We found 3 inactive nests, 2 that had apparently been predated and one that was probably destroyed in a storm. We observed 6 different broods. Nests were placed in homogenous stands of dense vegetation, while broods were located in more patchy areas, with clumps of vegetation for hiding and open pools for foraging.

From 20 July to 7 August we tried several methods to trap rails. We used walk-in traps, with or without speakers playing calls or leads made of chicken wire up to 50m long. We also tried nightlighting, by walking through the marsh during the night with a spotlight and a dip net. Neither method worked; the low density of king rails in this area renders walk-in traps and nightlighting ineffective at the end of the breeding season.

During the 2007 season we will extend our survey area farther up the Illinois River and include more private Wetland Reserve Program lands. We will capture king rails using speakers and walk-in traps at the beginning of the breeding season, using speaker and trap designs that have been used with success on king rails in northwestern Ohio. We will collect feather samples for stable isotope analysis to compare to samples taken from king rails in coastal Louisiana. We will place a leg band and radio transmitter using a 3-loop harness on all captured king rails. Rails will be tracked throughout the breeding season to gain more information about habitat use and movement patterns.

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 2006
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.

Secretive marsh birds include all species that primarily inhabit marshes (i.e., marsh-dependent species). Primary species of concern in North America include the King Rail (*Rallus elegans*), Clapper Rail (*Rallus longirostris*), Virginia Rail (*Rallus limicola*), Sora (*Porzana carolina*), Black Rail (*Laterallus jamaicensis*), Yellow Rail (*Coturnicops noveboracensis*), American Bittern (*Botaurus lentiginosus*), Least Bittern (*Ixobrychus exilis*), Pied-billed Grebe (*Podilymbus podiceps*), Purple Gallinule (*Porphyrula martinica*), and Common Moorhen (*Gallinula chloropus*). The U.S. Fish and Wildlife Service has identified the Black Rail, Least Bittern, and American Bittern as species of special concern because they are relatively rare and we lack basic information on status and trends in most areas.

This project will inventory secretive marsh birds in the Delta of Arkansas by employing a combination of survey methods. The data collected will be used to estimate occupancy rates. Methods include using call-playback broadcasts at randomly selected wetlands to elicit responses from secretive marsh birds. Each wetland will be surveyed ≥ 5 times to determine presence/absence to a 90% certainty.

2006 results

We surveyed 110 sites during the 2006 season (Figs.1-3, Table 1). Eighty-six percent of the sites were surveyed 9 times, and 95% were surveyed ≥ 5 times. In addition to the randomly selected wetlands we also surveyed 52 rice fields, and irrigation ditches.

Forty-nine (45%) sites were occupied by at least one secretive marsh bird. Twenty sites (18%) were occupied by more than one species. Occupied sites average 2 species, with 1 species occurring most frequently. The maximum number of species found at any one site was 5, which occurred at 4 different sites.

We detected pied-billed grebes at 21 sites with 55 individuals counted. One nest and a successful brood were documented at Wallace Trust Wetland Reserve Program (WRP).

American bitterns occupied 16 sites with 24 individuals counted. Least bitterns were detected at 20 sites with ~ 37 individuals counted. Other least bitterns were found opportunistically on 15 non-selected wetlands with 16 individuals counted. Two active nests were found, as well as two that appeared to be the beginnings of a nest. Nests were found in square stem spike-rush (*Eleocharis quadrangulata*).

Purple gallinules were not detected at any sites this year. The only Purple gallinules detected this year were on Moore's Bayou at Arkansas Post, the same site as 2005. Common moorhens occupied 4 sites with ~ 11 individuals counted. Three nests were found at Wallace Trust WRP. All 3 nests were constructed in square stem spike-rush. American coots were found at 13 sites with ~ 204 individuals counted. Opportunistically we found coots at 6 locations with 37 individuals counted.

Soras were detected at 29 sites with 45 individuals counted overall. Soras were found opportunistically at 15 locations with 42 individuals counted. At 8 sites we detected Virginia rails with 10 individuals recorded overall. We opportunistically located Virginia rails at 4 locations. King rails were detected at 6 sites with 17 individuals counted. One brood was observed on 6 June at a WRP site ~ 11km west of the town of Portland, in Chicot County.

The highest densities for all marsh bird species appear to occur in the southern sections of the Delta.

Fisheries

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

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

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 temporal and spatial variation in predator-prey dynamics between otters and the aquatic community.
2. Quantify otter diet and develop a bioenergetics model to estimate the amount of each prey type consumed.
3. Use experimental manipulations to test hypotheses regarding the impact of otter predation on stream communities.

Management Implications:

1. Results will provide information regarding the impact of otters on stream communities, including potential impact to sport fishes.
2. Bioenergetics modeling will give insight into ecological constraints regulating otter populations.
3. This study will enable predictions concerning how predator and prey populations will respond to environmental variation associated with seasonal fluctuations in water levels, and habitat degradation and fragmentation.

Project Summary:

Predators are an important regulatory factor in aquatic communities. In the Ozark Mountains of northwest Arkansas, U.S.A., river otters (*Lontra canadensis*) may be an important and overlooked predator in stream communities. In particular, there is growing concern in this region 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. In 2005 and 2006, we sampled possible otter prey items for stable isotope analysis and food web development. In addition, we sampled otter fecal matter in the field and we obtained stomachs from otter carcasses donated during the winter trapping season. In 2006, we began blood sampling from live-captured individuals to supplement scat and stomach contents data. In addition, we conducted crayfish tethering experiments to assess crayfish mortality associated with terrestrial and aquatic predators. Results indicated that otters rely heavily on crayfish prey during the summer months and switch to fish during the winter. We are continuing the diet analyses and are beginning to develop a bioenergetics model to estimate the amount of each prey type consumed. In addition, we are beginning crayfish population monitoring and laboratory experiments to assess direct and indirect effects of otter predation on aquatic communities.

Fisheries

Experimental crayfish and central stoneroller grazing exclusions in the Little Mulberry River, AR

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:

1. Test the hypothesis that stream drying will increase grazer-mediated stream functioning (GMSF) resulting in decreased fine sediment deposition and algal abundance, and increased biomass specific primary production and leaf litter decomposition.
2. Test the hypothesis that grazer identity will have important consequences for the responses of GMSF to stream drying and predation risk.

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.

Results from the first summer of fieldwork indicate that responses to grazer exclusion differed among pools in both early and late drying periods. In some pools, grazer exclusion increased the abundance of algae, sediment, and invertebrates, while in other pools there was no difference. Additionally, grazer effects increased with drying duration. Currently, work is focused on identifying the variables responsible for the variation in GMSF among pools. We are using manipulative field experiments with electric fence chargers to control the presence of grazers on tiles and leaf packs. We are also using experimental stream mesocosms to investigate how changes in grazer species richness can alter stream functioning within small pools.

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 on the White River

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.

Fisheries

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 May 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:

Special regulations were instituted on portions of the cold tailwater fisheries in Arkansas. Catch-and-release (C-R) trout fishing regulations were implemented by the Arkansas Game and Fish Commission (AGFC) on Jan 1, 1995 on five sections, totaling 8.9 km, of the Bull Shoals and Norfolk tailwaters of the White River, Arkansas. These areas were developed in Arkansas to provide high catch rates of larger sized trout. The basic assumption behind the C-R areas is that exploitation rates of trout will decrease and residence times will increase. 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 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 third assumption and we will address assumptions one and two in a companion project.

Preliminary Results:

Seasonal (spring, summer, fall, winter) foraging patterns of brown trout and rainbow trout were investigated in Bull Shoals, Norfork, and Sylamore C-R areas in Arkansas tailwaters using stable isotope analysis (SIA) and gut-content analysis (GCA). SIA and GCA were performed on sixty brown trout in three size classes of small (<250 mm TL), medium (250-400 mm TL), and large (>400 mm TL) and sixty rainbow trout in two size classes of small ($\leq$400 mm TL) and large (>400 mm TL) each season for a year. Trout were collected using boat electrofishing. Immediately after collection stomachs were removed and placed in 10% buffered formalin. In the laboratory prey items were identified, counted, and measured for dry weights using regression. Carbon (^{13}C) and nitrogen (^{15}N) stable isotope ratios were obtained from the trout and prey samples using an elemental analyzer with an isotopic mass spectrometer (University of Arkansas, Stable Isotope Laboratory). Individual samples of dorsal muscle tissue (about 1 cm^3) were used for SIA of trout. A minimum of three individual macroinvertebrates by family were pooled per prey sample and sculpin were ground whole for SIA. A linear stable isotope-mixing model was used to determine the contributions of prey items to trout production.

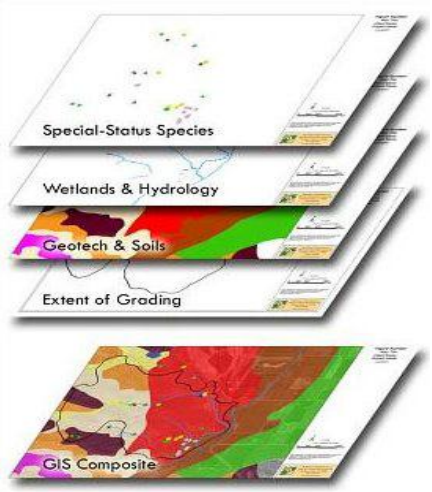
Brown trout signatures became progressively more enriched in $\delta^{15}N$ as fish length increased in Bull Shoals ($r = 0.401$, $P<0.0001$), Norfork ($r = 0.470$, $P<0.0001$). Nitrogen values in brown trout at Sylamore were enriched with size ($r = 0.477$, $P<0.0001$), but were asymptotic with larger fish. Large brown trout had elevated $\delta^{15}N$ values (2.5-3.2‰) relative to smaller brown trout indicating a dietary shift and an increase in trophic position. Also larger, more piscivorous brown trout were on average enriched in $\delta^{15}N$ relative to sculpin, but generally less than the predicted +3.4‰. Mixing model results indicated that smaller rainbow trout in Bull Shoals and Norfork C-R areas contained isotopic "memory" from hatchery food (Range 56-70%) that is highly enriched in carbon and depleted in nitrogen, accentuating the shift to more depleted carbon and enriched nitrogen with size. Large rainbow trout gained most of their energy from chironomids in Bull Shoals (Range 60-66%) and chironomids (Range 44-61%) and cladocera (37-43%) in Norfork.

Based on GCA, Amphipoda, Chironomidae, *Cladocera* spp., Decapoda, Gastropoda, Isopoda, and sculpin were commonly ingested by brown and rainbow trout. However, seasonal percent compositions within each C-R were significantly different between species and across seasons (MANOVA, Wilk's lambda, $P < 0.0001$). Despite the lack of energetic value to trout, filamentous algae was also found in high proportions in stomachs of rainbow trout, indicating epibenthic foraging. Trout were primarily feeding on isopods in the summer and fall in Bull Shoals, but shifted to amphipods in the winter and spring. In Norfork amphipods were the predominately consumed invertebrate. Benthic invertebrates were the major prey item of smaller brown trout (<250 mm TL), whereas larger brown trout shifted partly to piscivory on sculpins with size. Piscivory was highest in brown trout at Norfork (60%), Bull Shoals (18%) and Sylamore (12%).

SIA and GCA both showed that brown trout shifted ontogentically from benthic invertebrates to piscivory, whereas rainbow trout of all sizes consumed mostly benthic invertebrates. Mixing model results for rainbow trout indicated chironomids and cladocerans were important prey, whereas GCA indicated that amphipods and isopods were important energy sources. This may be the result of SIA providing a time-integrated signal of foraging patterns relative to the "snapshot" provided from GCA. Stable isotope ratios of carbon and nitrogen, appear to be complementary to, and not a substitute for, GCA in detecting ontogenetic diet shifts and temporal foraging patterns.

NEW PROJECTS

Wildlife



Identification and Assessment of Arkansas Marshbird Habitat

Fundng Source:	Arkansas Game & Fish Commission
Project Duration:	1 September 2007 to 1 June 2009
Principal Investigator:	DAVID G. KREMENT
Co-Investigator:	JASON TULLIS
Graduate Research Assistant:	To be determined

Research Objectives:

1. To identify and assess potential marshbird habitats on AGFC lands.

Management Implications:

1. Based on habitat scoring, advice will be developed to prioritize those AGFC lands that currently have potential marshbird habitat.

2. Prioritize AGFC lands that could be managed to better attract and hold marshbirds.

Project Summary:

Marshbirds are declining range-wide mostly because of loss and/or alteration of wetland habitat. Based on an on-going State Wildlife Grant marshbird survey in the Arkansas Delta, my graduate student (Mike Budd) and I determined that across the board, many marshbirds are rare at best. During those surveys, we identified potential habitats used by marshbirds in the Delta. My co-investigator and I propose to conduct a statewide geographic information survey of potential marshbird habitats using habitat information derived from my recent Arkansas Delta surveys. Through identifying potential habitats, we hope to assess wetlands that are currently capable of harboring marshbirds and those wetlands that can be improved by AGFC to enhance the functionality of AGFC lands for marshbirds.

The primary goal of our study will be to identify and assess potential marshbird habitats. In particular, we intend to identify which moist-soil units and green-tree reservoirs (GTRs) on AGFC lands could harbor marshbirds. Should state wetlands be deficient in recognized marshbird habitat requirements, we would identify those areas that, with management, would enhance the functionality of these properties for marshbirds. These goals will be developed in 2008 and through consultation with AGFC, a prioritization list of wetlands to be managed for marshbirds will be produced.

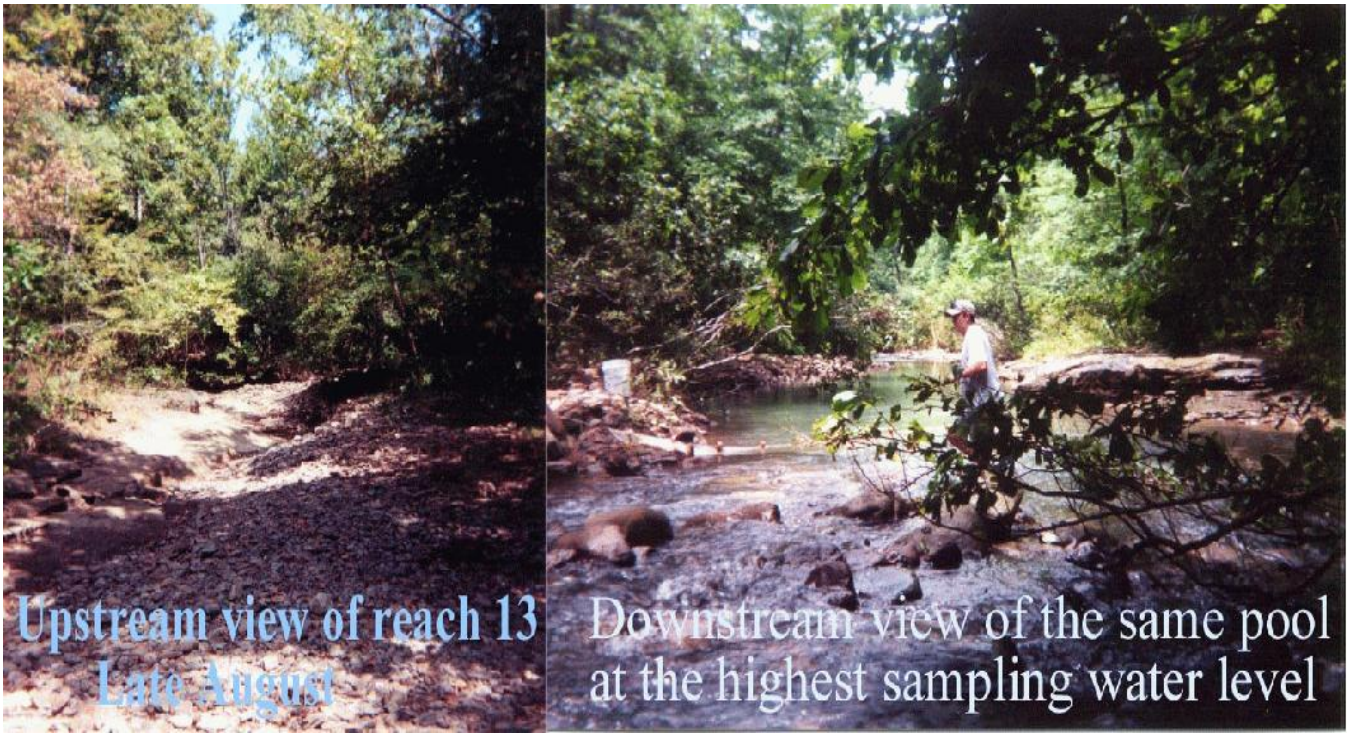
Expected Products:

We will develop maps of AGFC wetlands capable of harboring marshbirds. These wetlands will be ranked as to their relative attractiveness for marshbirds and whether habitat management practices can improve current wetland capabilities for marshbirds.

Conservation priority addressed:

Marshbirds that occur in Arkansas include a host of high priority birds: 1) king rail (33-priority score), 2) common moorhen (23), 3) purple gallinule (23), 4) least bittern (19), 5) American bittern (15), 6) black-crowned night heron (19), 7) yellow-crowned night heron (15), and 8) wood stork (9). All of these species directly depend on wetlands, primarily tall emergent wetlands, which are disappearing at an alarming rate. Most of these rarer wetland types are now only found on public lands in the Mississippi Alluvial Plain. The king rail in particular is a species of concern in Arkansas. Once considered a common nesting bird in the Arkansas Delta, this bird is now quite rare there and is considered a "focal species" by the U.S. Fish and Wildlife Service (USFWS). The king rail Conservation plan targets stabilizing and improving breeding performance of king rails north of the Gulf Coast. The breeding population of king rails in Arkansas is thought to be the largest breeding population remaining north of the Gulf Coast based on data collected from our SWG marshbird monitoring project and on a USFWS survey of state biologists in the Mississippi Flyway. In addition to the specific concerns over the king rail, the recent population declines in marshbirds in general has elevated this bird group to the forefront by federal, state and non-government organizations. For example, in Arkansas, the first five species are mentioned under the CWCS-monitoring needs document for inclusion under the National Marshbird Monitoring Program because the current status of these birds in Arkansas is little known.

Fisheries



Reduced flow due to seasonal drought on a stream reach of Indian Creek in the Ozark Mountains of Arkansas. The reach is shown in late August and mid-June.

Effect of seasonal drought on fish population and community dynamics in Ozarks streams

Funding Source:	To be submitted to NSF
Project Duration:	
Principal Investigators:	DANIEL D. MAGOULICK, GARY HUXEL
Graduate Research Assistant:	To be determined

Research Questions:

1. Do stream drying and predation interact to affect survival and movement of fishes?

2. How do drying intensity and habitat connectedness affect fish movement and survival in these systems?

Management Implications:

1. Understanding what habitats act as refugia in drying streams and how refuge availability, distribution and structure influence fish and invertebrate habitat selection,

survival and growth will allow natural resource managers to implement effective conservation strategies for fish and invertebrates in drying streams.

2. Stream drying is likely to increase in frequency and severity under recent climate projections so understanding how drying effects population and community dynamics is important for effective management.

Project Summary:

Drying disturbances in streams can lead to environmental extremes and isolated habitats at multiple spatial and temporal scales, but little is known regarding how these factors affect fish and invertebrate population and community dynamics. We have found that fish movement, survival and refuge use during stream drying are species-dependent. We will examine the interaction between stream drying and abiotic (water volume and temperature) and biotic factors (competition and predation) related to survival and movement. Additionally, we will examine fish metacommunity dynamics during a drying cycle and whether stream pool habitats act as sinks at the reach scale, but as sources at the watershed scale during seasonal drying. Finally, we will use our data to model effects of habitat connectivity, drying frequency and intensity on fish metacommunity dynamics. We plan to use a combination of comparative studies and manipulative experiments in the field along with mathematical modeling to address these questions.

PRODUCTIVITY

HONORS AND AWARDS

Jon M. Flinders – Scott D. Shull Award, Department of Biological Sciences, University of Arkansas, 2006
Jon M. Flinders – Best Student Paper, American Fisheries Society, San Antonio, TX, 2006
Jon M. Flinders – North Arkansas Fly Fishers Scholarship, 2006
John Ludlam – Causey Grant, University of Arkansas, 2006
John Ludlam – Distinguished Doctoral Fellowship, University of Arkansas, 2006
Aaron W. Cushing – Embrace a Stream Award, Trout Unlimited Arkansas Council, 2006
Aaron W. Cushing – Academic Tuition Scholarship, Federation of Fly Fishers, Southern Council, 2006
Aaron W. Cushing – Outstanding Member, American Fisheries Society, University of Arkansas Student Subunit, 2006
Matthew Dekar – Leggett Fellowship, University of Arkansas 2006
Matthew Dekar – Doctoral Academy Fellowship, University of Arkansas, 2006
Kristofor Nault – Accepted into MS program at Grand Valley State University, 2006
David G. Krementz – Promotion to Full Research Professor, University of Arkansas, 2006
David G. Krementz – 20 Years of Services with U.S. Department of Interior, 2006
Daniel D. Magoulick – USGS Services Excellence Award, 2006
Daniel D. Magoulick – Full member of Sigma Xi, 2006

COURSES TAUGHT

Krementz – Wildlife Management Techniques – Spring 2006
Magoulick – Biometry – Spring 2006

PUBLICATIONS AND PROFESSIONAL PAPERS PRESENTED

Scientific Publications

Thatcher, B.S., **D.G. Krementz,** and M. Woodrey. 2006. Henslow's sparrow winter survival estimates and response to prescribed burning. J. Wildl. Manage. 71:198-206.

Clifton, A., and **D.G. Krementz.** 2006. Estimating numbers of greater prairie-chickens using mark-resite techniques. J. Wildl. Manage. 70:479-484.

Stober, J. M., and **D.G. Krementz.** 2006. Variation in Bachman's sparrow territory size at the Savannah River Site, South Carolina. Wilson Bulletin 118:138-144.

Collier, B.A., and **D.G. Krementz**. 2006. White-tailed deer management practices on private lands in Arkansas. Wildl. Soc. Bull. 34:307-313.

Rabalais, M.R., and **D.D. Magoulick.** 2006. Is competition responsible for species displacement: native and invasive crayfish interactions. Biological Invasions 8:1039-1048.

Rabalais, M.R., and **D.D. Magoulick.** 2006. Influence of an invasive crayfish species on diurnal habitat use and selection by a native crayfish species in an Ozark stream. American Midland Naturalist 155:295-306.

Technical Publications

Magoulick, D.D. 2006. Factors affecting migration and recruitment in headwater fish assemblages of Buffalo National River. Final Report prepared for the National Park Services, Harrison, Arkansas.

Non-Technical Publications

Green, A. and **D. Krementz**. 2006. Shortstopping: Fact or fiction? Delta Waterfowl Magazine.

Theses and Dissertations

Green, A.W. 2006. Harvest and winter distribution of mallards in the Mississippi and Central Flyways. M.S. Thesis, University of Arkansas.

Papers Presented

Krementz, D.G. 2006. Shorebird population status and habitat management. Mississippi Alluvial Valley Habitat Goals and Objectives Workshop.

Krementz, D.G., **M.J. Budd**, and **A. Darrah**. 2006. King rail surveys and habitat use in Arkansas and Missouri. King Rail Focal Species Workshop.

Budd, M.J., and **D.G. Krementz.** 2006. Secretive marshbird surveys in the Arkansas Delta. Webless Committee of Mississippi Flyway Technical Section.

Green, A.W., and **D.G. Krementz.** 2006. Changes in harvest and winter distributions of mallards in recent times. Fourth North American Duck Symposium.

Green, A.W., and **D.G. Krementz.** 2006. Changes in winter distributions of mallards in the Mississippi and Central flyways during recent times. The Wildlife Society Mtg.

Krementz, D.G. and E.E. Gbur, Jr. 2006. American woodcock wingbee reliability. Tenth American Woodcock Symposium.

Krementz, D.G. and G.R. Huxel. 2006. Population dynamics of American woodcock in the Central Region. Tenth American Woodcock Symposium.

Myatt, N.A., and **D.G. Krementz.** 2006. Fall migration rates, routes, and habitat use of American woodcock in the Central Region. Tenth American Woodcock Symposium.

Myatt, N.A., and **D.G. Krementz.** 2006. American woodcock fall migration using Central Region band recovery and wing-collection survey data. Tenth American Woodcock Symposium.

Doster, R.H., and **D.G. Krementz.** 2006. Habitat and landscape associations of wintering grassland and shrubland bird communities in the lower Mississippi River alluvial valley. Ecological Society of America Mtg.

Flinders, J.M., and **D.D. Magoulick.** 2006. Foraging patterns of brown trout and rainbow trout in an Arkansas tailwater: a stable isotope and gut content analysis approach. Symposium on Trout Fisheries in Regulated Rivers, Southern Division American Fisheries Society, San Antonio, Texas.

Cushing, A.W., and **D.D. Magoulick.** 2006. Effects of catch and release areas on movement and mortality of rainbow trout in Bull Shoals and Norfork tailwaters. Symposium on Trout Fisheries in Regulated Rivers, Southern Division American Fisheries Society, San Antonio, Texas.

Huxel, G. and **D.D. Magoulick.** 2006. Trophic structure in pools subject to drying. Ecological Society of America, Memphis, Tennessee.

Magoulick, D.D., M.P. Dekar, S.W. Hodges, M.K. Scott, C.M. Bare, and M.R. Rabalais. 2006. Relationship of hydrologic variability and disturbance to temporal variability in fish assemblage structure. North American Benthological Society, Anchorage, Alaska.

Scott, M.K. and **D.D. Magoulick.** 2006. Swimming performance of five warmwater stream fish species. Southern Division American Fisheries Society, San Antonio, Texas.

Cushing, A.W., and **D.D. Magoulick.** 2006. Effects of catch and release areas on movement and mortality of rainbow trout in Bull Shoals and Norfork tailwaters. Arkansas Chapter American Fisheries Society, DeGray Lake State Park, Arkansas.

Flinders, J.M., and **D.D. Magoulick.** 2006. Diet, growth, and biomass of brown and rainbow trout in catch and release areas of Bull Shals and Norfork tailwaters. White River Fisheries Partnership, Mountain Home, Arkansas.

Cushing, A.W., and **D.D. Magoulick.** 2006. Effects of catch and release regulations on rainbow trout movement in Ozark tailwaters. White River Fisheries Partnership, Mountain Home, Arkansas.

Flinders, J.M., and **D.D. Magoulick.** 2006. The contribution of prey to trout production in Ozark tailwaters: stomach contents versus stable isotope analysis. Southern Division American Fisheries Society Trout Committee meeting, Mountain Home, Arkansas.

Cushing, A.W., and **D.D. Magoulick.** 2006. Effects of catch and release regulations on rainbow trout movement and mortality in Ozark tailwaters. Southern Division American Fisheries Society Trout Committee meeting, Mountain Home, Arkansas.

Magoulick, D.D. 2006. The role of drought in streams: affects on population and community dynamics. Sigma Xi Chapter, University of Arkansas.

Cushing, A.W., and **D.D. Magoulick.** 2006. Movement and mortality of rainbow trout in Arkansas tailwaters. Trout Unlimited, Springdale, Arkansas.

Cushing, A.W. 2006. The Effect of Catch and Release Areas on Movement of Rainbow Trout in Arkansas Tailwaters. Mid-South Fly-Fishing Expo. Memphis, Tennessee.

Cushing, A.W., and **D.D. Magoulick.** 2006. Movement of Rainbow Trout in the Catch and Release Areas on Bull Shoals and Norfork Tailwaters. American Fisheries Southern Division Trout Committee Meeting, Lake View, Arkansas.

Flinders, J.M., and **D.D. Magoulick.** 2006. The relationship between trout production and their forage base in Bull Shoals and Norfork tailwaters. Southern Division Trout Committee Meeting, Mountain Home, Arkansas.

Posters Presented

Green, A.W., and **D.G. Krementz.** 2006. Changes in winter distributions of mallards in the Mississippi and Central flyways during recent times. The Wildlife Society Mtg.

Committees/Task Forces/Recovery Teams

Jon M. Flinders – Secretary of American Fisheries Society, University of Arkansas, 2006
Michael J. Budd – President of The Wildlife Society, University of Arkansas, 2006
Michael J. Budd – Chairman Outreach Committee, U.S. Fish and Wildlife Services, King Rail Recovery Plan, 2006
John Ludlam – President, Biology Graduate Student Association, University of Arkansas, Fayetteville, AR, 2006
Eric Larson – President of American Fisheries Society, University of Arkansas, 2006
Abigail Darrah –Treasure of The Wildlife Society, University of Arkansas, 2006
Krementz, D.G. – Ivory-billed Woodpecker Recovery Team - Biology Working Group. 2006.
Krementz, D.G. – The Wildlife Society Contributed Papers Subcommitte Chair, 2006

Krementz, D.G. – King Rail Conservation Plan Workshop – Chairman Research and Monitoring Committee, 2006
Krementz, D.G. – Migratory Shore & Upland Game Bird Subcommittee of the Mississippi Flyway Technical Section – Chair of committee, 1999-present
Krementz, D.G. – Lower Mississippi Alluvial Valley Joint Ventrue Migratory Bird Science Team member, 2001-present.
Krementz, D.G. – Woodcock Task Force of the International Association of Fish and Wildlife Agencies, 2001-present.
Magoulick, D.D. – Graduate Studies Committee, 2005–present
Magoulick, D.D. – Faculty Search Committee, Ecologist, 2004-present.
Magoulick, D.D. – Transactions of the American Fisheries Society Best Paper Award Committee, 2006.

TECHNICAL ASSISTANCE

Training Offered

Training Received

Cushing, Aaron – Adult CPR and First Aid, University of Arkansas.
Kitterman, Christy – Adult CPR and First Aid, University of Arkansas.
Flinders, Jon – Adult CPR and First Aid, University of Arkansas.
Darrah, Abby – Adult CPR and First Aid, University of Arkansas.
Magoulick, Dan – Adult CPR and First Aid, University of Arkansas.
Ludlam, John – Adult CPR and First Aid, University of Arkansas.
Dekar, Matt – Adult CPR and First Aid, University of Arkansas.
Budd, Michael J. – Occupancy Estimation and Modeling Workshop, San Marcos, Texas
Moler, Diane – USGS Administrative Training, Jacksonville, Florida
Jarrell, Miller – Adult CPR and First Aid, American Red Cross, Florence, Alabama
Jarrell, Miller – Boat Safety Training U.S. Coast Guard Auxiliary, Florence, Alabama
Krementz, David – Occupancy Estimation and Modeling Workshop, San Marco, Texas