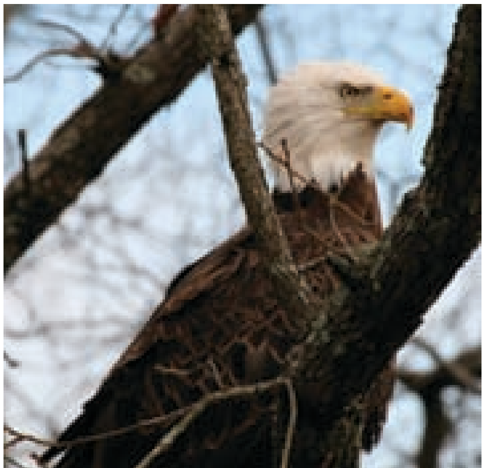

Kentucky Department of Fish and Wildlife Resources

Annual Research Highlights 2012

Volume VI, Oct. 2013

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Our Mission:

To conserve and enhance fish and wildlife resources and provide opportunity for hunting, fishing, trapping, boating and other wildlife related activities.

Foreword

Biologists band a young falcon and test it for disease / KY Transportation Cabinet

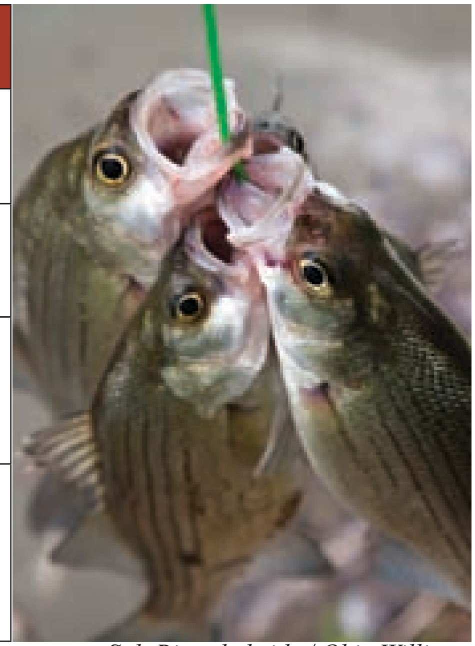
Conserving and enhancing fish and wildlife resources in Kentucky is a primary goal of the Kentucky Department of Fish and Wildlife Resources (KDFWR). Research and monitoring are key steps towards conserving and enhancing fish, wildlife, and habitat resources of the Commonwealth. The 2012 KDFWR Research Highlights document represents targeted efforts by KDFWR and partners to fulfill statewide conservation goals. As stewards of all species in Kentucky that are not held in federal trust, it is our job to ensure seasons and bag limits are sustainable and to determine if management actions achieve desired goals. The following project summaries serve as a testament to KDFWR's vigilance in the conservation of the fish and wildlife resources that we hold in trust for the public.

Funding Sources and Guide to Federal Programs

KDFWR receives no general fund taxpayer dollars. As a result, the Department relies on hunting and fishing license fees, boat registration fees, and federal programs to fund the seven divisions within KDFWR. Projects that are entirely funded by the state are labeled "non-federal aid" (NFA); however, most of the projects included in this document are partially or fully funded by federal programs such as the State Wildlife Grant Program (SWG), the Wildlife Restoration Act (Pittman-Robertson), the Sport Fish Restoration Program (Dingell-Johnson), and the Cooperative Endangered Species Conservation Fund (Section 6).

These federal programs serve a variety of purposes; however, each has an underlying goal of fish, wildlife, and/or habitat conservation. Brief descriptions of each of these programs are as follows:

Federal Funding Source	Program Goal
Wildlife Restoration Act (Pittman-Robertson)	To restore, conserve, manage and enhance wild birds and mammals and their habitats
Sport Fish Restoration Program (Dingell-Johnson)	To fund fishery management projects, boating access, and aquatic education
Cooperative Endangered Species Conservation Fund (Section 6)	To fund conservation projects for candidate, proposed, or listed species
State Wildlife Grant Program (SWG)	To develop and implement programs that benefit wildlife and their habitats; specifically, species and habitats of conservation concern



Salt River hybrids / Obie Williams

These federal programs provided approximately 17.5 million dollars to KDFWR in 2012, while the sale of hunting and fishing licenses provided 25 million dollars, over half of KDFWR's budget (see Figure 1). For reference, we have included the state and federal funding sources for each project; however, these projects may be additionally supplemented by outside funding provided by non-profit organizations or universities. When possible, we listed these sources in addition to the state and federal funding sources. For each project summary, we also identify the specific goals addressed by either Kentucky's Strategic Plan or Kentucky's State Wildlife Action Plan, the two guiding documents for our agency.

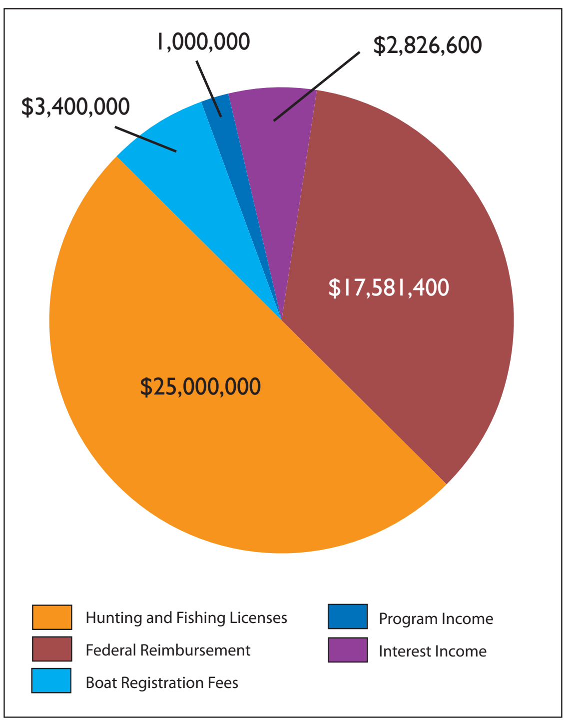


Figure 1. Kentucky Department of Fish and Wildlife Resources Funding Sources 2012. Total revenues for 2012 were $49,808,000.

How to Use This Document

This document is divided into **four main sections:** published research, completed projects, project highlights, and project updates. Citations for all published research with Kentucky Department of Fish and Wildlife involvement are included in the Table of Contents. For projects that have been completed and not yet published, a detailed summary will be included in the first portion ("**completed projects**") of the document. For projects that began in 2012, a brief 1-page overview of the project is included in the second portion ("**project highlights**") of the document. For select ongoing projects, brief status updates are included in the last section ("**project updates**") of this document. In the table of contents, an expected date of completion, where applicable, is listed for each project. This will facilitate looking up detailed summaries of completed projects in later years. A comprehensive **project reference guide** lists all projects included in Research Highlights documents, beginning with publication year 2007.

Please use the following citation when referencing this document:

Kentucky Department of Fish and Wildlife Resources Annual Research Highlights, 2012. Volume VI. Publication of the Wildlife and Fisheries Divisions. October, 2013, 116 pp.

Table of Contents

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Contact Research Coordinator, Danna Baxley (danna.baxley@ky.gov) for reprints of these publications.

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Elliott, C.L. and T. Edwards. 2012. Evaluation of tooth-wear and replacement method for aging **white-tailed deer** (*Odocoileus virginianus*) on the Blue Grass Army Depot, Madison County, Kentucky. Journal of the Kentucky Academy of Science 73:73-76.

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Unger, A. M., E. P. Tanner, C. A. Harper, P. D. Keyser, J.J. Morgan. 2012. **Northern bobwhite survival** related to movement on a reclaimed surface coal mine. Proceedings of the National Quail Symposium 7:223-228.

West, A.S., P.D. Keyser, and J.J. Morgan. 2012. **Northern bobwhite** survival, nest success, and habitat use in Kentucky during the breeding season. Proceedings of the National Quail Symposium 7:217-222.

Completed Projects

Fisheries

Wildlife

Project Highlights

These projects began in 2012

Fishes

Big Game

Project Updates

This section includes brief updates for selected projects that began prior to 2012.

FISHES

Warm Water Fisheries

Urban Fisheries

Lake Investigations/ Cold Water Fisheries

River and Stream Fisheries

Non Game Fishes

WILDLIFE

Big Game

Small Game

Black Bear

Furbearer

Songbirds and Raptors

Reptiles and Amphibians

Mollusks

Appendix

KDFWR Contacts

Hunters preparing to flush bobwhite quail / Obie Williams


Processing elk / John Brunjes

Completed Projects

Impacts of Spawning Habitat Manipulation on Largemouth Bass Year-Class Production in Meldahl Pool, Ohio River

Jason Herrala, David Baker, Nick Keeton, Kentucky Department of Fish and Wildlife Resources

Introduction

Rising popularity and fishing pressure for black bass have led to increased efforts to understand the ecology and management of black bass. Black bass make up an important part of the sport fishery in Kentucky. In November 1997, Kentucky Department of Fish and Wildlife Resources (KDFWR) staff met with angler dissatisfied with the bass fishery in the Meldahl Pool. Historical electrofishing data collected by KDFWR indicates that a poor largemouth bass population exists in the Meldahl Pool in comparison with other pools of the Ohio River.

Habitat requirements of largemouth bass have been the focus of many previous studies (Aggus and Elliott 1975; Eipper 1975; Nack et al. 1993). The presence or absence of critical habitats during different life stages, especially the first year of life, likely restricts populations (Kramer and Smith 1962; Eipper 1975). Spawning largemouth bass generally associate with firm substrates such as gravel and cobble often located adjacent to other structures (i.e., rocks, stumps, logs [Kramer and Smith 1962; Miller and Kramer 1971; Vogele and Rainwater 1975; Nack et al. 1993; Hunt 1995]). Pearson and Krumholz (1984) documented the importance of embayments for successful spawning of black bass in the Ohio River. Unfortunately, embayments in the Meldahl Pool have filled with silt from erosion within the watershed, and very little structure still exists (D. Henley, personal comm.). Central to the sustainability of black bass populations is the recruitment of young-of-year (YOY) fish into the population.

Impacts of spawning structure / Doug Henley

Electrofishing surveys performed by KDFWR indicate that year-class production of largemouth bass may be limited by the lack of suitable spawning habitat.

The addition of artificial habitat to aid largemouth bass spawning has been well documented (Vogele and Rainwater 1975; Johnson and Stein 1979; Hoff 1991; Hunt 1995; Annett et al. 1996; Hunt and Annett 2002). Positive results (increased spawning success and increased population numbers) would indicate that year-class production of largemouth bass in the Meldahl Pool of the Ohio River may be improved by the addition of artificial spawning habitat. The objective of this study was to determine if the addition of artificial spawning structures could enhance the reproductive potential of largemouth bass in the Meldahl Pool of the Ohio River and improve YOY largemouth bass year-class contributions to the fishery.

Study Area

The Ohio River extends along the entire 664-mile northern border of Kentucky, and drains 39,210 mi^2 of the state. The Kentucky portion of the Ohio River is comprised of 8 high-lift dams and 2 wicket dams that form a series of pools and tailwaters along the river. The Meldahl Pool runs from Ohio River Mile (ORM) 341 to ORM 436 (95 mi), with a surface area of 170,469 acres. Four embayments in the Meldahl Pool were sampled: Bracken Creek (ORM 426) and Big Snag Creek (ORM 436) were used as study sites with spawning structures added, and Big Turtle Creek (ORM 429) and Big Locust Creek (ORM 433) were used as control sites with no spawning structures added.

Methods

Supplemental spawning structures (SSS) were added to Bracken Creek and Big Snag Creek beginning in 2004 and were maintained annually through 2010. Additionally, Christmas tree units (2 trees, 1 cinder block) were added near SSS to provide cover for YOY fish, and silt meters were placed in each embayment to record the level of siltation that occurred annually. All SSS were removed from each experimental embayment prior to spring sampling in 2010 to evaluate the effect of spawning habitat loss. During the early spring of each year, each SSS was located and manually cleaned of silt.

Nocturnal electrofishing (four 15-minute transects per embayment) was conducted in the spring and fall of 2003 to gather preliminary, base-line data from all embayments in the Meldahl Pool to document largemouth bass population structure before the addition of SSS. After the installation of SSS, nocturnal electrofishing (four 15-minute transects per embayment) was conducted each spring and fall from 2004 to 2010. All black bass collected were measured to the nearest 0.1 in and weighed to the nearest 0.01 pound. Otoliths were taken from up to 10 fish per inch class in spring 2004 to 2006 and in fall 2001 to 2005 in order to assess age and growth of largemouth bass in the Meldahl Pool.

Results

Spring

A total of 138 hr of electrofishing effort was expended during spring 2003-2010 in the 4 embayments. Largemouth bass dominated the catch in both control and experimental embayments throughout the study. Mean CPUE of largemouth bass in all embayments from 2003-2010 was 38.2 fish/hr compared to just 6.5 fish/hr for spotted bass. Trends in CPUE data for largemouth bass data were consistent in all embayments throughout the study period and were the highest for each embayment in 2008 (43.0 – 84.0 fish/hr). Mean CPUE of largemouth bass in control embayments (36.2 fish/hr) was higher than mean CPUE in experimental embayments (27.9 fish/hr). Spotted bass followed that same trend. Mean CPUE of spotted bass in control embayments was 12.9 fish/hr compared to 5.2 fish/hr in experimental embayments. No consistent trends were seen in either largemouth bass or spotted bass abundance following the removal of the SSS from the experimental embayments in 2010. Catch rates of largemouth bass declined in Big Snag Creek (8.0 fish/hr), but remained the same in Bracken Creek (30.0 fish/hr). Catch rates of spotted bass following the removal of SSS in experimental embayments decreased in Big Snag Creek (2.0 fish/hr) and increased slightly in Bracken Creek (1.0 fish/hr).

Spring electrofishing CPUE of <8.0, 8.0 – 11.9, 12.0 – 14.9, and ≥15 in largemouth bass was compared between embayments. Mean CPUE of <8.0 in largemouth bass for experimental embayments was 5.1 fish/hr and was slightly higher than mean CPUE in control embayments (4.5 fish/hr). Catch rates varied in all embayments throughout the study but followed the same general trends. Catch rates of <8.0 in largemouth bass peaked in 2008 for all embayments, while 2009 and 2010 yielded catch rates that were below average in each embayment. Mean CPUE of 8.0 – 11.9 in. fish was 10.2 fish/hr in experimental embayments and 14.2 fish/hr in control embayments, and catch rates in all embayments decreased with the removal of SSS in 2010. Mean CPUE of 12.0 – 14.9 in. fish was 8.5 fish/hr in experimental embayments and 11.2 fish/hr in control embayments and decreased in all embayments except Big Turtle Creek with the removal of SSS in 2010. Catch rates of largemouth bass over 15 in varied greatly in and among embayments throughout the study, but mean catch rates were similar. Mean CPUE of largemouth bass ≥ 15 in. in experimental embayments was 2.6 fish/hr and 4.0 fish/hr in control embayments.

CPUE of <7.0, 7.0 – 10.9, 11.0 – 13.9, and ≥14 in spotted bass were also evaluated. Mean CPUE of spotted bass <7 in. was 1.1 fish/hr in experimental embayments and 3.8 fish/hr in control embayments and fluctuated greatly in all embayments throughout the study. Catch rates of 7.0 – 10.9 in spotted bass averaged 2.8 fish/hr in experimental embayments and 6.0 fish/hr in control embayments with consistently higher catch rates for all embayments occurring in 2006. Mean catch rates of 11.0 – 13.9 fish/hr was 0.9 fish/hr in experimental embayments and 2.2 fish/hr in control embayments. For spotted bass ≥14 in, mean CPUE in experimental embayments was 0.3 fish/hr and 0.4 fish/hr in control embayments. All length classes that were evaluated yielded catch rates of 0.0 fish/hr in multiple years within each embayment.

Age frequency for largemouth bass was determined for each embayment from spring bass data. Mean CPUE of all ages were greater in control embayments than in experimental embayments. Age-1 catch rates were low in all embayments in 2004 and 2009, indicating poor survival from the 2003 and 2008 year classes. Age frequency of spotted bass was also examined from spring bass data and followed trends similar to largemouth bass. Mean CPUE of spotted bass of all ages were greater in control embayments than in experimental embayments, and poor year class survival from 2003 and 2008 was evident from no age-1 spotted bass captured in 2004 and below average catch rates in 2009.

Fall

A total of 104 hr of electrofishing effort was expended during fall 2003-2010. Fall sampling in 2006 was not conducted due to dangerously high river levels. Largemouth bass were the predominate black bass species in all 4 embayments throughout the study. Mean CPUE of largemouth bass in all embayments from 2003-2010 was 37.3 fish/hr, while mean CPUE of spotted bass was just 6.8 fish/hr. Mean CPUE of largemouth bass in control embayments (41.5 fish/hr) was higher than mean CPUE in experimental embayments (33.1 fish/hr). Spotted bass followed that same trend. Mean CPUE of spotted bass in control embayments was 16.3fish/hr compared to 6.6 fish/hr in experimental embayments. No negative effects on CPUE of largemouth bass or spotted bass were seen with the removal of SSS in 2010. All embayments displayed increased catch rates from 2009 when SSS were still in place.

Fall electrofishing CPUE of <8.0, 8.0 – 11.9, 12.0 – 14.9, and ≥15 in largemouth bass were compared between embayments. Mean CPUE of largemouth bass <8.0 in in experimental embayments (12.9 fish/hr) was higher than in control embayments (8.2 fish/hr). Catch rates for <8.0 in. largemouth bass increased in 2010 after SSS were removed in all but one embayment, Big Snag Creek (experimental embayment). For all other length classes evaluated, mean CPUE of control embayments was higher than experimental embayments. The removal of SSS in 2010 showed no consistent effects on CPUE of other length classes.

Fall electrofishing CPUE of <7.0, 7.0 – 10.9, 11.0 – 13.9, and ≥14 in spotted bass were also evaluated. Mean CPUE for all length classes of spotted bass were higher in control embayments than in experimental embayments. Similar to largemouth bass, catch rates for <7.0 in spotted bass increased from 2009 to 2010 after SSS were removed in all embayments. Catch rates of other length classes had mixed results with the removal of SSS.

Electrofishing CPUE for black bass by age-classes for fall 2003-2010 were also compared. Mean CPUE of age-0 largemouth bass in experimental embayments (11.0 fish/hr) was slightly higher than in control embayments (9.2 fish/hr); however, catch rates of age-1, age-2, and age-3 fish were all higher in control embayments. Mean CPUE of age-4 largemouth bass were similar across all embayments. Age-0 catch rates were below average in all embayments in 2003 and 2008 indicating poor year classes. Conversely, CPUE of age-0 largemouth bass were consistently above average in 2005 and 2007. Age frequency of spotted bass was also examined from fall data. Mean CPUE of all age classes examined were higher in control embayments than in experimental embayments. No age-0 spotted bass were sampled in any embayments in 2003 and were only captured in control embayments in 2008 (still below average). As with largemouth bass this is indicative of weak year classes in 2003 and 2008.

Discussion and Management Implications

Multiple studies have shown that the addition of bass spawning habitat can increase spawning success and overall population numbers (Vogele and Rainwater 1975; Johnson and Stein 1979; Hoff 1991; Hunt 1995; Annett et al. 1996; Hunt and Annett 2002); however, results from the Meldahl Pool of the Ohio River were contrary. Noticeable increases in CPUE of black bass in experimental embayments were not seen after the deployment of SSS. Often times, spring and fall CPUE was higher in control embayments with no added structure than in experimental embayments in any given year. Additionally, the removal of SSS prior to 2010 sampling did not have any negative effects on catch rates of black bass in experimental embayments as both spring and fall CPUE was higher in 2010 than in 2009.

The lack of success shown by the addition of SSS likely indicates that the availability of suitable spawning habitat is not the main limiting factor to reproductive success of black bass in

Meldahl Pool. Additional factors such as flow, flood pulse length, siltation, and dissolved oxygen all likely play a role in the spawning success of largemouth and spotted bass in Meldahl Pool. Of particular interest in this study is flow and the timing of high-flow events. Poor catch rates of age-0 black bass in the fall and age-1 bass the following spring indicate that 2003 and 2008 were poor year classes for black bass. Above average spring river flow and an extended flood pulse were observed in both years. In 2005 and 2007, below average spring flows were observed on the Ohio River, and catch rates of age-0 black bass were far above average in all embayments during those years. Bettoli and Maceina (1998) found that largemouth bass year class strength was inversely related to late spring discharge on the Tennessee River. Weaker year classes were associated with high flow events after spawning, while stronger year classes were associated with prolonged periods of low water. Conversely, Raibley et al. (2011) found that an extended flood pulse provided stronger year classes on the Illinois River. Spawning success was associated with prolonged inundation of floodplain habitat that was more conducive to spawning that many of the river's backwater lakes. Inundation of the floodplain of Meldahl Pool does not provide the habitat as described by Raibley et al. (2011), and spawning success was generally lower when spring flow was higher.

Increased siltation as a result of high spring flows may also play a factor in poor year classes. Negative effects of siltation on spawning have been documented for multiple species (Kemp et al. 2011). Spawning largemouth bass generally associate with firm substrates such as gravel and cobble (Kramer and Smith 1962; Miller and Kramer 1971; Vogele and Rainwater 1975; Nack et al. 1993; Hunt 1995). Increased siltation in the Meldahl Pool of the Ohio River likely rendered portions of spawning substrate in embayment unusable or lead to an unsuccessful hatch. Although, a relation between increased siltation levels and high spring flows was not directly observed in this study, no siltation levels less than 2.1 in. were recorded from 2004-2008. Siltation in all years was sufficient enough to have a possible negative impact on spawning success.

The addition of artificial spawning structures has been used to increase year class production in other systems (Aggus and Elliott 1975; Eipper 1975; Heidinger 1975 Nack et al. 1993). Data from 2003-2010 indicate that the addition of SSS in Meldahl Pool of the Ohio River did not have the desired effect, and their application in large river systems to improve year class strength appears to have little if any merit. We believe that black bass year class production (i.e., spawning) in the Ohio River is the first issue that limits abundance. To combat this, the Department has begun stocking fingerling (2 in.) largemouth bass in the Markland and Meldahl Pools of the Ohio River. Stockings occur in June and likely avoid many of the problems caused by high spring flows and siltation. Preliminary results indicate strong survival and bolstered year classes due to departmental stockings. Although a more in-depth investigation of environmental impacts on spawning success may be needed, it is possible that flow and increased siltation are the limiting factors of spawning success in Meldahl Pool.

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Funding Source: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 2, Strategic Objective 3.

Analysis of the Environmental Requirements for *Etheostoma maydeni* (Redlips Darter) and *Percina squamata* (Olive Darter) in the Rockcastle River, Kentucky

Michael Compton and Christopher Taylor, Texas Tech University

KDFWR Contact: *Matt Thomas and Stephanie Brandt*

Introduction

The southeastern region of the United States has a rich fish fauna with numerous species restricted to a few river systems (Page & Burr 2011). The conservation of these species and their stream ecosystems is a paramount challenge for resource managers (Dudgeon et al. 2006; Abell et al. 2008). The decline of many species has been well documented (Etnier 1997; Warren et al.1997; Jelks et al. 2008), with the local extinction of many populations attributed to anthropogenic alterations of the landscape, water pollution, habitat degradation, and the presence of exotic species (Benke 1990; Allan & Flecker 1993; Richter et al.1997; Dudgeon et al. 2006). Benthic species (e.g., madtoms and darters) are particularly susceptible to habitat degradation, because habitat at the bottom of the stream is typically the most severely impacted (Angermeier 1995). Effective management and conservation of imperiled species will require knowledge of life history, evolution, and multiscale habitat associations; only then can implementation of stream restoration projects, species reintroductions, critical habitat designations, and sound policy be made successfully (Warren et al.1997; Fausch et al. 2002; Durance et al. 2006).

The Olive darter (*Percina squamata*, Figure 1) is listed as endangered (KSNPC 2007) and as a species of greatest conservation need (SGCN) by Kentucky Department of Fish and Wildlife Resources (KDFWR 2005). This species occurs in the Cumberland and Tennessee River systems in Georgia, Kentucky, North Carolina, and Tennessee (Page and Burr 2011). It is considered imperiled or critically imperiled in each of the occupied states (NatureServe 2007; Jelks et al. 2008). It is known from only 12 records in the Big South Fork Cumberland River and Rockcastle River (Burr and Warren 1986); it has not been collected from the Kentucky portion of the Big South Fork Cumberland River since 1968 and has been collected sporadically in the Rockcastle River. Although the species has declined across its range, its status in Kentucky is uncertain.

The Redlips darter, *Etheostoma maydeni*, (= *E. cinereum*, Ashy darter, Figure 2) is endemic to the Cumberland River drainage in Kentucky and Tennessee (Shepard & Burr 1984; Powers et al. 2004; Powers et al. 2012). The species is known from Big South Cumberland River, Buck Creek, Red River, and Rockcastle River in Kentucky, where is it sporadic and uncommon (Shepard & Burr 1984; Burr and Warren 1986). The *E. cinereum* complex is considered vulnerable by Jelks et al. (2008) due to habitat loss and increasing range fragmentation. Effective management of this species is hindered because known habitat associations are primarily based on anecdotal observations and vary greatly (e.g. Shepard & Burr 1984; Etnier & Starnes 1993). A comprehensive assessment of microhabitats and stream reaches used by the species is needed.

The incorporation of multiple spatial scales in species distribution and habitat association studies has benefitted conservation efforts for many fish species (e.g., Watson & Hillman 1997; Heggenes et al. 1999). Schlosser and Angermeier (1995) demonstrated the importance of knowing: 1) how the interaction of ecosystem processes across spatial and temporal scales creates and maintains habitat features that support fishes; and 2) the spatial variation in demographic processes such as emigration and immigration within lotic fish species across different hierarchical scales. Understanding these factors would allow resource managers to identify environmental factors necessary for the persistence of a species or assemblage (Schlosser & Angermeier 1995; Fausch et al. 2002). Our study focused on the Rockcastle River drainage because it supports relatively robust populations of Olive darter and Redlips darter. We documented the distribution, relative abundance, and environmental resource use across stream reach and microhabitat spatial scales. Our goal was to document spatial patterns of Redlips darters and Olive darters to facilitate conservation efforts in areas most likely to enhance the persistence of the species.

Methods

Study Area

The Rockcastle River is a moderate gradient, 5th order tributary of the Cumberland River with a

Figure 1: *Percina squamata* (Olive darter)/*Matt Thomas*

catchment area of approximately 2,000 km^2 (764 mi.^{2}). The watershed is primarily within the Southwestern Appalachian Ecoregion, with only the headwaters of the most northwestern tributaries located within the Interior Plateau Ecoregion (Woods et al. 2002). The watershed is approximately 40% forest, 25% grassland, 25% urban and 10% agriculture (Homer et al. 2004). In the headwaters of the watershed, agriculture, grassland, and urban land use are more common. The lower mainstem of the river is mostly forested and has been designated as a Kentucky Wild River; this section of the watershed is primarily within the boundaries of the Daniel Boone National Forest. Coal mining activity within the watershed was prominent, but most current land use influences include silviculture, agriculture, and numerous small communities scattered across the landscape. The mouth of the river is inundated by the backwaters of the impounded Cumberland River (Wolf Creek Dam), which fluctuates seasonally and can influence the river approximately 10 river km upstream.

Study Design

Fifty-six sites were established for the purpose of obtaining fish distribution and assemblage data as well as habitat data at the stream reach and microhabitat scales during the summers of 2008-2010. Thirty of the 56 sites were located within the 4th and 5th order stream reaches and selected randomly. At each of the 30 sites, biological and physical data were collected from a series of plots during the summers of 2009 and 2010 to construct reach and microhabitat use models for both species. Any focal species encountered were identified and enumerated for each plot. In addition to the plot sampling, supplemental electrofishing and seining was conducted within a stream reach to enhance fish assemblage and distributional data. Water quality data was also collected at each site. All focal species captured were measured for total length (TL mm) and classified as adult (TL $\geq$ 70 mm) or juvenile (< 70 mm). A variety of univariate and multivariate techniques were used in the development of habitat use models and to understand the habitat linkage between the two scales. Analysis techniques are detailed in Compton and Taylor (2013).

Results

Rockcastle River Fishes

A total of 46,475 individuals from 67 species of fish were collected from 96 sample events during 2008 – 2010. Seven new species were collected, *Acipenser fulvescens* (lake sturgeon), *Lepisosteus osseus* (longnose gar), *Notropis telescopes* (telescope shiner), *Gambusia affinis* (mosquitofish), *Morone saxatilis* (striped bass), *Lepomis gulosus* (warmouth), and *Percina sciera* (dusky darter), resulting in 79 species now known from the Rockcastle River. All of the fish SGCN for the Rockcastle River were collected, except for *Chrosomus cumberlandensis* (blackside dace). The families Cyprinidae and Percidae were the most diverse with 22 and 15 species and the most abundant with 62% and 20% of the total fish collected, respectively. Redlips darter and Olive darter ranked 9th and 14th in order of abundance, with each species representing 3.9% (365 individuals) and 0.24% (23 individuals) of the total darter individuals collected from 2008 – 2010, respectively.

Olive Darter:

Olive darters were restricted to larger sized streams within the Rockcastle River drainage, but their distribution was more isolated and fragmented than the Redlips darter. Twenty-three individuals from eight sites were encountered. All of the sites except for the Middle Fork Rockcastle River location were 5th order and had a catchment area > 750 km^2, with the majority of locations present within the lower reaches of the mainstem. Olive darters were encountered during 11 fish sampling events and ranged from 1-4 individuals. The species was always less than 0.01 % of the total fish abundance and represented 0.4-2.6 % of darter species captured.

Given the low abundance of Olive darters, particularly from the plot surveys (7 individuals captured

	Juveniles (n= 15)		Adults (n= 23)		Mann-Whitney *U*-Test	
Variable	**Median**	**I.R.**	**Median**	**I.R.**	**U-statistic**	**P-value**
Catchment Area (km^2)	1,181.60	591.9	1,220.60	869.3	193	0.539
Elevation (m)	256.9	11.6	251.1	21	152	0.539
Maximum Depth (m)	1.5	0.2	1.6	0.2	216	0.162
Canopy Cover (1 – 4)	3	0.8	2.8	1	151.5	0.501
EPA RBP Habitat Score	147	19.3	158	19	245.5	**0.029**
Alkalinity (mg/L)	69.1	16.2	75.7	10.4	243.5	**0.034**
Conductivity (µs/cm)	215	18	222.1	20.3	217	0.183
Organic Carbon (mg/L)	2.4	0.2	2.2	0.6	141.5	0.354
% Urban	23	0	19	8.7	150	0.443
% Forest	39	0	45	15.2	195	0.443
% Grassland	27	0	26	4.5	150	0.443
% Agriculture	7	0	7	2.2	150	0.443
% Sand	15	8	14	8.3	151	0.519
% Pebble	25	15	23	13	142	0.36
% Cobble	19	11	23	9.8	189.5	0.611
% Boulder	8	8	13	11	225	0.116

Table 1: *Stream reach scale comparison of juvenile and adult Redlips darter median and interquartile range (IR) environmental variable values and Mann-Whitney U-test results.*

Bolded variables were significantly different between juvenile and adult darters.

during 4 sample events from 3 sites), analysis was limited to descriptive interpretation. Six of the eight sites where the species occurred were very similar based on shared habitat characteristics. Each of these sites had a catchment area of at least 1500 km^2 with instream habitat composed of approximately 55% run, 33 % pool, and a maximum depth of 1.6 meters. Substrate composition was predominantly boulder and cobble (40-50 %), followed by pebble and gravel (30-40 %). The land cover associated with these sites is mostly forest (> 50 %) with urban and agriculture roughly 20 %, combined. All Olive darters were encountered via backpack electrofishing.

Redlips Darter:

Redlips darters were encountered at 23 sites in 4th and 5th order stream reaches having a catchment area greater than 100 km^2. The species was present at all of the mainstem reaches and the lower reaches of the major tributaries, except for Skegg Creek. The mean distance from the Redlips darter tributary locations to the confluence of the Rockcastle mainstem was 2.7 river km (SD = 2.8), with a range of 0.5-9.5 km. Redlips darters were consistently present only at the most downstream locations in Horse Lick Creek, Middle Fork Rockcastle River, and South Fork Rockcastle River; presence was less consistent in the mainstem Rockcastle River. The most downstream site in Horse Lick Creek had a population with a mean greater than ten individuals per collection. Individuals captured in Roundstone Creek and Sinking Creek represented new drainage records for the species. During the course of our study, Redlips darters were encountered during 41 fish sampling events ranging from 1-25 individuals per location and event. The species was always less than 1% of the total fish abundance, but represented 0.9 -13.9 % of the total darter community, with a median value of 4.9 %.

Habitat Use Analysis

Analysis of the stream reach and microhabitat data revealed that the distributions of adult and juvenile

Redlips darters were non-random (selective). In addition, Mann-Whitney *U*-test indicated that adult and juvenile darters use the same stream reaches, but segregate themselves within the reaches by using different microhabitats. The stream reach characterization for Redlips darters included all of the mainstem Rockcastle River reaches with catchment areas > 750 km^2 and 4^{th} order tributary reaches with catchment areas > 100 km^2 and close proximity (< 10 river km) to the mainstem. The land cover associated with these reaches was approximately 40% forest, 25% grassland, 20% urban and less than 10% agriculture. The reaches contained approximately 12% riffle, 55% run, and 33% pool habitats, with the maximum depth typically 1.5 meters. Substrate composition was approximately 50% cobble and pebble, 15% boulder and 15% sand, with a mixture of gravel, silt, and bedrock comprising approximately 20% of the remaining reach substrates. Redlips darters were present exclusively at reaches containing at least one boulder greater than 0.50 m in size within at least 20% of the plots sampled within that reach. Typically reaches included a diverse mixture of flow and depth patterns, numerous habitat types with minimal sediment deposition, stable banks, and a wide (> 20 m) riparian zone (Table 1).

Comparison of microhabitat variables for adult and juvenile Redlips darters revealed several similarities and differences (Table 2). Mann-Whitney *U*-tests indicated that the use of the outside bend of the channel, gravel and boulder substrate, and mean largest boulder size were statistically different between adults and juveniles darters. Adults were present along the margin of the stream channel in 68% of the plots, with 80% of those plots present along the outside bend of the channel, indicating a strong association with the erosional zone of the channel. Juveniles were present along the margin of the channel in 54% of the plots and were present along the outside bend of the channel in 52% of those plots, indicating no preference in channel location. Although a difference in channel location was seen among adult and juvenile darters, flow and depth were not statistically different between the groups. Flow was typically classified as 'slow' (0.01-0.3 m/s), but was occasionally classified as 'no flow'. The median depth for adults and juveniles was 0.33 m and 0.34 m, respectively.

Comparison of substrate use between adult and juvenile Redlips darters showed that adults were more often associated with larger substrates than juveniles (Table 2). Cobble and boulder were present in 87% of the plots containing adults and composed 50% of the substrate within those plots. In plots occupied by juveniles, cobble and boulder were not as common and was approximately 25% and 6% of substrate composition within a plot, respectively. Gravel, pebble and cobble composed over 60% of the substrate within plots containing juveniles. The median largest-boulder size within plots was approximately 50% greater in plots containing adults than for juveniles. Adults and juveniles were similarly associated with sand, silt, bedrock and mud/clay, which represented a small percentage (< 10%) of the substrate composition when the species was present. Water willow and large woody debris (LWD) were infrequently used by adult and juvenile darters (< 10% of the plots containing the species). Large woody debris was used slightly more often by juveniles than adults, but this habitat was present in less the 25% of plots occupied by juveniles and 15% of plots occupied by adults.

Figure 2: *Etheostoma maydeni* (Redlips darter)/*Matt Thomas*

Discussion

The Olive darter was encountered too infrequently during this study to make a quantitative assessment of habitat use. However, based on our observations the species appears to be limited to reaches of the mainstem Rockcastle River with an abundance of large boulders. This type of habitat is common in the lower mainstem and it is possible that the species is more common than our results indicate. Furthermore, the Olive darters that were encountered typically did not fit the habitat descriptions as noted by Etnier and Starnes (1993) and exhibited a wide range of habitats. Encompassing the entire study, Olive darters were taken in swift water and associated with large boulders as described in Etnier and Starnes (1993), but they were also taken in areas with minimal flow. In general, Olive darter habitat can be characterized by areas with large boulders (often over 1.0 m, b-axis length), minimal fine substrate, and with slow flow (0.01 – 0.3 m/s). Lastly, only two juvenile darters were collected, which were both located along the margin of the channel. One juvenile, 64 mm TL, was associated with a small boulder and large woody debris. The largest adults were taken in the mid-channel and in the swiftest waters. One adult, 139 mm TL, was taken at the head of a riffle in swift water, associated with a large boulder (1.1 m, b-axis length).

The Redlips darter was common and occasionally locally abundant in the 4th and 5th order segments. We suspected that the environmental quality of the stream reaches and microhabitats were linked, such as higher quality reaches would have a greater proportion of higher quality plots containing Redlips darters and a greater abundance of adult and juvenile individuals within them. Our analysis indicated that the two spatial scales were mostly independent of each other. Lower and higher quality reaches contained plots of varying quality. In addition, the results indicated that a sufficient network of suitable microhabitats within a reach is needed to support a large population of adult darters.

One of the most important limiting factors for the Redlips darter at the stream reach scale was stream size. The species was present at all of the mainstem sites (5th order with catchment area > 750 km^2), and in the lower reaches of the tributaries (4th order with catchment area > 100 km^2) typically < 3 km upstream from the Rockcastle River confluence. The species is known to inhabit small to large rivers (Etnier & Starnes 1993; Powers & Mayden 2002; Page & Burr 2011). We classified the Rockcastle River mainstem as a medium-sized river, the major tributaries as small rivers or large creeks, and the Cumberland River as a large river. We suspect that the species inhabits primarily medium-sized rivers based on known occurrences in the Big South Fork Cumberland River in KY/TN and Buffalo River in TN. The species appears to have an occasional or seasonal presence in small rivers (e.g., Buck Creek, KY) and large rivers (e.g., Clinch River, TN/VA). Large rivers may serve as important natural dispersal corridors between populations.

In addition to stream size, a minimal proportion of large boulders within a stream reach was identified as an important limiting variable for the Redlips darter. Individuals were always present in reaches having at least one boulder > 0.5 m b-axis in 20% of the plots surveyed. Although boulders have been identified as a substrate type used by the species (Shepard & Burr 1984; Etnier & Starnes 1993), our study is the first to demonstrate the importance of boulder size and frequency within a stream reach.

Several microhabitat variables influenced the distribution of Redlips darters within a reach. Adults and juveniles frequently occupied pool habitats, or occasionally along the margins of run habitat, with similar depths (0.20–0.80 m) and flows (slow or no flow). They were segregated within the stream reach by channel location and rock substrate preference. Adults occurred more frequently along channel margins, particularly the outside channel bend, and were mostly associated with larger substrates, such as boulder and cobble. Juveniles were more evenly distributed within the channel and were associated with smaller substrates, such as gravel and pebble. Adults were generally associated with boulders approximately 50% larger than the boulders associated with juvenile darters. We view the large rock substrates as the primary cover for the species. Although bedrock (fractured bedrock) was not significantly associated with Redlips darter use, we recognize its importance and similar function as cover (Etnier & Starnes 1993).

Microhabitat features such as silt, LWD, and water willow have been associated with Redlips darter presence (Shepard & Burr 1984; Etnier & Starnes 1993; Boschung & Mayden 2004). We quantified the use of these substrates and their importance relative to other microhabitat features used. We found the Redlips darter occasionally associated with silt, which represented a small proportion of the general habitat. The species did not occur in heavily silted areas unless a large boulder (> 1.0 m b-axis) was present in the immediate area along with an adjacent clean swept benthic area. We encountered three adults within this habitat combination. Our observations agree with other reports (e.g., Shepard & Burr 1984) that silt limits Redlips darter persistence and we emphasize that excessive silt is one of the principal factors detrimental to the species.

The use of LWD or water willow as cover was first noted by Shepard & Burr (1984) and has frequently been noted in subsequent works (Burr &

	Juveniles (n= 50)			Adults (n= 60)			Mann-Whitney *U*-Test	
Variable	**Median**	**I.R.**	**P.F.**	**Median**	**I.R.**	**P.F.**	**U-statis-**	**P-value**
Outside bend (0/1)*	1	1	0.52	1	1	0.8	712	**0.013**
Large woody debris (0/1)	0	0	0.24	0	0	0.15	1347	0.18
Justicia spp. (0/1)	0	0	0.1	0	0	0.08	1472.5	0.741
Flow category (0 – 3)	1	1	0.7	0.8	1	0.63	1436.5	0.679
% Fines	0	0	0.06	0	0	0.15	1634	0.137
% Sand	12.5	25	0.54	0	13	0.42	1290	0.171
% Gravel	25	37.5	0.74	6.3	13	0.5	955.5	**0.001**
% Pebble	13	25	0.76	12.5	13	0.65	1211	0.076
% Cobble	25	25	0.86	25	31.5	0.87	1782.5	0.086
% Boulder	6.3	13	0.5	25	24.8	0.87	2270.5	**< 0.001**
% Bedrock	0	0	0.1	0	0	0.23	1696.5	0.073
% Mud/Clay	0	0	0.04	0	0	0.02	1465	0.456
Mean depth (m)	0.34	0.3	1	0.33	0.16	1	1507.5	0.964
Depth coefficient of variation	0.44	0.51	1	0.58	0.35	1	1768.5	0.107
Mean largest boulder (m)	0.48	0.32	0.92	0.73	0.37	1	2414.5	**< 0.001**

Table 2: *Plot scale comparison of juvenile and adult Redlips darter median, interquartile range (IR), and plot frequency (PF) environmental variable values and Mann-Whitney U-test results.*

*adjusted to only account for plots along the margin of the stream channel. **Bolded** variables were significantly different between juvenile and adult darters.

Warren 1986; Etnier & Starnes 1993). We found the species to be rarely associated with LWD when appropriate rock substrate (i.e., boulder) was present within a plot. When a boulder was absent from a plot, LWD was used presumably because it served as the largest stable substrate. Water willow was rarely used (< 10%), but we speculate that the vegetative cover may play a role in other aspects of life history not addressed in our study, such as egg attachment (Etnier & Starnes 1993).

Management Implications

This research provides the foundation for two concepts that could benefit the conservation of the species across its entire range. The first concept is based on our findings that the species primarily occupies sections of medium-size rivers. We postulate that the Redlips darter conforms to a nonequilibrium metapopulation model, where dispersal capabilities and connectivity of habitats are diminished by natural or anthropogenic factors (Harrison 1991; Falke & Fausch 2010). The tributaries of the Cumberland and Tennessee rivers can be viewed as separate systems relatively isolated from each other by the mainstem based on their spatial position within the drainages, and exacerbated by the presence of impoundments (Osborne and Wiley 1992). Within this context, rates of colonization and gene flow among populations inhabiting the tributaries decreases and the influence and dependency of local habitats to maintain local populations increases (Yan et al. 2011). In addition, viewing the insular tributaries in the framework of island biogeography theory (MacArthur & Wilson 1967), we suspect that populations in the smallest and most isolated tributary watersheds are at the greatest risk of local extirpation. For example, the Little River population has been documented as being stable/good (Etnier & Starnes 1993), but has declined greatly (Powers et al. 2004). We suspect that movement into this system is minimal or nonexistent because of impoundment and local habitat degradation over time resulting in population decline. Therefore, within this geographic framework, an assessment of watershed size (km^2), connectivity, and colonization potential among the tributaries should be conducted. In addition, an assessment of the available habitat within the tributaries should be made to prioritize conservation efforts. Although we did not test for transferability within our study, we are confident that a strong baseline in habitat use was achieved and can be used cautiously in other tributaries. This should guide resource managers in watershed restoration projects, critical habitat enhancement, or species augmentation efforts.

The second concept focuses on the microhabitats used by Redlips darter. Our study provided strong evidence that stable rock substrates, in particular large boulders (> 0.5 m), minimal silt, pool habitat, and no or slow flow are important variables in localized presence of the species. We hypothesize that adults are dependent upon the hydrology within the erosional zone of the channel and on the presence of large boulders. The erosional zone contains the greatest current velocities and sheer stress within the channel during high flows (Rosgen 2006). During periods of high flow the material is lifted and transported downstream, and is most prevalent within the erosional zone of the channel, where finer substrates such as sand and silt are flushed. It is this hydraulic flushing mechanism that cleans the interstitial spaces between the larger substrates used by the Redlips darter. This is important because Redlips darter frequently occurs within pool habitat and is associated with no or slow flows (< 0.30 m/s) during base-flow periods. This makes pools highly susceptible to excessive sediment loads. We suggest the strong association between the Redlips darter and large boulders is related to the fact that boulders are stable substrates that provide shelter against increased suspended material being transported downstream during rain events. We believe this hypothesis provides resource managers with a sound framework to focus endeavors in local conservation efforts, such as biological surveys, critical habitat protection, and stream restoration efforts.

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KDFWR Strategic Plan. Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.9; Class Actinopterygii and Cephalaspidomorphi: Taxa specific research and survey project.

Description and Geography of Two Unique Populations of the Stonecat, *Noturus flavus* (Siluriformes: Ictaluridae)

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Introduction

The genus *Noturus* (madtoms) is a strictly North American freshwater ictalurid (North American catfishes) composed of approximately 30 species. Most are small, typically less than 10 cm standard length (SL), and can be differentiated from other ictalurids by their attached adipose fin (Page and Burr, 2011).

Noturus flavus Rafinesque (Siluriformes: Ictaluridae), commonly called Stonecat, has one of the largest geographic ranges in the genus occurring latitudinally from southern parts of Canada to northern Alabama and longitudinally from Montana to Vermont. Within Kentucky, Stonecats occur throughout the eastern half of the state in the Cumberland, Kentucky, Licking, and Salt River drainages, and Tygarts Creek and the Little Sandy River (Figure 1). Stonecats occur in streams and small to large rivers where they are usually associated with riffle habitats (Burr and Warren, 1986).

The Stonecat attains the largest size among all the madtoms reaching up to 31 cm standard length (SL). Although not as spectacularly pigmented as some other madtom species, it does have several diagnostic characteristics. These include a light, cream colored blotch at the rear of the dorsal fin base and a backward extension from each side of the premaxillary tooth patch (Page and Burr, 2011). Due to its broad distribution, there is natural morphological variation among Stonecat populations (Taylor 1969); however, there are several references to two distinct phenotypes that could be considered separate species.

The first phenotype, which we herein refer to as the “Highlands Stonecat,” is found in the Cumberland River (below Cumberland Falls) drainage and sporadically in the Tennessee River drainage (Figure 2). The Highlands Stonecat shows a distinctive pigmentation pattern of

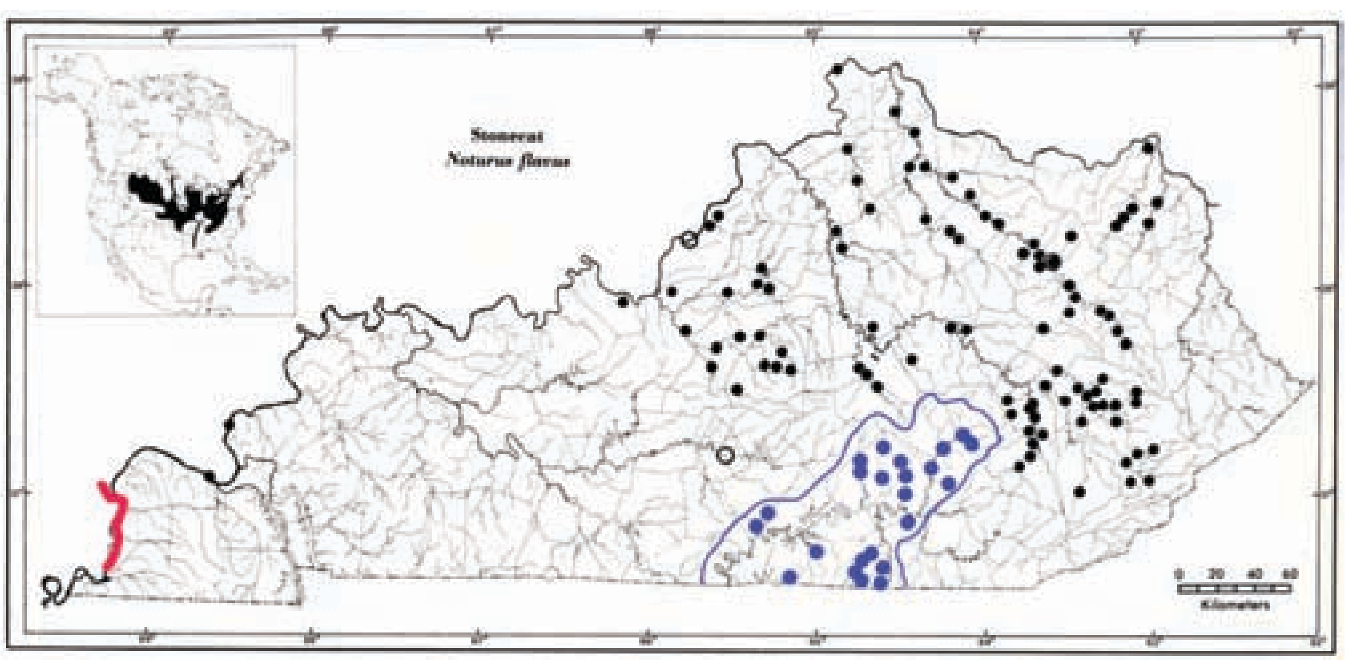

Figure 1: Kentucky range map of *Noturus flavus* (modified from Burr & Warren 1986) depicting distributions of Stonecats (black spots, Ohio River basin), Highland Stonecats (blue dots, Cumberland River drainage), and Smalleye Stonecats (red line, Mississippi River mainstem).

a cream-colored crescent and two ovals across its nape (Figure 4). In a recent phylogeographic analysis of Stonecat populations using mitochondrial DNA, the Tennessee and Cumberland River lineages formed a monophyletic group which was the sister group to all remaining populations (Faber et al., 2009).

Several references to the unique phenotype in the Cumberland and Tennessee River drainages suggest that it represents a distinct and undescribed species (Burr and Warren, 1986; Burr and Stoekel, 1999; Boschung and Mayden, 2004; Faber et al., 2009; Page and Burr, 2011).

Table 1: *Description of measurements used in the morphometric analyses*

01. snout to occiput	19. dorsal fin insertion to anal fin origin
02. snout to dorsal fin origin	20. dorsal fin insertion to adipose fin origin
03. snout to pectoral fin origin	21. pelvic fin origin to adipose fin origin
04. snout to pelvic fin origin	22. pelvic fin origin to anal fin origin
05. between the eyes to occiput	23. adipose fin origin to anal fin origin
06. between the eyes to pectoral fin origin	24. adipose fin origin to adipose fin insertion
07. between the eyes to meeting of gills	25. adipose fin origin to anal fin insertion
08. meeting of gills to occiput	26. adipose fin insertion to anal fin origin
09. meeting of gills to pectoral fin origin	27. adipose fin insertion to anal fin insertion
10. occiput to dorsal fin origin	28. anal fin origin to anal fin insertion
11. occiput to pectoral fin origin	29. standard length
12. head depth at occiput	30. pectoral spine length
13. dorsal fin origin to pectoral fin origin	31. dorsal spine length
14. dorsal fin origin to pelvic fin origin	32. head width under nasal barbels
15. dorsal fin origin to dorsal fin insertion	33. head width under eyes
16. pectoral fin origin to pelvic fin origin	34. body width at pectoral fin origin
17. pectoral fin origin to dorsal fin insertion	35. body width under dorsal fin origin
18. dorsal fin insertion to pelvic fin origin	36. least interorbital width
	37. orbit width

The second phenotype which we refer to here as the "Smalleye Stonecat" is found in the lower Missouri River from approximately Kansas City, Missouri, to its mouth and middle Mississippi River from the mouth of the Missouri River to the mouth of the Hatchie River, Tennessee (Figure 2). A few specimens are available from the Mississippi River in Kentucky, and more trawling will probably yield a better sample size than what is available at present. Larval Smalleye Stonecats have been collected from the main channel of these rivers leading to the assumption that this phenotype remains in turbid, deep channel habitats for the duration of its life and may be isolated from *N. flavus* in adjoining tributaries. Additionally, *N. flavus* has not been collected in tributaries to the Mississippi River below the Meramac River (Smith, 1979; Pflieger, 1997) leading to further isolation of these southern Mississippi River populations. The Smalleye Stonecat has smaller eyes than nominotypical *N. flavus* and they also appear to be less developed (almost vestigial). Faber et al. (2009) included four Smalleye Stonecats from Cape Girardeau, Missouri, in their phylogeographic analysis, and they discovered that they shared a haplotype with the majority of the other lowland clade. Some references to this phenotype suggest that it may warrant recognition as a distinct species (Burr and Stoeckel, 1999; Boschung and Mayden, 2004).

Objectives

Multiple observations since the late 1960s have been made regarding these two distinct phenotypes of *N. flavus* (see above) yet no formal taxonomic study has been conducted to date. The recommendations by other researchers that these phenotypes could be described as new species warrants this research. Both the Highlands Stonecat and Smalleye Stonecat along with nominotypical Stonecats are found within or in waters bordering the state of Kentucky. Clarification of distinctions among these three is essential to fully understanding the ichthyofauna of the state.

The objectives of this research are:

1. To formally describe a new

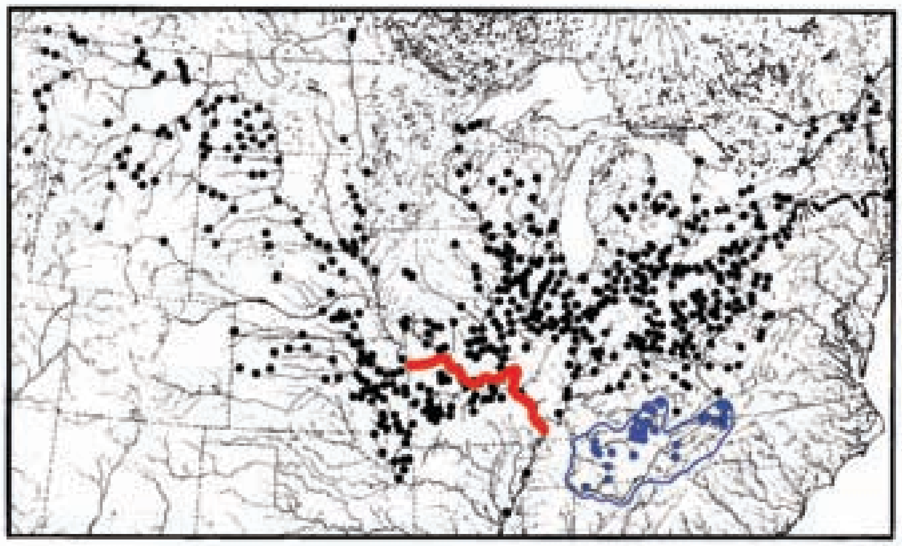

Figure 2: General spot distribution of the Stonecat (*Noturus flavus*) in the northern United States and southern Canada. Stonecats (black spots), Smalleye Stonecats (red line), and Highland Stonecats (blue spots) are so indicated on the map.

species of catfish (Ictaluridae) of the genus *Noturus* related to *Noturus flavus* (Stonecat) that is known in Kentucky, Tennessee, Alabama, and Virginia only from the Cumberland River (e.g., Rockcastle River, Big South Fork) and Tennessee River drainages herein referred to as the "Highlands Stonecat".

2. To describe and discuss the population of *Noturus flavus* (Stonecat) herein referred to as the "Smalleye Stonecat" that is known in the lower Missouri River and Mississippi River from the mouth of Missouri River to the mouth of Hatchie River and recommend future work regarding this population.

Methods

Specimens examined in this study were borrowed from natural history collections at the following institutions: Southern Illinois University Carbondale (SIUC), Illinois Natural History Survey (INHS), University of Michigan Museum of Zoology (UMMZ), Tulane University (TU), University of Kansas (KU), United States National Museum (USNM), Canadian Museum of Nature (CMNFI), Cornell University (CU), The Manitoba Museum (MM), and University of Alabama (UAIC).

Specimens were initially assigned to a phenotype (Stonecat, Highlands Stonecat, or Smalleye Stonecat) based on collection location and historical references to the ranges of these hypothesized phenotypes. Specimens from the Missouri River downstream of Kansas City, Missouri, to the mouth, and Stonecats from the Mississippi River downstream of the mouth of the Missouri River were designated Smalleye Stonecats. Specimens from the Cumberland River drainage or Tennessee River drainage were designated Highlands Stonecats. Specimens from other locations were designated normal *N. flavus* (Stonecat).

To evaluate shape variation among the three putative taxa, a series of 37 point-to-point measurements (Table 1) were taken on 229 *N. flavus*, 224 Highlands Stonecats, and 64 Smalleye Stonecats. These measurements form a typical box truss (Bookstein et al., 1985) along with additional standard morphological measurements (Hubbs and Lagler, 2004). All measurements were made with Mitutoyo Absolute Digimatic digital calipers to the nearest 0.1 mm on the left side of the specimens. Morphometric data were log-transformed and subjected to principal component analysis (PCA) using JMP 7.0.1 software.

The low number of Smalleye Stonecats examined was due to the rarity of museum specimens and the difficulty of collecting this phenotype in large rivers. Field collected specimens of Stonecat, the Highlands Stonecat, and Smalleye Stonecat were also used in this study and deposited in the SIUC Fluid Vertebrate Collection (SIUC FVC). Stonecats and Highlands Stonecats were collected using seines and backpack electrofishing methods in streams. Smalleye Stonecats were collected using a benthic trawl. All museum and field collected fish used in this study were georeferenced using DeLorme Topo USA 7.0 software to the best possible location if latitude and longitude were not provided by the lending institution.

Three pigmentation patterns were scored using scales created for this study (following Burr et al., 2005) based on the observed range of patterns. These patterns were observed and scored by using a dissecting microscope or naked eye. In order to score nape pigmentation, a scale ranging from 1 to 3 was developed: 1) no nape pigmentation; 2) cream colored crescent on nape; 3) cream colored crescent and two ovals on nape. Observations have also revealed a ventral pelvic fin and abdominal pigmentation pattern which were scored as a number 1-4: 1) no pigmentation present on abdomen or in ventral pelvic fins; 2) pigmentation present in ventral pelvic fins only, 3) pigmentation present on abdomen only, 4) pigmentation present on abdomen and in ventral pelvic fins. The lower lip was also examined for any pigmentation and scored as a yes (presence) or no (absence) value.

A subset of specimens was also examined to determine gender. These individuals were dissected and examined internally when permission was obtained from the lending institution. Gender was recorded as male, female, or undetermined. The genital papillae were also examined to determine if fish could be sexed by external methods following Walsh and Burr (1985).

Results

Principal component analyses of the 37 body shape characters used in this study did not separate *N. flavus*, the Highlands Stonecat, and the Smalleye Stonecat into separate clusters under any scenario (e.g., gender, size); *Noturus flavus* always clustered as an intermediate between Highlands Stonecat and Smalleye Stonecat (Figure 3). However, when Highlands Stonecats and Smalleye Stonecats were analyzed apart from nominotypical *N. flavus*, these two phenotypes separated into nearly distinct clusters. Measurements driving this separation were dorsal fin spine length and bony orbit width.

Analyses of each of the three phenotypes separately did not reveal any separation of body shape among drainages except for one case involving Smalleye Stonecats. There was a compelling pattern in which individuals from the Missouri River formed a tight cluster that was separate from Mississippi River specimens. Missouri River Smalleye Stonecats have slightly larger eyes and shallower heads than Mississippi River specimens which show more variation in these characters.

The dorsal pigmentation pattern including the pale crescent along the nape does separate the Highlands Stonecat from *N. flavus* and Smalleye Stonecat (Figure 4). Nominotypical Stonecats (97% of specimens examined) and Smalleye Stonecats (98%) were typically scored as having no pattern and no specimens of these two types had the complete crescent and oval pattern. Highlands Stonecats were scored a 3 (complete pattern present) in 93% of the specimens examined and only 1%, 3 specimens, were scored as having no pattern. The lip pigmentation pattern showed similar results as the nape pattern: Highlands Stonecats typically had lip pigmentation present (91%) while normal Stonecats and Smalleye Stonecats typically had no lip pigmentation present, 94% and 100% respectively.

Abdominal pigmentation pattern was the most variable pattern scored in this study with almost all three phenotypes showing all four patterns scored. Highlands Stonecats were usually scored as having some pigment present, 73% of specimens examined; whereas, nominotypical Stonecats (79%) and Smalleye Stonecats (95%) usually were scored as having no pigment present in either the pelvic fin or on the abdomen.

Almost equal numbers of male and female fish were examined for each of the three phenotypes. Sheared PCA showed no separation of males from females for any of the phenotypes examined. Sex was not a determinate of any of the pigmentation patterns present either. External examination of the genital papillae was not successful in determining gender for any of the three phenotypes; Taylor (1969) also found that examination of the gonads was the only reliable method and external examinations were usually inconclusive. Dissection and internal examination in this case was much faster and gave conclusive results with minimal damage.

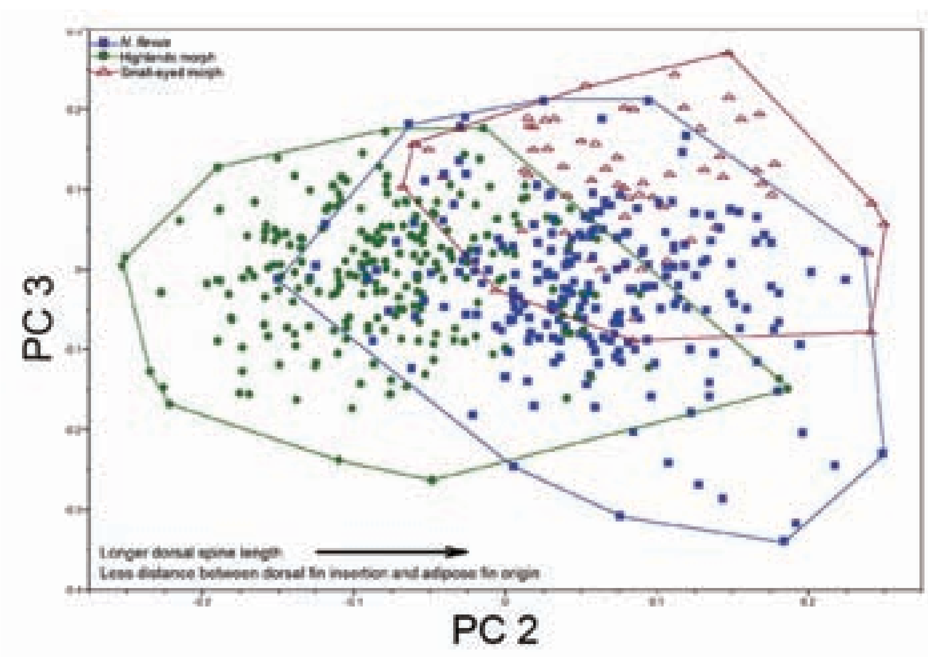

Figure 3: Plot of factor scores for 37 morphometric measurements on sheared PC axes 2 and 3 for all *Noturus flavus* (N=228), Highlands Stonecat (N=224), and Smalleye Stonecat (N=64) specimens.

Discussion

In his masterful revision of the genus *Noturus*, Taylor (1969) described 10 species and 1 subspecies as new to science. In two separate, but earlier papers (Bailey and Taylor, 1950; Suttkus and Taylor, 1965) he had already described 2 additional species. As of 1970, there were 23 species known and Taylor had described over half of them. Because of the apparent completeness of Taylor's work most systematic ichthyologists of the time turned to percids, cyprinids, and catostomids for new discoveries of formally undescribed species of North American freshwater fishes.

The significance of Taylor's (1969) work is, in part, that he showed external morphological characters that are generally informative of the taxonomic status of fish populations are conserved among madtoms. He also demonstrated that character differences among madtoms can be subtle, particularly in aspects of pigmentation. One other often overlooked detail is that several madtom species are naturally rare and occupy narrow ranges or are endemic to relatively small physiographic provinces (e.g., the Ozark Highlands). Limited geographic ranges and the slow but steady decline of stream integrity have led to 6 species (20% of known species) being listed as endangered or threatened by the U.S. Fish and Wildlife Service. One of these 6 species, *Noturus trautmani*, is probably extinct (not seen since 1957).

The two phenotypes, Highlands Stonecat and Smalleye Stonecat, partially described in this report were also predicted to be unknown in the formal taxonomic sense (i.e., undescribed; Burr and Stoeckel, 1999). The highly distinctive karyology (LeGrande and Cavender, 1980) and mitochondrial DNA (Faber et al., 2009) leave little doubt that what we are calling the Highlands Stonecat is a formally undescribed species. This study found some variation in the body shape between the Highlands Stonecat and Smalleye Stonecat, but very little between nominotypical *N. flavus* and either of the two phenotypes. However, the pigmentation patterns across the nape and on the lips of the Highlands Stonecat can be used to distinguish it from both nominotypical Stonecat and Smalleye Stonecat and hold true throughout the hypothesized range. The pigmentation distinctions are again subtle but consistent and have been shown previously in both editions of the Peterson Field Guide to Freshwater Fishes of North America (Page and Burr, 1991; Page and Burr, 2011), and in the fishes of Alabama (Mettee et al., 1996; Boschung and Mayden, 2004) and Virginia (Jenkins and Burkhead, 1994). The recent book on Indiana fishes (Simon, 2011) used the illustration of the Stonecat that had been previously used in the fishes of Alabama (Boschung and Mayden, 2004). The Highlands Stonecat does not occur in Indiana.

Figure 4: Pale crescent pattern along the nape (yellow arrow) distinguishing the Highlands Stonecat (A) from the Stonecat (B) and Smalleye Stonecat. Photos by Matt Thomas (KDFWR).

The Smalleye Stonecat, presumably found only in the main stems of the Lower Missouri River and the Mississippi River from the mouth of the Missouri River to the mouth of the Hatchie River, Tennessee, requires further study centered on karyology, DNA sequence data, histology, and reproductive biology. We have numerous tiny juveniles from the main stem Mississippi River that we do not believe have been "washed" out into the river from tributaries. The Smalleye Stonecat almost certainly spawns and lives out its entire life in big rivers similar to the *Macrhybopsis* chubs. No distinctive body shape or pigmentation pattern differences could be found in this study to distinguish Smalleye Stonecats from nominotypical Stonecats. Smalleye Stonecats do have longer dorsal fin spines and smaller eyes than Highlands Stonecats. Faber et al. (2009) showed that Smalleye Stonecats from Cape Girardeau, Missouri, shared a haplotype with the remainder of the Mississippi-Erie-Hudson clade. We believe that more research is required before salient differences can be found that separate Smalleye Stonecats from the other two phenotypes.

The relatively recent phylogenetic analyses completed by Hardman (2004), Near and Hardman (2006), and Egge and Simons (2009; 2011) have included DNA sequence data, morphology, and venom gland structure. The trees generated by these studies include nearly all described species and corroborate species-level distinctions and clearly defined clades of species for all 29 described taxa. It does appear that there is little phylogenetic support for a separate subgenus for *Noturus flavus* (subgenus *Noturus*), and the nomenclature of the future will probably reflect the idea that species are not recognizable as such, but that distinct lineages and groups of lineages will be given clade names. In the most recent phylogeny, *Noturus flavus* and 5 other species have "unclear" relationships and have not been placed in any named clade (Egge and Simons, 2009).

Management Implications

Conservation involves the preservation, maintenance, sustainable use, restoration, and enhancement of biodiversity. Such programs must be based upon knowing the organisms that are involved, where they live, and how they are related to one another (Savage, 1995). Several studies have shown that poorly resolved taxonomy or inaccurate estimates of taxonomic diversity can hinder conservation efforts (e.g., Funk et al., 2002; McNeely, 2002). Numerous putative, but undescribed taxa in the Tennessee and Cumberland River drainages are recognized by biologists and the conservation community (Warren et al. 2000); however, for most of these taxa, knowledge of their distributions, population densities, and ecological requirements is insufficient to make accurate conservation status assessments. Newly recognized taxa tend to be imperiled at a higher rate than the general fish fauna, oftentimes due to narrow endemicity (Burkhead and Jelks, 2000). An accurate account of diversity is imperative for the wise management, preservation, and recovery of regional fishes (Butler, 2002; Angermeier and Winston, 1999).

This study provides clarification of distinctions among three phenotypes of the stonecat and better resolution of their distributional limits. While Ohio River drainage populations of the Stonecat and the Highlands Stonecat in the Cumberland River drainage appear to be currently stable (Butler, 2002), the status of the Smalleye Stonecat in the Mississippi River is less clear. The following products generated from this study provide a crucial foundation for effective monitoring programs: 1) maps created in ArcGIS including detailed species distributions based on georeferenced collection records, as well as distribution of pigmentation scores to depict phenotypic variation among populations; and 2) the formal description of the Highlands Stonecat, which will be included in a forthcoming publication, will provide a table of characteristics useful in distinguishing each of the phenotypes relative to nominotypical *Noturus flavus*.

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KDFWR Strategic Plan. Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.9. Class Actinopterygii.

Northern Bobwhite *(Colinus virginianus)* Ecology on Reclaimed Mined Lands

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Banding northern bobwhite / Evan Tanner

Introduction

Northern bobwhite (*Colinus virginianus*), here after "bobwhite," have experienced declines throughout the species' range, with a 2.8% decline in Kentucky between 1966–2009 (Sauer et al. 2011). Habitat degradation has been attributed to these range-wide declines in populations (Brennan 1991, Williams et al. 2004). Habitat fragmentation has exacerbated these problems by isolating remaining habitat. It is imperative to re-establish early successional vegetation at a landscape scale to reverse declining population trends (Guthery 1997, Dimmick et al. 2002, Williams et al. 2004).

Reclaimed mined lands offer a unique opportunity to increase the amount of habitat at a large-scale for bobwhite in many areas of the eastern United States. Large tracts of early successional vegetation are often created through the auspices of the Surface Mining Control and Reclamation Act of 1977 (SMCRA). Although much of the area reclaimed is in early successional vegetation, these lands are often vegetated with species that may not provide suitable food, or at seeding rates in which vegetation structure is not ideal (Eddy 1999). To better understand the effects of vegetation composition of reclaimed mined lands on bobwhite, research must focus at both survival and habitat selection.

Little is known about the suitability of reclaimed mined lands for supporting populations of bobwhite (Stauffer 2011). The reclamation process can create a unique vegetative landscape, and an understanding how this composition affects bobwhite survival and habitat selection is essential for implementing effective management that optimizes population size. To understand if reclaimed mined lands can support viable bobwhite populations, and how habitat on reclaimed mined lands affected bobwhite survival, nest success, and habitat selection, we conducted a radio telemetry study on Peabody Wildlife Management Area (WMA), Kentucky from 2009-2011.

Study Area

We conducted the study on a reclaimed coal mine, Peabody WMA (3,323 ha) in Muhlenberg and Ohio counties in western Kentucky. The study area consisted of open herbaceous vegetation (36%), shrub vegetation (25%), deciduous forests (22%), native warm-season grasses (NWSG) (8%), and small lakes, wetlands, and annual grain food plots (9%). Habitat management on both units include dormant-season (January-March) prescribed fire, disking (all months), and plantings of food plots. Efforts have focused on maintaining early successional vegetation while trying to limit coverage of invasive, non-native plants that had been established previously. We conducted our research on two different sites on Peabody WMA (Ken and Sinclair). These two sites are separated by the Green River and are 18 kilometers apart. Sericea lespedeza covered ≥ 50% of both sites. Forest covered 12% of the sites, while NWSG, open herbaceous, and shrub areas covered ≥45% of the area.

Methods

We captured bobwhites year-round (Sep 2009 - Sep 2011) using funnel traps (Stoddard 1931). We defined the non-breeding season (1 Oct-31 Mar) and breeding (1 Apr-30 Sep) based on Burger et al. (1995). We fitted captured birds with necklace-style collars weighing 6g based on meeting a minimum body mass requirement (120g). We determined sex, age, and weight of all birds, and released birds at their capture site. Our trapping and handling methods complied with University of Tennessee Institutional Animal Care and Use Committee Permit (no. 2042-0911) protocol.

We attempted to locate radio-marked individuals at least three times/week. We located birds by homing within 50m. Once birds were detected, we recorded the distance and azimuth to the actual bird location and recorded the Universal Transverse Mercator (UTM) coordinates. We then used the distance and azimuth to estimate the location of each bird. We located transmitters emitting a mortality signal (12-hr signal) immediately after detection and determined the fate of the individuals as predation (mammal, avian), investigator induced, or unknown, based on evidence at the site of recovery and condition of the recovered transmitter.

During the breeding season, we considered birds with identical subsequent locations to be nesting. We located the actual nest and counted eggs when the radio-marked bird was away from the nest, then monitored the incubation status daily by locating the radiocollared adult. If incubating adults were located away from the nest, we returned to the actual location of the nest to monitor the clutch (Taylor et al. 1999) every 7-10 days and recorded the nest fate. We recorded locations of broods daily, and flushed broods weekly to confirm their presence.

Survival Analysis

We calculated home ranges for individual birds with $\geq$20 locations (DeVos and Mueller 1993) using the 95% fixed-kernel method (Seaman et al. 1999) and the Animal Movement Extension (Hooge and Eichenlaub 1997) in ArcView 3.2. We estimated seasonal survival rates using the known fate model with a logit link function in Program MARK (White and Burnham 1999). Each survival period (non-breeding and breeding) consisted of 183 days. Survival analysis consisted of 3 hierarchical stages with different metrics: group, home range, and landscape.

We estimated daily survival rate (DSR) of nests and the influence of vegetation covariates on DSR using the nest survival model with a logit link function in Program MARK (White and Burnham 1999). On Peabody WMA, we had a 122-day nesting period, which encompassed 7 May-7 Sep across both years. We assumed a 23-day incubation period and defined nest survival as the probability of a nest surviving the incubation period. Nest survival analysis consisted of 2 hierarchical stages: group and landscape.

Results

Bobwhite survival

We captured and double-banded 841 bobwhites (457 males, 326 females, and 58 birds for which we could not determine sex) from 1 Sep 2009 – 30 Sep 2011. We captured more juveniles (n = 674) than adults (n = 167). Of the 841 captured birds, we radio-marked 627, but were only able to use 619 in our survival analysis because of censoring. The only difference detected in survival rates was between sites (χ^2 = 7.87, P = 0.005; Sinclair = 0.141, 95% CI = 0.097-0.184; Ken = 0.316, 95% CI = 0.263-0.368). Mammalian predation accounted for the highest percentage of known mortalities during the non-breeding season (40.3%) while avian predation account for the highest percentage of known mortalities in the breeding season (14.5%)

Of all three stages of survival analysis, our top model (group+year+site+season+FOR) for explaining variation in survival contained no landscape metrics, and only one home range metric (% of forest in a bird's home range). This model was 1.54 times more likely than the second best approximating model. The beta estimate for the amount of forest within a home range (β = 0.024, CI = 0.003-0.046) suggested an increase in survival associated with a higher proportion of forest vegetation in a bird's home range.

Nest survival

We located a total of 57 nests, of which 46 were incubated by females and 11 were incubated by males. Peak nesting (number of nests initiated) occurred during the first week in June across both breeding seasons. Of the 57 nests, 47.4% were successful and 52.6% were unsuccessful. Of the successful nests, 74.1% were first-attempt female nests, 11.1% were second-attempt female nests, and 14.8% were first-attempt male nests. Predation was the primary cause of unsuccessful nesting events, with mammalian predation being the greatest cause of losses.

Of the two stages of analysis for nest survival, our top model included the site, nest age, and distance to bare ground (DtoBG) from nest location covariates. The beta value for the DtoBG covariate (β = 0.011, CI = 0.006-0.039) suggests that the effect of this covariate is minimal. Based on this top model, DSR for nests was 0.951 (SE = 0.010), and the probability of a nest successfully hatching after the 23-day incubation period was 0.317 (SE = 0.081). Nest age was the most influential covariate after two stages of analysis, with daily survival rate (DSR) of nests increasing as nest age increased.

Nest Site and Brood Habitat Selection

Based on our AIC value results, our models poorly explained nest site selection. Our top model had an AIC value of 200.61, and without covariates the AIC value was 204.26. Most of our models did not explain any of the variation in nest site selection, however our top model was significant ($P = 0.02$). It included only the contagion index value, and had a negative parameter estimate ($\beta = -0.045$), indicating that bobwhite selected to build nest in areas with more interspersion and dispersion of vegetation types in the area.

Vegetation type and treatment were significant variables in our top brooding habitat selection model, however the interaction of the two was not significant. Brooding birds avoided use of the forest, NWSG, and roads ($P \leq 0.02$). They also avoided areas 1 growing season after a burn or that had been disked, however they used areas burned 2 growing seasons prior as expected ($P = 0.638$). Despite the lack of use for disked areas, they used firebreaks more than expected ($\beta = 0.991$).

Discussion

Bobwhite survival was statistically different between sites. Survival rates on the Ken unit were consistent with previous research, but survival rates were relatively low on the Sinclair site (Burger et al. 1995, Seckinger et al. 2008, Holt et al. 2009). Differences in survival among sites may exist because of the variation in survival across space caused by factors such as habitat suitability and predator abundance (Terhune et al. 2007).

Estimated nest survival rates on our study site were relatively low compared to the range of estimates observed in previous research throughout the species' range. Vegetation composition and landscape scale vegetation metrics were not shown to be influential to nest survival. Nest site selection work was equally unrevealing, suggesting that selection may be taking place at a more macro or

Northern bobwhite nest / Evan Tanner

mirco scale than what we considered. Instead, nest age was shown to be the most important factor to survival, with DSR of nests increasing as nest age increases. This is to be expected in precocial species, because nests that are ill placed or are in locations of higher risk will likely be predated earlier in the incubation period (Klett and Johnson 1982).

Management Implications

Birds responded favorably year-round to treatment, therefore we recommend that disking and burning continue. Management should also focus on providing year-round woody cover to potentially increase adult survival, while also focusing on increasing coverage of native warm-season grasses to increase nest success.

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KDFWR Strategic Plan. Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2. Class Aves. Priority Research Project #2 and #3.

Foraging and Roosting Behaviors of Rafinesque's Big-eared Bat at the Northern Edge of the Species Range

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KDFWR Contact: *Brooke Slack*

Introduction

Effective conservation of bat populations requires detailed knowledge of the daytime (day-roosting) and nocturnal (foraging) behaviors of various species during the summer and winter. This knowledge is needed now more than ever, as populations of many bat species in the United States and Canada are seriously threatened by loss of summer habitat, mortality from collisions with commercial wind turbines, and infection with white-nose syndrome during winter hibernation (Arnett et al. 2008, Reeder et al. 2012). These anthropogenic factors threaten different species to varying extents, and species-specific approaches to conservation are merited.

This report is meant to aid in the conservation of Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) in Kentucky, a rare forest-dwelling bat found only in the southeastern United States, and considered a species of conservation concern (Barbour and Davis 1969, NatureServe 2010). Few data on the summer ecology of Rafinesque's big-eared bat were available to researchers and managers until the last decade, during which the number of studies investigating summer behaviors increased dramatically (Bennett et al. 2008, Carver and Ashley 2008, Gooding and Langford 2004, Mirowsky et al. 2004, Trousdale and Beckett 2005, Trousdale et al. 2008). The majority of these studies were conducted in the southern portion of the species range, where habitats and climate differ from those present at northern edge of the range, including Kentucky. This report focuses on summer daytime and nocturnal habitat use of colonies of Rafinesque's big-eared bat in bottomland hardwood forests, managed by the Kentucky Department of Fish and Wildlife Resources (KDFWR) as the Ballard and Boatwright Wildlife Management Areas, in western Kentucky. Bottomland hardwood forests are frequently occupied by Rafinesque's big-eared bats throughout the southern portion of the range, so the data presented in this report provide an important comparison of regional behaviors.

Methods

Data were collected on the Ballard and Boatwright Wildlife Management Areas (WMAs) located in Ballard County, Kentucky (37.180° N, -89.029° W). The WMAs contain over 8,000 ha of land managed by KDFWR. The WMAs consist of several disconnected parcels ranging 280 m to 350 m in elevation along the floodplains of the Ohio and Mississippi Rivers; the northern edge of the Mississippi Alluvial Valley. KDFWR manages these lands primarily for waterfowl habitat and recreational hunting, including maintenance of old and active agricultural fields covering approximately 30% of the total area. Remaining land cover includes deciduous forests (hereafter forest; representing habitat on higher, drier soil; 22%), forested and herbaceous wetlands (hereafter wetland; 39%), and permanent lakes (8%) (Figure 1). Dominant tree species on the WMAs include bald cypress (*Taxodium distichum*), water tupelo (*Nyssa aquatica*), sweetgum (*Liquidambar styraciflua*), oaks (*Quercus* spp.) and hickories (*Carya* spp.). Land use in the area surrounding the WMAs is primarily agricultural.

Bats were captured in mist nets (Avinet, Inc., Dryden, NY) placed over rivers, forest roads, forest edges, and outside known day-roosts of Rafinesque's big-eared bats from late May through September 2009–2011. Age, sex, reproductive condition, body mass, and right forearm length were recorded for all bats. We aged bats as adult or juvenile by examining epiphyseal-diaphyseal fusions of long bones in the wing and we categorized females as pregnant, lactating or post-lactating based on the presence of a fetus or teat condition. We categorized females with no sign of a fetus or lactation as non-reproductive. We categorized males as scrotal or non-scrotal based on swelling of the epididymides. We banded bats for future identification with individually numbered split-lip aluminum bat bands supplied by KDFWR. Males were banded on the right forearm and females on the left forearm. We fitted adult males and females with 0.42 g (model LB-2N and LB-2N-T, Holohil Systems, Ltd., Carp, Ontario) radio-transmitters attached between the shoulder blades using surgical adhesive (Torbot, Cranston, RI; Perma-Type, Plainville, CT). All methods were approved by the University of Kentucky Institutional Animal Care and Use Committee (IACUC No. A3336-01).

We attempted to locate day-roosts of all radio-tagged bats by homing in on radio signals using TRX-1000S telemetry receivers (Wildlife Materials Inc., Murphysboro, IL) and three-element yagi antennas (Advanced Telemetry Systems, Inc., Isanti, MN). We triangulated nocturnal locations of radio-tagged bats during the first 5 hours of the night on 47 evenings to determine nighttime habitat use. Nocturnal locations were triangulated at 2-min intervals by two field personnel communicating with hand-held radios and recording simultaneous bearings. We took no more than five consecutive bearings on individual bats to reduce autocorrelation among locations. We followed bats by vehicle as they moved across the landscape, stopping to take bearings when possible. A dense network of roads in the study area facilitated this approach and allowed personnel to select temporary tracking stations situated close to the signal source, eliminating the need for a third person to ground-truth estimated locations.

Nocturnal locations were triangulated using Locate III and imported into ArcView v3.2. We generated 95% (hereafter, home range) and 50% (hereafter, core area) probability areas using the fixed kernel method with the least square cross-validation method contained in the Animal Movement Extension for ArcView. Day-roost locations were included in kernel estimates, using each roost location once, regardless of the number of days a bat occupied the roost. We compared home ranges and core areas among sex and reproductive classes using a one-way analysis of variance (ANOVA).

We analyzed nocturnal habitat use at the second (placement of home ranges on the landscape) and third (use of habitats within home ranges) order levels for bats with a sufficient number of telemetry locations to permit generation of kernel estimates using the Euclidean distance method. Euclidean distance analysis determines if triangulated locations are closer to or farther from available habitats than would be expected under random habitat use. This requires comparing the mean distance between nocturnal locations and available habitats to the mean distances between random locations and habitats using a multiple analysis of variance (MANOVA). Where habitat use was non-random, habitats were ranked from closest to farthest from bat locations using Student's t-tests. We defined the study area for second order analysis by surrounding all bat locations with a minimum convex polygon and then

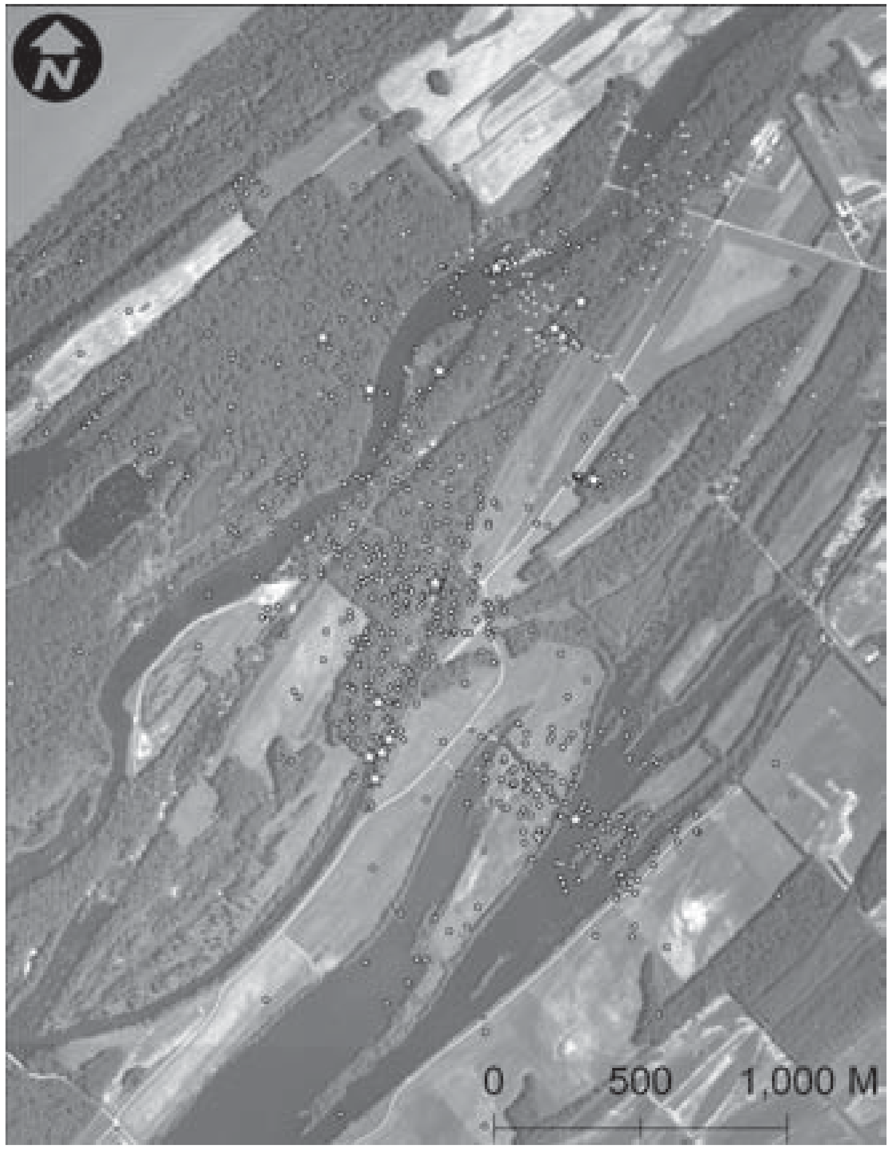

Figure 1: *Aerial photo showing the northern section of the study area in Ballard County, Kentucky. White stars represent day-roosts used by Rafinesque's big-eared bats and white circles represent triangulated nocturnal foraging locations.*

	95% kernel home range (ha)	50% kernel home range (ha)
Males (5)	116 ± 51.7	10.8 ± 4.8
Pregnant females (9)	111 ± 37.1	10.3 ± 3.4
Lactating females (10)	201 ± 63.5	12.3 ± 3.9
Post-lactating females (10)	102 ± 32.4	7.3 ± 2.3
Non-reproductive females (3)	84.2 ± 48.6	14.4 ± 8.3
All bats (37)	173 ± 22.4	24.7 ± 3.4

Table 1: *Summary (means ± 1 SE) of 95% and 50% kernel home range estimates for sex and reproductive classes of Rafinesque's big-eared bats radio-tracked in Ballard County, Kentucky, from May–September, 2009–2011. Sample sizes of bats are in parentheses.*

buffering this polygon by the greatest distance any bat was observed traveling in a single night (4,334 m). Thus, the study area for analysis included land managed as part of the WMAs, as well as surrounding lands. We selected five habitats for our distance analysis using the 2001 National Land-cover Database (NLCD, available at http://kygeonet.ky.gov/). We verified the NLCD by comparing habitat polygons to 2008 aerial photographs (http://kygeonet.ky.gov) and by driving and walking the study area. Habitats included in analyses were: wetlands, forests, active and inactive agricultural fields, field–forest edges, and lake–forest edges.

We counted the number of bats inhabiting each roost with emergence counts, visually inspecting the interior of tree cavities, or by taking digital photographs of bats inside tree cavities. Emergence counts were conducted from 15 min prior to sunset to ca. 1 hour after sunset with the assistance of night-vision goggles (ATN Corp., San Francisco, CA).

We identified all roost trees to species and recorded geographic coordinates for all day-roosts with an accuracy of 3 m using a handheld GPS (Garmin International, Inc., Olathe, KS). We measured habitat characteristics of a sub-sample of day-roost trees including tree species, diameter at breast height or above any basal swell (cm), roost tree height (m), canopy closure (%), cavity height (m), number of cavities (n), presence of basal cavity entrances, presence of a "top" cavity entrance (broken tree tops, hollow knots or other cavities), presence of entrances along the tree bole (broken tree tops, hollow knots or woodpecker cavities), and whether or not the roost tree was alive or dead. Heights were measured with a laser hypsometer (Opti-Logic Corp., Tullahoma, TN), diameters were measured with a dbh tape (Forestry Suppliers, Inc., Jackson, MS), and canopy cover was visually estimated. Because many roost trees were located in standing water, trees were measured in August when water level was near the summer minimum. Roosts trees were categorized into roost types based on the location of entrances to the main cavity. Roost trees were classified as type I if possessing only a basal entrance to the main cavity, type II if possessing basal and top entrances, type III if possessing a top but not a basal entrance, and type IV if possessing only bole entrances to the main cavity. Habitat values for day-roosts used by lactating and post-lactating females were compared using Wilcoxon tests.

Results

We captured 71 female (61 adult and 10 juvenile) and 16 male (8 adult and 8 juvenile) Rafinesque's big-eared bats during 42 nights of mist-netting on the WMAs between May and

Table 2: *Second and third order habitat use of female reproductive classes of Rafinesque's big-eared bats radio-tracked in Ballard County, Kentucky, from May to September, 2009–2011.*

Second order	Closest				Farthest
Pregnant (9)	Wetland [A]	Forest [A]	Lake edge [B]	Field edge [C]	Field [D]
Lactating (10)	Wetland [A]	Forest [B]	Lake edge [C]	Field edge [D]	Field [E]
Post-lactating (10)	Wetland [A]	Forest [B]	Lake edge [B]	Field edge [C]	Field [D]
Third order	**Closest**				**Farthest**
Pregnant (9)	Forest [A]	Wetland [A, B]	Lake edge [A, B]	Field edge [B]	Field [B]
Lactating (10)	Forest	Wetland	Lake edge	Field edge	Field
Post-lactating (10)	Forest	Field edge	Wetland	Lake edge	Field

Within rows, home ranges are located closer or farther from habitats not sharing common letters ($P < 0.05$).

September of 2009–2011. An additional 6 captures of Rafinesque's big-eared bats (5 female and 1 male) consisted of individuals that were previously captured and banded. We radio-tagged 42 adult female (11 pregnant, 14 lactating, 11 post-lactating, and 6 non-reproductive females) and 6 adult male Rafinesque's big-eared bats. Pregnant females were radio-tracked during the last 2 weeks of gestation before parturition occurred in early June. The average increase in wing-loading was (3.9% ± 0.1 SE). Bats were radio-tracked for 5–21 d (mean = 12.0 d ± 0.5) days each. We successfully located bats on 549 of 568 (97%) potential roost-days (1 roost-day = 1 radio-tagged bat tracked for 1 day).

Home range ($F = 0.54$, $P = 0.71$) and core area ($F = 0.77$, $P = 0.55$) estimates did not differ among sex and reproductive classes (Table 1). Second order habitat use by pregnant (Wilk's $\lambda = 0.0007$, $F = 1120$, $P < 0.0001$), lactating (Wilk's $\lambda = 0.002$, $F = 448$, $P < 0.0001$), and post-lactating females (Wilk's $\lambda = 0.0007$, $F = 1418$, $P < 0.0001$) was different from random (Table 2). Third order habitat use by lactating (Wilk's $\lambda = 0.65$, $F = 0.54$, $P = 0.74$) and post-lactating females (Wilk's $\lambda = 0.51$, $F = 0.95$, $P = 0.52$) did not differ from random. Third order habitat use by pregnant females was significantly different from random (Wilk's $\lambda = 0.10$, $F = 7.0$, $P = 0.04$). We were unable to analyze habitat use by males ($n = 5$) and non-reproductive females ($n = 3$) due to insufficient sample sizes.

Bats switched roosts every 3.0 days (± 0.4), with no difference among sex and reproductive class ($F = 1.44$, $P = 0.24$) or colonies ($F = 0.09$, $P = 0.92$). Bats traveled 829 m (± 112) between consecutive roosts, with distances varying among sex and reproductive class ($F = 9.93$, $P < 0.001$) and among colonies ($F = 16.7$, $P < 0.0001$). Maximum population counts for female roosts ranged from 1–96 (mean = 18.3 ± 3.3, $n = 43$). Maximum population counts for male roosts ranged from 1–13 (mean = 2.9 ± 1.1, $n = 15$). Maximum counts did not differ between bald cypress and water tupelo roosts ($t = 1.57$, $P = 0.12$). Southeastern myotis (*Myotis austroriparius*) were not observed in 243 digital photographs taken inside Rafinesque's big-eared bat roosts; however, southeastern myotis were captured exiting big-eared bat roosts on 2 different occasions; both individuals were captured exiting water tupelo trees. Roost counts, therefore, consisted almost entirely of Rafinesque's big-eared bats.

We located 64 day-roosts consisting of 45 bald cypress, 13 water tupelo, 2 swamp white oak (*Quercus bicolor*), 2 shellback hickory (*Carya laciniosa*), 1 sweetgum, and 1 concrete slab bridge. Roost trees were located almost exclusively in wetlands ($n = 59$; 92%) located in low-lying areas such as lake edges and sloughs within the WMAs; however, swamp white oak and shellbark hickory roosts were located in deciduous forests on higher ground. No habitat characteristic differed among trees used by lactating and post-lactating females (Table 3). The majority of roost trees were type II (44.1%) and type III (41.2%) trees.

Discussion

Wetlands and deciduous forests were important habitats for Rafinesque's big-eared bats in western Kentucky. Bats roosted almost exclusively in wetlands containing large-diameter, hollow bald cypress or water tupelo trees. These roosts were situated in local topographic depressions, with bald cypress located along the shallow edges of lakes, and water tupelo located primarily in sloughs. Reproductive females centered their home ranges closer to wetlands than any other habitat, likely because of the critical day-roosting habitat forested wetlands provided. Although deciduous forests were relatively unimportant as roosting habitat, reproductive females also located their home ranges significantly closer to these habitats than expected, suggesting their importance as nocturnal foraging habitats.

We found no evidence to suggest that size of home range varied among sex and reproductive classes of Rafinesque's big-eared bat. Rafinesque's big-eared bats had home ranges that were smaller than those recorded for bats in other North American genera (Lacki et al. 2007). These data are not surprising given data on other *Corynorhinus* species (Adam et al. 1994, Wethington et al. 1996) and two studies of Rafinesque's big-eared bats inhabiting upland forest ecosystems (Hurst and Lacki, 1999, Menzel et al. 2001). Small home ranges among Rafinesque's big-eared bats may be related to the wing morphology of the species, which although well suited to maneuverable flight and gleaning prey off vegetation surfaces, is likely less efficient in long distance flights compared to species with higher wing loadings (Norberg and Rayner 1987).

Bald cypress roosts averaged 164 cm (± 5.1) in diameter, always presented access to the main cavity by either broken tops or holes located along the bole, and were always hollow for the entire length of the tree bole. Thus, bald cypress roosts offered large cavities for social groups to aggregate in throughout the year. In our study, all roost counts ≥25 bats were observed in bald cypress trees, with counts for 4 roosts ranging from 50–96 bats. Water tupelo roosts averaged 101 cm (± 6.0) in diameter and often presented only basal access to the main cavity ($n = 3$ trees, 23%). These entrances remained covered by flood waters until mid-June and became re-submerged during heavy rains, frequently making them unavailable for roosting.

Management Implications

These data demonstrate that Rafinesque's big-eared bat in western

Table 3: *Percentages or means (± SE) of habitat characteristics of day-roosts of Rafinesque's big-eared bats in Ballard County, Kentucky, 2009.*

Characteristic	Lactating female	Post-lactating female	Male
No. of roost trees	24	10	5
Diameter (cm)	150.5 ± 7.65	135.4 ± 11.8	150.6 ± 14.8
Tree height (m)	17.5 ± 1.2	17.9 ± 2.1	20.5 ± 3.3
Canopy cover (%)	27.7 ± 5.4	26.5 ± 8.8	20.0 ± 9.1
Type I trees (% of total)	0	10	20
Type II trees (% of total)	41.7	60	40
Type III trees (% of total)	45.8	20	40
Type IV trees (% of total)	12.5	10	0
Alive (% of total)	83.3	60	100
Cavity height* (m)	13.5 ± 2.0	10.7 ± 1.6	13.1 ± 4.6
No. of cavities	4.9 ± 0.77	7.0 ± 1.9	10.2 ± 4.7

*Cavity heights could not be measured for type III and type IV roosts, reducing sample sizes to 10 for lactating females, eight for post-lactating females, and three for males.

Kentucky is a highly social species dependent on large tree cavities within bottomland hardwood forests for summer maternity roosts, most notably in live bald cypress trees. Bald cypress trees are critical sites of social fusion because they offer roosting bats with the greatest amount of space for social roosting. This suggests that potential exists to enhance summer roosting habitat of Rafinesque's big-eared bat on both private and public lands in western Kentucky, and to increase carrying capacity of Rafinesque's big-eared bats by managing bottomland hardwood forests to promote higher densities and wider distributions of large-diameter live bald cypress trees.

Silvicultural strategies are also needed to ensure the future replacement of the existing cohort of these tree roosts, as colonies of bats inhabiting areas with limited availability of bald cypress will be further threatened when existing roost trees age and decline. It is prudent that management actions on WMAs in western Kentucky consider long-term recruitment of future roosts and short-term creation of artificial roosts. Promoting a continuous and dispersed availability of suitable roosts across the WMAs, while attempting to connect these "islands" of bottomland hardwood forest to nearby forests, should be a management goal for the long-term conservation of Rafinesque's big-eared bat in western Kentucky.

Further research exploring roosting behavior of Rafinesque's big-eared bats on the WMAs during the pre-hibernation and early hibernation periods is needed to identify the extent to which these bats might overwinter in bottomland hardwood forests in western Kentucky. Such a hibernation strategy would have implications for the vulnerability of these populations of Rafinesque's big-eared bats to white-nose syndrome.

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KDFWR Strategic Plan. Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2, Class Mammalia, Priority Research Project #1 and #4, Priority Survey Project #1.

Alligator snapping turtle/ public domain photo

Unsuccessful Attempt to Document Alligator Snapping Turtle Populations (*Macrochelys temminckii*) in Kentucky

Danna Baxley and Jim Barnard, Kentucky Department of Fish and Wildlife Resources; Heather Venter, Murray State University

Introduction

The Alligator Snapping Turtle (*Macrochelys temminckii*) is limited to the southeastern United States, in river systems draining into the Gulf of Mexico. Although status assessments have occurred in multiple states, to our knowledge, no previous status assessment has occurred within the state.

Historically, Alligator Snapping Turtle populations have been negatively impacted by overharvest as well as habitat loss and alteration (Jensen and Birkhead 2003, Riedle et al. 2005, Shipman and Riedle 2008). Age at first reproduction for this species is estimated between 11 and 16 years of age (11-13 years, Dobie 1971; 16 years, Tucker and Sloan 1997). This delayed reproductive maturity, in conjunction with other life history traits such as a slow growth rate, contributed to the severe impacts of commercial harvesting during the 1960's and 1970's (Reed et al. 2002).

In response to these population declines, all but one state fish and wildlife agency pursued regulatory action to ban commercial harvest by 1998, and by 2004, commercial harvest of the Alligator Snapping Turtle was illegal throughout the range. Although regulatory efforts will safeguard the Alligator Snapping Turtle from future overharvest, its current conservation status is not promising: Texas, Arkansas, Louisiana, Mississippi, Alabama, Georgia and Florida list the species as vulnerable (S3), Oklahoma, Missouri, Kentucky, and Tennessee list the species as imperiled (S2), and Kansas and Illinois list the species as critically imperiled (S1) (Nature Serve 2012).

Management and restoration decisions for the Alligator Snapping Turtle are complicated by the fact that distribution and habitat requirements are not well understood, particularly for the northern limits of the range. In Kentucky, only ten verified Alligator Snapping Turtle records exist (Figure 1). Observation year for Kentucky's verified records ranges from 1969 (Ernst and Ernst 1969) to 2004.

In an era of limited conservation funding, it is important for state and federal fish and wildlife agencies to prioritize and focus conservation efforts. Within the southeastern United States, the Alligator Snapping Turtle warrants a high degree of conservation attention for the following reasons: 1) *Macrochelys* is a monotypic genus; 2) This species has a limited distribution, confined only to Gulf Coast drainages; and 3) Severe population declines have previously been documented.

In an effort to better understand the status and distribution of the Alligator Snapping Turtle, we conducted a multi-year survey, targeting historical distribution records and suitable habitat in Western Kentucky. Our ultimate goal was to identify populations in Kentucky to facilitate habitat management, population monitoring, and ensure persistence of remaining populations.

Materials and Methods

Survey sites (Table 1) were identified based on a suite of criteria including presence of historical distribution records, access and feasibility of sampling, habitat quality assessed on the ground and from aerial imagery, and anecdotal reports of Alligator Snapping Turtle sightings. We made a strong effort to survey all historical distribution records; however, we were unable to survey within the main stems of the Ohio and Mississippi Rivers due to barge traffic and general safety concerns.

Sampled habitats included multiple stream orders as well as slow-moving oxbow habitats directly adjacent to

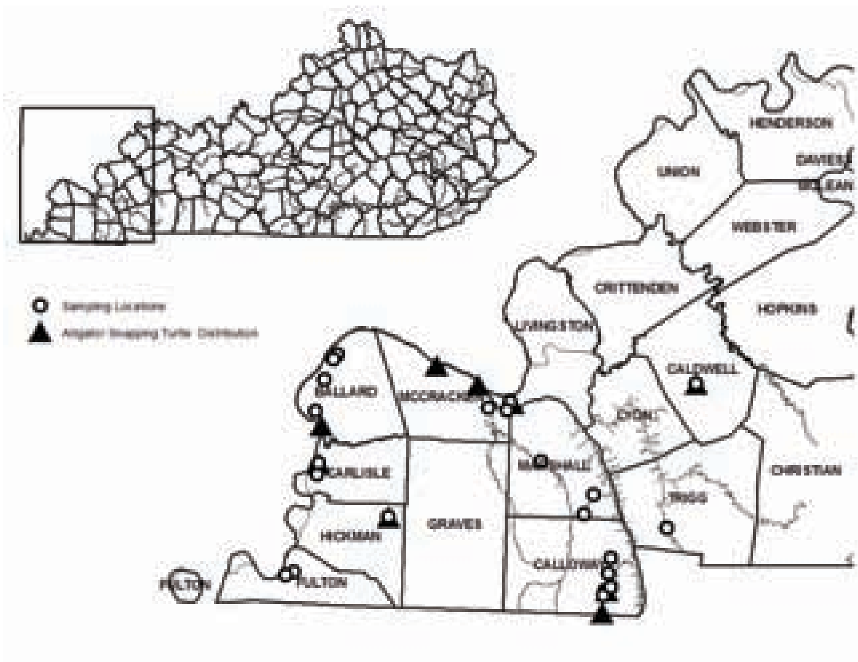

Figure 1. *Historical occurrences and Sampling Locations for Alligator Snapping Turtles in Kentucky*

the Mississippi River. As there was no consistency in stream order for historical Alligator Snapping Turtle occurrence records in Kentucky, we did not eliminate smaller order streams from consideration and survey.

Surveys were conducted between 1 April and 19 September, when water temperatures exceeded 10º C. Within each stream reach or oxbow sampled, we saturated suitable habitat with hoop nets, baited with Bighead Carp (*Hypophthalmichthys nobilis*) or Koi (*Cyprinus carpio*). Twenty total hoop nets were used, ranging from 3-4 hoops, length ranging from 1.5-2.4 m, and mesh size ranging from 3.8-12.7 cm. Spreader bars made of 1.9 cm PVC pipe were cut to fit each net (2 per net) and used to minimize the risk of net collapse and allow surveyors to more easily position nets from the boat or the bank. The use of spreader bars also allow surveyors to secure the nets using just one stake or point of contact on the bank. Using twine, we suspended split bait fish from the hoop farthest from the net opening, and positioned nets immediately upstream of aquatic structure, undercut banks, and log jams, when present. Metal rebar or wooden stakes were used to secure nets in place, and nets were positioned to allow captured turtles to breathe (at least 7 cm of each net above water). Oxbow habitats were surveyed by placing hoop nets around the entire perimeter of the oxbow, while nets in riverine habitats were placed in a staggered pattern until suitable habitat was saturated. Nets were checked each morning, all captured turtles were processed, and nets were re-baited regardless of the amount of bait remaining in the net. We consider one net night to be one baited hoop net set for one 24 hour period, and one survey night to be one continuous 24-hour period of time.

Captured turtles, with the exception of *Trachemys scripta elegans* (Red-Eared Slider), were identified, sexed, measured, weighed, and released at the site of capture. Due to high capture volume, we did not sex, measure, or weigh Red-Eared Sliders.

Captured Common Snapping Turtles (*Chelydra serpentina*) were marked with uniquely numbered metal cattle tags drilled into the rear marginal scute to allow for identification of re-captures.

Results

Kentucky survey efforts from 30 May 2003 through 17 May 2012 resulted in no Alligator Snapping Turtle captures. The total survey effort comprised 118 survey nights and 829 net nights at 24 sites within 10 Kentucky counties. The average number of survey nights per site was 4.9 and average number of net nights per site was 34.5. Historical records occurred at 10 of the 24 total survey sites. The remaining 14 sites were surveyed due to the appearance of suitable habitat (e.g. abundant in-stream structure, intact riparian corridors). In total, we captured 3,071 turtles representing 10 species.

Discussion

No Alligator Snapping Turtles were detected in this study, despite 829 net nights of effort within the historical range in Kentucky. In his extensive work on the Alligator Snapping Turtle, Pritchard (1989) indicates a low level of confidence in direct sampling of Alligator Snapping Turtle habitat unless surveyors have years of experience as a commercial or professional trapper. Although surveys for this species by biologists may be far less efficient than efforts of commercial trappers, previous studies report catch per unit effort rates (CPUE; total number of captures divided by total number of net nights) ranging from 0.0 in Kansas to a high of 0.28 in Arkansas (Table 2; Shipman et al. 1995; Trauth et al. 1998). Two studies (Louisiana and Oklahoma) report CPUE of 0.06 (Boundy and Kennedy 2006; Riedle et al. 2005). If Alligator Snapping Turtles occurred in Kentucky at similar

County	Site	Habitat Type	# Survey Nights	# Net Nights
Ballard	Axe Lake	Oxbow	3	18
Ballard	Castor Lake	Oxbow	11	62
Ballard	Fish Lake	Oxbow	6	36
Ballard	Swan Lake	Oxbow	6	64
Caldwell	**Eddy Creek**	**4th Order Stream**	**2**	**34**
Calloway	Beechy Creek	3rd Order Stream	3	15
Calloway	**Blood River**	**Embayment**	**13**	**85**
Calloway	**Blood River Bottoms**	**3rd Order Stream**	**2**	**22**
Calloway	**Panther Creek**	**3rd Order Stream**	**8**	**72**
Calloway	Sugar Creek	2nd Order Stream	5	25
Calloway	Wildcat Creek	2nd Order Stream	4	11
Carlisle	Doug Travis WMA	Oxbow	2	36
Carlisle	**Back Slough**	**Oxbow**	**5**	**30**
Fulton	Bayou Du Chien	5th Order Stream	10	44
Fulton	Obion Creek	6th Order Stream	11	46
Hickman	**Obion Creek**	**3rd Order Stream**	**2**	**20**
Livingston	**Private Oxbow #1**	**Oxbow**	**2**	**34**
Livingston	**Private Oxbow #2**	**Oxbow**	**2**	**34**
Marshall	Bee Creek	2nd Order Stream	1	5
Marshall	Clark's River NWR	3rd Order Stream	2	30
Marshall	Jonathan Creek	3rd Order Stream	4	25
Marshall	Sportsman's Marina	3rd Order Stream	3	15
McCracken	Clark's River	5th Order Stream	2	34
Trigg	Duck Pond at Lake Barkley	Embayment	9	32

Table 1. *Survey locations, habitat type, and survey effort for 24 survey sites in Kentucky. Sites listed in bold represent historical occurrences.*

densities, our sampling effort should have resulted in 50 captured animals at a CPUE of 0.06 and 232 captured animals at a CPUE of 0.28.

It is important to note that the main stems of the Ohio and Mississippi Rivers were not sampled, and it's possible that these larger rivers sustain Alligator Snapping Turtle populations. It would be worthwhile to educate and inform both commercial and recreational fisherman of the desire to document extant populations within the Ohio and Mississippi Rivers since trapping is not feasible in these areas.

Western Kentucky has seen immense habitat changes over the past 100 years. The Tennessee Valley Authority impounded the Tennessee River in 1944, creating Kentucky Lake, while Lake Barkley was created in 1966 when the U.S. Army Corps of Engineers impounded the Cumberland River. The area in Kentucky with the highest density of verified historical occurrence records is the Tennessee River just north of Kentucky Dam. Panther Creek, and the Blood River, both located near the southernmost reaches of the Kentucky Lake impoundment, also produced verified occurrence records. Pre-impoundment, the Tennessee River likely offered excellent habitat for Alligator Snapping Turtles. Impounding the Tennessee River eliminated any potential northern migration of turtles between the Ohio River and the Tennessee River. Further, the documented Alligator Snapping Turtles confirmed at the southernmost reaches of the impounded Kentucky Lake may be the result of remnant individuals seeking more suitable habitat and moving south until Kentucky Lake dissolves in a network of small, ephemeral, 2nd order streams. These large-scale habitat changes in Western Kentucky may explain the presence of Alligator Snapping Turtles in atypical stream reaches in Kentucky; specifically, 2nd through 4th order streams are widely assumed to be too small to support Alligator Snapping Turtle populations elsewhere in the range.

The landscape of western Kentucky is primarily agricultural. The United States Department of Agriculture (USDA) ranked Graves and Hickman Counties (two counties within our survey area) as the #2 and #7 top agricultural counties in Kentucky (USDA , 2011). Many areas of historically suitable habitat are currently characterized by row crop agriculture adjacent to riverine habitats, with no riparian corridor. The open nature of streams and rivers lacking riparian corridors typically limits in-stream structure; consequently, nesting habitats within these areas is minimal.

Management Implications

It is likely that Alligator Snapping Turtles remain in suitable habitats at densities which were too low to detect with our survey methods. These survey methods have been successfully used to document Alligator Snapping Turtle populations elsewhere. Given our lack of success in Kentucky, future management steps, if deemed a KDFWR priority, would include:

1) Identification of watershed(s) in Kentucky where suitable nesting habitat and in-stream structure exists (e.g. Obion Creek) for Alligator Snapping Turtles.
2) Initiation of intensive trapping efforts within these watershed(s) to determine existing turtle community structure (e.g. are other rare turtle species thriving?), and if Alligator Snapping Turtles remain at low densities in these watershed(s).
3) If efforts to document Alligator Snapping Turtles are unsuccessful in targeted watershed(s), partner with Tennessee Wildlife Resources Agency (TWRA) to conduct a pilot re-introduction program in Kentucky.

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Publication	Survey Year(s)	State	Net Nights	Total Captures	CPUE	Conclusions
Shipman et al., 1995	1991	Kansas	600	0	0	Possibly no breeding populations in Kansas
Moler, P.E., 1997	1993-1996	Florida	367	92	0.25	Current harvest restrictions are adequate
Trauth et al.,1998	1995-1997	Arkansas	352	98	0.28	Continued depletion of large adults is not sustainable
Riedle et al., 2005	1997	Oklahoma	1,085	63	0.06	Dramatic population declines evident
Boundy and Kennedy, 2006	1996-1997	Louisiana	3,504	200	0.06	Recommend re-survey of sites to determine trends
Jensen and Birkhead, 2003	1997-2001	Georgia	281	55	0.2	Legal protection against harvest in Georgia is warranted
Shipman and Riedle, 2008	1994, 1997	Missouri	396	48	0.12	Habitat alteration continues to impact populations
Baxley et al., This study	2003-2012	Kentucky	829	0	0.00	No known breeding populations exist

Table 2. *Review of Alligator Snapping Turtle trapping effort and catch per unit effort (CPUE) reported in the literature.*

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Funding Sources: *State Wildlife Grant Program (SWG) and Murray State University*

Comprehensive Wildlife Conservation Strategy: appendix 3.2. Class Reptilia, Priority Research Project #1.

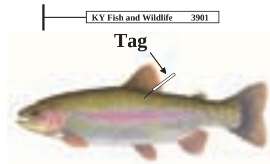

Mussel release on the Big South Fork / Lee McClellan

Project Highlights

Evaluation of a Seasonal Rainbow Trout Fishery in Cedar Creek Lake

Dave Dreves and Paul Wilkes, Kentucky Department of Fish and Wildlife Resources

CEDAR CREEK LAKE RAINBOW TROUT TAGGING STUDY



Rainbow Trout

REWARD

FOR ALL RETURNED TAGS

Anglers receive a collectible pewter fish pin for each returned tag. Each tag returned also goes into a monthly drawing for 9 **CASH** awards ranging from **$10 to $100**.

Place tags in postage paid envelopes found at any of the drop boxes around the lake. For more information call **(800) 858-1549**.

Rainbow trout (*Oncorhyncus mykiss*) are stocked in many small impoundments throughout Kentucky by KDFWR. This project represents an effort to create an alternative fishery to traditional warmwater species and to provide a fishing opportunity during the cooler months of the year when other species do not bite as well.

In a 2002 trout angler survey of various waters stocked with trout, the category "lakes and reservoirs" was second in terms of the amount of effort expended fishing for trout. Most of these impoundments are small urban lakes that are part of KDFWR's Fishing in Neighborhoods (FINS) program. However the KDFWR does stock rainbow trout in a few larger reservoirs that are believed to have sufficient water quality to support trout year round. Cedar Creek Lake is the largest reservoir (784 acres) that KDFWR has stocked with rainbow trout exclusively for a seasonal fishery.

Cedar Creek Lake, impounded in 2002, is a KDFWR-owned lake in Lincoln County. From conception, the lake was designed and intended to be primarily a sport fishing lake. There is no swimming, no water skiing or jet skis allowed. The lake has a 300 ft buffer zone around the shoreline which is also owned and managed as a Wildlife Management Area by KDFWR. Since Cedar Creek Lake is promoted and managed by KDFWR as a "fishing lake," it is reasonable to desire year round fishing opportunities for anglers. The lake already has tremendous fishing pressure during warmer months of the year. In a 2009 creel survey conducted at the lake, there were an estimated 49.2 trips per acre and about 245.8 man/hours per acre of fishing pressure. This represents more pressure than at any other lake of a similar size or larger. So, it is expected that the stocking of rainbow trout will provide another fishing opportunity that will extend the quality fishing at the lake throughout the winter months. It is hoped that this new fishing opportunity will spur increased fishing license and trout permit sales.

The primary objective of this study is to evaluate the angler utilization of rainbow trout and angler satisfaction with this new seasonal fishery in Cedar Creek Lake. Previous temperature and dissolved oxygen profiles at Cedar Creek Lake have shown that suitable water quality conditions exist to support trout from about the beginning of October to about early May. A total of 21,000 harvestable-size (9 in.) rainbow trout will be stocked annually at Cedar Creek Lake, with 12,000 fish being stocked in October and 9,000 fish in February. Each stocking will be allocated evenly among three stocking sites: 1) the lower ramp, 2) the middle ramp and 3) the bank fishing area near the Hwy 1770 bridge. An exploitation study and a creel survey will be conducted in years 1 and 3 to evaluate rainbow trout angling pressure and harvest. The results of this study will be used to: 1) make the determination to continue the rainbow trout stocking program or to cease stockings and 2) determine whether this type of fishery could be successful in other warmwater reservoirs in the state.

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

Kentucky Trout Fishing, Attitudes and Opinions: 2013 Trout Angler Survey

Dave Dreves and Paul Wilkes, Kentucky Department of Fish and Wildlife Resources

There were an estimated 38,000 trout anglers in Kentucky who fished an estimated 336,000 days for trout in a 2006 U.S. Fish and Wildlife Service survey. The KDFWR manages roughly 300 miles (97 miles in tailwaters) of trout fisheries in 66 streams (include 15 tailwaters). The KDFWR has periodically surveyed constituents to gain insight into angler attitudes regarding fisheries resources, regulations, programs and needs. This information is used to assist in making decisions on where to focus management efforts and where resources can best be utilized.

The KDFWR surveyed Kentucky anglers with a mail survey in 1982, a telephone survey in 1991, and another mail survey in 2003. Each of these surveys focused on general statewide attitudes and opinions. In 2003, a survey was conducted for the first time specifically targeting Kentucky trout anglers. The trout angler attitude mail survey was designed to gather information from the broad spectrum of trout anglers on their fishing habits and opinions.

Now, a decade later, the KDFWR plans to again conduct a mail survey of trout anglers to get an up-to-date snapshot of trout water use, attitudes and opinions. Brainstorming sessions with the Fisheries Division staff began in late summer 2012 in order to determine what questions should be asked of trout anglers. This process continued through the end of the year entailing multiple meetings and reviews of potential questions via email by all Fisheries Division staff. Revisions of the survey questions will continue into 2013. A questionnaire booklet will be constructed with the final survey questions giving careful consideration to the layout of the survey. Copies of the survey booklet will then be distributed to a small number of people having a wide spectrum of trout angling experience for pre-testing. Any problems by respondents in filling out the survey will be addressed before the full mail out begins.

Trout Anglers / Dane Balsman

The survey sample will be randomly selected from the total population of all anglers who purchased a trout permit in 2012 and who can be matched with an address. The sample will not include children under age 16 and persons who purchased either Sportsman's or Senior/Disabled licenses, though these populations can legally harvest trout. With a population of greater than 17,000 trout permit purchasers, a minimum of 400 responses will be needed for statistical significance at the 95% confidence level. Based on observations from our previous mail surveys, very conservative estimates on the number of bad addresses and return rates are used to ensure an adequate beginning sample size. It is estimated that a sample size of 1,800 potential respondents will be needed.

The 2013 trout angler survey will again follow the multiple contact model advocated by Dillman and the accepted standard in survey work. This methodology prescribes multiple contacts with each potential respondent to maximize response rate. Each person on the mailing list will be contacted a minimum of three times and a subset who don't return the survey initially will be contacted a fourth time. The implementation of this survey is expected to occur in April and May of 2013 and results should be available by the end of the year.

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

Cow elk recovering post-capture / John Hast

Cause-Specific Mortality, Behavior, and Group Dynamics of Cow Elk in Kentucky

Brittany L. Slabach, John T. Hast, John J. Cox, and P.H. Crowley. University of Kentucky; Kristina Brunjes, R. Daniel Crank, Will Bowling, and Gabriel Jenkins, Kentucky Department of Fish and Wildlife Resources

Since the reintroduction of elk in Kentucky a variety of research has been conducted in an effort to better understand population health and persistence. Post-release research provided pivotal information regarding habitat use and movement as well as productivity of the herd. With an established herd that is actively hunted, information concerning cause-specific mortality, habitat use, and herd demographics (e.g., the age and sex classes that compose the herd) are important to understand population persistence. These parameters can aid in management decisions concerning hunter placement, number of available tags, and overall population health.

Cow elk are ecologically important for the growth and persistence of the population. Cow elk differ behaviorally and in their activity patterns from bull elk in that they live in groups year round. Group membership commonly consists of related individuals, with a variety of age classes present at any one time throughout the year (e.g., calf, yearling, and older individuals). The lifespan, and potential lifetime reproductive rate (how many calves a cow has over her lifetime) of cow elk is not completely understood, but individuals more than twenty years of age have been harvested. Group membership and dynamics (interactions between individuals) can have important implications for population spread and use of habitat, response to disturbances (e.g., hunter-harvest and roadways), and for disease transmission within a population. Harvest of individuals is presumed to be the greatest cause of mortality of cow elk in Kentucky, yet cause-specific mortality has not been documented. Therefore we aim to address, (1) cause-specific mortality, (2) lifespan, (3) lifetime reproductive rate of cow elk, (4) group membership, demographics, and movement between groups, and (5) develop a model to investigate how disease may spread through the population if a crisis situation were to occur.

In the winter of 2013, an initial sample of 40 cow elk were outfitted with VHF radio collars and ear tags in order to monitor for cause-specific mortality and behavioral patterns. Physiological data (e.g., age, body condition, body size) were collected and behavioral interactions between individuals, as well as herd membership, are being assessed. Five vaginal transmitters have also been deployed to assess the potential to monitor calving events and subsequently capture and sample calves of marked cows in an effort to assess reproductive rate and lifespan. Although age analysis has not been conducted, three known age individuals were recaptured including two original release cows both aged at least 15 years. Better understanding of the longevity and lifetime reproductive rate will provide information to inform models of population growth and recruitment. Assessing behavioral patterns and group membership can provide tools to assess hunter placement, minimum group size necessary for translocation, and mitigation of disease outbreak if it were to occur.

Funding Sources: *Rocky Mountain Elk Foundation, Wildlife Restoration (Pittman-Robertson)*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5.

Catching brown trout at Long Bar public access on the Cumberland River / Dave Baker

Project Updates

Evaluation of a 20-in Minimum Length Limit on Largemouth Bass at Cedar Creek Lake

Christopher W. Hickey and Ryan Kausing, Kentucky Department of Fish and Wildlife Resources

As the most sought after sport fish in Kentucky, Largemouth bass (*Micropterus salemoides*), or black bass (*Micropterus* sp.) in general, are managed extensively by the Kentucky Department of Fish and Wildlife Resources (KDFWR) with the primary goal of producing as many high quality fisheries as possible in different regions throughout the state. And yet, prior to 2002, Kentucky was still missing what could be classified as a true "trophy" largemouth bass lake. This changed in 2002 when the department decided that the newly constructed Cedar Creek Lake would offer the best opportunity to finally establish a highly-coveted trophy largemouth bass population. This new 784-acre reservoir in central Kentucky was expected to already enjoy the ideal levels of productivity, habitat and forage that would be needed for the bass population to thrive. The KDFWR hoped to provide that final component by establishing the type of regulations that would seriously limit the harvest of largemouth bass. The primary objective for this research project was to monitor all aspects of the largemouth bass population at Cedar Creek Lake and then identify the fishery's response to highly-restrictive regulations that included a 1 fish daily creel and a 20-in minimum length limit.

Since the spring of 2003,

Cedar Creek Largemouth bass / Chris Hickey largemouth bass at Cedar Creek Lake have been sampled via nocturnal electrofishing at least twice a year (spring and fall). Each bass that is sampled during these efforts is counted, measured and weighed to gather data that will later be analyzed to determine the relative abundance, length frequency, average condition, reproductive success, and sometimes, the age & growth of the entire largemouth bass population. Electrofishing efforts are also conducted regularly during the summer to examine the stomach contents of the fish, which provides valuable information on the feeding habits of the largemouth bass in Cedar Creek Lake. Periodically during the course of this project, other procedures have been conducted to provide further insight into everything from the age & growth of the fish to the opinions of anglers who regularly use the fishery. Finally, other fish populations in the lake have also been sampled to determine their status and how they are affected by the type of management decisions that are geared towards increasing the number of large predators in the lake.

Once the first ≥ 20.0 in largemouth bass was collected in 2006, they have become a regular occurrence, especially during the spring electrofishing efforts. Even though catch rates of the larger fish have fluctuated during this project, there has been a notable trend showing that the number of ≥ 20.0 in bass has been increasing from one year to the next. This includes 2012 when during mid-April electrofishing efforts, there was a total of 26 largemouth bass in the sample that measured 20.0 in or more, which is quite a jump from the 15 bass that were observed each year in both 2010 and 2011. Furthermore, overall catch rates of largemouth bass in 2012 (254.3 fish/hour) were the highest that it has ever been since the sampling efforts officially started in 2003, but more importantly, the increases did not come from smaller age-1 fish that usually indicate a highly successful spawn during the previous year. In fact, it came from the catch rates of ≥ 12.0 in largemouth bass (139.7 fish/hour), which was a substantial increase over spring 2010 when the previous high of 90.7 fish/hour was obtained. Ultimately, all results from largemouth bass sampling efforts in 2012 were at or above normal, which included the examination of both the food habits in the summer and the average condition (Wr = 88.1) of the fish in the fall. The only exception may have been the lower catch rate of age-0 fish (18.2 fish/hour) during the late-September electrofishing efforts. This is an indication that the largemouth bass spawn during spring 2012 had below average success, which may actually be needed to combat over-crowding that usually accompanies any regulations that reduce harvest rates.

The analysis of all the data obtained for this project over the years especially that from the latest sampling efforts in 2012 provide evidence that the construction of Cedar Creek Lake and KDFWR's decision to specifically manage for its largemouth bass fishery is well on its way to being considered a success. It is more apparent every year that the 20-in minimum length limit and 1 fish daily creel is still working towards increasing the number of high-quality fish in the lake, even if it still might be too early to officially designate it as a trophy fishery. Many largemouth bass are growing to total lengths of 20 inches in just 5 to 6 years on a diet consisting of crayfish, silversides, bluegill and gizzard shad. Creel surveys indicate that anglers are coming to the lake from all over the state in search of high-quality largemouth bass fishing. In fact, estimates have shown that on an acre-by-acre basis, Cedar Creek Lake is one of the most heavily fished water bodies in the entire state. This project and the associated sampling efforts will continue throughout 2013 to make certain that the largemouth population is responding well to the restrictive regulations and still pushing towards attaining the official status of a "trophy" fishery.

Funding Sources: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

Evaluation of a 12.0-in Minimum Size Limit on Channel Catfish in Kentucky's Small Impoundments

Christopher W. Hickey and Ryan Kausing, Kentucky Department of Fish and Wildlife Resources

During an average year, Kentucky's fish hatcheries will be asked to produce nearly 150,000 channel catfish that are needed to be stocked into various small impoundments throughout the state. These annual stocking efforts, which usually require fish that are at least 8 in long, are often the only way to maintain a fishery at these water bodies because of high harvest rates and low to no levels of natural reproduction. Although the data on how anglers use these put-grow-take fisheries is very limited, those creel survey results that are available indicate that as much as 30% - 60% of these channel catfish are harvested each year. Historically, there have been very few regulations placed on these fisheries even though the majority of the catfish are likely being harvested before they are able to reach their full potential. In 2004, the KDFWR started working on the first large scale attempt at regulating these fisheries by implementing a 12.0-in minimum length limit for channel catfish populations at 11 state-owned lakes. This research project was developed to monitor the response of the channel catfish populations to this minimum size limit. Ultimately, KDFWR wants to determine if the 12.0-in minimum length limit can be used effectively at other small impoundments with catfish populations that are sustained solely through annual stocking efforts.

Collecting channel catfish for size limit study / Ryan Oster

During the early stages of this project, it was determined that tandem hoop nets (3 hoop nets fastened together) were the most effective method for sampling these channel catfish populations. A sampling protocol was soon developed that centered on allowing 5 baited tandem hoop nets soak for 3 days at each project lake. At the end of the sampling period, the tandem hoop nets would be retrieved by project biologists and all captured channel catfish would be counted, measured and weighed. The first stage of this project involved sampling the channel catfish every fall at 6 different water bodies, which included 4 experimental lakes that were under the new 12.0-in minimum length limit and 2 control lakes that had no restrictions on catfish harvest. The data collected from these study lakes was used to monitor the status of each catfish population and determine if the minimum size limit was able to improve the fishery.

The experimental lakes for the first 6 years (2006 – 2012) of the project were Beaver, Elmer Davis, Guist Creek and Shanty Hollow lakes and all of their channel catfish populations were being managed under the 12-in minimum size limit. Annual sampling efforts were used to determine if this new size limit was adequately protecting the channel catfish without causing too many fish to pile up just below the 12-in mark. In fact, there were 2 different occasions during this first phase of the project that biologists made the decision to cut back on the annual stocking densities to be certain that stunted growth did not become a problem. Alleviating demand on the limited resources at either of the two state fish hatcheries is considered to be a big benefit of any new regulations. In total, these experimental lakes appear to be responding well to the minimum size limit as all four fisheries could easily be considered at or above average. Because it appears to be a benefit to both the fisheries and the state's hatchery system, the 12-in minimum size limit on channel catfish has been considered a success, especially for the lakes that have been sampled regularly during the course of this study.

The next logical step would be to expand this regulation to other small impoundments that are stocked regularly, but have below average channel catfish fisheries. A good start would be to apply the regulation to McNeely and Reformatory Lakes, which previously served as the control lakes for the first phase of this study. Tandem hoop nets have been used to sample channel catfish at both of these lakes for several years now and despite the regular stocking efforts, there are still low numbers of fish caught each year. Both of these water bodies are under heavy angling pressure and many of the channel catfish are harvested within the first year of being stocked. The third lake chosen for this phase of the project, Lake Reba, also receives a lot of pressure from anglers. However, the numbers of channel catfish in the population are kept at a level that is higher than the other two lakes because of much more intensive stocking efforts. Resource managers hope that by implementing the 12-in minimum size limit on Lake Reba that they will be able to maintain or even improve the channel catfish fishery even after reducing the amount of fish that are stocked annually.

The previous year, 2012, was more of a transition period for the project. The majority of the effort was focused on gathering data from catfish populations at the 3 different water bodies that will serve as the experimental lakes during the 2nd phase of this project. As was expected, tandem hoop nets, which were used to sample channel catfish during the fall of 2012, continued to catch low numbers of fish from both McNeely and Reformatory lakes. The same methods to sample catfish at Lake Reba resulted in catch rates that were similar to those of an experimental lake during the first phase of the project. However, by this time of the year, Lake Reba had already been stocked with channel catfish on multiple occasions with total numbers that were similar to that of a lake that was at least twice its size. In March 2013, the 12-in minimum length limit for channel catfish will be officially enforced at all 3 of these lakes. Project biologists will continue to very closely monitor these channel catfish populations for several years to come. Ultimately, the hope is that the fisheries at each lake will improve over years, even if stocking efforts need to be cut back to alleviate more of the pressure on the state fish hatcheries, which is a system that is already being asked to produce nearly 150,000 channel catfish each year for lakes like these.

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 1,Strategic Objective 5.

Evaluation of Kentucky's Largemouth Bass Stocking Initiative

Christopher W. Hickey and Ryan Kausing, Kentucky Department of Fish and Wildlife Resources

Biologist mark largemouth bass / Chris Hickey

Supplemental stocking is a common management tool that has been used in Kentucky to enhance large-mouth bass (*Micropterus salemoides*) fisheries, but as of late, there is an increasing demand on the state's only two hatcheries that has required the smarter use of its resources. One possible way to approach this is to develop a system that could predict where the fish are really needed each year so that limited number of largemouth bass fingerlings produced by the hatcheries will be stocked only in water bodies that will get the most benefit. Another advantage of a system that predicts the abundance of age-1 bass during that 1st year is that it gives resource managers a chance to assist a poor natural year class before it is too late to respond. For example, if the system predicts that a lake will have high numbers of age-1 bass in the following spring, then the stocking could be diverted elsewhere so there is less chance of unintentionally disrupting the natural population. On the other hand, during a year with a below average spawn, the system should predict a low abundance of age-1 fish, which would be a cue to stock the largemouth bass fingerlings in the fall in order to offset these numbers. Kentucky's Largemouth Bass Stocking Initiative (BSI) attempts to do just that by developing a protocol that successfully predicts a below average number of age-1 largemouth bass next spring by looking at the abundance of age-0 bass this fall.

For each of the 34 lakes in the project, historical data is used to understand the specific relationship between the density of age-0 fish in the fall and the density of age-1 fish of the same year class in the following spring. Two predictive equations and average year-class strength at age-1 were developed for each lake using this historical data. The first equation uses the overall age-0 catch rate (CPUE) of largemouth bass in the fall to make a prediction about spring age-1 density. The second equation is very similar, except that it relies only on the fall age-0 CPUE of larger fish that have a length of ≥ 5.0 inches. The regression equation with the lowest p-value is then used to predict the density of the year class at age-1. The catch rate of age-0 bass that are determined during each lake's annual fall sampling is inserted into this equation and the prediction is checked against the lake's average age-1 density. If the predicted value is below the average, then it could be stocked with bass fingerlings at a density that can vary from a low of 2.5 fish/acre to a high of 15 fish/acre. The chosen density depends on how far the predicted spring age-1 catch rate is below the average for that lake. For the first 7 years of this project (2005 – 2011), each largemouth bass fingerling was marked with a specific fin clip prior to being stocked, which is how they would be distinguished from the natural fish in the population.

Ever since this project started in 2005, the predictive equations generated via the BSI have been used to determine where largemouth bass are stocked every fall. In earlier years of the project, larger lakes with perennial spawning problems (i.e. Laurel River Lake) received the bulk of the fish even though stocking the largemouth bass fingerlings at densities of 5 – 10 fish/acre appeared to have very little impact on the fishery. Beginning in fall of 2009, the project began placing more emphasis on smaller lakes. This shift actually lowered the overall demand on largemouth bass fingerlings and allowed stocking densities to be increased to as high as 15 fish/acre. Not surprisingly, the higher densities proved to be effective as there were more recaptures of stocked fish during the spring 2010 than in any other year of the project. In the fall of 2010, the higher 15 fish/acre density was used again at 50% of the stocked lakes. Even though flood conditions throughout the spring 2011 made it difficult to effectively sample largemouth bass, 6 of the 8 project lakes that were eventually accessible all had recaptures of recently stocked bass. Once again, in 2011, there were 8 project lakes that exhibited catch rates of age-0 largemouth bass that were low enough to be considered as a below-average spawn. Even though all 8 lakes eventually received fish, there were only 5 with poor enough densities of natural age-0 largemouth bass to be stocked at the highest rate of 15 fish/acre. In total, nearly 120,000 largemouth bass fingerlings were marked with a fin clip and stocked as a part of the BSI during the fall of 2011.

During the spring of 2012, the conditions were good enough to sample all the project lakes and any catch rates of age-1 largemouth bass were used to update the predictive equations for that water body. In total, 6 of the 8 lakes (75%) that were stocked with bass fingerlings during the fall of 2011 had recaptures of clipped fish. This indicates that once again hatchery-reared largemouth bass have made a notable contribution to the natural population at the majority of the lakes that were stocked during the previous fall. Statewide sampling efforts during the fall of 2012 indicated that only 6 project lakes exhibited a low enough year-class strength to warrant the supplemental stocking efforts. In 2012, only a total of 88,000 largemouth bass fingerlings were needed to be stocked for this project, but unlike previous years, the bass were not marked prior to leaving the hatchery. In the near future, including 2013, the plan will be to conserve the manpower that had been regularly needed to mark every bass fingerling before it was stocked. Project biologists will now rely solely on the strength of the predictive equations and the average year class strength for each project lake to help make decisions on where the bass fingerlings will be stocked each year. If a stocked lake has above average numbers of age-1 bass in the following spring, it will then be assumed that the addition of the hatchery-reared largemouth bass to the natural population was successful of preventing a poor year class.

Funding Sources: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

KDFWR Fisheries staff at work / Chris Hickey

Bass fishermen preparing for a tournament / Ryan Oster

Black Bass Tournament Results in Kentucky

Christopher W. Hickey and Ryan Kausing, Kentucky Department of Fish and Wildlife Resources

The KDFWR is able to conduct electrofishing efforts annually to sample black bass populations at lakes and rivers throughout Kentucky, but this data alone cannot describe every aspect of the fishery especially when it pertains to the anglers. Information on angler use and success can be gained through creel surveys, but due to limitations on funding and manpower, only a handful of them can be conducted at any given time. The high costs associated with these surveys also makes it nearly impossible to use them on the same lake over back to back years, which would be necessary to identify trends in the relationship between bass populations and angler success. The KDFWR realizes how critical this kind of information is to the management of the resource, so a program was initiated in 1999 that sought to collect data from black bass tournaments that were already being organized at water bodies across the state. The tournament results can provide invaluable information on angler pressure and catch rates that, when combined with survey data gathered via annual electrofishing efforts, will give resource managers the increased ability to explain and forecast changes to various black bass populations. When the program data is summarized into a yearly report, it should also prove useful to anyone looking to plan a fishing event in the near future.

After developing the specifics of the program, especially what kind of data would be requested, researchers were faced with the task of getting the necessary information out to all groups (i.e. bass clubs, marinas, etc) that organize bass tournaments in Kentucky. During 1999 and for first few years that followed, this consisted of mailing out information packets that contained details on the program and any materials that the tournaments would need to record and submit the necessary data. In time, the tournament reporting program evolved to include an online system where organizers could schedule their tournaments and ultimately report their catch data in an easier, more efficient manner. The word spread quickly about the online system and its popularity lead to a steady increase in the number of fishing events that were submitting their data. Another tool that helped boost the exposure of the program was the annual report. This report contained information on the results that were submitted during the previous year, which included statistics that presented details on the tournaments, the anglers that participated in them and the quality of the bass that they caught.

In 2010, and for the first time since the program started, KDFWR made some major updates to the kind of data that would be requested from tournaments. Besides making changes to the size at which a bass would be classified as a "big fish", these updates also started asking tournaments to provide some detailed information on the format that they had used for the event. The primary reason for this was that team tournaments had grown in popularity since the program was initially designed. Once researchers had information on tournament format, they could analyze the catch data accordingly and start treating teams like a single unit rather the 2 individual anglers, which was a simple adjustment that would greatly increase the accuracy of the results.

In 2012, tournament catch data was reported from 27 different waterbodies throughout Kentucky. There was a total of 233 tournaments that participated, which is down considerably from the 350 events in 2011. In fact, this was the 2nd year in a row that the number of tournaments participating in the program has decreased. It has been several years since there was any emphasis put on how important tournament participation was to the continued success of the program, so researchers hope to reverse the current decline by increasing the promotion efforts in 2013. Even though there was a substantial decline in participation, it did not affect the other aspects of the catch data as much as would have been suspected. The 13,636 anglers, or 8,050 angling units (individual anglers + teams), that fished these events in 2012 appear to have been more successful at catching bass than in previous years. For instance, the number of anglers was down by over 33% from the 17,093 that were reported in 2011, but when comparing the actual number of "keeper" bass caught in 2012 (n = 22,815) to those in 2011 (n = 26,440), there was only a 13.7% decrease. There were other important statistics derived from the 2012 tournament data that were higher than they had been in previous years. These included the average weight of a bass caught during a tournament (2.44 lb), the average number of bass caught per angling-unit (2.83 fish/unit) and the average weight to take 1st place at a standard 8-hour event (14.52 lbs). In comparison, 2011 was considered to be a very good year for tournament fishing, but each of its values for these same statistics were lower and included 2.34 lb for average weight per bass, 2.49 fish per angling-unit and 13.62 lbs to win the standard 8-hour event. The highest winning weight for a 1-day tournament in 2012 was 29.38 lbs at Lake Beshear and the biggest bass caught in a tournament was 8.83 lbs, caught from Lake Barkley. Further analysis of the catch data was also used to demonstrate how the many water bodies in Kentucky can differ in terms of angler success, as well as the number and size of the bass that they caught. Ultimately, the results from the 2012 tournaments contributed a great deal to the long-term database that has been building for well over a decade. This program will continue into 2013, and as long as bass tournaments are willing to participate.

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 1, Strategic Objective 5

Taylorsville Lake blue catfish / Chris Hickey

Preliminary Assessment of a Newly Established Blue Catfish Population in Taylorsville Lake

Christopher W. Hickey and Ryan Kausing, Kentucky Department of Fish and Wildlife Resources

The blue catfish (*Ictalurus furcatus*) stocking program is a relatively new tool used by the KDFWR to expand the sport fishing opportunities at some lakes in Kentucky. These efforts have undoubtedly established fisheries that are popular among Kentucky anglers, and several of these fisheries have exceeded expectations enough to indicate that they can produce trophy-sized blue catfish. Not long after the stocking started in 2002, it became apparent that the blue catfish population at Taylorsville Lake was well on its way to developing into a high-quality fishery. Since very little was known about the dynamics of this population, a research project was initiated in 2007 to assess the status of the fishery. However, it was soon realized that the fishery's popularity was becoming a liability as the number a catfish being harvested each year was increasing exponentially. As a result, the focus of this project ultimately shifted from being a simple assessment to an evaluation of new regulations that were implemented to curb harvest rates and encourage the development of a trophy component to the fishery.

Information gathered prior to the start of this project indicated that the blue catfish were doing well, with average growth rates of 3–5 inches a year. More specifically for this project, low-pulse DC electrofishing has been conducted annually (2007 – 2012) during the summer months to sample catfish in both the upper and lower ends of the lake. All blue catfish were counted, measured and weighed before being released. This data was analyzed so that it could be used to identify any changes to the fishery over time. Other methods used during the course of this project to evaluate the blue catfish and the anglers that target them included an angler exploitation study that took place in 2008 and a creel survey that was conducted during the peak fishing season of 2009.

Results from the 2007 sampling efforts indicated that blue catfish at Taylorsville Lake were doing very well. From both ends of the lake, 590 blue catfish were sampled for an impressive catch rate of 236 fish/hr. By 2009 and 2010, catch rates had decreased to only 119 and 116 fish/hr, respectively. These catch rates actually represented an acceptable density for what was a young population of blue catfish without any natural reproduction. However, a 2009 creel survey estimated that nearly 12,000 blue catfish were harvested during that year, which turned out to be a 5-fold increase from the 2,400 blue catfish that were taken by anglers in 2006. This increase in harvest and the more than 100 fish/hr decrease in catch rates from 2007 through 2010 were alarming enough to warrant new regulations, especially after surveyed anglers unanimously agreed that further actions were needed to protect the fishery. The regulations, which were set for March 2011, limited the harvest to only 15 catfish per day with only one that was allowed to be 25 inches (in.) or more. Although a "1-over" limit of 25 in was restrictive, it was needed because of the relatively young age of the fishery and the growing need to protect enough sexually mature fish to facilitate a successful spawn. As the fishery gets older and/or there is evidence of natural reproduction, resource managers will likely revisit the regulation to alter the "1-over" length limit to a level that is appropriate for a fully-developed blue catfish population (i.e. 1-over-30 inches).

As previously mentioned, the purpose of this study shifted after March 2011 to evaluate the newly implemented regulations on blue catfish at Taylorsville Lake. Low-pulse electrofishing has been conducted in the summer of both 2011 and 2012. Efforts in July 2011 concluded with such a poor catch rate (27.1 fish/hr) that biologist decided to repeat the sampling in order to ensure that these results were indicative of the actual population. After the additional efforts in August 2011 ended with catch rates of around 50 fish/hr, it was determined that the previous sampling was indeed accurate regardless of poor results. Fortunately, in July 2012, biologists were able to obtain catch rates from low-pulse electrofishing that showed that the blue catfish population in Taylorville Lake was indeed improving. Even though the upper end of the lake had only slightly improved (58 fish/hr), the much higher catch rates obtained from the lower end (150 fish/hr) was enough to push the overall density up and over the 100 fish/hr mark for the 1st time since 2010. It is also important to note that the 2012 catch rates for ≥ 25 in blue catfish reached over 6 fish/hr, which is the highest density ever obtained for the larger size-class. In 2013, and for several years that follow, low pulse electrofishing will be used repeatedly as project biologists continue to monitor the blue catfish population's response to the regulations. Even without recent evidence of natural reproduction, it is expected that the increasing numbers of larger blue catfish in the population will eventually lead to a successful spawn. As the regulations continue to work, biologists should soon be able to determine not only if the fishery is able to sustain itself through natural reproduction, but also if it is able to produce trophy-size catfish on a regular basis.

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 1,Strategic Objective 5.

Evaluation of the Growth of Two Different Sizes of Blue Catfish Stocked into Three North Central Kentucky Small Impoundments

Christopher W. Hickey and Ryan Kausing, Kentucky Department of Fish and Wildlife Resources

Blue catfish (*Ictalurus furcatus*) were initially stocked into some of Kentucky's small impoundments as a potential management tool aimed at improving bluegill fisheries. Although they were not the ideal predator to control bluegill numbers, the blue catfish eventually became a popular fishery at some of these lakes. During regular efforts to monitor the status of these fisheries, it was revealed that growth rates of the blue catfish in many of these populations were erratic. For example, some blue catfish would differ in length by as much as 15 inches even though they belonged to the same year-class. There have been other studies that recognized such a large disparity in growth rates, but there has been very little information on the relationship between this growth and the size of the blue catfish when they were stocked. Since it has been identified that the growth of piscivorous fish does not increase substantially until they switch to an all-fish diet, it is possible that when blue catfish are stocked at a larger size they are able to consume small forage fish immediately, which could lead to a higher overall growth potential. As a result, this project was developed with the objective of determining whether or not the size at which a blue catfish is stocked has an influence on the long-term growth potential.

In order to reach this project's objective, two distinct size groups of blue catfish (< 10 in and > 12 in) were stocked at the same density into three small impoundments. These study lakes (Boltz, Bullock Pen and

Beautiful blue cat taken during sampling / Chris Hickey

Reformatory lakes) were chosen because the results from previous sampling efforts indicated that they contained blue catfish that were the same age, but had very different growth rates. Beginning in 2007, age-1 blue catfish were stocked into each study lake during the late summer for 3 consecutive years. In order to keep track of the year it was stocked and what size group it belonged to, each catfish received two different marks prior to going into a study lake. A coded micro-wire tag was injected into a particular area of the fish's body to identify the size group and a specific fin clip was used to mark the year that it was stocked. The blue catfish at each study lake would then be sampled at least once every year using low pulse DC electrofishing. Any catfish collected during these efforts would first be measured and then examined closely for any marks. If a fish was discovered to have had a fin clipped, the location would be noted and then a wand-style metal detector would be used to verify the presence and position of the micro-wire tag. Since this whole procedure utilized non-lethal methods for identifying the existence of the marks, each blue catfish would eventually be released with the opportunity to continue growing. The lengths from all stocked fish that were identified as being a part of the same size and year class would then be averaged together in order to estimate how much each study group had grown since being released into the lake. This process needs to be repeated for several years after the last fish was stocked so that project biologists would have the chance to monitor the growth of each study group over longer time period.

After some unexpected difficulty during the first few years of the project, researchers have been able to sample blue catfish from both size groups with some regularity since 2010. After the last batch of catfish was stocked for this project in 2009, sampling efforts have increased substantially with the specific goal of collecting a representative sample of both groups from each project lake. This was certainly the case during the summer of 2012 when all lakes in the project were sampled multiple times in order achieve this goal. However, even when a total 152 clipped/tagged fish were collected during the year, they were spread out among enough different lakes and study groups that there were still some sample sizes that were not as large as researchers desired. For instance, Reformatory Lake was sampled with low-pulse electrofishing on 3 separate occasions in 2012, but there was still only a total of 7 tagged catfish recaptured from the < 10 in size group and an even smaller total of 5 tagged fish collected from the > 12 in group.

Luckily, there were a couple of situations in 2012 where the sample sizes have been large enough to produce reliable data, and like previous years, these results continue to indicate that even though the blue catfish are growing, neither size group appears to be doing substantially better than the other. For example the analysis of the data collected from Boltz Lake in 2012 shows that age-6 blue catfish stocked as part of the > 12 in size group (n =11) had a mean length of only 17.0 inches, while the same age fish stocked in the smaller < 10 in group (n = 14) had a mean length of 16.6 inches. This difference of only 0.4 inches actually means that the lengths of catfish in the 2 size groups might in fact be getting closer together, especially since there was an average difference of around 4.2 in when these fish were initially stocked in 2007. If this trend continues and the mean lengths of the 2 size classes eventually turn out to be the same for multiple study groups, project biologists might be able to effectively dismiss the hypothesis that the blue catfish's size at the time of stocking has an influence on the overall growth potential. However, before this can happen, further data is required and any other factors that might influence the growth of the 2 size groups differently (i.e. differential angler harvest rates) must first be ruled out. Hence, project biologists will continue to sample the blue catfish populations at each study lake in 2013, while taking a broader look for anything that might be specifically affecting the growth rates of these fish.

Funding Sources: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

Shocking for white crappie / Chris Hickey

Evaluation of a Supplemental White Crappie Stocking Program at Three Kentucky Reservoirs

Christopher W. Hickey and Ryan Kausing, Kentucky Department of Fish and Wildlife Resources

Despite their popularity, crappie (*Pomoxis* sp.) can be frustrating to both anglers and resource managers. The status of a fishery changes on a regular basis especially when successful crappie spawns rely so heavily on different biotic and abiotic factors coming together at the right moment. Subtle differences in the habitat requirements of white (*P. annularis*) and black crappie (*P. nigromaculatus*) also allow these factors to influence which species will dominate the fishery. In the past decade, some of Kentucky's most popular crappie lakes (i.e. Kentucky Lake) have seen a shift from a fishery consisting of mostly white crappie to one where black crappie are the most abundant. And yet unfortunately, it is the white crappie that is caught with techniques that are most commonly associated with "crappie fishing" (ie. vertical jigging and using live bait under a slip bobber). So when white crappie numbers decline, anglers using these more traditional methods are most likely to also experience decreases in catch rates. Crappie anglers become very concerned when lower catch rates occur for several years in a row, which often leads them to request that the KDFWR take a more proactive approach to addressing the issue.

Since regulations are already in place at most water bodies, fisheries biologists had the task of identifying other management options that have been shown to help bolster crappie populations. Some fish and wildlife agencies have turned to supplemental stocking in an attempt to offset consecutive years of poor crappie spawns. However, each attempt seems to have been met with different results; consequently, this project was started to evaluate the effectiveness of the most recent attempts at stocking white crappie in Kentucky and to help identify any factors that could potentially increase the chances of their success.

After four reservoirs were initially chosen for the project, the number was reduced to three in order to focus the efforts and allow stocking rates to be increased. Prior to being delivered to any lake, the white crappie fingerlings were marked so they could still be identified many years after being stocked. In the fall of 2009, the first official white crappie fingerlings were produced and then stocked into Carr Creek Lake, Taylorsville Lake and the Blood River Embayment of Kentucky Lake. This entire process was repeated in 2010, 2011 and 2012 when white crappie fingerlings were marked and transported to the same three reservoirs. The most notable change came when a Missouri state fish hatchery began assisting with the production of the crappie fingerlings, which gave resource managers the opportunity to use stocking densities that would be very difficult to duplicate under normal situations. For instance, the stocking rates for the Blood River Embayment ranged from 12 – 20 fish/acre during the first couple years, but after the 2nd hatchery joined the project, the rates for the same water body in 2011 and 2012 more than doubled to 45 – 55 fish/acre.

Because of the different topography of the lakes in this project, there were a variety of different methods used in 2012 to sample the crappie populations. The most common gear used to sample crappie at water bodies throughout the state is trap nets, which have been used effectively at both the Blood River Embayment of Kentucky Lake and Taylorsville Lake. Unfortunately, with its steep shorelines, Carr Creek Lake cannot be effectively sampled with trap nets, and so by default, electrofishing has been used to sample its crappie population even though this method itself can be inefficient when it comes to collecting the smaller age-0 and age-1 fish that have been targeted up to this point in the project. Besides the trap nets, another method used to sample crappie at the Blood River Embayment in 2012 was bottom trawling, which in contrast to the electrofishing has proven to be quite effective at collecting the younger white crappie. The newest sampling method used during 2012 was possible only through the assistance of local anglers who have allowed biologists to remove the otoliths from fish caught during one of their tournaments at the Blood River Embayment. This method may actually turn out to be even more important during the 2nd half of the project when further year classes of stocked crappie begin to grow into the size range that is often targeted by the tournament anglers.

During the past several years, the level at which stocked white crappie contributed to the natural population often varied substantially by reservoir. However, the preliminary results from fall 2012 trap net samples indicated that stocked fish made up exactly 20% of the total combined catch of age-1 and age-2 white crappie at both Taylorsville Lake and the Blood River Embayment. However, when referring specifically to fish that were only caught by anglers at the Blood River Embayment, stocked crappie made a smaller 4.7% contribution to all the age-2 fish in that sample. Although this was less than some might have expected, it is still encouraging to find stocked crappie making up any percentage of the harvestable-size fish, especially since this entire sample was pulled from a single tournament held during the fall of 2012. Unfortunately, there were still no recaptures of stocked fish during the spring 2012 efforts to sample white crappie at Carr Creek Lake. However, it is too soon to conclude that the stocking efforts have not contributed to the population at all, especially since it has already been noted that electrofishing is not the ideal method for sampling the smaller size classes of crappie. As for the future of the project, white crappie fingerlings will once again be stocked at relatively high rates during the fall of 2013 and all the previously discussed sampling methods will continue to be used. After a total of 5 year-classes of hatchery-reared white crappie have been stocked by the end of 2013, the efforts to sample crappie at all 3 project lakes will likely increase during the years to come.

***Funding Source**: Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

Evaluation of a Smallmouth Bass Stocking Program at Paintsville Lake

Christopher W. Hickey and Ryan Kausing, Kentucky Department of Fish and Wildlife Resources

As part of the black bass family, smallmouth bass (*Micropterous dolomieu*) are among the most popular sportfish in Kentucky. Presently, populations are doing well in many of the state's rivers and streams, but they only thrive in a handful of its reservoirs. As past research has suggested, a potential reason for this is that smallmouth bass possess specific habitat requirements that are not commonly available. Aside from their preference for lower trophic levels and year-round cool water habitat, other characteristics (i.e. mean depth & exchange rate) have been identified that coincide with self-sustaining smallmouth bass populations. These characteristics could also be used to predict if a waterbody might benefit from smallmouth stocking efforts.

Paintsville Lake was first stocked with smallmouth bass fingerlings very soon after it was impounded in 1983, and it was not long before a fishery developed that became popular among local anglers, even though it was determined that smallmouth only made up about 5% of all the black bass in the lake. Throughout the 1990's, the proportion of smallmouth bass in the population failed to improve; eventually, the stocking program was suspended to free up some of the state's limited hatchery resources. Shortly thereafter, the fish management objectives for Paintsville Lake changed altogether and the dam began releasing cooler water in favor of conserving the warmer water preferred by largemouth bass. Although the largemouth in the lake and the trout in the tailwater may have benefitted from this water release schedule, the smallmouth bass began to decline substantially as the critical cool water habitat faded from Paintsville Lake during the summer months. When this was joined by multiple years of abnormally high amounts of rainfall, the increased discharge rates through the dam only compounded the habitat problems. After a while, the smallmouth bass numbers declined so much that they could no longer be found in either the anglers' creel or during the black bass sampling efforts.

Despite its recent history, Paintsville Lake has remained one of the few water bodies in Kentucky where minimal changes could possibly create the type of habitat that is required for the establishment a smallmouth bass fishery. Since its impoundment, the lake's watershed remains undeveloped enough to maintain a lower trophic level. A new water release schedule was developed in 2005 to offer a compromise to fish populations already present in both the lake and tailwater, and to allow cooler water to be held back. By 2005, the cooler, oxygenated water (≤ 74.3 °F) that smallmouth bass needed to survive the summer months was returning to the main lake. Even though this critical habitat might have been unstable, especially during the longer periods of heavy rainfall, KDFWR made the decision to resume a multi-year experimental stocking program for smallmouth bass to determine if the new water release schedule could successfully accommodate all the sport fish populations for which it was originally developed. This specific research project was implemented to determine if this stocking program could be used to re-establish the smallmouth bass fishery at Paintsville Lake under the conditions and habitat created by the new water release.

Smallmouth bass fingerlings have officially been stocked into Paintsville Lake during the late spring to early summer for 4 consecutive years (2009 – 2012). With the exception of a much smaller effort of 6.5 fish/acre during the first year (2009), the target density for the stocking of smallmouth bass fingerlings was 20 fish/acre, but since the main priority was to establish a fishery, higher rates were used based on the maximum number of fish available. Since the rates used from 2010 to 2012 depended solely on the number of fish being produced by the hatchery, the actual stocking density ranged from a low of 17.8 fish/acre in 2010 to a high of 43.9 fish/acre in 2011. The final stocking rate for smallmouth bass fingerlings (27.7 fish/acre) in 2012 was lower than that used in 2011 because biologists ended up stocking a large proportion of the final year's fish as fry during the spring to accommodate the need to free up some of the hatchery's resources earlier than in previous years. So even though the number of fingerlings stocked in 2012 was down, the lake had already received over 100,000 smallmouth bass fry nearly 2 month earlier. All smallmouth bass, with the exception of the fry stocked in 2012, were marked via OTC immersion prior to being released into the lake. This was done so that biologists could determine that any smallmouth bass collected during the years that followed were those stocked for this study and not one of the few native fish that might have remained from the historical population.

Despite the fact that smallmouth bass have always been targeted during annual black bass sampling (spring and fall) at Paintsville Lake, very few stocked smallmouth bass have been recaptured. Following a poor showing in 2011, when only 3 stocked smallmouth bass where collected all year, the black bass sampling in both the spring and fall of 2012 yielded only slightly better results when electrofishing efforts were able to bring in a total of 4 smallmouth bass that were stocked during this project. Although the efforts to locate the stocked fish will continue throughout 2013, the poor results so far have led to the decision to make the smallmouth bass stocking efforts in 2012 the last year for this program. The biggest concern is that it is possible that the critical habitat required for the smallmouth bass fishery to thrive has never really taken hold at Paintsville Lake. Although further investigation is warranted, high rainfall during the first few years of this study and continued problems with the release gates at the dam over the last couple of years have all worked against the establishment of the cooler, oxygenated water that smallmouth bass need to survive in Paintsville Lake year after year.

Funding Sources: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

The Fishing in Neighborhoods (FINs) Program: Providing Fishing Opportunities to Residents in Cities across the Commonwealth

Dane Balsman and Jason McDowell, Kentucky Department of Fish and Wildlife Resources

Young anglers fishing at a FIN's lake / John Williams

In an effort to boost license sales and increase fishing opportunities, the Kentucky Department of Fish and Wildlife Resources (KDFWR) initiated the Fishing in Neighborhoods (FINs) program in 2006. The FINs program currently includes 39 lakes in 24 counties. Quality fishing opportunities now exist in cities of all sizes across the Commonwealth thanks to partnerships between KDFWR and local municipalities. As part of a cooperative agreement between KDFWR and local governments, the lake owners provide a 25% in-kind match for services at the lake to cover the cost of fish stockings. With the cooperative agreement, KDFWR works with the local parks departments to arrange fish stockings, provide technical guidance and promote fishing in the park lakes.

These lakes are conveniently located near large population centers. Anglers do not have to travel far from home to find good fishing. In 2012, 137,500 trout and 98,650 catfish were stocked in the FINs lakes. The fish stockings provide fishing opportunities in lakes that in the past were overfished due to their size and fishing pressure exceeding the resources' capabilities. These lakes require routine stockings of catchable-size fish to sustain quality fishing opportunities to a diverse group of anglers. Lakes are stocked up to four times annually with catchable-size catfish (12-18") and three times annually in the cool months (Oct.-Mar.) with rainbow trout (8-12"). Bass and sunfish populations are routinely sampled to ensure natural reproduction is meeting the needs of the anglers. In 2012, hybrid sunfish were produced at Pfeiffer Fish Hatchery and 17,375 (5-7.5") hybrids were stocked in September at lakes that had poor sunfish numbers or heavy fishing pressure. An additional 35,000 hybrid sunfish are expected to be ready for stocking at FINs lakes in 2013. A standard set of creel limits is in place at all FINs lakes to help spread out fish harvest and ensure fishing opportunities can be enjoyed by as many people as possible. Daily limits for each angler fishing a FINs lake includes five rainbow trout, four catfish, one largemouth bass over 15 inches, and 15 bluegill or other sunfish.

Information kiosks have been erected at nearly all of the lakes to disperse information to the public about fish stockings, license requirements, fish identification, poacher hotline, basic knot typing instructions and the mission statement of the FINs program. Additionally, the program has been intensively marketed through press releases, social media, radio, television, license vendors, boat shows and the KDFWR website.

Angler attitude surveys indicate that the FINs program is attracting families with 32% of anglers ≤ 15 years old. The program is also recruiting new license buyers with 10% of anglers reporting they had never bought a license and 24% reporting they had not bought a license the previous year. Angler satisfaction was extremely high at the FINs lakes with 85% of anglers reporting their overall trip as "good" or "excellent". Attitude and creel surveys continue at FINs lakes statewide. Fishing pressure continues to increase at these lakes and the feedback from local parks and anglers has been very positive. Additionally, an exploitation study is currently ongoing to assess fish catch and harvest rates at several FINs lakes.

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 2, Strategic Objective 3, Goal 4. Strategic Objective 1.

Use of Flathead Catfish to Reduce Stunted Fish Populations in a Small Kentucky Impoundment

Dane Balsman and Jason McDowell, Kentucky Department of Fish and Wildlife Resources

A.J. Jolly Lake, a 175 acre impoundment located in Campbell County, Kentucky has historically contained a sub-par sport fishery for sunfish and largemouth bass. The Kentucky Department of Fish and Wildlife Resources (KDFWR) has tried several alternative management actions in an attempt to improve growth of sunfish and largemouth bass. Management actions have included stocking intermediate-sized largemouth bass to improve recruitment of largemouth bass and stocking of blue catfish to consume overabundant sunfish. Unfortunately, these management actions have proven unsuccessful for improving the sunfish population.

In June 2007, the KDFWR stocked 417 flathead catfish that ranged in length from 8.4 to 36.0 inches. In September 2009, an additional 308 flathead catfish were stocked. Fish ranged in size from 3.0 to 32.3 inches. In June 2011, 403 flathead catfish were stocked into A.J. Jolly Lake ranging in size from 3.8 to 38.2 inches. Flathead catfish were obtained from Georgia Department of Natural Resources as part of their non-native flathead catfish eradication program. All flathead catfish were fin-clipped prior to stocking to differentiate from native flatheads in subsequent sampling attempts. In addition to the Georgia flathead catfish, Pfeiffer Fish Hatchery raised 2,862 flathead catfish averaging 5.1 inches that were stocked on 2 September 2011. The hypothesis of the project was that the stocking of a top-level predator would reduce densities of abundant sunfish. Ultimately, this should help improve size structure and growth rates of sunfish and possibly other sport fish species including largemouth bass and channel catfish.

A regulation was passed in 2009 that prohibited the harvest of flathead catfish from A.J. Jolly Lake. This regulation was critical to ensure that the stocked flathead catfish would remain in the lake to have the hypothetical desired effect. Sunfish and bass electrofishing are conducted each spring and fall to determine abundance, size structure, age, growth and condition. Bass catch rates and size structure have improved over the last several years. There have been two strong spawning years in 2010 and 2011 and catch rates observed in 2012 for bass were the second highest observed in 16 years of sampling. However, sunfish size structure has continued to decline, while the catch rate for bluegill continues to increase, with fish in the 2 – 4 inch range dominating the population. Very few bluegill reach 6 inches. Bluegill analyzed for ageing revealed slow growth. Sampling for flathead catfish has yielded low numbers of fish. Sampling has been conducted at various times of the year, and with different DC pulse electrofishing settings with little luck. Little information exists on effective ways to sample for flathead catfish in small impoundments. In 2012, 123 flathead catfish were sampled; however, 99 of the fish were $\leq$ 7 inches (likely from the 2,862 flatheads stocked from Pfeiffer Hatchery in 2011). Twelve of the 24 flatheads captured $\geq$ 8 in were fish from the Georgia stockings, while the other 12 were native fish. There were more flathead catfish sampled in 2012 (123), than in 2011 (49), 2010 (31), or 2009 (17). However, sampling numbers remained low for the year and the true population size of flathead catfish is still unknown. KDFWR will continue to sample flathead catfish, largemouth bass, sunfish, and channel catfish, to determine if flathead catfish can improve sportfish populations at A.J. Jolly Lake.

Flathead catfish sampled from Kentucky impoundment / Dane Balsman

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 1, Objective 5.

Tagged channel catfish awaiting release / Dane Balsman

Exploitation Rates of Stocked Channel Catfish and Rainbow Trout in Fishing in Neighborhoods (FINs) Lakes

Dane Balsman and Jason McDowell, Kentucky Department of Fish and Wildlife Resources

The Fishing in Neighborhoods (FINs) program provides fishing opportunities to cities of all sizes across the Commonwealth. These lakes require routine stockings of catchable-size fish to maintain quality fishing opportunities to a diverse group of anglers. An exploitation study was conducted at three FINs lakes from late 2010 to 2012. Jacobson Park Lake (7 acres) in Fayette County currently has an ongoing exploitation study. These exploitation studies in conjunction with creel and attitude surveys are necessary for assessing angler use of the fishery and fine tuning stocking rates.

An angler exploitation study of rainbow trout was conducted at Upper Sportsman's Lake in Franklin County (6.2 acres), Middleton Mills Shelterhouse Pond in Kenton County (1.2 acres) and Stein Community Park Lake in Campbell County (7 acres). Tagged rainbow trout released for the study ranged in size from 8.0 – 11.9 inches and averaged 0.36 pounds. Fish were tagged with yellow Floy FD-94 anchor t-bar tags below the dorsal fin. A total of 640 – 688 tagged trout were stocked in each of the three lakes in November, February and March. Exploitation rates were corrected for non-reporting, tag loss and tagging mortality with a 28%, 46% and 78% corrected harvest rate respectively. The corrected catch rates were 88%, 86% and 82% at the three lakes respectively. While harvest rates varied significantly between the three lakes, the corrected catch rates were quite similar among all lakes. The average number of days the trout were at large before being caught ranged from 23 – 40 days with a median of 16 – 23 days.

A channel catfish exploitation study was also conducted at the three above-mentioned lakes from March – October. The dates of the study coincide with the date of the first stocking of the spring through the end of the anticipated fall fishing season. Only one catfish tag was returned after 31 October. Tagged channel catfish ranged in size from 10.0 – 22.0 inches and averaged 0.98 pounds. Fish were tagged with yellow carlin-dangler tags. The tags were attached to the fish using stainless steel wire threaded through the fish below and anterior to the dorsal spine. In total, 299 – 600 channel catfish were tagged in March, April and May at each of the three lakes. Exploitation rates were corrected for non-reporting, tag loss and tagging mortality Corrected harvest rates ranged from 32 – 49%, while corrected catch rates ranged from 69 – 85% at the three lakes. The average number of days the tagged fish were at large before being caught was 12 – 19 days with a median of 3 – 7 days at the three lakes.

From the exploitation study we conclude the catfish are caught quickly after stocking, but less than one half of catfish are initially harvested. Trout are not caught as quickly as catfish likely due to fewer anglers fishing during the cool weather months. Exploitation rates for trout were highly variable between lakes. When we view the creel surveys, the estimated catch for catfish far exceeds the number of stocked fish, while the number of harvested fish mirrors the number of stocked fish. It appears the catfish are caught multiple times before ultimately being harvested by anglers. The exploitation study fails to capture the estimated higher harvest rate due to the tag being removed the first time the fish is hooked and likely being harvested on subsequent catches. The creel survey data for trout also estimates the catch to be larger than the number of stocked fish indicating stocked trout are likely caught multiple times by anglers.

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

Investigation of the Restoration of Native Walleye in the Upper Levisa Fork

Dave Dreves and Paul Wilkes, Kentucky Department of Fish and Wildlife Resources

Walleye is a freshwater fish native to most of the major watersheds in Kentucky, including the Levisa Fork watershed located in extreme eastern Kentucky. By the late-1800's, growing concern for declining fisheries prompted the stocking of Kentucky rivers and lakes by the U.S. Fish Commission and the Kentucky Game and Fish Commission. In 1912 and from 1914-1917, these two agencies stocked walleye fry in various rivers and streams throughout Kentucky, including the Levisa Fork in 1915. Unfortunately, it was not yet known that the Lake Erie strain walleye used in the stocking efforts are adapted to lentic (lake) environments, unlike the native Kentucky walleye which are adapted to lotic (river) environments. Biologists later realized that these northern walleye are genetically distinct from native Kentucky walleye; as a result, it is believed that the majority of these stocked northern walleye could not survive in the river environment or were ultimately confined to lake systems (e.g. Lake Cumberland). Since there are no known recent reports of walleye from the Levisa Fork or Fishtrap Lake, it is suspected that the "northern" strain fry stockings in 1915 were not successful and the native population in the river had been lost.

Although portions of the Levisa Fork are impounded by Fishtrap Lake, there are approximately 15 miles of unimpounded mainstem of the Levisa Fork between the lake and the Virginia state line and at least that many more miles beyond. The broad goal of this project is to re-establish a reproducing native "southern" strain walleye population to this section of the Levisa Fork. An established population of native walleye in the Levisa Fork will serve as a source of broodstock for potential native walleye restorations in other Kentucky river systems and will create a walleye sport fishery in the upper Levisa Fork. In order to accomplish these restoration goals, beginning in 2010, native strain walleye were collected from Wood Creek Lake and the Rockcastle River in the spring and transported to Minor Clark Hatchery to be used as broodfish. Walleye are spawned and the resulting fry are reared to fingerling size (1.5 in.) in ponds, then stocked in the Levisa Fork in late May or early June. We are using a stocking rate of a minimum of 20 fingerlings/acre (240 fingerlings/mile), and we plan to continue these efforts through at least 2015. In conjunction with stocking, we assess 24-hour stocking mortality using mesh-lined barrels secured in the river. To monitor and assess stocking success, we sample walleye in the spring at multiple sites using boat-mounted pulsed DC electrofishing gear, and a sample of walleye are collected such that weight and length measurements and sex ratios can be recorded. All stocked fingerlings are marked with oxytetracycline (OTC) to determine recruitment of stocked fish. Limited sampling took place in 2011 and 2012 due to the inability to navigate the river at anything but elevated flows with good water clarity. Only a single walleye has been collected to date, however we have received multiple anecdotal reports of anglers catching walleye. Beginning in 2016, small walleye may be sacrificed and otoliths removed for examination for OTC marks. We also plan to implant PIT tags in captured walleye to follow movement and growth rates. Walleye sampling in the Levisa Fork is slated to continue through 2020 to allow for the reproductive potential of the stocked walleye population to reach a point where natural recruitment is possible and detectable.


Native walleye from the Upper Levisa Fork / Dave Dreves

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

Investigation of the Walleye Population in the Rockcastle River and Evaluation of Supplemental Stocking of Native Strain Walleye

Native walleye from the Upper Barren River / John Williams

Dave Dreves and Paul Wilkes, Kentucky Department of Fish and Wildlife Resources

Prior to impoundment in 1952, the Cumberland River was known for tremendous spring runs of walleye (*Sander vitreum*) that provided a very popular regional fishery. This fishery included the Rockcastle River, a tributary to the Cumberland River which enters at what is now the headwaters of Lake Cumberland. Walleye spawning runs at Lake Cumberland rapidly declined in the late 1950's and early 1960's due to a variety of factors including: 1) lack of spawning sites due to the inundation of rock shoals by the impoundment; 2) over-harvest of adults during spawning runs; and 3) acid mine pollution of spawning areas. The KDFWR first stocked walleye in the Cumberland River, above Lake Cumberland, in 1973 in attempts to improve the declining walleye fishery in the river. These broodfish were not from rivers in Kentucky, but were fish from Lake Erie origins. The Erie strain walleye evolved in a lentic (lake) environment, thus they generally do not make large spawning migrations up rivers in the spring, but rather spawn within the lake or reservoir. Before advances in genetics, it was erroneously assumed that all walleye were the same and these stocked walleye would perform well in lotic environments. It is now believed that the majority of these walleye, because of their lentic origins, made their way back down into the lake and remained within the reservoir. Fortunately, no Erie strain walleye were ever stocked by the KDFWR above the inundated portion of the Rockcastle River. Consequently, Kentucky's unique strain of walleye still exists in the Rockcastle River, while Lake Cumberland continues to support the Erie strain.

There are two main goals of this study: 1) to assess the genetic origin of the existing walleye population in the Rockcastle River and what, if any temporal and spatial differences exist between the native strain and the Lake Erie strain; and 2) to evaluate the contribution of stocked native strain walleye to the existing population. We collect native strain walleye from the Rockcastle River each spring and transport them to Minor Clark Fish Hatchery to be used as broodfish. These walleye are spawned and resulting fish are reared to fingerling size (1.5 in). Fingerling walleye were marked with oxytetracycline (OTC) prior to stocking. Target stocking rates were a minimum of 20 fingerling/acre (270 fingerlings/mile) for 6 years. We conduct electrofishing surveys during various seasons and locations throughout the 54 miles of the mainstem Rockcastle River to monitor the walleye population. Captured walleye are measured, weighed, tagged, released, and fin clips are taken for genetic analysis. Small individuals were sacrificed and otoliths removed for later examination for OTC marks.

To date, all walleye captured in the free-flowing section of the Rockcastle River were found to be genetically pure native walleye. The overwhelming majority of walleye examined were stocked fish, indicating no natural recruitment of native walleye from 2002 to 2007. After 6 consecutive years of stocking, native walleye stocking was discontinued to determine the effect of stocking on the production of natural year-classes. A small amount of natural recruitment was observed in spring 2012 walleye sampling. This was the first time natural recruitment had been observed since stocking was discontinued. This research study will conclude in 2014.

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

Evaluation of a 36-inch Minimum Length Limit on Muskellunge at Three Kentucky Reservoirs

Dave Dreves and Paul Wilkes, Kentucky Department of Fish and Wildlife Resources

The muskellunge (*Esox masquinongy*) is an ecologically and economically important sport fish in many temperate fresh water ecosystems of North America. The species is native to many of the river drainages of Kentucky, including the Green, Kentucky and Licking River drainages and historically provided very popular fisheries. During the 1960's and 1970's, the U. S. Army Corps of Engineers constructed dams impounding these rivers, creating Buckhorn Lake (1,230 acres) on the Middle Fork of the Kentucky River, Green River Lake (8,210) on the Green River and Cave Run Lake (8,270) on the Licking River. The Kentucky Department of Fish and Wildlife Resources maintains a muskellunge fishery in these reservoirs through annual stockings of 0.33 fish/acre. Each of these reservoirs now supports excellent sport fisheries for muskellunge with exceptional growth potential. A demand for increased quality of muskellunge fisheries by anglers precipitated recent fisheries management strategies directed towards establishing trophy fisheries through the use of regulations such as minimum size and bag limits. These regulations are designed to equitably distribute the catch and protect certain size classes of fish in order to develop the trophy fishery.

In an effort to enhance the quality of the muskellunge fishery, the KDFWR increased the minimum length limit for muskellunge in Cave Run and Green River lakes from 30 to 36 inches in spring 2010. The minimum size limit was also set at 36 inches at Buckhorn Lake, which had been changed to a 40-inch size limit in 2003. The daily bag limit at all lakes was maintained at one fish per day. The expected result of this regulation change is to increase the abundance of muskellunge below 36 inches and to increase the average length of all muskellunge in the populations at Cave Run and Green River lakes. However, due to the paucity of information pertaining to stocking efforts and the aforementioned regulation changes, it is unknown whether these effects will be realized with this management strategy, as well as how these population changes may affect the entire fish community. A thorough evaluation of this management strategy will add to the existing knowledge base in the field and allow the KDFWR to most effectively manage the muskellunge fishery and fish community in these reservoirs.

All individuals of each cohort of stocked muskellunge were permanently marked with a fin clip prior to stocking in the fall. Population sampling was conducted with boat-mounted pulsed DC electrofishing gear from mid-February through the end of March at all three reservoirs. Electrofishing catch per unit effort data (CPUE) collected in the spring of each year is being used to index age-1 year-class strength, the relative frequency of various length groups of interest and mortality calculations. In the future, length at age, relative weight and length-weight equations will be calculated and analyzed for changes in growth and condition. Creel surveys and angler attitude surveys will be conducted at each study lake. Muskellunge will also be tagged to estimate angler exploitation. Statistical comparisons of CPUE of size groups for pre-regulation and post-regulation change will be made. We will also compare the changes in CPUE of size groups within and among the three study lakes. All existing muskellunge data on each of the study lakes will be compiled, including CPUE, creel and angler attitude data.

A couple of Kentucky muskellunge / Chad Nickell

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

A healthy rainbow from the Cumberland River/ Dave Dreves

Evaluation of a 15-20 Inch Protective Slot Limit and 5 Fish Creel Limit on Rainbow Trout in the Lake Cumberland Tailwater

Dave Dreves and Paul Wilkes, Kentucky Department of Fish and Wildlife Resources

Over the last decade, the Kentucky Department of Fish and Wildlife Resources (KDFWR) have attempted to optimize stocking practices in the Lake Cumberland tailwater to increase the quality of the put-and-take rainbow trout fishery. The KDFWR commission passed new regulations for rainbow trout that were implemented in 2004. These regulations were a 15-20 inch protective slot limit with a creel limit of 5 trout per day (only one of which may be over 20 inches). These regulations are expected to protect enough rainbow trout to prevent overharvest and increase quality, yet still allow for a put-and-take fishery.

The primary goal of this project is to evaluate the effectiveness of these more restrictive regulations on rainbow trout in Kentucky's most valuable trout fishery. Additionally, Wolf Creek National Fish Hatchery annually stocks a minimum of 5 strains of rainbow trout, and long-term performance of these various strains in the Cumberland tailwater is unknown. As part of the special regulation evaluation, we differentially batch marked and stocked two rainbow trout strains in the tailwater (one domesticated strain and a relatively wild strain). The goals of the strain evaluation were to determine if there is differential growth and survival, and if the wild strain fish are less susceptible to angling. The survival, growth, and contribution to the population of the two rainbow trout strains are being monitoring by conducting electrofishing surveys for fish previously marked with fin clips.

Changes in the size and structure of the rainbow trout population as a result of the change in size and creel limit are being evaluated by relative abundance estimates from fall nocturnal electrofishing surveys. Periodically during the project, we clipped the adipose fin of a cohort of fish and then determined monthly growth rates of rainbow trout during their first growing season by collecting those fish during monthly electrofishing. We also conducted a creel survey in 2006 and 2009 to assess changes in angler catch rates, harvest rates, and pressure in comparison to the 2002 creel survey. Results from the strain analysis revealed that the domestic Arlee strain rainbow trout grew more slowly and suffered higher mortality than the McConaughy strain. Creel survey results indicated that the Arlee strain was harvested at a much higher rate.

The Wolf Creek Dam rehabilitation has resulted in poor water quality conditions in the Lake Cumberland tailwater since 2007. These conditions have limited the rainbow trout population response to this new regulation; consequently, this research study ended in 2012 and data analysis will be completed in 2013.

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

Investigation of the Restoration of Native Walleye in the Upper Barren River

Dave Dreves and Paul Wilkes, Kentucky Department of Fish and Wildlife Resources

Walleye is a freshwater fish native to most of the major watersheds in Kentucky, including the Barren River watershed located in southwestern Kentucky. By the late-1800's, growing concern for declining fisheries prompted the stocking of Kentucky rivers and lakes by the U.S. Fish Commission and the Kentucky Game and Fish Commission. In 1912 and from 1914-1917, these two agencies stocked walleye fry in various rivers and streams throughout Kentucky, including the Barren River. Unfortunately, it was not yet known that the Lake Erie strain walleye used in the stocking efforts are adapted to lentic (lake) environments, unlike the native Kentucky walleye which are adapted to lotic (river) environments. Biologists later realized that these northern walleye are genetically distinct from native Kentucky walleye; as a result, it is believed that the majority of these stocked northern walleye could not survive in the river environment or were ultimately confined to lake systems (e.g. Lake Cumberland). Another walleye stocking attempt (4.15 million walleye fry) in the Barren River occurred in 1966, in response to low population numbers, shortly after the river was impounded in 1964. Since there are no recent reports of walleye from the Barren River or Barren River Lake, it is suspected that the "northern" strain fry stockings in 1917 and 1966 were not successful and the native population in the river has been lost.

Although portions of the Barren River are impounded, there are approximately 31 miles of unimpounded mainstem of the Barren River above Barren River Lake. The broad goal of this project is to re-establish a reproducing native "southern" strain walleye population to this section of the Barren River. An established population of native walleye in the Barren River will serve as a source of broodstock for potential native walleye restorations in other Kentucky river systems and will create a walleye sport fishery in the upper Barren River. In order to accomplish these restoration goals, beginning in 2007, native strain walleye were collected from Wood Creek Lake and the Rockcastle River in the spring and transported to Minor Clark Hatchery to be used as broodfish. Walleye are spawned and the resulting fry are reared to fingerling size (1.5 in.) in ponds, and then stocked in the Barren River in late May or early June. We are using a stocking rate of a minimum of 20 fingerlings/acre (240 fingerlings/mile), and we plan to continue these efforts through at least 2013. In conjunction with stocking, we assess 24-hour stocking mortality using mesh-lined barrels secured in the river. To monitor and assess stocking success, we sample walleye in the spring at multiple sites using pulsed DC electrofishing gear, and a sample of walleye are collected such that weight and length measurements and sex ratios can be recorded. We have been successfully sampling walleye in the Barren River for several years now and fish have been observed in excess of five pounds. In 2008, we began marking stocked fingerlings with oxytetracycline (OTC) to determine recruitment of stocked fish. Beginning in 2013, small walleye may be sacrificed and otoliths removed for examination for OTC marks. We also have implanted PIT tags in captured walleye to determine movement and growth rates. Walleye sampling in the Barren River is slated to continue through 2016 to allow for the reproductive potential of the stocked walleye population to reach a point where natural recruitment is possible and detectable.

Barren River native walleye / Dave Dreves

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

Relative Survival, Growth and Susceptibility to Angling of Two Strains of Brown Trout in the Lake Cumberland Tailwater

Dave Dreves and Paul Wilkes, Kentucky Department of Fish and Wildlife Resources

An impressive brown trout from the Cumberland River / Lee McClellan

Trout (*Oncorhyncus* spp. and *Salmo* spp.) sport fisheries in Kentucky's reservoir tailwaters are unique and important resources. These fisheries were created in reservoir tailwaters having coldwater discharges for either the entire year or a portion of the year. The Lake Cumberland tailwater trout fishery is the largest in Kentucky with more than 75 miles of suitable habitat available throughout the entire year.

The Lake Cumberland tailwater receives the largest stocking in the state allocation of trout with approximately 161,000 rainbow (*O. mykiss*) and 38,000 brown (*S. trutta*) trout stocked per year. Growth and survival of stocked trout in the Cumberland River are sufficient to create a high quality trout fishery with opportunities to catch trophy-size fish. Since the brown trout fishery in the Lake Cumberland tailwater is managed as a trophy fishery, it is imperative that stocked brown trout grow rapidly and reach trophy size in as short a time period as possible. Over the last 15 years, the Kentucky Department of Fish and Wildlife Resources (KDFWR) has used regulations and stocking practices to enhance the trout fishery in the Lake Cumberland tailwater. One further way to optimize stocking includes determining the most suitable strain of trout for the physical conditions and management goals of a particular fishery. Characteristics such as movement, mortality, growth and susceptibility to angling are of particular importance.

In 2007, a comparison was conducted between the Plymouth Rock (PR) and Sheep Creek (SC) strains of brown trout stocked in the Lake Cumberland tailwater. Like in a previous rainbow trout strain analysis, the comparison is between a more "domesticated" hatchery strain (PR) and another being a relatively "wild" strain (SC). Preliminary results from this study showed that growth was similar between the two strains but the SC strain was much more abundant after one growing season than the PR strain. This same comparison was made again in 2009. This cohort of the two strains performed more evenly. However, the Wolf Creek Dam rehabilitation has resulted in poor water quality conditions in the Lake Cumberland tailwater since 2007 and has affected the comparison. The rehabilitation has also affected the susceptibility to angling component of the research as poor water quality and lower survival of brown trout has made it challenging to catch enough of the marked fish to make comparisons.

The dam rehabilitation appears to have been completed and Lake Cumberland water levels are expected to be partially raised to normal in spring 2013 and anticipated to be fully raised in spring 2014. It may take a year or two for conditions to return to normal in the Lake Cumberland tailwater, after which another cohort of the two brown trout strains will be compared. Information gained from this study will help to enhance the management of the trophy brown trout fishery in the Lake Cumberland tailwater.

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

River Sport Fishery Survey – Kentucky River

Jason Herrala, David Baker, and Nick Keeton, Kentucky Department of Fish and Wildlife Resources

The Kentucky Department of Fish and Wildlife Resources (KDFWR) has stocked sauger and walleye in the Kentucky River since 1981. Between 1981 and 1985, the Department stocked over 2,000,000 sauger in the upper pools of the river. Walleye stocking began in 1989 with walleye fry and fingerlings being stocked in the upper reaches of the Kentucky River. However, neither stocking (sauger or walleye) was evaluated. As a result, the Department implemented a *Sander* study along the entire reach of the Kentucky River in the winter/spring of 2002-2003. From this evaluation, it became evident that the walleye stockings were not successful, with little reproduction having been documented. Because sauger are better adapted to the conditions present in the Kentucky River, it was decided that walleye stockings would cease and sauger fingerling stockings would begin again in Pools 4 through 14.

In 2006, the KDFWR began stocking sauger fingerlings into the Kentucky River along with a full evaluation of the *Sander* populations in the mid and upper river sections. The goal of this study was to evaluate the potential of establishing a self-sustaining sauger recreational fishery through supplemental stocking in select pools of the upper Kentucky River. In the summer of 2011, the Department suspended stocking sauger so that we could evaluate whether the sauger population can be self-sustaining through recruitment of naturally reproduced fish.

Spring nocturnal electrofishing surveys were conducted in 2012 in the tailwaters of Lock and Dams 5, 10, 11, and 12. A total of 51 sauger, 41 white bass, and 2 hybrid striped bass were collected in 4.5 hr of electrofishing. Sauger catch rates were lower than in 2011, and have continuously declined since stocking ceased. Spring sauger catch rates varied from 1.0 fish/hr at Lock and Dam 11 to 24.0 fish/hr at Lock and Dam 10 (mean=11.3 fish/hr). Fall sampling also occurred to monitor catch rates of age-0 sauger. Only 17 sauger were collected, and no age-0 fish were observed. Data collected by the Department indicates that the sauger fishery in the Kentucky River is not self-sustaining, and that supplemental stocking will likely not create a self-sustaining fishery. A brief creel survey done on the Kentucky River in 2012 indicated that when river conditions allowed for safe fishing, the majority of anglers knew that the Department stocked sauger into the river and many of the anglers were targeting them. With that in mind, a put-grow-take fishery may be the most viable option for future sauger management on the Kentucky River.

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson*)

KDFWR Strategic Pan: Goal 2, Strategic Objective 3.

Kentucky River sauger / Nick Keeton

River Sport Fishery Survey – Ohio River

Jason Herrala, David Baker, and Nick Keeton, Kentucky Department of Fish and Wildlife Resources

Commercial fishing for catfish in the Ohio River has existed for decades. Originally, commercial anglers caught catfish for the flesh market, however in recent years much interest has developed in harvesting catfish and selling them to pay lakes. Pay lake owners increase angler interest by stocking trophy size catfish in their lakes. Many of these fish are believed to come from the Ohio River. At the same time, a high quality, primarily catch and release trophy-size catfish fishery has developed for sport anglers in the Ohio River. This has led to conflicts between sport anglers that desire to catch and release large catfish and commercial fishers that desire to catch and sell large catfish to pay lakes. Of particular interest is data obtained from trophy catfish (blue and flathead catfish ≥35.0 in and channel catfish ≥28.0 in).

Due to the increased interest in catfish, the Kentucky Department of Fish and Wildlife Resources began looking at basic population parameters of the three major catfish species (blue, channel, and flathead) from the Ohio River beginning in 2004. The study was initiated to obtain baseline information on length frequency, weight, and age profiles of these three species and determine methods to most efficiently catch each of these species.

During spring 2012, trotlines (250 feet each with 50 hooks) baited with cut gizzard shad were used to sample blue, channel, and flathead catfish in Meldahl Pool, Cannelton Pool, and Pool 52 of the Ohio River. Seventy-six total trotlines were fished throughout those three pools: 29 in Meldahl Pool, 18 in Cannelton Pool, and 29 in Pool 52. Catch rates for blue catfish varied and increased the further downriver that sampling occurred. CPUE of blue catfish in Cannelton Pool (3.7 fish/line) and Pool 52 (3.9 fish/line) fell near the historical average trotline catch; however, CPUE in Meldahl Pool (1.4 fish/line) was well below that mark. Blue catfish lengths ranged from 10.1-44.1 in. with a mean length of 24.2 in. Channel catfish CPUE was above average in the Meldahl and Cannelton pools (2.2 fish/line and 2.3 fish/line, respectively), but was much lower in Pool 52 (0.4 fish/line). Lengths of channel catfish ranged from 13.0-30.1 in. with a mean length of 20.0 in. Only three flathead catfish (<.01 fish/line) were caught with lengths ranging from 18.4-30.0 in. Trophy catfish (blue and flathead catfish ≥35.0 in. and channel catfish ≥28.0 in.) accounted for 3.8% of the total catfish catch. Otoliths were taken from blue and channel catfish to assess mean lengths at age for each species. On average, it took blue and channel catfish at least 16 years to grow to trophy size (≥35 in and ≥28 in, respectively).

Trotlining for big blues on the Ohio River / Doug Henley

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Pan: Goal 2, Strategic Objective 3.

Ohio River Supplemental Stocking Survey-Markland Pool

Jason Herrala, David Baker, and Nick Keeton, Kentucky Department of Fish and Wildlife Resources

Supplemental stocking the Ohio / Doug Henley

Angler concerns over the decline in largemouth bass in the Ohio River became apparent to the Kentucky Department of Fish and Wildlife in 1997. Because of this concern, research was initiated to document the structure of largemouth bass populations throughout the Ohio River, verify if largemouth bass are declining in the river and if so, identify the causes for these declines. Recent research determined that largemouth bass year-class production in the Ohio River may be negatively impacted by an extended flood pulse and increased sedimentation. In turn, poor year-class production results in the largemouth bass fishery in the river being less than optimal. Supplemental stocking has been shown to benefit largemouth bass population levels in some large riverine systems, but could supplemental stocking of largemouth bass in the Ohio River be a viable technique used to increase year-class strength and ultimately improve the bass fishery in the river? As a pilot project, the Kentucky Department of Fish and Wildlife Resources began stocking largemouth bass fingerlings produced at Kentucky's fish hatcheries into embayments of the Markland Pool in June of 2007 and continued stocking through June of 2012.

For the duration of the initial stocking project, the goal stocking rate was 100 fish/acre in each of the selected embayments. Fingerlings were marked with oxytetracylcine (OTC) in transit to each embayment, so that we could determine the contribution of stocked fish from age-0 to adulthood, compare growth between stocked and wild fish, and determine the contribution of stocked fish to year-class strength. Preliminary results from this study showed that stocked fish composed 38% to 79% of the age-0 fish and that this contribution to year-class strength appears to be adding to the fishery. To further investigate the success of stocking the Ohio River embayments, in 2011 the stocking rates for study embayment were varied (0 fish/acre, 50 fish/acre, and 100 fish/acre). This should allow us to determine if a reduced stocking rate will result in similar contributions to year class strength and the fishery as well as the potential for movement out of stocked embayments. A total of 139,879 fingerling (mean length=1.5 in) were stocked into these 13 embayments.

Spring nocturnal electrofishing was used to sample black bass in 6 embayments. A total of 510 largemouth bass were collected during 5.7 hrs of nocturnal electrofishing of the Markland Pool in April 2012. Catch rates of largemouth bass ranged from 40.2 fish/hr to 149.0 fish/hr (mean CPUE=88.2). Mean largemouth bass CPUE was much higher than in previous years, 28.4 fish/hr in 2010 and 19.2 fish/hr in 2011.

A total of 673 largemouth bass were collected during 5.6 hrs of nocturnal electrofishing in 6 embayments of the Markland Pool in September 2012. CPUE of largemouth bass ranged from 66.7 fish/hr in Craigs Creek to 191.2 fish/hr in Gunpowder Creek (mean CPUE=116.4 fish/hr) and 0.0 fish/hr in Steeles Creek to 21.6 fish/hr in Craigs Creek for spotted bass (mean CPUE=7.8 fish/hr). Mean CPUE of largemouth bass followed the trend set by spring results, being the highest catch rate ever recorded for the Markland Pool and was nearly more than double any previous years. Stocked fish were collected in all embayments in fall 2012 except for Steeles Creek. Overall catch rates for age-0 largemouth bass increased in all embayments sampled. Those embayments with the 50 fish/acre stocking rate (Craigs, Big Bone) showed no true pattern; overall age-0 largemouth bass catch rates remained near 2011 levels in Craigs Creek, while Big Bone Creek increased from 26.5 fish/hr in 2011 to 66.0 fish/hr in 2012. Stocked fish comprised 38.1% of the age-0 largemouth bass sampled in the fall of 2012, which was nearly identical to 2011 (38.6%), despite the reduced number of overall largemouth bass stocked (reduction of around 20,000 fish) due to the changes in the study.

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Pan: Goal 2, Strategic Objective 3.

Ohio River Supplemental Stocking Survey-Meldahl Pool

Fishermen volunteered to help stock Meldahl Pool of the Ohio River / Doug Henley

Jason Herrala, David Baker, and Nick Keeton, Kentucky Department of Fish and Wildlife Resources

Meetings with Ohio River black bass fishermen in 1997 informed the Department that problems existed with black bass population structure in the Meldahl Pool. Efforts were initiated to sample various embayments and main river sites in this pool and determine the factors influencing these populations. The Department has sampled Meldahl Pool since 1997; however it began sampling using Ohio River Fish Management Team sampling protocol during the fall of 2001. This preliminary sampling confirmed anglers concerns and indicated that a relatively poor largemouth bass population existed in Meldahl Pool compared to other Ohio River Pools. Electrofishing surveys indicated that young-of-the-year production was low, potentially due to limited spawning habitat.

The Department implemented a spawning habitat manipulation study in 2003 through 2010 to determine if largemouth bass spawning could be enhanced through the introduction of supplemental spawning structures and cover. While, black bass were observed utilizing both structures, the effort needed to significantly influence black bass reproduction on a pool wide basis through these means appeared immense. Based on the bass stocking study conducted in Markland Pool, it seems that stocking may be a more viable option to increase year-class strength and ultimately enhance the largemouth bass fishery. A total of 33,447 largemouth fingerlings averaging 1.5 in were stocked in May 2012. Five embayments (Big Snag, Big Locust, Bracken, Lawrence, and Lee's Creek) were stocked at a rate of 100 fish per acre and Big Turtle Creek was stocked at a rate of 200 fish per acre.

Nocturnal electrofishing was conducted in each embayment in spring 2012 for a total of 33 transects (5.5 hr total sample time). Catch rates of black bass in 2012 were up from 2011 as a total of 133 largemouth bass and 44 spotted bass were collected. Mean CPUE of largemouth bass was 23.7 fish/hr and ranged from 0.0 fish/hr in Lees Creek to 42.2 fish/hr in Big Turtle Creek. Two stocked age-2 largemouth bass were captured; however, the oldest stocked fish in the Meldahl Pool were only age-1 (2011 year class) indicating that those 2 fish were stocked in 2010 in the Markland Pool and expanded upriver.

A total of 133 largemouth bass were observed in 5.5 hr of nocturnal electrofishing in fall 2012. Catch rates ranged from 43.1 fish/hr in Big Snag Creek to 84.3 fish/hr in Big Turtle Creek, while the mean CPUE across all embayments for largemouth bass was 66.4 fish/hr. Catch rates for stocked largemouth bass fingerlings in fall 2012 ranged between 14.6 fish/hr in the Bracken Creek (stocking rate 100 fish/acre) and 45.5 fish/hr in Lees Creek (stocking rate 100 fish/acre). Mean CPUE of stocked age-0 largemouth bass decreased slightly from 26.2 fish/hr in 2011 to 23.1 fish/hr in 2012. Of interest is Big Turtle Creek embayment. It was stocked with the highest rate (200 fish/acre), yet it had the lowest catch rate of stocked age-0 fish in 2011 and the second lowest in 2012. As was the case in 2011, all embayments in 2012 except for Bracken and Big Turtle Creek had a higher percentage of age-0 largemouth bass being stocked fish, with stocked fish composing 63.9% of all age-0 fish collected in the Meldahl Pool.

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Pan: Goal 2, Strategic Objective 3.

Indeed, Kentucky has some quality fishing opportunities / Cory Woosley

Warm Water Stream Sport Fish Surveys

David Baker, Jason Herrala and Nick Keeton, Kentucky Department of Fish and Wildlife Resources

There are countless miles of rivers and streams that flow throughout Kentucky making stream fishing accessible to all of Kentucky's anglers. Anglers have taken notice of the resource, and realize how valuable and productive stream fishing is throughout the state. With all this attention, the Kentucky Department of Fish and Wildlife Resources (KDFWR) has taken note that more information is needed to better inform the public of these opportunities while making sure that these resources are being managed in a way that not only protects these fisheries but maximizes the fisheries potential.

Beginning in 2012, a new push was made to conduct general sport fish surveys on our streams in an effort to obtain base line data such as relative abundance, size structure, growth rates and condition. Sites are currently being selected based on public access and recommendations from Fishery District Offices based on public input. Sampling will occur in the spring and fall when water temperatures range from 50-75°F. New sites will be added annually, with streams scheduled to be sampled on a 3-5 year rotation based on the amount of recreational pressure that the stream receives.

These surveys are intended to collect sport fish data on rivers and streams for the purpose of developing trend data that will help the KDFWR make informed management decisions, use this information to further promote stream fishing in Kentucky, inventory current access sites and identify new public access sites. During the 2012 sampling season, eight streams were sampled at 33 sites. Data collected revealed that, trophy smallmouth bass (≥20 in.) and muskellunge (≥40 in.) were collected on the Barren and Green Rivers. Green River recorded the best smallmouth bass catch rates at 39.8 f/h. The Green, Barren, Salt, South Fork Licking and Drakes Creek all received smallmouth bass assessment rating of "good" or "excellent" during 2012. The rock bass fishery in the Green River (77.2 f/h), Slate Creek (51.3 f/h) and Salt River (29.3 f/h) was impressive not only for quantity but quality. Trophy sauger (≥18 in) was collected in the Licking River while trophy walleye (≥25 in) was collected in the Green River.

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

Sauger Stocking Evaluation in the Kentucky, Green, Barren, and Salt Rivers

David Baker, Jason Herrala and Nick Keeton, Kentucky Department of Fish and Wildlife Resources

In Kentucky, sauger (*Sander canadensis*), are found in the Ohio and Mississippi Rivers and their major tributaries. Sauger are a native top-level predator that inhabit main channel areas of large turbid rivers. During the spring, sauger tend to congregate below dams and near the mouth of creeks to spawn, creating an important seasonal fishery in many of Kentucky's rivers.

Sauger populations fluctuate naturally due to biotic and abiotic factors that affect spawning success and recruitment, causing year-class strength to be highly variable. Long-term declines in sauger populations are largely associated with the loss of suitable spawning habitat due to channel alterations and barriers that impact seasonal migrations. Research shows that supplemental stocking can enhance these populations.

In an effort to enhance the sauger fishery in the Kentucky River, the Kentucky Department of Fish and Wildlife Resources implemented a sauger stocking program from 2006-2010 in the Kentucky River after a 2002-2003 study indicated that walleye stockings were not successful at producing a self sustaining fishery. The determination was made that the water conditions in the Kentucky River were more suitable for sauger. Sauger stocking in the Kentucky River have been successful in establishing a put-grow-take type fishery; however, very little natural reproduction has been detected. The lack of recruitment could be due to many factors, including the lack of suitable spawning habitat.

Similar stockings are being evaluated in the Green, Barren and Salt rivers. Fingerling sauger averaging 1.5 inches in length will be stocked in the Green, Barren, and Salt river systems from 2012-2016 at an annual rate of 10 fish/acre. Sauger populations in these three river systems will be monitored through at least the spring of 2020 to determine if a self sustaining fishery will develop. All stocked fish will be marked with oxytetracycline to determine the contribution of the stocked hatchery fish to each year class. Stockings will be conducted in each river system as late in the spring as possible to reduce the potential negative impacts that certain abiotic variables, such as high spring flows, might have on the survival of the stocked fish. The goals of this project are to determine if stocking in these systems will create a self-sustaining sauger recreational fishery, and to look at the utility of providing a put-grow-take type fishery.

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

Kentucky River sauger / Nick Keeton

Juvenile lake sturgeon being stocked into the Cumberland River / Matt Thomas

Lake Sturgeon Telemetry in the Cumberland River

Jason Herrala, David Baker, Nick Keeton, Steve Marple, and Nick Skudlarek, Kentucky Department of Fish and Wildlife Resources

Lake sturgeon were once native to the Mississippi, Ohio, and Cumberland Rivers in Kentucky, but since the 1950's lake sturgeon have been extirpated from the Cumberland River due to destruction of habitat and loss of range due to barriers. Because of this, the Kentucky Department of Fish and Wildlife Resources (KDFWR) has committed to a twenty year stocking program to restore lake sturgeon populations in the Cumberland River Basin. One major component to the success of reintroduction programs is to assess the survival, movements, and habitat use of stocked sturgeon and document their transition into the natural environment. A telemetry project can provide insight into survival, movements, and habitat preferences of stocked lake sturgeon, leading to initial measures to quantify the success of the hatchery stocking program.

In April 2012, 30 lake sturgeon were surgically implanted with ultrasonic transmitters at the Pfeiffer Fish Hatchery. These 3.0 to 6.5 lb sturgeon were held at the hatchery for two weeks to allow surgery wounds to heel and recover. Twelve stationary receivers were deployed at sites upstream and downstream of the two stocking sites in the Big South Fork and Cumberland River to determine movement out of the stocking areas. Fifteen of the implanted lake sturgeon were stocked at the mouth of the Laurel River, and 15 were stocked at the Turkey Run Ramp on the Big South Fork. All fish have been accounted for throughout the study and all stationary receivers have detected fish. Some of the lake sturgeon have been detected moving over 35 miles, while others appear to be staying in the areas where they were stocked. The fish that displayed movement traveled downstream into Lake Cumberland during the summer and early fall, and current tracking data and stationary receiver logs indicate that the majority of fish are still in Lake Cumberland below the KY Route 90 Bridge. Four months of manual tracking has yielded three detections, all of which were recorded near the edges of the study site. Although not enough manual detections exist to quantify habitat use, all three detections occurred in inside bend habitats which provide sandy substrate and low velocity habitats often preferred by lake sturgeon.

Manual tracking will continue through November 2013, and VR2s will be downloaded monthly until the conclusion of the study in 2015. Trotlining efforts will begin in spring 2014 to gather CPUE, survival, and age/growth data and assess the success of the Department's stocking efforts. If reintroduction efforts are proved to be successful and a self-sustaining population is established, we can begin to manage for a unique sport fishing opportunity.

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson)*

KDFWR Strategic Pan: Goal 2, Strategic Objective 3.

Lake Sturgeon / Rick Hill

Lake Sturgeon Restoration in the Upper Cumberland River Drainage in Kentucky

Matthew Thomas, Steven Marple, and Stephanie Brandt, Kentucky Department of Fish and Wildlife Resources

The Lake Sturgeon is considered critically imperiled in Kentucky, where it is currently limited to the Ohio and Mississippi Rivers. In 2007, the Kentucky Department of Fish and Wildlife Resources (KDFWR) initiated a long-term (20+ years) project to restore a self-sustaining population of Lake Sturgeon to the upper Cumberland River drainage, where the species occurred historically. The project area extends from Wolf Creek Dam, upstream to Cumberland Falls, including major tributaries such as Rockcastle River and Big South Fork.

Since 2007, fertilized eggs have been obtained annually from the Wisconsin Department of Natural Resources taken from upper Mississippi basin stock (Wisconsin River). These eggs are hatched and reared at the Pfeiffer Fish Hatchery in Frankfort, Kentucky. Since spring 2008, young Lake Sturgeon have been released annually at two locations in the upper Cumberland River drainage. The Cumberland River at the mouth of Laurel River received 959 fish (average 7.4-8.5 inches) in 2008; 2,004 fish (average 7.5 inches) in 2009; 4,539 fish in 2010 (average 5.5-7.8 inches); and 2,150 fish (average 8.2-8.9 inches) in 2011. The Big South Fork Cumberland River at the Alum Creek access area received 716 fish (average 7.4 inches) in 2008; 1,973 fish (average 7.5 inches) in 2009; and 4,063 fish (average 5.5-7.8 inches) in 2010. No Lake Sturgeon were stocked at either location during 2012. Total Lake Sturgeon stocked into the Cumberland River above Lake Cumberland is 16,404 fish. Young Lake Sturgeon were differentially marked by sequentially removing two adjacent scutes in the lateral series to distinguish year classes: right anterior scutes 2-3 for 2007, left anterior scutes 2-3 for 2008, right anterior scutes 3-4 for 2009, left anterior scutes 3-4 for 2010, and right anterior scutes 5-6 for 2011.

Twenty reports of Lake Sturgeon captured by anglers were received in 2009-2012. A variety of sampling techniques are being evaluated to determine survival, habitat use, and movement patterns of stocked fish. A telemetry project will occur from 2012-2015 within the restoration area. KDFWR biologists implanted transmitters in 30 Lake Sturgeon to monitor habitat use and movement patterns. Twelve stationary receivers were placed within the restoration area to track large range movement patterns.

The Cumberland River above Lake Cumberland / Stephanie Brandt

Funding Source: *State Wildlife Grant Program (SWG)*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2; Class Actinopterygii and Cephalaspidomorphi: Priority Research Project #1.

Juvenile alligator gar ready to be stocked / Michael Flinn

Alligator Gar Propagation and Restoration in Western Kentucky

Steve Marple, Matt Thomas, and Stephanie Brandt, Kentucky Department of Fish and Wildlife Resources

The alligator gar (*Atractosteus spathula*) is the largest of the living gars and one of the largest freshwater fishes in North America. These fish are capable of reaching lengths of over 9 feet and weights of over 300 lbs. The largest reported size of an alligator gar is 9 feet, 8 inches. This specimen weighed approximately 302 lbs. Its native range once occurred from the Florida panhandle west into the Gulf Coastal Plain to Veracruz, Mexico and throughout the Mississippi River Basin, including the lowermost Cumberland and Tennessee Rivers. In Kentucky, the alligator gar is native to the Ohio, Mississippi, and lower Cumberland and Tennessee River systems.

Little is known about the biology and habitat of this species in Kentucky and throughout the majority of its native range. In its southern range, the alligator gar typically inhabits big rivers, swamps, bayous, and brackish waters. The alligator gar is the most salt tolerant of all the gar species. In Kentucky, the alligator gar occupied sluggish pools, backwaters, and embayments of big rivers and larger reservoirs in western Kentucky. Female alligator gar tend to grow larger than males and reach sexual maturity at 11 years and live in excess of 50 years. Males reach sexual maturity at 6 years and live up to 26 years.

Alligator Gar records have been confirmed from five locations in Kentucky: 1) Cumberland River, 3 miles below Dycusburg, Crittenden County (1925); 2) Ohio River at Shawnee Steam Plant, McCracken County (1975); 3) mouth of the Ohio River, Ballard/Carlisle County (1966); 4) mouth of Bayou du Chein, Fulton County (1974); and 5) Kentucky Lake at Cypress Creek embayment, Henry County, TN (1976). Alligator Gar have not been reported in Kentucky since 1977, despite numerous surveys. Currently, the Alligator Gar is listed as endangered by the Kentucky State Nature Preserves Commission and is listed as a Species of Greatest Conservation Need by the Kentucky Department of Fish and Wildlife Resources Wildlife Action Plan.

The last alligator gar to be verified in Kentucky was in 1977 when a dead specimen was found floating in Kentucky Lake near the Cypress Creek embayment. In an effort to restore this species back to the waters of the Commonwealth, the Kentucky Department of Fish and Wildlife Resources (KDFWR) implemented a captive propagation and stocking program in 2009. In partnership with the United States Fish and Wildlife Service (USFWS), the KDFWR has committed to a long-term restoration effort of this species. Annually, the KDFWR will receive alligator gar fry from the Private John Allen National USFWS Fish Hatchery. These fry will be reared at both the Pfeiffer Fish Hatchery and Minor Clark Fish Hatchery prior to being released into the wild. Alligator gar stocking sites will be those areas that have historically contained alligator gar and which still provide suitable habitat for optimal survival of alligator gar.

From 2009-2012, a total of 19,520 alligator gar were stocked by the KDFWR. Size at stocking ranged from 7.3 to 14.5 inches. Alligator gar were stocked in the following areas: (1) Clarks River; (2) Phelps Creek; (3) Bayou Creek; (4) Tradewater River; (5) Deer Creek; (6) Obion Creek; (7) Massac Creek; (8) Bayou de Chein; (9) Mayfield Creek; (10)Ballard WMA; (11) Barlow Bottoms WMA; and (12) Doug Travis WMA.

Funding Source: *State Wildlife Grant Program (SWG)*

KDFWR Strategic Plan. Goal 1, Objective 5. Comprehensive Wildlife conservation Strategy: Appendix 3.2; Class Actinopterygii and Cephalaspidomorphi: Priority Research Project #8.

Alligator Gar Telemetry Project

Jared Militello and Dr. Michael Flinn, Murray State University

KDFWR Contacts: *Matthew Thomas and Stephanie Brandt*

Chart 1. *Home Range Estimates (Note some gar were left out because they did not meet the minimum number of relocations for the home range calculations)*

Transmitter #	Number of relocations	Linear Home Range (km)
39863	15	5.11
39865	14	15.43
39868	9	6.26
39869	8	0.91
39870	25	14.43
39871	18	15.15
39872	22	16.72
39873	9	1.27
39874	16	14.31
39876	23	15.8
39877	21	12.33
39878	13	6.58
39879	20	14.95
39880	20	9.03
39881	22	10.95
Mean	**14.15**	**10.62**

As part of a restoration initiative by the Kentucky Department of Fish and Wildlife Resources (KDFWR), 20 age-0 juvenile alligator gar (~ 60 cm) were released into the Clarks River of northwestern Kentucky in October 2010. Each fish was surgically implanted with both Vemco V13 acoustic transmitters and 2.2 mm microwire tags for tracking and identification purposes. The focal objective associated with reintroducing this extirpated species is to determine seasonal and spatial movement patterns and distribution. In order to obtain migration information, mobile tracking via watercraft was implemented, which allowed for real-time relocations of individual fish on a weekly basis. This biweekly tracking was conducted for approximately one full year, commencing immediately upon release of the gar in October 2010 and lasting until late September 2011. At the end of this time period contact with 12 alligator gar was still being maintained on a regular basis within the mainstem of the Clarks River. Home range calculations (Chart 1, n = 15) show a high degree of variability among individual fish (0.91 km – 16.72 km), but, as a group overall, the mean home range for these tagged fish is relatively large (10.62 km). A distinct seasonal distribution pattern was exhibited by the juvenile gar, with fish overwintering in deep bend pools, spending a majority of the spring on the floodplain or in flooded back waters, and moving up tributaries or responding heavily to fluctuations in water levels during the summer and fall. Initial stomach content samples (n = 8) have been dominated by small forage fish. Further analysis will be performed to determine actual prey species, frequency of occurrence and entire weights of stomach samples. Furthermore, stationary receivers were also deployed in the Clarks River, Tennessee River and Ohio River to supplement mobile tracking. Uploaded detections on both the Tennessee and Ohio Rivers have shown that select individuals have utilized these larger bodies of water at some point, but then returned to the Clarks River at a later date.

Field sampling is currently being conducted to continue to identify gar diet preferences using experimental gill nets and gastric lavage, along with distinguishing habitat types present in different reaches of the Clarks River by performing transect surveys. Additional hydrology related data is also being collected through the use of YSI multi-probes and HOBO water loggers. Final results will provide the KDFWR with vital information on juvenile alligator gar movement trends, habitat suitability and diet selectivity.

Funding Source: *State Wildlife Grant Program (SWG), Murray State University*

KDFWR Strategic Plan. Goal 1, Objective 5. Comprehensive Wildlife conservation Strategy: Appendix 3.2; Class Actinopterygii and Cephalaspidomorphi: Priority Research Project #8

Propagation and Reintroduction of the Cumberland Darter (*Etheostoma susanae*) in the Upper Cumberland River Drainage.

Matthew Thomas and Stephanie Brandt, Kentucky Department of Fish and Wildlife Resources; Crystal Ruble, Patrick Rakes, Melissa Petty, and J. R. Shute, Conservation Fisheries, Inc.

The Cumberland Darter, *Etheostoma susanae*, has a limited range in the upper Cumberland River drainage, most of which is in Kentucky. The U.S. Fish and Wildlife Service recently published a final rule (September 8, 2011; Federal Register / Vol. 76, No. 153) designating the Cumberland Darter as endangered because of recent range curtailment and fragmentation resulting from habitat degradation. In 2008, the Kentucky Department of Fish and Wildlife Resources (KDFWR) partnered with Conservation Fisheries, Inc. (CFI) to develop successful spawning protocols for the Cumberland Darter and produce offspring needed to re-establish extirpated populations within its historic range. Cogur Fork (Indian Creek-upper Cumberland River drainage) in McCreary County was chosen as the reintroduction stream because: 1) it is within the historic range of the species; 2) habitat conditions are suitable; and 3) there is some level of protection (i.e., within the Daniel Boone National Forest).

A total of 25 Cumberland Darters were collected on 18 January from Barren Fork, McCreary County, Kentucky. Eight individuals were large adults and the rest were small (<40 mm TL) presumed young-of-the-year. A portion of these adults were utilized as broodstock in the 2012 propagation effort along with the remaining (N=28) collected in 2010—2011 production efforts.

Following observations of darkly pigmented males (heads and fins) defending cavities under slabs, weekly checks for eggs were initiated on 22 March, at which time the first nest was collected. By 9 April all eggs from the first clutch had hatched and water temperatures were ~17°C. The last nest (~ 40 nests total) was collected on 11 May, at which point temperatures were ~19°C. From 3,940 eggs produced by the Cumberland Darters, 2311 larvae hatched (~59%). Approximately 1,827 larvae were reared successfully to juveniles yielding ~79% overall larval survivorship.

On 14 June and 28 August, a portion (1,127) of the juvenile propagated Cumberland Darters were released into two nearly adjacent reaches in lower Cogur Fork, McCreary Co., Kentucky. A week or so prior to release all fish were marked on either the right or the left dorsum beside the first dorsal fin with a green visible implant elastomer (VIE) tag. Since 2009, a total of 2,549 captive-spawned Cumberland Darters have been marked and released into Cogur Fork. Following each release, mark-recapture sampling was conducted to assess survivability and initial movements. These surveys were conducted in Cogur Fork using backpack electrofishing within the release section, as well as arbitrarily chosen distances upstream and downstream of that section. All fishes captured were identified, enumerated, and released on site. So far, monitoring efforts have resulted in recapture of up to 15% of tagged fish and have confirmed the survival of propagated individuals released into Cogur Fork for periods exceeding one year. Although evidence of natural reproduction has not yet been detected, other non-game fish restoration attempts have shown that it can take up to 10-15 years to document success, particularly for smaller, short-lived species.

Funding Source: *State Wildlife Grant Program (SWG), Conservation Fisheries Inc.*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.9; Class Actinopterygii and Cephalaspidomorphi: Taxa specific research project #1.

Cumberland darter / Conservation Fisheries, Inc.

Propagation and Reintroduction of the Kentucky Arrow Darter (*Etheostoma sagitta spilotum*) in the Upper Kentucky River Drainage

Matthew Thomas and Stephanie Brandt, Kentucky Department of Fish and Wildlife Resources; Crystal Ruble, Patrick Rakes, Melissa Petty, and J. R. Shute, Conservation Fisheries, Inc.

Long Fork in Clay County / Stephanie Brandt

The Kentucky Arrow Darter, *Etheostoma spilotum*, has a limited distribution in the upper Kentucky River drainage, where it inhabits headwater (mostly first- and second-order) streams. The Kentucky Department of Fish and Wildlife Resources (KDFWR) indentified the Kentucky Arrow Darter as a Species of Greatest Conservation Need in its State Wildlife Action Plan to address research and survey needs for the species. Based upon the species apparent, recent decline, the U.S. Fish and Wildlife Service determined that the Kentucky Arrow Darter warrants listing under the Endangered Species Act. It is currently a Candidate for Federal Listing based on its inclusion in the USFWS Candidate Notice of Review published in the Federal Register on November 10, 2010.

In 2008, the KDFWR partnered with Conservation Fisheries, Inc. (CFI) to develop successful spawning protocols and produce offspring needed to re-establish extirpated populations within the Kentucky Arrow Darter's historic range. Long Fork (Red Bird River drainage) in Clay County was chosen as the reintroduction stream because: 1) it is within the historic range of the species; 2) habitat conditions are suitable; and 3) there is some level of protection (i.e., within the Daniel Boone National Forest).

Three male and 8 adult female Kentucky Arrow Darters were collected on 8 March 2012 from Big Double Creek, Clay County, Kentucky near where the currently held brood stock were collected from 2008—2011. The 2012 collections brought the total number of broodstock females and males used in this year's effort to 21 and 5, respectively.

Breeding groups were first introduced on 8 March. On 10 March spawning was observed with water temperatures ranging from 8-11°C. Spawning activity by the various breeding groups continued through the end of April. Manual egg collections and total passive collection of Kentucky Arrow Darter larvae were the highest to date. From the 163 eggs that hatched and 1,102 larvae captured, 835 survived to the early juvenile stage (~66% survivorship).

A total of 829 VIE-tagged young-of-year fish were released into Long Fork in August and October, 2012. On January 29, 2013 surveys were conducted using a seine, visual observation, and dip nets by KDFWR and CFI. We captured 47 (5.7%) of the tagged fish; most were found in pools (about 8" to 24" deep) with mixed-sized rock substrate with exposed areas of bedrock and often with some marginal cover (e.g., undercut or tree roots). These individuals appeared to be in very good condition and some growth was evident. We observed an abundance of aquatic insect larvae actively swimming over the substrate, suggesting that food resources are plentiful in the stream. Captive propagation and field monitoring will continue in 2013.

Funding Source: *State Wildlife Grant Program (SWG), Conservation Fisheries Inc (CFI)*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2; Class Actinopterygii and Cephalaspidomorphi: Taxa specific research project #8.

Distribution, Habitat, and Conservation Status of Rare Fishes in Kentucky

From top to bottom, left to right: Mountain Brook Lamprey, undescribed barcheek darter, Spring Cavefish, Flame Chub / Matt Thomas

Matthew Thomas and Stephanie Brandt, Kentucky Department of Fish and Wildlife Resources

Species of Greatest Conservation Need (SGCN) are recognized in the Kentucky Wildlife Action Plan (Kentucky Department of Fish and Wildlife Resources, 2013), based on levels of endemism, lack of knowledge of current population status, distribution, and life history characteristics, and potential importance as hosts to rare mussel species. Many fish species on this list are also included on the current List of Rare and Extirpated Biota of Kentucky (Kentucky State Nature Preserves Commission, 2011), as well as six species listed by the U.S. Fish and Wildlife Service as threatened or endangered. In 2010, the Kentucky Wildlife Action Plan was revised for the first time since its inception in 2005. Of the state's 244 native fish species, the Plan identifies 68 as in need of conservation action.

The Cumberland River drainage supports one of the most diverse and unique assemblage of fishes in Kentucky, including 28 (41%) of 68 fish SGCN. In 2010, we initiated a basin-wide assessment of the fish fauna of Buck Creek, a tributary of the upper Cumberland River drainage in Lincoln, Pulaski, and Rockcastle counties. A comprehensive survey of the fishes of Buck Creek had not been accomplished in over 25 years. Our objectives were to assess long-term changes in fish community structure and evaluate the status of SGCN. Fish community sampling in Buck Creek was completed in 2012. A total of 68 species representing 16 families was collected from 47 sites distributed throughout the drainage. Overall faunal composition has changed slightly during the past 25 years, although shifts in relative abundances in several species and the longitudinal distribution of species have also occurred. Twelve species reported previously were not detected in our study; however, we documented new drainage records for seven species, including three fish Species of Greatest Conservation Need (SGCN). This discrepancy likely resulted in large part from differences in sampling gear used between the present and past surveys, but may also reflect changes in habitat and environmental fluctuations.

The Buck Creek drainage supports seven fish SGCN. Among these, the Bloodfin Darter (*Etheostoma sanguifluum*) has the strongest population with the most occurrences and highest abundance levels; it was one of the most abundant species in the middle and lower sections of the mainstem and was also present in lower Brushy Creek. Mountain Brook Lamprey (*Ichthyomyzon greeleyi*), Lake Sturgeon (*Acipenser fulvescens*), and Southern Cavefish (undescribed form of *Typhlichthys subterraneus*) are documented here for the first time in the Buck Creek drainage. These

Red River, Logan County / Matt Thomas

Buck Creek, Pulaski County / Matt Thomas

species appear to be rare and limited to specific habitat types in the lower portion of the drainage. The Popeye Shiner (*Notropis ariommus*), Redlips Darter (*Etheostoma maydeni*), and Striped Darter (undescribed form of *Etheostoma virgatum*) were documented previously and continue to persist, but are rare (i.e., fewer than 20 total individuals at 1-3 sites) within the drainage. The Striped Darter is of particular concern because it was detected at less than 10% of sites having historic presence and now appears to be restricted to Flat Lick Creek. Changes in fish species composition and community structure documented in Buck Creek demonstrate the need for periodic surveys to monitor the distribution and population status of rare species. We recommend periodic (every 5-10 years) fish sampling in Buck Creek at fixed locations having baseline data to assess changes to the fish community.

The Red River, a tributary of the lower Cumberland River located in south-central Kentucky and north-central Tennessee is known to contain at least seven fish SGCN, but available fish collection records are sparse and unevenly distributed relative to other river basins (e.g., Green River). In 2010, we initiated an assessment of the fish fauna of the Kentucky portion of the Red River to obtain more complete and up-to-date information on the distributions and population status of rare or imperiled fishes. As of 14 September 2012, fish community data were obtained from a total of 41 sites, including 12 with baseline data for comparison. A total of 55 species have been recorded to date, including five of eight fish SGCN known from the drainage. A new drainage record was obtained for the Flame Chub (*Hemtremia flammea*), a species that had not been seen in Kentucky for more than 120 years and was presumed extirpated from the state. This small, colorful minnow appears to be restricted to Spring Creek, a small spring-fed stream in Simpson County. Historic occurrences for Spring Cavefish (*Forbesichthys agassizii*) were substantiated and new occurrences in three streams were documented. The Stone Darter (*Etheostoma derivativum*) was documented at five sites in Whippoorwill Creek, where suitable habitat conditions remained intact; one of these sites represents a downstream expansion of its known distribution within this system. Sampling in 2012 detected the Blotched Chub (*Erimystax insignis*) at two sites in the South Fork Red River, one of which represents an upstream expansion of the known distribution of this species in the drainage. The Smallscale Darter (*Etheostoma microlepidum*) persists in the mainstem Red River in Logan County and a new drainage record for this species was documented in the South Fork Red River. In 2013 we will complete fish community sampling needed to complete the basin-wide ichthyofaunal assessment for the Red River drainage in Kentucky.

Funding Source: *State Wildlife Grant Program (SWG)*

KDFWR Strategic Plan. Goal 1, Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.9, Class Actinopterygii and Cephalaspidomorphi. Priority monitoring needs by taxonomic class (p.1). Establish protocols, schedules, and sites for long-term population monitoring to assess status and trends for priority species.

Resource Selection, Movement Patterns, Survival, and Cause-Specific Mortality of Adult Bull Elk in Kentucky

John Hast and John J. Cox, University of Kentucky; Kristina Brunjes, R. Daniel Crank, Will Bowling, and Gabriel Jenkins, Kentucky Department of Fish and Wildlife Resources

Over the past two years we have successfully captured and radio-collared 168 adult bull elk in south-eastern Kentucky to estimate survival, determine cause-specific mortality, and to characterize resource selection and movement patterns of this important age-gender class. Herein we describe preliminary findings on survival and cause-specific mortality. Cementum annuli analysis from captured bulls has allowed us to determine age-specific mortality rates where sufficient sample size is available.

All 67 bulls captured in 2011, would have been at least 4.5 years old in fall 2012. Additionally, 31 of 62 bulls darted in 2012 would also fall in the ≥ 4.5 age class. Anecdotal evidence suggests that the 4.5-5.5 age class represent an approximately 280 inch bull that is selected for harvest by the majority of both archery and gun season hunters. When examining Figure 1, it can be seen that hunter harvest comprised 74% of mortality events occurring over the course of this study. Additionally, we have detected a 7% wounding loss rate overall with a 9% wounding loss rate during the fall 2012 hunting season.

In the fall of 2012, we saw a 68% increase in both the number of hunter harvested mortality events as well as other causes of mortality not observed in 2011; hunter harvest mortality events rose from 11 in 2011 to 43 in 2012. Bull mortality for 2011 and 2012 totaled 18 and 55, respectively (73 to date). The detection of more varied forms of mortality can be largely attributed to the increased number of collars in the Hazard study area. In 2011, there were 47 collared animals in the Hazard study area, while prior to the fall hunting season in 2012 that number was increased to 89. Using the Lincoln-Petersen estimator from an August mark-resight exercise, we conclude that approximately 42% of the bulls in the area are wearing our tracking collars. Thus, a larger number of collars in the study area has likely allowed for a more representative sample and estimate of bull mortality.

In summary, hunting appears to be the greatest source of mortality for bull elk in Kentucky, thus careful management of hunter numbers remains critical to maintaining bull elk harvest numbers and quality, overall hunter experience, and breeding individuals within the population. Other sources of mortality we have observed, such as meningeal worm and wounding loss, appear to be important and should be accounted for in population models. Additionally, wounding loss numbers were surprising, and reduction would be largely dependent on hunter education and willingness to avoid poor shot selection. Because hunters are by far the largest contributor to bull elk mortality, this dictates an adaptive management strategy that must account for hunter numbers and appropriate harvest zone delineation to meet population management and hunting experience goals.

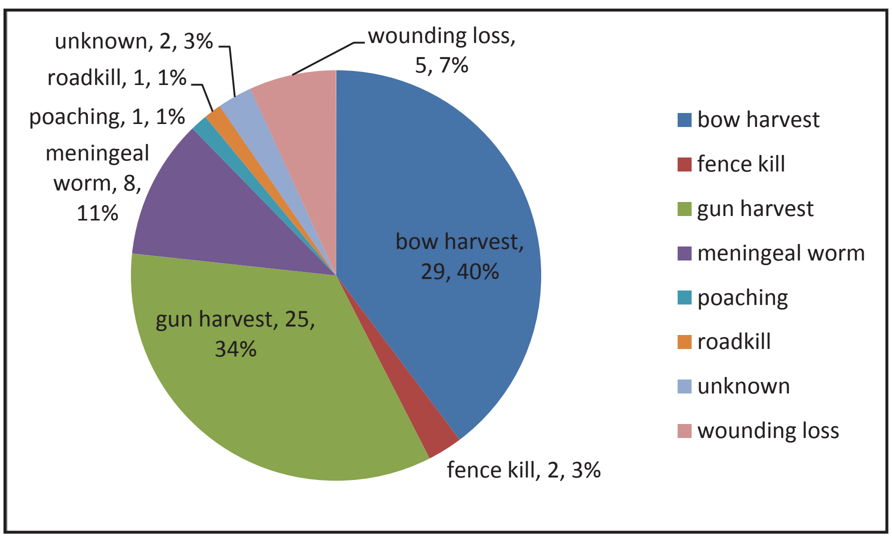


Figure 1: *Cause specific mortality events for adult bull elk in Kentucky from January 1, 2011 to the present. N=73.*

Funding Source: *Wildlife Restoration Act (Pittman- Robertson)*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5.

Can Body Condition and Select Physiological Indicators Predict Survival of Elk Post-Translocation?

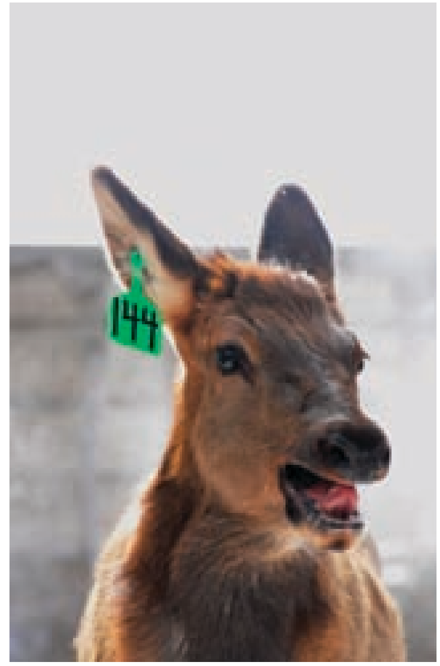
Aaron M. Hildreth, John T. Hast, Alejandra Betancourt, and John J. Cox, , University of Kentucky; Kristina Brunjes, Gabriel Jenkins, Will Bowling, and Dan Crank, Kentucky Department of Fish and Wildlife Resources

States began reintroducing elk (*Cervus elaphus*) only a few decades after extirpation from the eastern United States in the mid-1800s. The majority of these reintroduction attempts failed, although the causes were often unknown or misunderstood. It is well-established that elk and many other ungulates are susceptible to stress and physical injuries that can lead to death during capture, processing, captivity, translocation, and shortly after release. Despite these problems, little is known about what factors determine the relative susceptibility of individuals to injurious or lethal conditions from capture through final release.

With a reintroduced elk population > 10,000 individuals, the Kentucky Department of Fish and Wildlife Resources (KDFWR) is now able to serve as a source state to other states desiring elk. In 2011, Missouri became the first recipient of translocated Kentucky elk followed by Virginia in 2012, with the goal of moving up to 50 per year over the next several years. We took advantage of this opportunity to work with captive elk to characterize and monitor body condition and select physiological parameters during a 90-day holding period, and to model whether one or more of these factors are predictors of elk survival post-translocation (all elk are fitted with GPS collars and will be monitored by the University of Missouri and Virginia Department of Game and Inland Fisheries upon release). A successful predictive survival model could inform wildlife managers as to characteristics of individual elk most likely to survive future capture and translocation efforts.

In 2012, KDFWR captured a total of 58 elk (37 cows, 13 calves, 8 spike bulls) with either corral traps (n = 46) or chemical immobilization (n =12) and held them in quarantine for a period of 90 days before translocation to Missouri and Virginia. The elk were tested twice for tuberculosis (TB) during the holding period. We weighed, drew blood, collected ticks, and a fecal sample for each individual elk on all 5 handling days. In addition to the fecal samples collected during each workup, we collected fecal samples from each pen throughout the quarantine period. We also measured rump fat and loin thickness with the aid of an ultrasound during each workup.

Fecal samples were analyzed for parasite load by performing a fecal float and assayed to determine fecal glucocorticoid levels. Fecal glucocorticoid levels will help us understand how elk respond to quarantine and handling stressors. We performed a total panel blood test on each blood sample to look for indicators of capture-related stress. Ultrasound measurements of rump fat thickness were used to determine the overall body condition of each elk and how it changed throughout quarantine. Loin thickness measurements will be compared from the first workup to the third to look for signs of protein catabolism. Morphometric and physiological data collected will be used to construct a model to determine factors predictive of elk survival post-translocation.



Cow Elk / Aaron Hildreth

In May 2012, 35 elk were translocated to Missouri, 15 to Virginia, and 1 bull was relocated within Kentucky. A total of 7 elk died or were euthanized while in quarantine in Kentucky. Upon release in Missouri, 9 elk died as a result of factors associated with translocation. In January 2013, KDFWR captured 51 additional elk (23 cows, 28 calves). As a result of knowledge gained in 2012, changes to the holding facility, workup procedures, and dietary regimen have been implemented for 2013. Analysis of 2012 and 2013 data has begun and will be completed by August 2013.

Funding Sources: *Rocky Mountain Elk Foundation, University of Kentucky, and Wildlife Restoration (Pittman-Robertson)*

KDFWR Strategic Plan. Strategic Goal 1. Strategic Objective 5.

Population Ecology and Habitat use of Northern Bobwhite on a Reclaimed Surface Coal Mine in Kentucky

David Peters, Jarred Brooke, Craig Harper and Patrick Keyser, University of Tennessee; John Morgan and Eric Williams, Kentucky Department of Fish and Wildlife Resources

Northern bobwhite (*Colinus virginianus*) populations are rapidly declining because of range-wide loss of habitat. The decline has been attributed to deterioration of early successional habitat as a result of clean farming practices, lack of disturbance, and habitat fragmentation. An opportunity to create large areas of contiguous habitat is through management of reclaimed surface mines. There are 1.5 million acres of reclaimed surface mines in the eastern US, and more than 600,000 acres within Kentucky. Unfortunately, many of these reclaimed areas have been planted to invasive, non-native species, such as sericea lespedeza (*Lespedeza cuneata*) and tall fescue (*Schedonorus phoenix*), which may not provide suitable nesting or brooding cover for northern bobwhites.

The Kentucky Department of Fish and Wildlife Resources (KDFWR) began implementing broad-scale habitat management on Peabody WMA in western KY in 2009 to improve habitat for northern bobwhite. We are monitoring movements, habitat selection, reproduction, and survival of northern bobwhite via radio telemetry to quantify the effects of this management. We are using an experimental design that incorporates treated and untreated areas on the 8,200-acre study site.

Since August 2009, we have trapped and collared 1,207 birds, with a 2.65% trapping success rate, which is comparable with other studies performed throughout the Southeast. Overall, crude mortality rate has averaged 67.5%. Using covey-call surveys, we estimated fall populations of quail on Peabody of 2,481 (2009), 3,889 (2010), 3,838 (2011), and 4,156 birds (2012). We have found 89 bobwhite nests in the 3 breeding seasons since the project began. The nest success (hatched ≥ 1 egg) rates for these 3 years were 50% (n = 32), 46% (n = 24), and 61% (n = 33), respectively. During winter (October-March), birds used annual food plots, native warm-season grass, and shrubland vegetation more than expected. During summer (April-September), birds have used native warm-season grass and open herbaceous (dominated by forbs and *Lespedeza cuneata*) vegetation more than expected and frequently used disked areas as well. We suspect habitat selection is influenced by structural components of the vegetation. In the summer of 2012, we sampled micro-site vegetation characteristics at 248 bird locations and 248 random locations to identify structural components influencing selection.

We will continue to monitor bobwhite response at Peabody as KDFWR continues to manipulate habitat. Our research should document the influence of these habitat management practices on northern bobwhite and provide wildlife managers information needed for sound decision making when managing reclaimed mined lands for northern bobwhite.


Small game biologists at Peabody WMA / Fred Adkins

Funding Source: *Wildlife Restoration Act (Pittman-Robertson) and the University of Tennessee*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2. Class Aves. Priority Research Project #2 and #3.

Cubs keep warm while their mothered is being processed / Aaron Hildreth

Population Ecology of Black Bears in Southeastern Kentucky

Sean Murphy and John J. Cox, University of Kentucky; Jayson Plaxico and Steven Dobey, Kentucky Department of Fish and Wildlife Resources

The black bear (*Ursus americanus*) historically inhabited all of Kentucky, but was extirpated from the state by the early 1900s as a result of overexploitation, habitat loss, and habitat fragmentation. Beginning during the mid-1980s, however, the black bear naturally recolonized a portion of extreme southeastern Kentucky in counties bordering Virginia, West Virginia, and Tennessee.

During the past 30 years, increased nuisance complaints and roadkills in southeastern Kentucky counties (KDFWR, unpublished data), coupled with live-trapping data and den site visits (University of Kentucky, unpublished data) suggest that population growth and expansion is continuing. Cumulatively, these data prompted the Kentucky Department of Fish and Wildlife Resources (KDFWR) to implement the first annual legal black bear hunt in Kentucky in over a century during winter 2009, yet the quota (10 bears/year) was only met during the 2012 season, suggesting the bear population may still be relatively small, has experienced little reproductive range expansion beyond the core counties, and is likely not connected to a separate subpopulation in Big South Fork National River and Recreation Area in south-central Kentucky that resulted from a late 1990's reintroduction effort (Hast 2010, Murphy 2011).

Although the legal harvest has remained a short season with a small quota, recent changes to the bear harvest, including a longer duration season and implementation of a hound chase season, have been implemented. Because black bears are one of the slowest reproducing mammals, and the current population size is estimated < 500 individuals, overharvest of black bears can be considered one of the primary threats to maintaining a viable population in Kentucky. It is therefore important that empirical population data be obtained to inform harvest regulations so as to ensure persistence of this important ecological and economic resource to the Commonwealth. We therefore initiated a population study of the black bear in 2011 with the following research objectives: 1) estimate population abundance, density, and growth rate of black bears in southeastern Kentucky counties considered the reproductive core range, 2) estimate survival and determine cause-specific mortality of black bears in southeastern Kentucky, 3) characterize patterns of range expansion of black bears on high quality public lands in peripheral counties adjacent to (within 50km) the reproductive core bear range in southeastern Kentucky.

To accomplish these objectives, we conducted a non-invasive hair sampling survey and live capturing in a systematic capture-mark-recapture study design to estimate population abundance, density, growth rate, and genetic characteristics and patterns of range expansion of black bears in southeastern Kentucky. In 2011 and 2012, we hair snare surveyed what has been generally considered the 2 core population areas (Pine Mountain-Black Mountain and Cumberland Gap National Historic Park), and a number of surrounding publically owned protected areas (Redbird Wildlife Management Area, Kentucky Ridge State Forest) considered high quality bear habitat. Hair snares were checked weekly from late May thru August for 8 consecutive weeks. A total of 384 hair samples were collected in 2011, and 432 collected in 2012 from survey areas. Hair samples are being analyzed using ≥ 12 microsatellite loci to identify individuals and delineate gender of sampled individuals. The hair snare survey in the core reproductive areas will be repeated in summer 2013, with the potential addition of one or more peripheral study areas. Robust design population models, which allow closed-population models to be used for estimating yearly population size and density, will be used to estimate population growth rate from 2011 – 2014.

To estimate survival and identify cause-specific mortality of black bear, live-trapping during the same summer trapping window was used to capture individual bears. Captured individuals are outfitted with vhf or GPS radio-collars to enable tracking. Aerial telemetry via fixed-wing aircraft is conducted every 10-14 days to locate individuals and determine survival status. A total of 54 individual yearling or older black bears were captured during the summers 2011 and 2012, and 10 (18.5%) have since died (3 were hit and killed by vehicles, 2 were illegally poached, 2 were euthanized due to excessive nuisance behavior, 2 were legally harvested in Virginia, and 1 was legally harvested in Kentucky), suggesting that anthropogenic mortality may play a larger role in slowing growth of the southeastern Kentucky black bear population than previously speculated. Live trapping of bears will be repeated in summer 2013.

Funding Sources: *Wildlife Restoration (Pittman-Robertson) and University of Kentucky*

KDFWR Strategic Plan: Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: appendix 3.9; Class Mammalia: Taxa specific conservation project.

Exploring Methods for Monitoring Bobcats in Kentucky

Laura Patton, Danna Baxley, Brian Gray, Gary Sprandel, and Steven Dobey, Kentucky Department of Fish and Wildlife Resources

As bobcat populations have successfully recovered and continue to exhibit increases in population numbers throughout North America, managers seek to identify effective methods with which to monitor the species. We initiated a camera survey in June 2012 and will run consecutive survey periods through April 2013. The 240km² survey grid is divided into 1.5km² blocks and covers the Green River Lake Wildlife Management Area and surrounding private lands. The entire grid is surveyed every one hundred days; forty cameras are rotated every twenty-five days throughout the grid. We will determine whether or not we can identify individual bobcats by unique markings and hope to identify bobcats that we have collared within the study area. To date, 18 bobcats (10M, 8F) have been collared with either gps or vhf radio-collars. Two mortalities have occurred; one harvested male and one female determined to have died from an infected wound.

Bobcat carcasses continue to be collected from harvesters. These are examined for pregnancy rates, litter sizes as determined from placental scar counts, and ages identified by cementum analysis. We will use the age data as well as harvester effort and auxiliary data to participate in a multi-state exploratory study to determine whether a suitable population model can be derived for bobcats using statistical population reconstruction techniques.

Funding Source: *Wildlife Restoration Act (Pittman- Robertson*)

KDFWR Strategic Plan. Goal 1.

Collared female bobcat / Chris Mason

Bald eagle tracking in Kentucky expands to collect information on adult home range

Kate Heyden, Kentucky Department of Fish and Wildlife Resources

KDFWR expanded the bald eagle tracking project which began in 2010 to include an adult male known to nest at Ballard WMA. The bird was trapped in April 2012, using a rocket-net and fitted with a backpack harness satellite transmitter which records locations each hour.

The home range of the adult male during the nesting season (usually November-July) is a bit larger than expected. Nesting territories are densely packed in Ballard County with nests as close as 1 mile from each other. While the adult male spends most of his time within 1 mile of his nest on Ballard WMA, his locations span as far as 16 miles (Figure 1). The adult male has travelled up to 10 miles from his nest, assumingly to forage. The summer drought in 2012 dried up many smaller lakes and sloughs on Ballard WMA and not surprisingly the adult male's locations for July and August were mostly concentrated on the larger lakes in the area which still had water for fishing. Eagle tracking updates are available via the web at: *http://fw.ky.gov/eagletrack.asp*.

Funding Source: *US Army Corps of Engineers*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5.

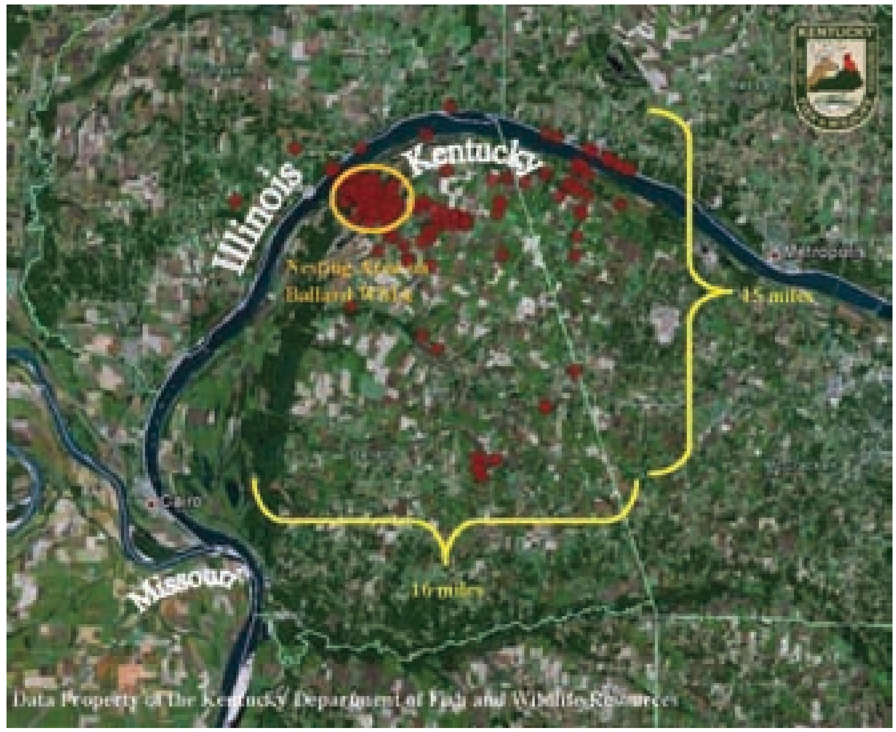


Figure 1: *Locations of adult male during April through December spanning 16 miles*

Adult bird being fitted with transmitter / KDFWR Photo

Adult peregrine falcon / Charlie Gannon

Map of peregrine territories in Kentucky

Update on Long-term Monitoring for Peregrine Falcons in Kentucky

Kate Heyden, Kentucky Department of Fish and Wildlife Resources

The American peregrine falcon (*Falco peregrinus anatum*) experienced severe population decline during the mid 1900's. This decline was mostly attributable to eggshell thinning caused by the widespread use of the pesticide DDT. In fact, there were no known nesting pairs of peregrine falcons in Kentucky for about 60 years until 1997, when peregrine falcons were discovered nesting in downtown Louisville. Since then, the number of territorial pairs has increased steadily and productivity has greatly increased (Figure 1).

In 1999, the peregrine falcon was removed from the Federal List of Threatened and Endangered Wildlife. Extensive monitoring has continued throughout the eastern United States to ensure the species maintains healthy population levels. Productivity and survival of peregrine falcons are monitored through the resighting of colored leg bands with a unique series of colors, letters and numbers.

A total of 13 peregrine falcon territories were documented within Kentucky state lines during the 2012 nesting season. There were 12 territorial pairs, and one solitary male. All nests were located on manmade structures including buildings, bridges, and power generating stations.

Nine nests were successful in fledging young. There were 30 young produced and 28 were assumed to survive fledging. KDFWR banded all accessible young (24).

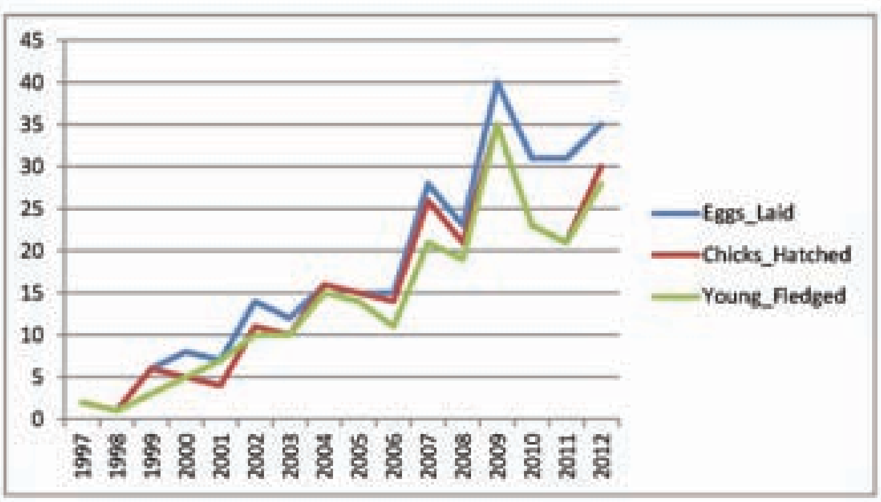


Figure 1: *Productivity of peregrine falcons since reestablishment*

Funding Source: *USFWS Post-delisting Monitoring Funds*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5.

Inventory, Monitoring, and Management of Amphibians and Reptiles in Kentucky

Will Bird and Phil Peak,
Kentucky Herpetological Society

KDFWR Contact*: John MacGregor*

Timber rattlesnake / Phil Peak

In the course of developing Kentucky's State Wildlife Action Plan (SWAP), it was determined by KDFWR that more baseline data needed to be collected in order to execute effective conservation action plans for our native reptile and amphibian species. While general distributions for reptiles and amphibians in Kentucky have been determined, more detailed distribution and abundance records need to be collected so that the populations of these animals can be monitored over time. Many of the records that we have in our current database are decades old and very vague. Species for which baseline data is most needed from all groups of reptiles and amphibians have been identified as have the regions within Kentucky where this information should be gathered.

Locating reptiles and amphibians can be difficult. We begin the process by identifying locations where we believe targeted species can be found. These locations are on state, federal, and private lands. Once permission is granted to conduct surveys we use different methods for locating specimens based on their biological requirements. Because they are ectotherms we are able to utilize Artificial Cover (AC) to locate many of the animals we search for. Heavy metal objects that absorb heat from the sun's rays and provide protection from the elements are set out at our study sites. We also deploy large wooden boards which retain moisture even during the drier months and provide refuge for many of the creatures that might otherwise stay far below the surface of the ground where they could remain undetected. There are species of reptiles and amphibians for which AC has proven less effective. When targeting these species we use box style funnel traps to assist in their location and also search natural forms of cover such as rocks and logs. Most importantly, we drive along old country roads when the conditions that induce snakes to move are present.

The information about where specimens are located is recorded in a very precise manner so that these locations can be visited and monitored into the future in order to continue to monitor populations and dynamics. Since the project began we have secured many new survey locations in areas targeted by the SWAP and continue to gather information and data for species of interest.

Funding Source: *State Wildlife Grant (SWG) and Kentucky Herpetological Society*

Comprehensive Wildlife conservation Strategy: Appendix 3.4, Class Reptilia: Prioritized Survey Projects 1 and 2. Class Amphibia: Priority Survey Projects #1 and #2.

Artificial Culture of Freshwater Mussels using Advanced in vitro Culture Methods at the Center for Mollusk Conservation (CMC)

Christopher Owen, Monte McGregor, Adam Shepard, Fritz Vorisek, Andy McDonald, Travis Bailey, and David Cravens, Center for Mollusk Conservation, Kentucky Department of Fish and Wildlife Resources

Figure 1: *Invitro culture in CO2 incubator / Monte McGregor*

In vitro mussel culture is a method used to develop glochidia (larval stage) into newly metamorphosed pediveligers (early stage juveniles) using a modern incubator with antiobiotics and physiological salts (Figure 1). Glochidia develop using basal cell culture media, animal sera and various nutritional and antibiotic additives, thereby bypassing the host fish altogether. Considerable research has gone into testing various media components, including basal media, serum source, lipids, cholesterol, amino acids, vitamins and sugar sources. Additional work has been done to test various combinations of antibacterial and antimycotic agents for controlling fungal and bacterial contamination. Over the course of this research, 36 species of North American unionid species have been shown to successfully metamorphose *in vitro*. Testing with multiple unionid tribes and brooding strategies indicates general success with most mussels (Table 1). The only group of mussels to not metamorphose *in vitro* are species that grow during metamorphosis. While many species were confirmed to metamorphose *in vitro*, research was not conducted to assess their growth and survival post-metamorphosis. Two large scale cultures were produced *in vitro* using the Plain Pocketbook (*Lampsilis cardium*, Figure 2) and the Wavyrayed Lampmussel (*Lampsilis fasciola*). Total number of viable larvae, percent metamorphosis, number of pediveligers and number of juveniles were estimated. Length – weight regressions were also recorded. Approximately ~144,000 glochidia were recovered from one female *L. cardium*. Of those ~128,000 were

Figure 2: *Lampsilis cardium, thousands, reared in vitro and grown in closed systems./ Monte McGregor*

Figure 3: *Small cup of Lampsilis cardium cultured in small bowl systems. / Monte McGregor*

viable (89%), and after 15 days *in vitro*, the number of newly metamorphosed pediveligers was ~113,152 (88%). After 100 days, an estimated 13,560 individuals remain, ranging from 2.8 mm to 1 cm. Approximately ~63,500 glochidia were recovered from one female *L. fasciola*. Of those ~52,500 were viable (83%), and after 18 days *in vitro*, the number of newly metamorphosed pediveligers was ~50,400 (96%). After 100 days, an estimated 7,232 individuals remain, ranging from 3 mm to 1.1 cm (Figure 2). Overall survival at 100 days was 9.4% for *L. cardium* and 11.4% for *L. fasciola.* The potential for culturing thousands (Figure 3) of juveniles from just a few mussels is one reason the CMC has developed this technique and is pioneering its approach.

Funding Source: *State Wildlife Grant Program (SWG), Kentucky Aquatic Resources Fund (KARF)*

KDFWR Strategic Plan: Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2, Class Bivalvia. Priority Research Project #1.

Species	River Source	# Females	Culture Start Date	# Glochidia	# Juveniles	% Metamorphosis
Utterbackia imbecilis	Pond, Butler Co.	1	4/2/2012	28,000	14,280	51%
Lampsilis siliquoidea	Licking River	2	4/23/2012	100,000	98,000	98%
Utterbackia imbeciliis	Owen County	3	4/30/2012	194,000	189,150	98%
Epioblasma triquetra	Cumberland River	1	5/15/2012	2,500	1,500	60% *
Lampsilis abrupta	Tennessee River	2	5/21/2012	18,000	-	0%
Ellipsaria lineolata	Tennessee River	4	6/1/2012	84,000	-	0%
Elliptio dilatata	Green River	1	6/13/2012	20,000	-	0%
Fusconaia ebena	Tennessee River	2	6/13/2012	3,000	-	0%
Quadrula cylindrica	Green River	3	6/13/2012	15,000	-	0%
Quadrula pustulosa	Green River	1	6/13/2012	3,000	-	0%
Lampisilis fasciola	Green River	1	6/19/2012	40,000	37,840	95% *
Toxolasma lividus	Green River	1	6/19/2012	3,000	600	20% *
Lampsilis cardium	Tennessee River	1	6/20/2012	120,000	118,320	99% *
Ligumia recta	Tennessee River	2	6/25/2012	46,000	39,560	86% *
Lampsilis teres	Ohio River	4	6/26/2012	156,000	145,080	93% *
Lampsilis teres	Ohio River	3	7/16/2012	215,600	6,600	3% *
Lampsilis fasciola	Green River	1	7/19/2012	86,000	78,260	91%
Lampsilis cardium	Tennessee River	1	7/24/2012	144,000	126,720	88% *
Lampsilis cardium	Tennessee River	1	8/16/2012	97,293	-	0%
Lampsilis ovata	Green River	1	8/20/2012	54,000	-	0%
				1,429,393	**855,910**	**60%**

Table 1: *List of the freshwater mussels cultured using in vitro culture methods in 2012.*
** currently in grow out stage*

Culture and Propagation of the Black Sandshell, *Ligumia recta*, and the Endangered Pink Mucket, *Lampsilis abrupta*, for Restoration in the Green River, KY

Adam C. Shepard, Monte A. McGregor, Travis J. Bailey, Ben Davis, Fritz C. Vorisek, and Jacob Culp, Center for Mollusk Conservation, Kentucky Department of Fish and Wildlife Resources; Bob Carson, Mammoth Cave National Park; and Leroy Koch, U.S. Fish and Wildlife Service

The Green River in Kentucky is home to 74 species of freshwater mussels, 17 (23%) of which are currently federally endangered. Five of the 17 species are now considered extinct and another 7 species extirpated from the river. Twenty nine mussel species are listed as a Species of Greatest Conservation Need. The Center for Mollusk Conservation (CMC) considers the Green River to have ~ 28% of its fauna currently stable, and 42 species are in need of some type of management (i.e., augmentation, translocation, or reintroduction). However, the Green River ranks sixth in North American river systems with respect to freshwater mussel diversity (Haag 2012). Trend data from the KDFWR monitoring efforts indicate recruitment for many species in the last 7 years, thus showing signs of increasing mussel populations for some sites. In 2011 and 2012, the Center for Mollusk Conservation (CMC) initiated propagation efforts with the endangered pink mucket (*Lampsilis abrupta*), and the non-listed black sandshell (*Ligumia recta*) for augmentation in the Green river. Both species are rare in the river, and researchers have only observed a few pink muckets in the last 10 years. Glochidia were extracted from the black sandshell and pipetted on the gills of sauger (*Sander canadensis*) and on the gills of largemouth bass (*Micropterus salmoides*) for the pink mucket. Host fish are held in Aquatic Habitat © Units during infestation (Figure 1). For initial grow out, all juveniles were held in Barnhart "mucket bucket" systems and were fed a diet of marine and freshwater algae. After mussels reached 4-6 mm in length, they were transferred to a re-circulating bowl system. The bowl system consists of 14 five liter bowls that have been partially filled with pool sand. When the mussels reached a size of 12mm or greater in length, they were tagged. On September 14, 2012, both species were released at two sites in the Green River. Two hundred sixteen pink muckets (avg. length ~14.0 mm) and 82 black sandshells (avg. length ~22.9 mm) were released upstream of Mammoth Cave National Park (Figure 1). One hundred six pink muckets (avg. length ~14.4 mm) and 99 black sandshells (avg. length ~22.9 mm) were released in the Green River in Mammoth Cave National Park. These mussels were released at current long-term monitoring stations, which are quantitatively accessed every 5 years (Figure 2).

Funding Source: *State Wildlife Grant Program (SWG), Kentucky Aquatic Resources Fund (KARF)*

KDFWR Strategic Plan: Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2, Class Bivalvia. Priority Research Project #1.

Figure 1: *Aquatic habitat units used to hold host fish during propagation./ Monte McGregor*

Figure 2: *Ligumia recta and Lampsilis abrupta release in the Green River, 2012 / Monte McGregor*

Research with the Endangered Fat Pocketbook, *Potamilus capax*

Travis J. Bailey, Monte McGregor, Adam Shepard, Christopher Owen, Fritz Vorisek, Andy McDonald, and David Cravens, Center for Mollusk Conservation, Kentucky Department of Fish and Wildlife Resources

Potamilus capax juveniles / Monte McGregor

Since 2010, the Center for Mollusk Conservation (CMC) has been conducting research with the production of the fat pocketbook, *Potamilus capax* . This species has proven difficult due to several factors: high mortality in captivity, non-hardy fish host (only 1 species), inability to collect brood stock in the spring when the animals are brooding, and lastly, unique habitat conditions. The adult *P.capax* are currently being held in a 100 gallon quarantine system equipped with a biological filtration system, automatic algae feeder system, and an automated water exchange system. Adult females are held in 30 gallon tanks with Ohio River substrate from the collection site. This year the CMC has worked with 7 adult female *P. capax*, yielding approximately 230,500 larvae infested on 167 freshwater drum (*Aplodinotus grunniens*), the only known host . We also tested 2 white crappie (*Pomoxis annularis*), 2 black crappie (*Pomoxis nigromaculatus*),and 1 sculpin (*Cottoidea spp.*) as potential host fish. We collected 1,672 transformed juveniles throughout the year, all from freshwater drum host. We currently have about 500 juveniles of *P.capax* at the CMC. Some of these were the result of infesting 7 freshwater drum with 13,000 *P.capax* larvae in 2013 from broodstock held during the winter. Individuals are growing at a rate similar to that observed in the wild populations (Figure 1). Much research is needed with this species with respect to diets, host fish work, habitat and water quality requirements, and general husbandry.

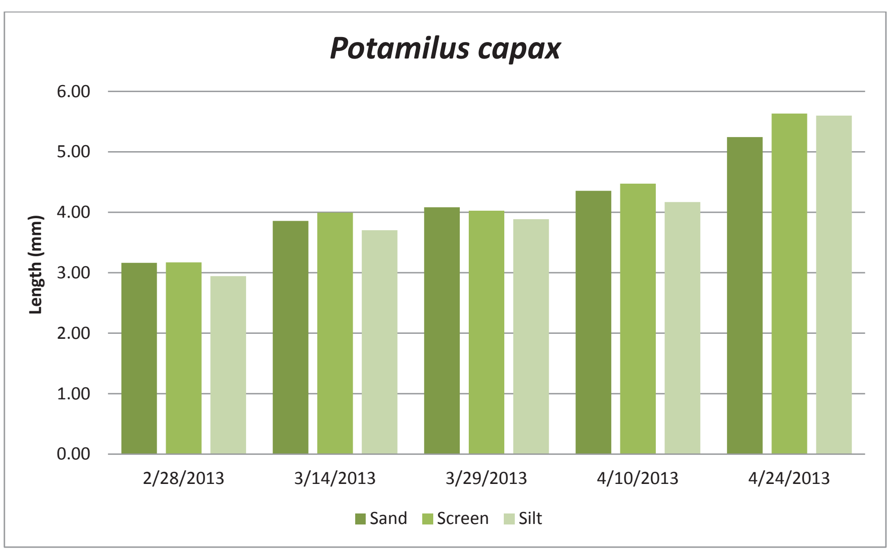


Figure 1: *Growth of the fat pocketbook in closed systems at the Center for Mollusk Conservation.*

Funding Source: *Kentucky Aquatic Resources Fund (KARF)*

KDFWR Strategic Plan: Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2, Class Bivalvia. Priority Research Project #1.

Long-term Monitoring of Mussel Populations in Kentucky: Trends in Diversity and Densities in the Licking River, KY.

Figure 1: *Quantitative sampling for mussels. / Monte McGregor*

Figure 2: *Cyprogenia stegaria high densities in the lower Licking River / Monte McGregor*

Monte A. McGregor, Adam Shepard, Fritz Vorisek, Travis Bailey, Christopher Owen, and Jacob Culp, Center for Mollusk Conservation, Kentucky Department of Fish and Wildlife Resources; Leroy Koch, U.S. Fish and Wildlife Service

In 2004, the Center for Mollusk Conservation (CMC) established several sites and protocols for quantitatively sampling freshwater mussel populations in Kentucky. Sites were selected based on locations within priority management units with boundaries defined by HUC (hydrologic units) 14. In Kentucky these areas have been identified based on presence of imperiled mussels as the most appropriate areas for augmentation, expansion, and reintroduction. Species richness was identified within each of the HUC units and prioritized based on the level of richness. We identified ten HUC 8 (larger watersheds) priority management units and several HUC 14 (smaller units) within the larger HUC 8. The highest HUC 8 was labeled Priority Management Unit 1. These ten Priority Management Units (PMUs) support most of the freshwater mussel richness in Kentucky. The PMUs in order by highest rank are the Green River, Barren River, Upper Cumberland River (rank 3, 5, and 6), Licking River, lower Tennessee River, lower Ohio River, and upper Ohio River. Within most of these rivers, the CMC has established monitoring sites. In 2012, we assessed 2 sites on the Licking River and one site on the Green River that had been previously examined.

Licking River Monitoring Sites

Fifty-nine species of freshwater mussels have been reported in the Licking River in Kentucky: 48 (81%) are still found today and 42% of the fauna is stable. Ongoing monitoring has discovered recruiting populations of the endangered fanshell, *Cyprogenia stegaria*, at multiple sites in the river. We assessed the natural recovery after removal of individuals from the survey site for a relocation project. In 2007, prior to fanshell removal, we estimated the population size at one site by randomly sampling a 20m x 50m area with 40 meter square grids (Figure 1). Twenty three species and an average of 29.9 mussels/m^2 were collected. Ten species were present at densities > 1.0/m^2 and four species were present at densities > 2.0/m^2 : the latter include *Truncilla donaciformis, Elliptio dilatata, Truncilla truncata*, and *Cyprogenia stegaria.* Population estimates for each of these four species ranged from 30,750 to 84,000 (with total numbers for all species estimated at 437,625 mussels). Fanshells were found in 35 samples (densities up to 6/m^2). In 2010, we surveyed a 5 x 5 m area (25 samples) where all mussels were removed, measured, and returned (except the fanshell) to the original grid. Twenty four species and 36.5/m^2 were collected. Ten species were present at densities > 1.0/m^2 and six species were present at densities > 2.0/m^2. Fanshell densities averaged 4.2/m^2 (104 individuals) (Figure 2). In 2012, the grid was resurveyed to determine immigration of new individuals of fanshells into the grid. Post survey analysis revealed 24 species (one new species and one undetected) and 32.4 mussels/m^2. Thirty individuals of the fanshell had immigrated into the grid (28.8% recolonization in 2 years). Total densities of all species were within normal variation over a 5 year monitoring period.

Clay Wildlife Management Area Monitoring Site and Cooperative effort with the Pennsylvania Game and Boat Commission to Reintroduce the Northern Riffleshell, Epioblasma torulosa rangiana

2012 (30 m^2 samples)				2007 (32 m^2 samples)		
Mussels	% of Mussels	Density (/m2)	Scientific Species Name	Mussels	% of Mussels	Density (/m2)
79	27.40%	2.63	*Actinonaias ligamentina*	71	24.60%	2.37
3	1.00%	0.1	*Amblema plicata*	10	3.50%	0.33
0	0.00%	0	*Cyclonaias tuberculata*	1	0.30%	0.03
0	0.00%	0	*Cyprogenia stegaria (FE)*	3	1.00%	0.1
1	0.30%	0.03	*Ellipsaria lineolata*	0	0.00%	0
13	4.50%	0.43	*Elliptio dilatata*	8	2.80%	0.27
1	0.30%	0.03	*Epioblasma triquetra (FE)*	0	0.00%	0
2	0.70%	0.07	*Fusconaia flava*	1	0.30%	0.03
72	25.00%	2.4	*Fusconaia subrotunda*	81	28.00%	2.7
1	0.30%	0.03	*Lampsilis cardium*	4	1.40%	0.13
5	1.70%	0.17	*Lasmigona costata*	4	1.40%	0.13
10	3.50%	0.33	*Leptodea fragilis*	4	1.40%	0.13
2	0.70%	0.07	*Ligumia recta*	2	0.70%	0.07
30	10.40%	1	*Megalonaias nervosa*	28	9.70%	0.93
11	3.80%	0.37	*Obliquaria reflexa*	9	3.10%	0.3
2	0.70%	0.07	*Pleurobema sintoxia*	2	0.70%	0.07
6	2.10%	0.2	*Potamilus alatus*	3	1.00%	0.1
13	4.50%	0.43	*Ptychobranchus fasciolaris*	10	3.50%	0.33
2	0.70%	0.07	*Quadrula metanevra*	4	1.40%	0.13
19	6.60%	0.63	*Quadrula pustulosa*	18	6.20%	0.6
4	1.40%	0.13	*Strophitus undulatus*	2	0.70%	0.07
1	0.30%	0.03	*Truncilla donaciformes*	1	0.30%	0.03
11	3.80%	0.37	*Truncilla truncata*	23	8.00%	0.77
288	**100%**	**9.6**	**Totals**	**289**	**100%**	**9.63**

Unique Species: 21 **Overlapping species: 19** **Unique Species: 21**

Table 1: *Table 1. List of the freshwater mussels found at the Clay WMA in 2010 and 2012 in the 5x5 grid monitoring area with the number of individuals, % abundance, and density/m2.*

In 2011, KDFWR worked with the KY Field Office (KFO) of the USFWS to develop a plan to reintroduce the Northern Riffleshell into Kentucky. KDFWR/KFO recommended 100 individuals be translocated to two sites in Kentucky. In 2011, the PA Scientific Collection permit was approved and the KDFWR team collected 99 northern riffleshell (*Epioblasma torulosa rangiana*) mussels from the Alleghany River site at Hunter Station Bridge in Forest County, Pennsylvania. On Sept 14-18, 2011, all individuals of the northern riffleshell were tagged (bee tags and P.I.T. tags), measured, aged, weighed and checked for zebra mussels, and placed in a 30 day quarantine tank where they were fed and maintained. This holding tank consisted of a 110 gallon (~ 70 gallons of water) polypropylene tank with a biological filter (media) sump (~70 gallon) and a 2 gallon feeder (algae and river sediment) connected to an automated timed delivery system. Water changes were done daily. Animals were targeted for release after a minimum of 30 days after the start of the quarantine period (started on ~ September 17-18, thus ~ October 18), but flows in the Licking River were too high (> 400 cfs) for completing this task. All 97 remaining animals (2 died in quarantine) were then transferred to the KDFWR Minor Clark Hatchery (KDFWR has been holding several rare mussels at the MC Hatchery since 2006) where they were held in 8 feet long feed trough tanks supplied with gravity flow Cave Run Lake (Licking River) water (supplying ~ 5-10 gallons per minute of wild water to the tanks). From Dec 2011 to June 2012, 67 of the

Figure 3: *Licking River at Clay WMA / Monte McGregor*

97 mussels died (67%) in captivity. The Licking River remained high (> 200cfs) until the following spring when the animals were released in mid June 2012. On June 15, 2012, thirty (30) northern riffleshells were transferred from the MC Hatchery to the Licking River at Clay Wildlife Management Area. Individuals were placed in a 3x3 m area.

On August 21, 2012, quantitative mussel sampling was conducted at the Licking River release site at the Clay WMA (as part of the 5 year monitoring program). The PIT tags attached to the northern riffleshells were located with a monitoring probe. Of the original 99 mussels collected from PA, 97 (98%) survived the quarantine period (min of 30 days), 30 (31%) survived the 8 month holding period, and 12 (12%) were collected during the evaluation period in August 2012. Of the 30 released at the Clay WMA site, 25 PIT tagged animals were located (28 were PIT tagged, ~89% recovery): 20 were females and 10 males. Survival was 41% for the females and 33% for the males. Of the 12 live animals, 7 were females and at least 2 individuals were displaying and had spawned at the site (i.e., gravid). Overall river survival was 40% of the 30 released in June 2012. The Clay WMA area has three endangered mussels, *Cyprogenia stegaria, Epioblasma triquetra,* and *Plethobasus cyphyus* (only found in qualitative searches). With the addition of the northern riffleshell, there are now four endangered mussels at the site. KDFWR will be adding *Lampsilis abrupta* (propagated animals) in 2013 and possibly others in the future. The area has additional rare species outside of the monitoring grid location, such as *Obovaria subrotunda, Simpsonaias ambigua, Alasmidonta viridis*, *A. marginata*, and others that are considered species of greatest conservation need in Kentucky (Figure 3). Results from the 2012 survey indicated 21 species (9.6 mussels/m^2) (See Table 1). This site compares well to other quality sites supporting T&E species in the state of Kentucky. We plan to try this release again but earlier in the year to allow more time post quarantine to release the adult mussels.

Funding Source: *State Wildlife Grant Program (SWG), United States Fish and Wildlife Service (USFWS)*

KDFWR Strategic Plan: Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2, Class Bivalvia. Priority Survey Project #1.

Propagation and Culture of Freshwater Mussels at the Center for Mollusk Conservation in Kentucky in 2012

Figure 1: *Culture systems for starter mussels / Monte McGregor*

Figure 2: *Algae culture systems at the CMC / Monte McGregor*

Figure 3: *Downweller system for culturing early stage juvenile mussels./ Monte McGregor*

Monte A. McGregor, Christopher Owen, Adam Shepard, Andy McDonald, Fritz Vorisek, Travis Bailey, and David Cravens, Center for Mollusk Conservation, Kentucky Department of Fish and Wildlife Resources

The restoration and recovery of endangered species of mussels in Kentucky via captive propagation and grow-out of these species is becoming an important component of the state-wide mussel conservation strategy. Due to degraded water quality in much of the state (and, in fact, the nation), it is important to be able to grow these animals in re-circulating systems with controlled water exchange. We have constructed various closed, recirculating systems which are capable of producing ~200,000-400,000 mussels per year to a tagable or stockable size for release. The challenge of raising large numbers of these small sensitive animals has led to the development of advanced recirculating systems with system checks and low maintenance requirements. Particle counts are monitored to maintain appropriate feeding levels and cultured freshwater algae (Figure 2) and commercially-available saltwater algae as well as bacterial cultures are fed continuously throughout the day. The standard "Mucket bucket" design has been altered for flow-through recirculation from a sump to improve water quality and ease maintenance (Figure 1). New larger-scale acrylic downweller systems have been designed and fabricated (Figure 3). Large-scale upweller systems and sand-substrate bowl systems are also designed for grow-out of larger-sized juveniles (Figure 4). Small and large bowl systems are also used to culture juveniles to a larger size in a more natural setting in our modern greenhouse (Figure 5). UV and mechanical filtration have

Figure 4: *Large scale upwelling system for mussel culture. / Monte McGregor*

been integrated into the design of the systems to control nuisance and disease organisms. Many functions of each system are automated including water changes and feeding. As the animals grow, moving them onto larger screens and increasing the grow-out area is essential. Flow rates are maintained at specified levels in all systems and daily maintenance and monitoring is performed. Currently, ~30,000 mussels are growing in these systems, ranging in size from 2mm to 10mm. Water quality is analyzed on a routine basis in the new research lab using a Hach © spectrophotometer; and algae cell counts are examined using a Beckman particle counter (Figure 6). Hatchery protocols, system design, and water quality parameters are recorded daily to document growth and survival of juvenile mussels. As of 2012, the CMC has worked with 54 species found in Kentucky, have grown 21 species to a tagable size, released 8 species back in the wild, and have worked with 13 endangered species (Table 1). Multiple species are scheduled for release in 2013.

Funding Source: *State Wildlife Grant Program (SWG), Kentucky Aquatic Resources Fund (KARF)*

KDFWR Strategic Plan: Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2, Class Bivalvia. Priority Research Project #1.

Figure 5: *Small bowl system for culturing juvenile mussels. / Monte McGregor*

Figure 6: *Water quality monitoring station in new research lab at the CMC. / Monte McGregor*

Mussel Propagation and Release Activity at the Center for Mollusk Conservation

Table 1

Common Species Name	Scientific Species Name	Endangered Species	Cultured to a Tagable Size	Juveniles Released
Mucket	*Actinonaias ligamentina*			
Pheasantshell	*Actinonaias pectorosa*		✓	
Cumberland Elktoe	*Alasmidonta atropurpurea*		✓	✓
Elktoe	*Alasmidonta marginata*			
Slippershell Mussel	*Alasmidonta viridis*		✓	✓
Flat Floater	*Anodonta suborbiculata*			
Rock Pocketbook	*Arcidens confragosus*			
Fanshell Pearlymussel	*Cyprogenia stegaria*	✓		
Dromedary Pearlymussel	*Dromus dromas*	✓		
Butterfly	*Ellipsaria lineolata*		✓	
Elephantear	*Elliptio crassidens*			
Spike	*Elliptio dilatata*			
Cumberlandian Combshell	*Epioblasma brevidens*	✓		
Oyster Mussel	*Epioblasma capsaeformis*	✓	✓	
Snuffbox	*Epioblasma triquetra*	✓	✓	✓
Wabash Pigtoe	*Fusconaia flava*			
Longsolid	*Fusconaia subrotunda*			
Pink Mucket	*Lampsilis abrupta*	✓	✓	✓
Plain Pocketbook	*Lampsilis cardium*		✓	
Wavyrayed Lampmussel	*Lampsilis fasciola*		✓	
Pocketbook	*Lampsilis ovata*			
Fatmucket	*Lampsilis siliquoidea*		✓	✓
Yellow Sandshell	*Lampsilis teres*		✓	
White Heelsplitter	*Lasmigona complanata*			
Flutedshell	*Lasmigona costata*		✓	
Fragile Papershell	*Leptodea fragilis*			
Black Sandshell	*Ligumia recta*		✓	✓
Cumberland Moccasinshell	*Medionidus conradicus*			
Round Hickorynut	*Obovaria subrotunda*			
Littlewing Pearlymussel	*Pegias fabula*	✓		
Sheepnose	*Plethobasus cyphyus*	✓		
Clubshell	*Pleurobema clava*	✓	✓	
Ohio Pigtoe	*Pleurobema cordatum*			
Pyramid Pigtoe	*Pleurobema rubrum*			
Round Pigtoe	*Pleurobema sintoxia*			
Fat Pocketbook	*Potamilus capax*	✓		
Pink Papershell	*Potamilus ohiensis*			
Bleufer	*Potamilus purpuratus*			
Kidneyshell	*Ptychobranchus fasciolaris*			
Giant Floater	*Pyganodon grandis*		✓	
Rabbitsfoot	*Quadrula cylindrica*	✓	✓	
Salamander Mussel	*Simpsonaias ambigua*		✓	✓
Creeper	*Strophitus undulatus*		✓	
Purple Lilliput	*Toxolasma lividus*		✓	
Lilliput	*Toxolasma parvus*			
Pistolgrip	*Tritogonia verrucosa*			
Fawnsfoot	*Truncilla donaciformis*			
Deertoe	*Truncilla truncata*			
Paper Pondshell	*Utterbackia imbecillis*		✓	
Rainbow	*Villosa iris*			
Little Spectaclecase	*Villosa lienosa*			
Kentucky Creekshell	*Villosa ortmanni*			
Painted Creekshell	*Villosa taeniata*			
Cumberland Bean	*Villosa trabalis*	✓	✓	✓

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Big Game
(Elk and Deer)

Small Game
(Quail, Squirrels, Rabbits)

Turkey

Furbearers

Bear

Birds

Songbirds and Raptors

Migratory Shorebirds and Colonial Nesting Waterbirds

Reptiles and Amphibians

Mollusks

Crayfish

Fishes

Habitat Restoration / Management

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