


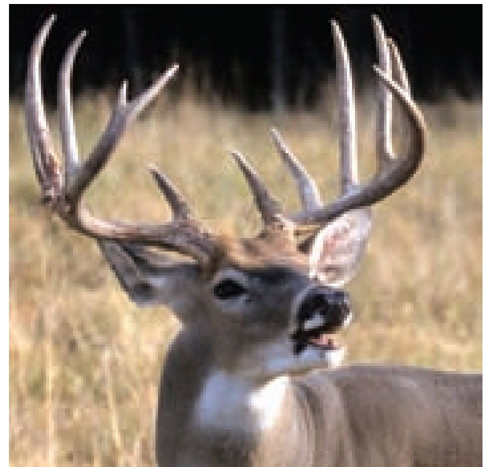

Kentucky Department of Fish and Wildlife Resources

Annual Research Highlights 2009

Volume III, Sept. 2010

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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

Prescribed burn / Joe Lacefield

Long Term Conservation Planning in Kentucky

The mission of the Kentucky Department of Fish and Wildlife Resources (KDFWR) is to conserve and enhance fish and wildlife resources and to provide opportunity for hunting, fishing, trapping, boating, and other wildlife related activities. To effectively conserve and enhance game and non-game fish and wildlife resources in Kentucky, long-term planning is necessary. Over the past several years, KDFWR has collaborated with multiple outside agencies, non-profit organizations, professionals, and biologists to complete two important planning documents: the Comprehensive Wildlife Conservation Strategy (completed in 2007; *http://fw.ky.gov/kfwis/stwg/*) and the 2008 – 2012 Kentucky Department of Fish and Wildlife Resources Strategic Plan (*http://fw.ky.gov/pdf/strategicplan2008-2012.pdf*). Both of these documents are designed to guide agency decisions; however, they serve two unique purposes. The Comprehensive Wildlife Conservation Strategy (CWCS) is Kentucky's roadmap for sustaining fish and wildlife diversity. The two primary goals of the CWCS are to identify and prioritize important species and habitats of conservation concern within Kentucky and to successfully implement conservation measures for these species and habitats. In contrast, the 2007 – 2012 Strategic Plan addresses fish and wildlife management issues as well as agency issues as a whole.

The five primary goals of the Strategic plan are:

1) To conserve and enhance fish and wildlife populations and their habitats;
2) To increase opportunity for, and safe participation in hunting, fishing, trapping, boating, and other wildlife-related activities;
3) To foster a more informed and involved public;
4) To expand and diversify our user base and
5) To create a more diverse, effective, and efficient organization.

These two documents are available to the public, and are intended for frequent revision and re-adjustment to incorporate ever changing agency and public needs and interests. The 2009 Kentucky Department of Fish and Wildlife Resources Research Summary represents our targeted efforts to fulfill the goals of our Comprehensive Wildlife Conservation Strategy as well as the goals of the 2008 – 2012 Strategic Plan. These 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 Guidance to Federal Programs

The Kentucky Department of Fish and Wildlife Resources 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 six 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 and Tribal Wildlife Grant Program, 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
State Wildlife Grant Program (SWG)	To develop and implement programs that benefit wildlife and their habitats, specifically species and habitats of conservation concern
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

Big South Fork mussel release / Lee McClellan

These federal programs provided approximately 18.9 million dollars to KDFWR in 2009 (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 of the strategic plan or CWCS fulfilled, as well as the KDFWR contact responsible for each project.

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 of the document. For projects that began in 2009, a brief 1-page overview of the project is included in the second portion ("project highlights") of the document. For select ongoing projects, brief updates are included in the last section of this document. In the table of contents, an expected date of completion is listed for each project with a finite end-date. This will facilitate looking up detailed summaries of completed projects in later years. Additionally, a comprehensive glossary of all projects included in Research Highlights documents (beginning in 2007) is listed after the Table of Contents.

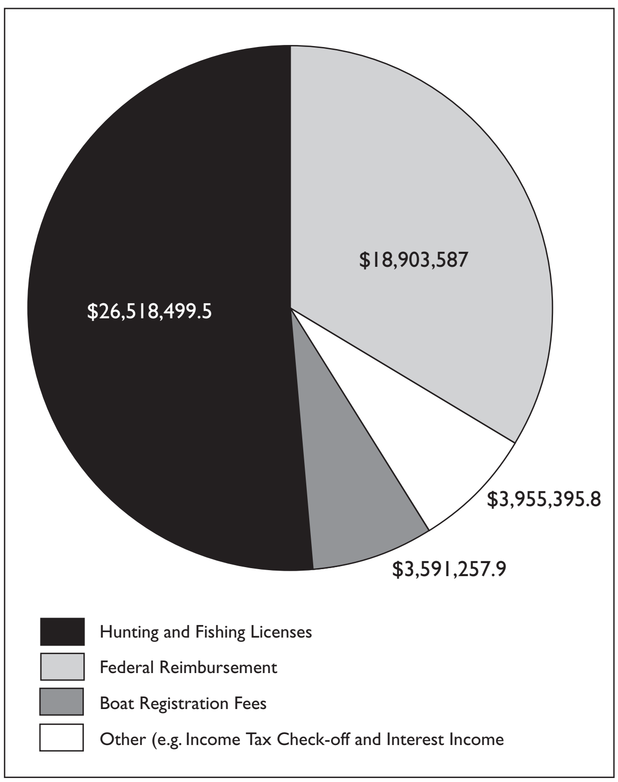

Figure 1. Kentucky Department of Fish and Wildlife Resources Funding Sources 2009

Please use the following citation when referencing this document:

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Published Research

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

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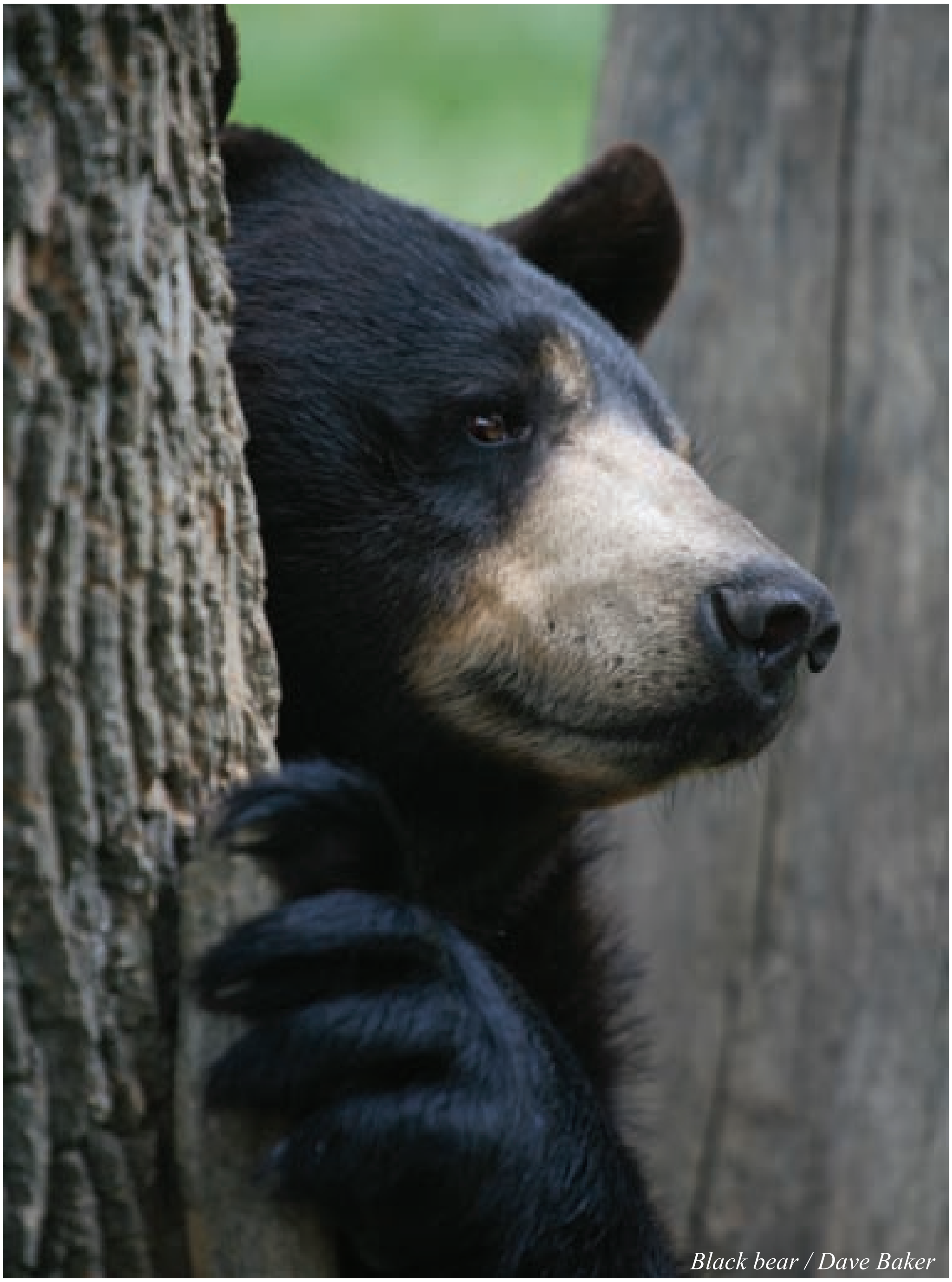
Appendix

KDFWR Contacts

Evening activity in a gray bat cave / John MacGregor and Mark Gumbert


Black bear / Dave Baker

Completed Projects

The Ichthyofauna of Rock Creek, Kentucky, with Observations on the Impact of Stocking Rainbow Trout on Native Fishes

Stephanie L. Brandt, Kentucky Department of Fish and Wildlife Resources; Sherry Harrel, Eastern Kentucky University

Introduction

Rock Creek, located in McCreary County, Kentucky, is a tributary of the Big South Fork Cumberland River. The stream spans thirty-three km (twenty-one miles), with its origin in Pickett County, Tennessee, and flows north into Kentucky to its confluence with the Big South Fork Cumberland River (Pierce 2002). From the state line to its confluence with White Oak Creek, Rock Creek has been designated a Wild and Scenic River and Outstanding Natural Resource Water by the Commonwealth of Kentucky (KDOW 2009). Rock Creek lies within the Big South Fork Cumberland River 8-digit hydrologic unit (HUC), which is ranked among the top five priority conservation areas for aquatic species in Kentucky's Wildlife Action Plan (KDFWR 2005). However, the lower section of Rock Creek from White Oak Creek to its confluence with the Big South Fork has been impacted by acid mine drainage (AMD) (Pierce 2002). Due to this impairment, lower Rock Creek was added to Kentucky's 1990 303(d) List of Impaired Waters as "nonsupporting for aquatic life and swimming" (KDOW 1990, Pierce 2002).

The Rock Creek Task Force was formed to solve water quality problems and consists of 12 state and federal agencies and organizations (Carew 2005). This was accomplished through reclamation activities including limestone sand treatment, refuse removal and treatment, open limestone channels, and vertical flow systems (Carew and Hohman 2007). Rock Creek's listing was revised from "nonsupporting for aquatic life and swimming" to "partial support" in 2004 (KDOW 2004). Reclamation has been ongoing, and since the addition of limestone to White Oak Creek and lower Rock Creek in 2000, fish abundance and species diversity have increased (Carew 2005).

Six fish Species of Greatest Conservation Need (SGCN) are either known to occur or have occurred historically in Rock Creek: sawfin shiner (*Notropis* sp. *cf. spectrunculus*), blackside dace (*Chrosomus cumberlandensis*), emerald darter (*Etheostoma baileyi*), ashy darter (*Etheostoma cinereum*), bloodfin darter (*Etheostoma sanguifluum*), and mountain brook lamprey *(Ichthyomyzon greeleyi*) (Burr and Warren 1986). Two species (sawfin shiner and mountain brook lamprey) are listed as threatened or endangered by the Kentucky State Nature Preserves Commission (KSNPC 2005), two (emerald darter and bloodfin darter) are known to be important fish hosts to federally endangered freshwater mussels, and one (ashy darter) has not been reported from Rock Creek since before 1920 (Burr and Warren 1986). Blackside dace (*Chrosomus cumberlandensis*) is also a federally threatened species and is known from tributaries


Rock Creek / Stephanie Brandt

of Rock Creek (Strange 2005).

Since the early 1960's, the USFWS has annually stocked Rock Creek with catchable-size rainbow trout (*Oncorhynchus mykiss*). It is classified as a general trout stream that is managed as a put-and-take fishery as well as seasonal catch and release fishery (KDFWR 2008). Stocking occurs from White Oak Creek upstream to the Kentucky/Tennessee state line.

Rock Creek / Stephanie Brandt

Adverse impacts on SGCN can occur as a result of stocking predatory fish species. Research has shown that predation by stocked rainbow trout can influence intrastream (habitat) and interstream (geographic) distributions of small native fishes (Blinn et al. 1993). Interactions among stocked rainbow trout and SGCN in Rock Creek have not been studied. Thus, an intensive survey of the fishes of Rock Creek (including stocked rainbow trout) was needed to update information on the distribution and status of SGCN relative to stocked rainbow trout distributions and habitat usage. Such information was necessary to determine any potential impact of stocked rainbow trout on the five SGCN that are known to exist in Rock Creek. The ichthyofauna of the Big South Fork Cumberland River drainage was surveyed by Comiskey and Etiner (1972), but only included one sampling site in Rock Creek in the headwaters in TN. Scott (2007) surveyed the fish fauna within the boundaries of the Big South Fork National River and Recreation Area with three locations within KY. Fish sampling by KDOW and KDFWR associated with biomonitioring of reclamation activities was limited to sites located in lower Rock Creek, with one site located above the AMD, which was sampled once in 1999 (Carew 2005).

Methods

Study Area

In Kentucky, Rock Creek is located within the Plateau Escarpment Ecoregion in McCreary County. This ecoregion is described by narrow ridges, gorges, and cliffs (Woods et al. 2002). This area contains wild streams such as Rock Creek that support many rare and endangered fishes and mussels. Streams within this ecoregion have high gradients with riffles, pools, and boulder or bedrock substrate. The Plateau Escarpment is more rugged, dissected, and forested than the surrounding Cumberland Plateau and Eastern Highland Rim (Woods et al. 2002). The majority of Rock Creek is managed by the U.S. Forest Service (USFS), and the National Park Service manages Rock Creek at the confluence of the Big South Fork Cumberland River which is part of the Big South Fork National River and Recreation Area (Carew and Hohman 2007). Rock Creek has a small number of private residences but is mostly forested. Coal mining in the Rock Creek drainage diminished after the 1960's and towns such as Yamacraw, Fidelity, and Co-Operative no longer exist (Carew and Hohman 2007). The Rock Creek watershed is used more as a recreational attraction and is visited for angling, camping, and hiking.

<u>Fish Distributions and Abundance:</u> For aquatic sampling purposes, Rock Creek was divided arbitrarily into three sections and sampled only within Kentucky. One sampling section encompassed Rock Creek from White Oak Creek downstream to the confluence with the Big South Fork Cumberland River (where stockings of rainbow trout do not occur). The remaining two sampling sections were located upstream of White Oak Creek (where stockings of rainbow trout do occur) to Bell Farm Horse Camp, and from Bell Farm Horse Camp to the Tennessee state line. At least three sites from each section

were sampled during each spring, summer, and fall sampling periods. Sample sites exhibiting maximum habitat diversity were chosen within sections of Rock Creek and its tributaries. All available habitats at each site were thoroughly sampled using a combination of seining and backpack electrofishing to ensure a complete representation of fish species richness and composition. All fishes collected were identified and enumerated, both in the field (released) and in the lab (from preserved specimens); SGCN were measured for TL (mm), and released; except for those kept as voucher specimens necessary for accurate identification in the laboratory. All sample localities were georeferenced. Vouchered specimens were deposited into the Branson Museum of Zoology at Eastern Kentucky University.

The Kentucky Index of Biotic Integrity (KIBI) was used to assess the fish community structure and biotic integrity of Rock Creek. The KIBI is composed of seven metrics that include: (1) Native Species Richness, (2) Darter, Madtom, and Sculpin Richness, (3) Intolerant Species Richness, (4) Simple Lithophilic Spawning Species Richness, (5) Relative Abundance of Insectivorous Individuals, (6) Relative Abundance of Tolerant Individuals, and (7) Relative Abundance of Facultative Headwater Individuals (KDOW 2002). Values were then ranked as excellent, good, fair, poor, or very poor to describe the stream health based on fish community composition.

Historical data concerning the fishes of Rock Creek were obtained through Ecological Data Application System (EDAS) database used by KDOW, KDFWR, and USFS and Kentucky Fish and Wildlife Information Systems (KFWIS) which included data from SIUC and KSNPC. A total of 88 past collections taken from 1961 to 2007 were reviewed. These collections were made by KYAML, KDOW, KDFWR, KSNPC, and NPS.

Habitat Conditions

Kentucky Division of Water's Rapid Habitat Assessment protocol was used to score ten habitat parameters (KDOW 2002) including riparian vegetation, bank stability, instream habitat and channel morphology. These parameters were ranked on a numerical scale from 0 (lowest)-20 (highest) and added to produce a score used as a relative measure of habitat quality. Temperature (°C), pH, dissolved oxygen (mg/L), and conductivity (µs) were measured with a YSI meter at each site.

<u>Rainbow Trout Impacts to SGCN:</u> In addition to assessing distributional overlap of stocked rainbow trout and SGCN, all trout collected were retained for gut content analysis in the laboratory.

Results

Diversity

A total of 44 species representing 8 families of freshwater fishes was collected in Rock Creek and its tributaries during 32 sampling localities. The total number of fishes identified during the study was 4,770. The most diverse families were: Cyprinidae (18), Percidae (13), and Centrachidae (7). Four families were represented by a single species; Petromyzonidae, Ictaluridae, Salmonidae, and Atherinidae. Main stem Rock Creek had a maximum of 29 and a minimum of 8 species per collection. Tributaries had a maximum of 5 and a minimum of 0 species per collection.

Rainbow Trout

Stocked rainbow trout (*Oncorhynchus mykiss*) were found in 6 of the 32 collections with a total of 11 individuals collected, ranging in size from 7.7 inches (195 mm) to 10.3 inches (261 mm) total length. They were found together with *N.* sp. *cf. spectrunculus* and *E. baileyi* at 4 of the 6 sites. Rainbow trout were collected throughout Rock Creek, including the lower section which does not get stocked. Gut contents of two individuals included *N. telescopus* (n=2), *E. obeyense* (n=1), while other trout collected had either empty stomachs or included macroinvertebrates.

Species of Greatest Conservation Need

A total of 70 individuals of *Notropis* sp. *cf. spectrunculus* was collected at 12 sites from the Kentucky/Tennessee line down to the confluence of Grassy Fork in lower Rock Creek ranging from 35 to 61mm in total length. A total of 8 individuals of *E. baileyi* was collected at 3 sites ranging from 24 mm to 36 mm. A single *E. sanguifluum* was collected near the confluence of Koger Fork with a total length of 55 mm. A total of 13 individuals of *E. cinereum* ranging from 41 to 91 mm in total length was collected near the confluence of Koger Fork and near the confluence of Grassy Fork. A total of 98 individuals of *C. cumberlandensis* ranging from 22 to 79 mm in total length were collected in White Oak Creek, Dolen Branch, Watts Branch, and Puncheoncamp Branch. *Ichthyomyzon greeleyi* was not collected during this project in 2008-2009 sampling.

Habitat

Using Rapid Assessment protocols (KDOW 2002), the upstream section of Rock Creek unaffected by AMD had a mean score of 148(±19) showing it is partially supporting the designated use. The middle section had a mean score of 134(±22) indicating it is not supporting the designated use as well as the lower section with a mean score of 124(±18). The mean pH for the upstream, middle, and lower sections was 8.30(±1.42), 7.97(±0.66), and 8.01(±0.28), respectively. The mean conductivity level for the upstream, middle, and lower sections was 0.86(±0.09), 0.15(±0.22), and 0.21(±0.09) µs, respectively.

KIBI results varied from very poor in headwater sites to excellent in wading sites. Approximately 70 percent of wading sites scored as excellent; while

22 percent were scored as good. Two wading sites were scored at fair/poor. Headwater sites scored much lower than wading sites with the majority at poor/very poor. Two sites did not have fish present during sampling and were scored very poor. Two sites scored as fair, four sites were poor, and one site was very poor.

Discussion

Diversity

Fish sampling in Rock Creek from the Kentucky/Tennessee state line to the confluence of Big South Fork Cumberland River found 93 percent of the fish species previously reported from the drainage and new occurrence records for five additional species not reported from Rock Creek previously. The known fish fauna for Rock Creek is now 50 species including the first records of palezone shiner (*Notropis albizonatus*), silver shiner (*Notropis photogenis*), dusky darter (*Percina sciera*), johnny darter (*Etheostoma nigrum*), and banded darter (*Etheostoma zonale*).

A single specimen of Notropis albizonatus was collected by KDFWR in June 2008 at Koger Fork but was likely misidentified as *N. stramineus*. *Notropis albizonatus* is federally endangered and is previously known only from the Little South Fork Cumberland River in Wayne Co., KY and Marrowbone Creek, Cumberland Co., KY (Burr and Warren 1986); the species also has a disjunct population in the Paint Rock River, Alabama. Subsequent sampling efforts to collect more individuals have thus far been unsuccessful. Lower Rock Creek was not intensely sampled historically due to the effects of acid mine drainage. *N. albizonatus* may be present within Rock Creek and Big South Fork Cumberland River but are perhaps in such low numbers they are not being detected. Sampling efforts should continue in Rock Creek and Big South Fork Cumberland to document any potential dispersal from Little South Fork Cumberland River.

Etheostoma nigrum is rare below Cumberland Falls known only from one specimen in the Rockcastle River (Burr and Warren 1986), Fishing Creek (D. Eisenhour, pers. comm.), and Alum Creek (Scott 2007). Only one individual was collected from Rock Creek at Koger Fork by AML in June 2008 but was likely misidentified as *Etheostoma* sp. *cf. stigmaeum* “longhunt darter”. The specimen was carefully examined to rule out Cumberland darter (*E. susanae*), a similar species found below Cumberland Falls that is currently under review for federal listing.

Fourteen species previously reported from Rock Creek were not collected during this study. Four of these species are considered valid records representing native populations, while two have been introduced. The remaining species lack vouchered specimens and are considered probable misidentifications. Questionable species records for which vouchered specimens were lacking or unavailable were not included in the comprehensive species list. Emerald shiner (*Notropis atherinoides*) and ghost shiner (*N. buchanani*) were collected by AML and vouchered specimens were examined and identifications were confirmed. *Notropis atherinoides* was collected at three different sites in 1999 but was not collected previously and has not been collected in Rock Creek since 1999. This species is generally distributed throughout the state and is found within main channels of big rivers (Burr and Warren 1986). *Notropis buchanani*, another big river species, was collected in lower Rock Creek in 1999 and was also not collected previously and has not been collected since 1999.

Species of Greatest Conservation Need

The only SGCN not collected during the 2008-2009 field season was *Ichthyomyzon greeleyi*, but it has been collected within the last three years in the upper section of Rock Creek (Thomas 2007; Scott 2007). *Notropis* sp. *cf. spectrunculus* appears to be more common in the upper portion of Rock Creek and was not previously recorded from below Hemlock Grove. The presence of this species in lower Rock Creek indicates either a downstream dispersal from upper Rock Creek or immigration from Big South Fork Cumberland River. *Etheostoma baileyi* appears to be uncommon with only eight individuals found in the lower section of Rock Creek. *Chrosomus cumberlandensis* was collected in Puncheon Camp Branch where it has not previously been reported. *C. cumberlandensis* was most abundant in White Oak Creek, including one site impacted by AMD. Individuals were collected in pools; usually around scoured and undercut banks, around root masses, and large woody debris. *Etheostoma cinereum* appears to be uncommon with 13 individuals collected at two sites in lower Rock Creek. According to Burr and Warren (1986), *E. cinereum* is rare and sporadic in the Big South Fork Cumberland River and reported a pre-1920 record for Rock Creek. A single individual was collected in 2000 and 2005 by AML at the Grassy Fork confluence but voucher specimens do not exist. It appears that *E. cinereum* is rare but is repopulating the lower section of Rock Creek. *Etheostoma sanguifluum* appears to be rare with only one individual collected at the Koger Fork confluence in lower Rock Creek. Burr and Warren (1986) noted a pre-1920 record at the mouth of Rock Creek and a post-1920 record close to the Kentucky/Tennessee line. KDOW reported a single individual at the Kentucky/Tennessee in 1991, but it is unconfirmed. The KY-AML reported two individuals collected above Schoolhouse Branch in 2003 and one individual was vouchered and confirmed. They reported seven individuals from Koger Fork confluence in 2003 but no voucher specimens exist. Those were likely misidentifications because upon examination of that collection, four specimens of *E. camurum* and no specimens of *E. sanguifluum* were present. This species is similar in appearance to *E. camurum*, which is abundant in Rock Creek, so it could be more abundant than records show.

Rainbow Trout

Rainbow trout and two SGCN, *N.* sp. *cf. spectrunculus* and *E. baileyi* were collected together at five sites. Gut contents of two trout specimens included the remains of *N. telescopus* and *E. obeyense*, as well as macroinvertebrates. These trout had survived the summer in warmer waters and were the only ones collected that had consumed fish. Those individuals that were collected more recently had gut contents of strictly macroinvertebrates. According to Blinn et al. (1993) and McDowall (2003), predation of introduced trout on native fish and macroinvertebrates has been previously recorded. There is no direct evidence of rainbow trout predation on SGCN, however, *N. telescopus* and *N.* sp.*cf. spectrunculus* are found within the same pools as rainbow trout, indicating a potential threat of predation.

Habitat

Conductivity and pH in Rock Creek fell within a normal range to support aquatic life. High conductivity has been reported to be negatively correlated with the presence of SGCN, including arrow darter (*Etheostoma sagitta sagitta*) and blackside dace (*C. cumberlandesis*) in headwater streams in eastern Kentucky (Mattingly et al 2005; Thomas 2007).

The majority of wading sites sampled in Rock Creek scored excellent or good in the KIBI. The headwater sites scored lower than expected but it is likely due to the low abundance of fish present in headwater streams. Darter and intolerant species richness values were low in headwater streams. There was a large percentage of tolerant individuals which contributed to the lower scores at these sites. All headwater sites seemed to be in good health with the exception of White Oak Creek because of the acid mine drainage effects that are still present. The overall health of Rock Creek and its tributaries based on fish communities seems to be good.

Management Implications

Based on the results of this study, I recommend management protocols for stocking streams in Kentucky should include preliminary sampling to determine what species exist in the system. If SGCN species are present, serious consideration should be given to not stocking trout in the system. Further studies are needed to determine the impact of non-native rainbow trout stockings on native fish populations.

Since 1999, reclamation activities including limestone sand treatment, refuse removal, and installation of open limestone channels, have led to improvements in water quality as well as species richness and abundance in lower Rock Creek. Based on these findings, such reclamation activities appear to be a relatively cost-effective means of mitigating water quality problems due to acid mine drainage, and should be continued to prevent any further degradation to the aquatic community.

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Funding Source: *State Wildlife Grant (SWG)*

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

Spatio-temporal Analysis of Fishes in Terrapin Creek, Kentucky

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KDFWR Contact: *Ryan Oster*

Terrapin Creek / M. Thomas

Introduction

Terrapin Creek is located in the southeast corner of Graves County, Kentucky with eastern portions of the watershed in southwestern Calloway County, Kentucky. The stream originates in Kentucky and flows southward into Henry County, Tennessee where it joins the Obion River. The Obion River is a direct tributary of the Mississippi River, making Terrapin Creek part of the Mississippi River Drainage. This hydrologic feature is fairly unique in Kentucky, as nearly all other streams in the state are in the Ohio River Drainage. Terrapin Creek lies on the Eastern Gulf Coastal Plain, and as is common in coastal plains streams, it is characterized by unconsolidated sand and small gravel substrates. These loose substrates are subject to major shifts during high water events, and significant alterations in the scour and deposition patterns of the streambed are evident when the high waters recede. It is a 3rd order stream formed by East and West Branch Terrapin Creek, with a small watershed of approximately 112 km2. West Branch of Terrapin Creek and the Terrapin Creek mainstem were ditched and channelized in the 1920's and 1930's from the headwaters to the confluence with the Obion River. This has resulted in obvious downcutting of the streambed, and subsequently, the tributaries. The spring fed rivulets along the length of Terrapin Creek are deeply incised, but still often set several inches above the bed of Terrapin Creek. These rivulets trickle down a short muddy slope before entering the creek, limiting access by fishes during low flows. Downcutting has also reduced floodplain connectivity, leaving wetlands perched and their associated fish populations disjunct from the stream community. East Branch Terrapin Creek, however, is largely unaltered and still sits in its natural streambed.

Terrapin Creek supports six fish species that are unique in the state of Kentucky, including the Blacktail Redhorse, *Moxostoma poecilurum*; Least Madtom, *Noturus hildebrandi*; Brown Madtom, *Noturus phaeus*; Gulf Darter, *Etheostoma swaini*; Brighteye Darter, *E. lynceum*; and Firebelly Darter, *E. pyrrhogaster* (Burr and Carney 1984, Burr and Warren 1986). In addition, at least four other species having limited ranges in Kentucky maintain viable populations in Terrapin Creek, including the Bluntface Shiner, *Cyprinella camura*; Central Mudminnow, *Umbra limi*; Dollar Sunfish, *Lepomis marginatus*; and Goldstripe Darter, *Etheostoma parvipinne*. All ten of the aforementioned species are Species in Greatest Conservation Need (SGCN) and considered imperiled or critically imperiled in Kentucky (NatureServe 2004) and threatened or endangered by Kentucky State Nature Preserves Commission (2004). This watershed has been listed in the top five of highest priority for conservation management efforts that benefit the largest number of species listed as SGCN in sections 4.3.2 and 4.3.3 of the Wildlife Action Plan. Under the mandate to acquire and manage significant examples of Kentucky's rare species and natural communities, the Kentucky State Nature Preserves Commission (KSNPC) committed to long term protection of Terrapin Creek in 1992 and now owns nearly 250 acres of Terrapin Creek floodplain, forming the Terrapin Creek State Nature Preserve (Cicerello 2004).

This study was initiated to gather detailed information on the status of the fishes of Terrapin Creek and to assess potential changes in the fish fauna over time. Additional objectives included synthesizing known data on the fish assemblage of Terrapin Creek, as well as establishing detailed baseline assemblage data using methods which are quantitative and repeatable for long term monitoring. Fish assemblage structure was examined temporally, over the course of the study, as well as over the last 55 years by making comparisons to previous studies and available museum collections. Long-term studies are essential for detecting shifts in species composition and abundance in stream systems. Quantitative studies over relatively long time periods can provide strongly supported evidence for relative stability or instability of fish assemblages and can reveal potentially catastrophic changes (Stewart et al. 2005). The fish assemblage was further characterized spatially along the course of the stream from the headwaters to the Kentucky/Tennessee border. The overarching goal of this project was to provide useful information for monitoring the conservation status of the unique fish assemblage found in Terrapin Creek.

Methods

Fish Assemblage

Five sites were selected to be sampled for fishes every two months for two consecutive years, as water levels and weather permitted. This included three sites on the mainstem of Terrapin Creek: 1) 200 meters downstream of Kentucky State Route 1485 (TPC.CR1485); 2) 400 meters upstream of Alderdice Road (formerly Carl Brown Road) (TPC.ALDRD); and, 3) 0.25 miles upstream of Kentucky State Route 97 (TPC.RT97). The remaining two stream sites were on West Branch Terrapin Creek approximately 100 meters upstream of Swan Road (TPC.SWNRD), and on East Branch Terrapin Creek approximately 40 meters downstream of Swan Road (TPC.SWRDTR). Three additional sites in wetlands and tributaries were sampled once each to further characterize the status of the watershed. These sites included Beaver Slough downstream of Route 97 (TPC.BVRSL), the wetland adjacent to Terrapin Creek on County Road 1485 (TPC.SWAMP), and the ditch running from this same wetland to Beaver Slough and ultimately to Terrapin Creek (TPC.MUD).

For the quantitative stream sites, a minimum of 100 meters of stream reach was sampled. In the three tributary and wetland sites, sampling continued until the available habitat types were exhausted. Fish sampling was achieved with an ETS pulse D/C backpack electrofisher and 6' x 15' minnow seine with 1/8" mesh. Sites were thoroughly sampled using a combination of seining and backpack electrofishing to ensure a complete representation of fish species richness and composition. Collected fishes were held in an instream live well, identified, and counted in the field, and returned to the stream where collected. Voucher specimens were preserved and deposited in the Southern Illinois University at Carbondale Fluid Vertebrate Collection as a permanent record of species occurrence.

Eight species were also measured to total length to develop length frequency histograms for each taxon. The species measured included seven SGCN in Kentucky: Blacktail Redhorse, *Moxostoma poecilurum*; Least Madtom, *Noturus hildebrandi*; Brown Madtom, *Noturus phaeus*; Gulf Darter, *Etheostoma swaini*; Brighteye Darter, *E. lynceum*; Firebelly Darter, *E. pyrrhogaster*; and Goldstripe Darter, *E. parvipinne*; and one additional species, the Brindled Madtom, *Noturus miurus*. A minimum of 30 individuals were measured at each site, for each species, on each collection date. In cases where more than 30 individuals of a target species were collected, a subsample of at least 30 individuals was measured.

Habitat Evaluation

A Physical Characterization/Water Quality Field Data Sheet, a Habitat Assessment Field Data Sheet – Low Gradient Streams (Barbour et. al. 1999), and a Qualitative Habitat Evaluation Index and Use Assessment Field Sheet (Ohio EPA) were all employed at the three mainstem quantitative seine sites. These habitat analyses provided scoring criteria for instream habitat, riparian quality, channel morphology, etc., so the sites could be directly compared. Only physical measurements and qualitative habitat notes were taken at the headwater, wetland, slough, and ditch sites due to size and/or water body type not being applicable to the quantitative habitat assessment sheets. Water quality and physical descriptive data were taken at the above mentioned sites, as well. Organic and inorganic substrates were classified based on percent coverage of the stream bottom and categorized according to particle diameter as follows: boulder (>60.4 cm), cobble (25.4 – 60.4 cm), pebble (7.6 – 25.4 cm), gravel (0.2 – 7.6 cm), sand (0.074mm – 0.2 cm), and bedrock, silt, muck/mud, and leafpack (no size classes). Depths were taken with a 2 meter graduated staff by wading in a zigzag pattern throughout the sample area and periodically taking a reading. A minimum of 40 depths were recorded in each quantitative area. This method was employed to insure all available depth ranges were represented. Current velocity was measured with a Marsh-McBirney Flo-Mate Model 2000 flow meter at 0.6 of the depth from the surface. Features such as stream morphology types (e.g. riffle, run, and pool), woody debris, and aquatic vegetation were visually estimated. Stream widths and length of sampled area were measured using a standard 100 meter roll tape.

Historic Land Use

To evaluate the land use practices over the last twenty years, Landsat 5 TM imagery for the area was downloaded from GLOVIS website (http://glovis.usgs.gov) for three dates, July 17, 1986, June 26, 1996, and July 24, 2006. Original Landsat data were reduced to watershed extent by vector masking using an ESRI shapefile outlining the HUC 12 boundary for Terrapin Creek Watershed. Raw digital number data were corrected to top of atmosphere reflectance values. Four user defined classes (dense vegetation, light vegetation, bare soil, and water) were created by using region of interest tools with 2D scatter plots and various band ratios. These regions of interest were then used in a minimum distance supervised classification for each of the three sets of images. Change detection analysis was performed between all pairs of images; 1986 – 1996, 1996 – 2006, and 1986 – 2006. Change detection analysis calculates "from – to" status of pixel classification between images and reports these changes in km2 of each class. All image transformations and analyses were performed using ENVI 4.7 software. These results should be viewed as strictly descriptive, as there was no attempt to statistically determine accuracy of the initial image classifications.

Results

Fish Assemblage

A total of 44,405 fishes representing 47 species and 12 families were collected in ten sampling trips between July 2007 and July 2009. The most abundant fish collected overall was the Johnny Darter (*Etheostoma nigrum*), which accounted for just over one-fourth of all of the fishes captured. Creek Chub (*Semotilus atromaculatus*), Bluntnose Minnow (*Pimephales notatus*), Brighteye Darter (*Etheostoma lynceum*), and Bluntface Shiner (*Cyprinella camura*) rounded out the five most abundant species collected over all samples, respectively. The next five most abundant species collected across all samples in Terrapin Creek during this survey included the Firebelly Darter (*Etheosotma pyrrhogaster*), Least Madtom (*Noturus hildebrandi*), Redfin Shiner (*Lythrurus umbratilis*), Western Creek Chubsucker (*Erimyzon claviformis*), and Least Brook Lamprey (*Lampetra aepyptera*), respectively.

Over 90% of the fishes collected during this program were collected at the three lower mainstem sites. This was due to the increased frequency of sampling at the lower sites, but also due to the diminutive size of the stream/water body at other sites. The total catch at the lower three sites was very similar in abundance as well as species composition. Percids ranked very high with Johnny Darter being the most abundant at all three sites, and Brighteye Darter (*Etheostoma lynceum*) and Firebelly Darter (*E. pyrrhogaster*) second most abundant at both Alderdice and RT 97, and sixth highest in abundance at CR 1485. Cyprinids were the next most prevalent group with Bluntface Shiners (*Cyprinella camura*), Bluntnose Minnows (*Pimepahles notatus*), Creek Chubs (*Semotilus atromaculatus*), and Suckermouth Minnows (*Phenacobius mirabilis*) abundant at all three sites. Two ictalurid species, the Least Madtom (*Noturus hildebrandi*) and Brown Madtom (*N. phaeus*), and two sucker species, the Blacktail Redhorse (*Moxostoma poecilurum*) and Western Creek Chubsucker (*Erimyzon claviformis*), were also represented well at these sites.

East Branch, West Branch, and the mud ditch were also similar in the relative abundance of captured fishes. Creek Chub, Johnny Darter, and Western Creek Chubsucker were common at all three sites. However, unlike East and West Branch, the mud ditch and Beaver Slough had a surprisingly high number of Firebelly Darters. The swamp samples were not very speciose and consisted of only centrarchids, including Bluegill (*Lepomis macrochirus*), Warmouth *(L. gulosus*), and Dollar Sunfish (*L. marginatus*). However, five Bantam Sunfish (*L. symmetricus*), were also captured in this remnant wetland. Bantam Sunfish typically inhabit good quality (generally clear and well vegetated) lowland habitats (Etnier and Starnes 1993).

Smith (1994) found that the species composition of the wetlands, headwater, and downstream sites of Terrapin Creek did not differ. Spatial analysis of the relative abundance of the fish community in Terrapin Creek from 2007-2009 showed that the lower three mainstem sites (CR 1485, Alderdice Rd, and Rt. 97), East Branch of Terrapin, and Beaver Slough were indeed similar. However, during this time period, the species assemblage of the swamp, West Branch, and the mud ditch were significantly different than the downstream sites. The difference in these findings could be caused by several factors that are not related to shifts in the overall fish assemblage of the drainage. The 2007-2009 headwater samples, East and West Branch, were taken well upstream of Smith's samples. The headwater samples collected by Smith (1994) were actually at CR 1485, one of the sites considered a lower mainstem site in this study. The wetland sites sampled during each time period were not the same, and in fact, the wetland site sampled during this study in March 2008 was partially drained in April 2008, removing most of the aquatic community. This was likely not the only time this area had been drained, and current management practices may be for a moist-soil unit. West Branch differed significantly from all other stream sites most likely because it is the smallest and appears to be the most impacted. West Branch appears to have recovered the least from channelization and has a very narrow riparian zone with row crop fields on both sides. It is the most prone to drying during low water periods of all of the stream sites, and the fauna consists mostly of pioneer species such as Creek Chub, Bluntnose Minnow, and Western Creek Chubsucker, and tolerant species such as Green Sunfish (*Lepomis cyanellus*). The mud ditch has a similar set of conditions to that of West Branch, with drying conditions occurring when there is not water flowing out of the wetland. This is probably why the relative abundance of these two sites was not significantly different. Beaver Slough is the wetland site sampled by Smith (1994), and this site is spring fed, supporting a more stable aquatic community. The small size of this site, often no more than 1.5 meters wide, lends itself to a more headwater community like that of West Branch. However, with perennial flows, more mainstem species such as Firebelly Darter and Dollar Sunfish are common here as well. In addition, the mud ditch connects Beaver Slough to the swamp, so wetland species such as Banded Pygmy Sunfish (*Elassoma zonatum*) also occur here. This combination of factors is likely what maintains a diverse fish assemblage in Beaver Slough and resembles headwater, swamp, and downstream sites, as observed by Smith (1994) and in this study.

Temporal shifts in the relative abundance of Terrapin Creek fishes over the course of this study (July 2007 – July 2009) were not significant (p>0.05). However, total number of captured specimens varied somewhat between samples and among seasons. The average number of individuals captured across all sample dates would have been approximately 4,400 fishes, with the highest recorded abundance coming during the October 2007 sample (7,223 individuals) and the lowest recorded catch rates on March 2009 (2,976 individuals). For most sample dates, total number of captured fishes differed only by a few hundred individuals from the two year average. These differences were probably more indicative of typical seasonal and annual shifts in the Terrapin Creek fish community. For example, the highest collection dates were typically observed in summer and early fall when young of year fishes are most abundant and most susceptible to the sampling gear used in this study. During the October 2007 sample, young-of year of several species were more prevalent than during any other sample period (e.g. Johnny Darter, Western Creek Chubsucker, Bluntnose Minnow, and Blacktail Redhorse). Young-of year fishes are small enough that they would go through the mesh of the seine during the early spring samples, so are underrepresented during this time period. Normal rates of mortality expected in some of the short lived fishes in Terrapin Creek (e.g. some darter species) have occurred by late fall and winter, further lowering catch rates during the late fall and early spring samples.

Temporal differences in the fish assemblage of Terrapin Creek were further compared qualitatively and quantitatively using data from as early as 1954. Temporal data was sorted based on obvious breaks or patterns in collecting activity, or former surveys (e.g. Smith 1994 and Cicerello 2004). This would lump data from specific time periods to provide a robust enough data set to allow for quantitative comparisons. For the time periods in 1954, 1999-01, and 2005-07, collection data was insufficient for analyses, but informative nonetheless. Collection data from 1954 was not extensive, but did give some insight into the presence, and potential absence, of some of the fish species in Terrapin Creek at the time. The one Bluntface Shiner was the only SGCN vouchered in this sample. Every other species included in this collection is a common, tolerant, or pioneer species. Given the paucity of data from this time period, an accurate description of the assemblage cannot be surmised, but the absence of the other nine SGCN is compelling.

One of the most interesting trends observed in the 1999-2001 data, is this is the first time Bluntnose Minnow, Emerald Shiner (*Notropis atherinoides*), and Mississippi Silvery Minnow (*Hybognathus nuchalis*) were observed in the stream. The immigration of Mississippi Silvery Minnow and Emerald Shiner into the system may have been in response to channelization of both the Obion River and Terrapin Creek. These are typically riverine species that are frequently found in the Mississippi River. Bluntnose Minnow, a common species in small streams throughout eastern North America, may have found its way into the system from waifs in the Mississippi River as well. Bluntnose Minnow is also a tolerant species and may have been able to capitalize on the channelized stream habitat.

The time periods from 1978 – 1984, 1988-1989 (Smith 1994), 2000-2001 (Cicerello 2004), and the data from this study, 2007-2009, were all compared based on relative abundance of captured fishes. The differences in numbers of reported fishes and collection techniques do not allow for comparisons to total number of fishes. Trends in relative abundance could still be detected, despite the differences in sample size. The 1978-84 data used in this comparison are from museum records and may not reflect the actual numbers of fishes collected over this time. The 1988-89 data collected by Smith (1994) is pulled from the unpublished master's thesis, and total number of fish for common and target species were reported, but the total number was not always reported for some of the less common species. For the less common species, museum records were used to fill these gaps. The 2000-01 data came from a quantitative effort by Kentucky State Nature Preserves Commission (Cicerello 2004) and is the actual collection data. For this comparison, the data from 1978-84, 1988-89, and the 2007-09 TREA data was inclusive of all samples at all sites. The monitoring effort by Cicerello in 2000-01 was limited to one site at Alderdice Road, but was compared to the other data sets which encompassed the entire watershed. This decision was made since the Alderdice RD data collected by TREA in 2007-09, when compared to the combined data collected across all sites during this time period, was not signigicantly different (p>0.5). And when comparing the 2000-01 data collected by Cicerllo at Alderdice RD to the 2007-2009 data collected by TREA at Alderdice RD, there was again no significant difference (p>0.5). In addition, Smith (1994) stated that the fauna from this site did not differ from other sites in the watershed during the 1988-89 analysis either.

Johnny Darter was the most commonly collected species across all four time periods. Four other species that were most abundant in all four time periods include Bluntface Shiner, Creek Chub, Brighteye Darter, and Firebelly Darter. When comparing relative abundance across the four time periods, the 2007-09 assemblage was not significantly different than that of any of the historic time periods. The relative abundance of the fish community collected by Cicerello in 2000-01 was also not significantly different than that of the 1988-89 community data collected by Smith. The relative abundance of species pulled from 1978-84 museum record data, however, was significantly different than the relative abundance of fishes collected in 2000-01 and 1978-84 time periods.

Habitat Evaluation

East Branch, West Branch, Alderdice RD, CR 1485, and the RT 97 site could all be characterized as low gradient stream reaches with abundant sand and small gravel substrates, with varying quantities of woody debris. Each sampled section contained at least one riffle-run-pool complex, but each typically had two or more. Habitat was analyzed at the beginning and end of the two year sampling period, as changes in the types and availability of habitat were evident over the course of the study.

Quantitative assessment scores, QHEI and Habitat Assessment, generally decreased from the 2007 to 2009 evaluation. The one obvious exception was the RT 97 QHEI score. QHEI scores are the total habitat “points” out of a possible 100, and the Habitat Assessment Score has a maximum of 200 “points”. These scores do provide a benchmark for stream health, but in the case of Terrapin Creek, they are probably more applicable for monitoring trends. The decrease in the habitat scores is most likely due to the transitional stage this stream appears to be going through. Raw, recently cut banklines, and unstable, embedded substrates lower the habitat evaluation scores, and these attributes are indeed present in Terrapin Creek. Bank sloughage and recently cut banklines are present throughout the stream. Over the course of this study, newly formed or widened point bars became present in the sample reaches, as well as the subsequent scour on the opposite bankline. As banklines shifted, new woody debris and whole trees would be introduced to the system. When trees and woody debris became lodged downstream, cut banks and scour and depostion patterns would change rapidly. These changes in scour and deposition patterns often decreased or increased the amount of pool, run, or riffle habitat in a sample reach, the stream width, velocities, and instream habitat.

Substrates throughout Terrapin Creek were predominantly a mixture of loose sand and gravel, with lesser amounts of silt and clay in the downstream reaches. The sand-gravel mixture was highly unconsolidated, especially after high water events, with field workers often sinking to their knees or hips while sampling. Large woody debris (LWD) was probably one of the most important habitat types available in Terrapin Creek, providing stable substrate for colonization by invertebrates, spawning habitat for fishes, and refuge from high flows. Woody debris was present in every quantitative stream site, and was prevalent upstream and downstream of each site as well.

Habitat in the swamp was typical of a wetland, with no flow, soft, detritus covered mud, and abundant aquatic vegetation in the summer, mostly consisting of Duckweed (*Lemna sp.*). The swamp was divided into two sections by a small berm. The smaller eastern portion of the wetland held water throughout the two year sampling period, while the large open water area to the west was drained in the spring of 2008. The permanent portion on the eastern edge is where sampling took place for this study.

The mud ditch was formed by water running from the wetland to Beaver Slough. Both Beaver Slough and the ditch were less than 1.5 meters wide, with soft silt and sand substrates. Both sites were enclosed in dense canopy cover, with abundant detritus and small woody debris. The water in both sites was relatively clear, with the ditch water being considerably warmer than that of the spring fed Beaver Slough. The water in Beaver Slough is perennial, while that in the ditch is dependent on flows from the wetland. Sampling in the ditch took place shortly after the open wetland was drained, and flow was still adequate to support fishes.

East and West Branch sites were both headwater sites that had intermittent flows in the summer and early fall. Some of the pooled areas in both sites presumably had groundwater influx, as they would remain cool and clear, and continue to support fishes, even after complete isolation.

Historic Land Use

The overall trend recognized from the Landsat images is a loss of dense vegetation (28 km2) and increases in bare soils and light vegetation from 1986 to 2006. This was especially evident in the headwater area of the Terrapin Creek watershed. Areas considered light vegetation in the Landsat images can be old field, pasture, or row crop fields. The increase in light vegetation and bare soil illustrates the transformation of wooded areas to agricultural lands.

Discussion

Despite the changes in land use practices, channelization, and wetland draining, the simple comparison of relative abundance of the Terrapin Creek fish assemblage over time indicates that the fish community may now be fairly stable. Although the relative abundance of fishes reported in 1978-84 and 1988-89 was significantly different than that of the fishes collected in 2000-01, the only two species in greatest conservation need that went down in absolute abundance across sample periods, were the Goldstripe Darter (*Etheostoma parvipinne*) and Central Mudminnow (*Umbra limi*). The total number of Gulf Darters (*Etheostoma swaini*) (n=183) and Dollar Sunfish (n=253) observed in the 2007-09 was also relatively low, when compared to their relative abundance in other time periods. The discrepancy in sampling effort in the wetland and slough would probably account for most of the reduced numbers in Goldstripe Darter, Central Mudminnow, and Dollar Sunfish. The numbers of juvenile Blacktail Redhorse dropped significantly over the course of the 2007-09 study, and Burr and Gerwig (2009) reported missing year classes from previous years in their findings as well. Annual or seasonal fluctuations may impact the number of adults that are able to ascend Terrapin Creek for spawning on successive years, but they appear to maintain a viable population in the stream. The other six SGCN found in Terrapin Creek, including Bluntface Shiner, Brighteye Darter, Brown Madtom, Firebelly Darter, and Least Madtom were all well represented in the most recent sampling period.

Management Implications

The purchase of the Terrapin Creek State Nature Preserve was an important step in conserving this unique fish fauna in Kentucky. As land use practices in this area shift to developed agricultural areas, the persistence of this stream community is still threatened. Semi-annual quantitative sampling is recommended to monitor the Terrapin Creek fish community. Methods set forth in this study and the 2000-01 study (Cicerllo 2004) are quantifiable and repeatable. Continuation of one or both of these protocols at least every five years would allow for detecting temporal shifts in the fish community. Whichever program is implemented in the future, additional effort needs to be included in the wetland and slough areas. The one Lake Chubsucker (Erimyzon succetta) captured in the 2007-09 survey came from the mud ditch, into which the drained wetland was running. This is a significant find for this area of Kentucky, and this species as well as other, obligate wetland species may be overlooked. The permanent wetland habitat, as well as the portion that had been drained, could continue to support rare and important species.

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Comprehensive Wildlife Conservation Strategy: Appendix 3.3, Class Actinopterygii: Priority monitoring needs by taxonomic class.

Conservation status and habitat of the longhead darter, *Percina macrocephala*, in Kinniconick Creek, Kentucky

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Introduction

Percina macrocephala (Cope), the longhead darter, is a large darter found in small to medium upland streams throughout the northern Ohio River basin. However, because of its sporadic distribution and its rarity in most areas of occurrence (Burr and Warren 1986, Etnier and Starnes 1993, Stauffer et al. 1995), it is considered "threatened" or "endangered" in most states in its range; in Ohio it is probably extirpated (Trautman 1981; NatureServe 2009).

In Kentucky this species is listed as "endangered" (KSNPC 2005) and as "S1" (critically imperiled) (Kentucky's Comprehensive Wildlife Conservation Strategy 2005). Percina macrocephala is most common in the upper Green River and Barren River systems (Burr and Warren 1986). It is likely extirpated from the Cumberland, Kentucky, and Big Sandy River drainages (Kirsch 1893, Page 1978, Burr and Warren 1986). *Percina macrocephala* was first documented in Kinniconick Creek by a specimen (UL, now SIUC) collected in 1938 and later by seven specimens collected by L. Kornman in 1981 from three sites (Warren and Cicerello 1983). Geographic variation has been noted in this species; the Kinniconick population is the only one in the state belonging to an upper Ohio group (Page 1978). Prior to this study, however, the distribution and abundance of this species in Kinniconick Creek was uncertain. Despite Warren and Cicerello's statement that Kinniconick Creek has a "healthy" population, no additional specimens were reported from there prior to this survey.

Most habitat descriptions for *P. macrocephala* or its sister species, *P. williamsi* (Page and Near 2007), are limited to anecdotal accounts (Page 1978, Etnier and Starnes 1993, Jenkins and Burkhead 1994, Stauffer et al. 1995). The single quantitative study of *P. macrocephala* habitat, from Elk River, West Virginia, is based on few observations (Welsh and Perry 1998). An additional study from the Little River, Tennessee (Greenberg 1991) offers some habitat and behavioral descriptions of *P. williamsi*. Habitat has been described as silt-free pools and raceways of small to large upland rivers. The species typically avoids turbid streams and is often associated with boulders, coarse woody debris, or vegetation.

Documentation of the range and abundance of this species provides information on its current status in the creek and baseline data for comparison with later status surveys. Assessment of required habitat is important in examining how changes in the use of the watershed affect this fish.

Objectives

We surveyed Kinniconick Creek, Lewis County, Kentucky from early summer to mid-fall of 2007 and 2008 for the longhead darter, Percina macrocephala. Our goals were, for *P. macrocephala* in Kinniconick Creek: (1) to determine its distribution; (2) to es-

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timate its population size; (3) to quantitatively describe its preferred habitat. These data are compared with historical data and observed habitat conditions to determine (1) changes in population size or range in Kinniconick Creek and (2) primary threats to this species in Kinniconick Creek.

Methods

Sampling station set-up

We surveyed, via canoe, 69 stream km (55 in 2007, 14 in 2008) to set up 198 sampling stations. Our sampling stations (reaches) were defined as the crest of one riffle to the crest of the next riffle, and requiring that the reach contains a pool. Reach length ranged from 36 to 3000 m. Because of time and other logistic constraints and results from some preliminary sampling, we sampled for darters only in the lower 54 stream km (155 reaches), in an area bound from the town of Kinniconick to Garrison. One of every three reaches was randomly chosen, using a stratified random sampling method (Brown and Austen 1996), to be surveyed for *P. macrocephala* by snorkeling, so that a total of 55 reaches were snorkeled (41 in 2007, 14 in 2008). Of these 55 reaches, 14 also were sampled by shocking and seining to evaluate the effectiveness of snorkeling.

Darter surveys

Snorkeling was accomplished by two persons moving parallel upstream through a reach. Positions of observed *P. macrocephala* were marked with a weighted flag. If multiple darters were found in a small area (< 1 m2), only one flag was dropped but the minimum numbers of darters were recorded. For reaches less than 120 m in length, the entire reach was sampled. Longer reaches were subsampled by snorkeling 40 m at each end of the reach and 40 m about in the middle of the reach. All other species observed while snorkeling were recorded for community comparisons.

For reaches that also were sampled by backpack electrofishing and seining, the same distances were sampled. Sampling methodology of seining and electrofishing followed guidelines of KDOW (2008). All fishes were identified and Kentucky Index of Biotic Integrity (KIBI) scores were calculated according to Compton et al. (2003).

Habitat analyses

Macrohabitat and microhabitat variables were collected and analyzed with methods similar to those Mattingly and Galat (2002) used for *Etheostoma nianguae*. For each reach snorkeled, we collected the following variables: length (m), width (m), depth (m), water temp (°C), dissolved O2 (mg/L), pH, conductivity (µS/cm), turbidity (NTU), substrate, siltation, embeddedness, species richness, KIBI (shock+seine reaches only) (Compton et al. 2003), and watershed area.

Substrate composition was estimated for the entire reach as percent sand (0.06-2 mm), gravel (2-64 mm), cobble (64-256 mm), boulder (>256 mm), and bedrock. There were collapsed into a single variable, average mean particle diameter. An additional habitat variable was calculated according to the methods described by Bain (1985), which assigns each substrate category a number (bedrock = 1, sand = 2, gravel = 3, cobble = 4, and boulder = 5) and them multiplies each by the percent occurrence of the corresponding substrate, giving a substrate score range of 1 (100% bedrock) to 5 (100% boulder).

When *P. macrocephala* was found, we collected microhabitat variables at the point of observation and in randomly chosen, nearby areas that we sampled, but did not contain *P. macrocephala*. These variables were depth (m), current velocity (m/s), substrate (mean particle size), siltation, and embeddedness. Substrate was measured with a 1 m2 grid centered over the flag. The grid was divided into 16 sections; the dominant substrate type was recorded for each section. Depth and flow were measured at each corner of the grid. Level of siltation was classified as < 1 mm, 0.5-2 mm, or > 2 mm. Embeddedness was classified as < 33% of coarse substrates embedded with silt and sand, 33-67% embedded, or > 67% embedded.

Data analysis was performed using SAS 9.01 and followed methods used by Mattingly and Galat (2002) and Osier and Welsh (2007) for univariate and multivariate comparisons, respectively. Variables with strongly non-normal distributions (e.g., flow) were log-transformed. Univariate comparison of macrohabitat and microhabitat use was evaluated with t-tests (which examines differences in means of reaches or microhabitats with and without P. macrocephala) and Fisher's exact test (a goodness-of-fit test that tests for nonrandom habitat use). Multivariate comparisons were evaluated with principal component analysis (PCA). Mean differences of scores along a single PC axis or multiple PC axes were evaluated with analysis of variance (ANOVA) and multiple analysis of variance (MANOVA), respectively.

Results

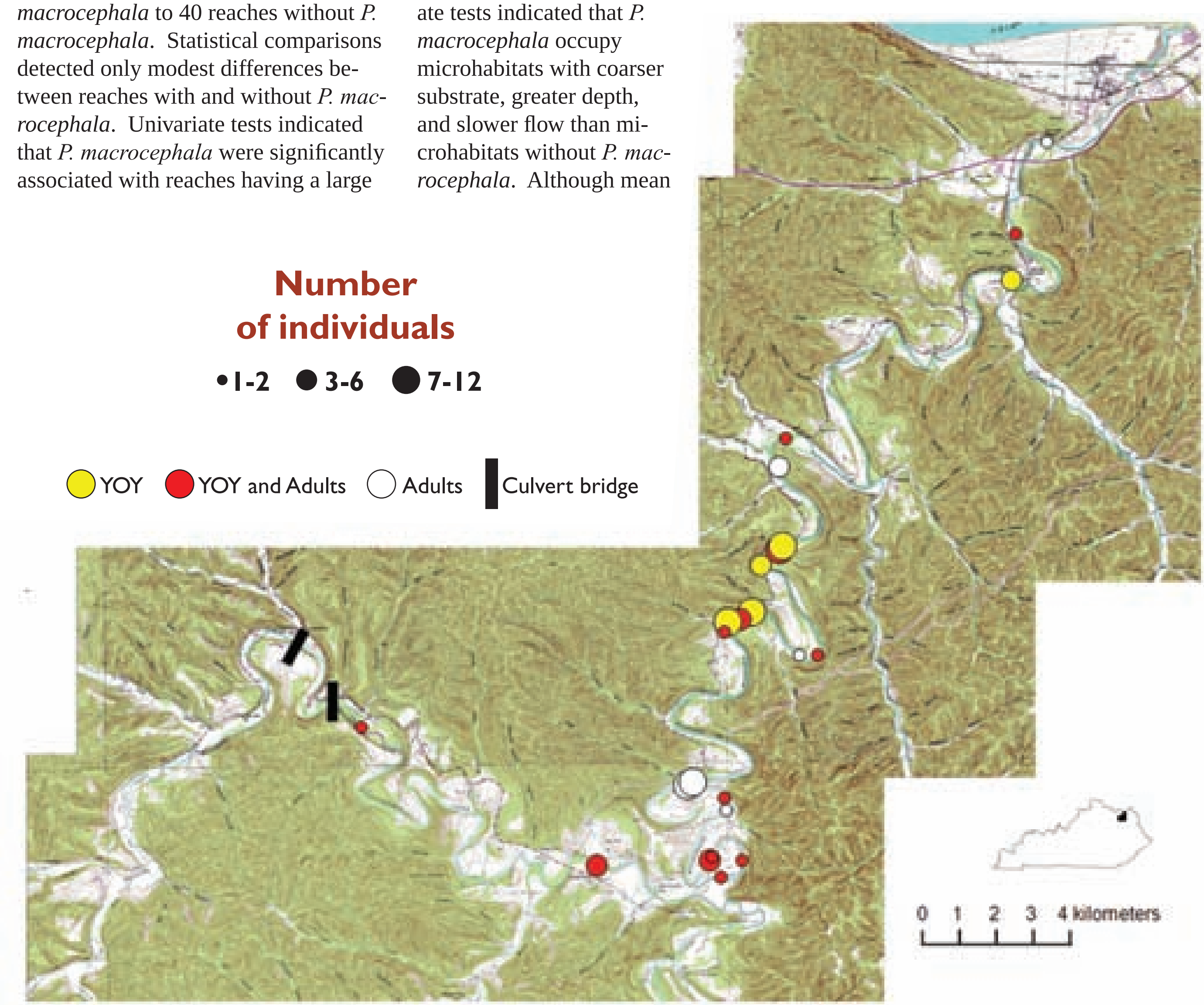
Darter survey

We found *P. macrocephala* in 15 of the 55 reaches sampled. This extends the known range in Kinniconick Creek to 50 stream km. Most longhead darters were found in the middle part of Kinniconick Creek, between the mouths of Laurel Fork and Town Branch. A total of 104 P. macrocephala were encountered, which included 65 individuals from sampled reaches and 39 additional individuals observed, often from canoe or while wading, in reaches not sampled or in portions of reaches not sampled. Both young-of-the-year and subadults-adults were found; most of the young-of-the-year were found in the lower part of the sampled region. Also, during the course of this study, R. Cicerello and R. Evans, while surveying Kinniconick Creek for mussels, observed *P. macrocephala* at four sites. Visibility (lateral Secchi disk distance) was not significantly different (t-test, P=0.1851) between reaches with and without P. macrocephala, suggesting differences of visibility among reaches did not affect our ability to detect darters while snorkeling.

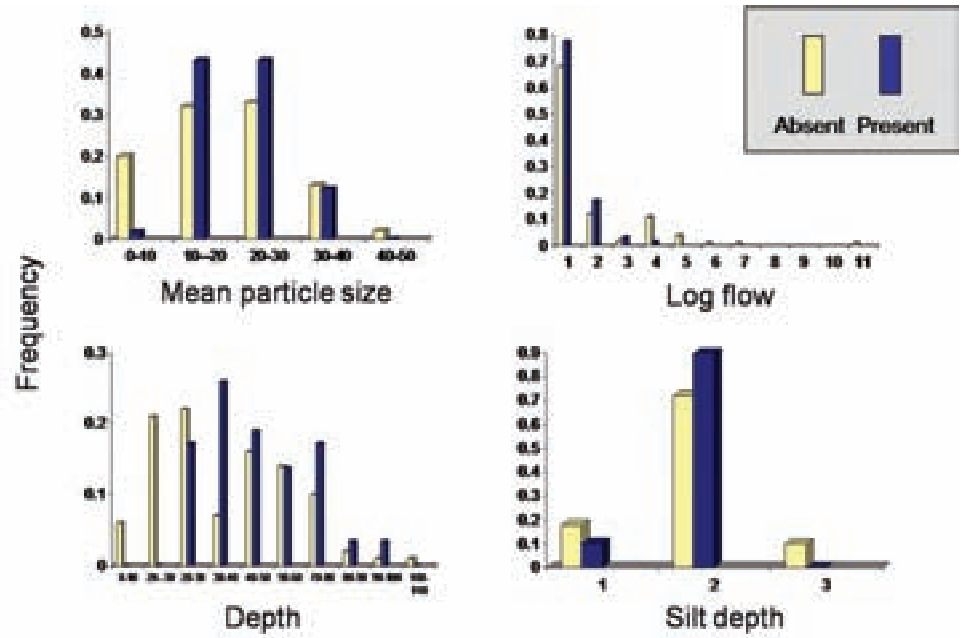
Habitat analysis

Analysis of macrohabitat compared variables from 15 reaches with *P. macrocephala* to 40 reaches without *P. macrocephala*. Statistical comparisons detected only modest differences between reaches with and without *P. macrocephala*. Univariate tests indicated that *P. macrocephala* were significantly associated with reaches having a large watershed area (P=0.0093) and high mean width (P=0.0133). Multivariate comparisons were similar, indicating P. macrocephala tended to occupy more downstream reaches that are relatively deep, wide, and long with high turbidity and coarse substrates, although discrimination was not strong. No reach-level variables were significant in comparisons of reaches containing adults vs. YOY.

Analysis of microhabitat compared measurements from 58 points (1 m2) with *P. macrocephala* to 100 points without *P. macrocephala*. Univariate tests indicated that *P. macrocephala* occupy microhabitats with coarser substrate, greater depth, and slower flow than microhabitats without *P. macrocephala*. Although mean silt depth did not differ in microhabitats with and without *P. macrocephala* (e.g., not significant with a t-test), usage of silted habitats was highly nonrandom (P=0.0076). That is, *P. macrocephala* tended to occupy areas of moderate silt, but avoided highly silted areas and highly "clean" areas. Multivariate comparisons were similar, indicating *P. macrocephala* used microhabitats with low flow and high depth. A MANOVA of PC 1 and PC 3 also indicates nonrandom microhabitat use (P=0.0038). Adults occupied slightly greater depths than YOY (P=0.0063)



Records of adult and YOY P. macrocephala from Kinniconick Creek, Lewis County, 2007-2008.



Frequency histograms of microhabitat variables significantly associated with P. macrocephala absence-presence.

Overall health of fish communities did not differ between reaches with and without *P. macrocephala* for KIBI scores or species richness. Fishes commonly associated with *P. macrocephala* were the minnows *L. chrysocephalus*, *L. fasciolaris*, and *P. notatus*, a centrarchid, *L. megalotis*, and the darters *E. blennioides*, *E. caeruleum*, *E. camurum, E. zonale, P. caprodes*, and *P. maculata*.

Discussion

Status in Kinniconick Creek

Prior to this survey, *P. macrocephala* was known from only eight specimens, mostly collected by L. Kornman in 1981 (Warren and Cicerello 1983) from a 25 stream km reach. We document the species from about 50 stream km and conservatively estimate the total population in Kinniconick Creek to be 2000-5000 (given we snorkeled 5.7 km and assuming we saw 20-50% of the individuals present in sections sampled). There is no evidence to suggest that *P. macrocephala* has declined in Kinniconick Creek. We judge *P. macrocephala* to be uncommon to locally common in Kinniconick Creek below the mouth of Laurel Fork and rare above the mouth of Laurel Fork.

The population of *P. macrocephala* in Kinniconick Creek is likely one of the most robust in the state. Although this species formerly was common and widespread in the upper Green and Barren River systems (Page 1983), it has apparently declined there. The only recent collections from these systems that we are aware of are three specimens collected by DJE in 2005 in Russel Creek and one specimen collected by Matt Thomas (pers. comm.) in 2007 in the Green River mainstem. Although this study documented a Kinniconick population larger than previously presumed and relatively stable, *P. macrocephala* is still uncommon there, and except for E. variatum, the rarest darter in Kinniconick Creek. We recommend maintaining the "endangered" status of this species in the state.

Habitat

Kinniconick Creek experienced severe drought during the summer and early fall of 2007 and 2008, with record to near-record low flows recorded at the USGS gauging station (03237255, at Tannery) throughout the sampling period. Flows fell to zero, or nearly so, by mid-July in 2007 and by late August in 2008. At this time, lower Kinniconick Creek (below mouth of Laurel Fork) flow was mainly interstitial seepage through riffles; upper Kinniconick Creek consisted of isolated pools, with intervening, completely dewatered sections as long as 500 m. Low flow associated with drought likely caused increased silt build-up in raceways and other low-flow microhabitats. Thus, our finding of *P. macrocephala* occupying areas of "moderate silt" might reflect association with certain flow-depth microhabitats, instead of "preferring" moderate silt. We often found P. macrocephala in fairly shallow areas near riffles: areas that had no or almost no current at very low streamflow (as in a severe drought), but would be expected to have stronger current at higher, "normal" streamflow. Thus at more "normal" flow conditions, we expect to find *P. macrocephala* in slight, but measurable flow instead of areas with zero flow.

In summary these darters most frequently occur in areas just above riffles, where there is little to zero flow (but flow nearby), low silt, abundant boulders and cobbles, and depths of 0.4-0.8 m. We occasionally encountered *P. macrocephala* below riffles and rarely encountered them in the middle of long pools, usually when shallow water (a "saddle") created slight flow. Most longhead darters were found in the lower and middle portions of Kinniconick Creek, which typically had a substrate with more boulders, larger, deeper pools, and cleaner substrates. We are unsure whether this means they are more successful in the deeper, boulder habitat, or it merely reflects an association with larger stream size.

Habitat usage of *P. macrocephala* is similar to that reported for this spe-

Microhabitat of P. macrocephala *in Kinniconick Creek. Left is in a long raceway. Right is a pool-riffle transition with points 3.7, 5.0, and 12.3 m above crest of riffle. Arrows show location of darters./David J. Eisenhour*

cies in the Elk River, West Virginia (Welsh and Perry 1998) and for *P. williamsi* (the sister species of *P. macrocephala*) in Little River, Tennessee (Greenberg 1991). Both previous studies documented usage of areas with slow flow, depths of 0.4-0.8 m, coarse substrates, and moderately-high relative siltation, often in riffle-pool transitions. Welsh and Perry (1998) found *P. macrocephala* to occupy faster currents (10-20 cm/sec) than in our study (mean = 2.7 cm/sec); however severe drought during our study resulted in little flowing water outside of shallow riffles.

Management implications

1. Snorkeling is the most effective sampling technique.

Most longhead darters (74%) were seen while snorkeling, but some were seen while canoeing or wading (20%), and a few were captured by electrofishing or seining (6%). These darters are large and often suspend themselves in midwater, making them fairly easy to see by snorkeling or from the surface. In many cases we saw numerous *P. macrocephala* while snorkeling, but were unable to collect any with a seine or backpack electrofisher. In some cases, we observed *P. macrocephala* moving away from an active backpack electrofisher, apparently sensing the electrical field from a distance and escaping before they could be stunned, as do pelagic minnows.

2. Percina macrocephala is probably very sensitive to siltation.—Siltation is one of the most important commonly cited reasons for decline of stream fish communities (Helfman 2007) and reduction of silt is usually recommended in management of jeopardized fish species. We propose, however, that this species is particularly vulnerable to siltation. The pools and slow raceways that this species occupies would be affected by sediment deposition earlier than riffles, where most darters and benthic fishes reside. Etnier and Starnes (1993) noted declines in pool-inhabiting darters *Etheostoma cinereum* (ashy darter), *Etheostoma marmorpinnum* (marbled darter), and *Percina williamsi* in the Little River, Tennessee, but no similar decline in riffle-inhabiting darters.

Although *P. macrocephala* commonly hovers in the water column, it gleans food from the substrate. We observed this species searching for prey while suspended slightly head-down, 5-20 cm above the substrate. Prey, including dragonfly and stonefly nymphs, was captured with a sudden dart down to boulder and cobble substrates. Increased silt input can be harmful to *P. macrocephala* by (1) reducing benthic invertebrate populations via increased sedimentation, and (2) reduced visibility from increased turbidity.

Our qualitative assessment from this study is that siltation is a slight to moderate, but not major problem in the mainstem of Kinniconick Creek. Urban development and agriculture occupies little of the watershed, but is responsible for some silt input. Removal of riparian vegetation and bank collapse, often due to cattle access, is most common along upper portions of Kinniconick Creek. Immediately below these damaged riparian zones are patches of dense algal growth (indicating eutrophication) and increased turbidity. The most important disturbance and source of sedimentation is channelization and gravel mining of the tributaries, especially Laurel Fork and Grassy Fork. McDowell Creek is a source of considerable sediment in the lowermost portion of Kinniconick Creek (R. Evans, pers. comm.). Most other small tributaries to lower Kinniconick Creek (e.g., Town Branch, Spy Run) have been straightened and deepened; we observed some to be "dug out" multiple times in a single field season. In Laurel Fork and Grassy Fork (and occasionally upper Kinniconick Creek) we observed active gravel mining and stockpiling, with heavy equipment (bulldozers, dump trucks, backhoes) occasionally in the creek bed.

Some efforts are currently employed to reduce siltation in the watershed. First, a section with eroding and devegetated banks at the junction of Indian and Kinniconick creeks is undergoing restoration, which should reduce silt input from that source (J. Zimmerman, pers. comm.). Second, some action has been taken by KDOW to stop illegal gravel mining in Laurel Fork. We applaud these actions and strongly recommend continued monitoring, protection, and restoration of streams of the watershed.

3. Road crossings should allow instream movements of darters.—In Kinniconick Creek, *Percina macrocephala* likely exists as a metapopulation, with small, local groups of individuals partly isolated by stretches with unfavorable habitat (e.g., long, deep pools or long, steep riffles). Our sampling occurred in two years with severe summer droughts, perhaps creating unusually poor quality habitat for *P. macrocephala* in upper Kinniconick Creek. We suspect that periodic extirpations occur in this portion of the stream during severe droughts; immigration from downstream areas is needed for recolonization. In addition, the distribution of adult and young *P. macrocephala* strongly suggest that source-sink dynamics (Pulliam 1988, Dias 1996) are present. Downstream areas, which have a high density of *P. macrocephala* and evidence of successful reproduction, likely harbor a "source" population that supplements populations by migration in upper Kinniconick Creek, a "sink." The upper Kinniconick populations may require immigration to supplement limited reproduction (acting as a "pseudosink") or no reproduction (acting as a true sink).

Some road crossings and other anthropogenic disturbances can affect fish movements by blocking or limiting migration (Warren and Pardew 1998, Schaefer et al. 2003). Many road crossings over Kinniconick Creek are high bridges, such as those over KY 10 and KY 59, which are not barriers for fish movement. However, two at the upstream limit of *P. macrocephala*'s range in Kinniconick Creek are low-water concrete bridges with hanging culverts. Upstream passage by fishes is impossible at low water, and difficult at high water, because flow is funneled through the culverts, creating rapid currents with no cover. Warren and Purdew (1998) and Schaefer et al. (2003) found that road culverts limited fish movements much more than other types of road crossings. We suggest that construction of road crossings be engineered to ensure that they permit upstream and downstream movement of fishes.

4. Priority protection.—If certain sections of reaches of Kinniconick Creek are to be protected, we suggest the middle section, between the mouth of Laurel Fork and Town Branch. This area has the least development, the "best" habitat (clear water, coarse, clean substrates, and good riparian vegetation), and the highest concentrations of *P. macrocephala*. In addition, this is the only section where we encountered another rare fish (*Notropis ariommus*, the popeye shiner), and where we most frequently observed live mussels.

Acknowledgments

This project was inspired by discussions with Lew Kornman (Kentucky Department of Fish and Wildlife Resources (KDFWR)), who "rediscovered" P. macrocephala in Kinniconick Creek in the 1980s. We wish to thank the following individuals for assisting in fieldwork: R. Broadway, J. D. Eisenhour, L. V. Eisenhour, T. Evans, A. J. Farwick, S. Fryman, J. Taylor, M. Thomas, and J. Thompson. R. Cicerello and R. Evans graciously provided records of *P. macrocephala* observed while snorkeling for mussels in 2007. Funding was provided by the State Wildlife Grants Program, administered via KDFWR. Permits to work with fishes were provided by KDFWR and Morehead State University IACUC.

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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 project #1.

Status Survey of the Northern Madtom, *Noturus stigmous*, in the Lower Ohio River

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KDFWR Contact: *Ryan Oster*

Introduction

The Northern Madtom is a small, secretive inhabitant of large creeks and rivers where there is moderate to swift flows, and clean sand and gravel substrates (Etnier and Starnes 1993). This species is sporadic and uncommon in every state in which it occurs, and is disappearing from the margins of its range (Page and Burr 1991, Thomas and Burr 2004, Scheibly et. al. 2008). In Kentucky, the Northern Madtom is listed as special concern by KDFWR's Comprehensive Wildlife Conservation Strategy, had a global rank of G3 (Vulnerable), and is considered a Species of Greatest Conservation Need (SGCN) (KSNPC 2000).

The Northern Madtom is sporadic and rare in the upper Kentucky, and Big Sandy, with isolated but apparently stable populations in the Licking and Salt Rivers (Burr and Warren 1986), and appears to be extirpated from the upper Green River. In the Ohio River there were only three records of this species before 1997. However, since 1997, Northern Madtom specimens have been collected four times from the lower Ohio River bordering Kentucky. These recent collections and ongoing sampling activities in the lower Ohio River indicate that the Northern Madtom may be much more abundant in these Kentucky waters than previously thought. This population has likely been overlooked for many years due to difficulty sampling small, benthic fishes in large, dynamic systems such as the Ohio River. Other factors may include the seasons and times in which sampling took place, as well as sampling gear selectivity.

The collection of baseline data for this species was also significant at this time due to the construction of the new lock and dam near Olmstead, Illinois at RM 964.4. This structure is within the area these fishes have most recently been found. The effects of this dam will be increased depth and reduced flows upstream, altered hydraulic regimen immediately downstream, and altered navigational patterns (Payne and Miller 2002). These shifts in river hydraulics impact sedimentation, substrate composition and substrate stability, all of which are crucial factors for benthic species.

Methods

Sampling for Northern Madtoms was conducted in five sections of the lower Ohio River between Smithland Dam and the confluence of the Ohio and Mississippi Rivers. Four of these sample sections included areas where specimens were recently encountered;

Northern Madtom / Matt Thomas

one below Lock and Dam 53, and three between Lock and Dam nos. 52 and 53. The fifth section was between Lock and Dam 52 and Smithland Lock and Dam. Below Lock and Dam 53, sampling was conducted throughout a seven mile reach including River Miles (RM) 966-973. This is in the area of Olmstead and Mound City, Illinois. The three sampled sections between Lock and Dam 52 and 53 included a six mile reach near Grand Chain, Illinois from RM 955-961; a nine mile reach near Joppa, Illinois from RM 945-954; and, a six mile reach near Metropolis, Illinois from RM 939-945. Sampling locations between Lock and Dam 52 and Smithland Lock and Dam were scattered due to the scarcity of habitats likely to harbor Northern Madtoms.

Sample sites were selected by reconnoitering an area to locate clean gravel/cobble/sand substrates with at least a minimal amount of flow that could be effectively sampled. Substrates in potential sample areas were evaluated with repeated ponar grabs throughout the reach. Areas with higher flows and coarser substrates that were less embedded were given preference. These areas were usually less than 20 feet deep along gravel bars (e.g. American Bar, Grand Chain Bar, Sharps Bar, Little Chain Bar, etc), tributary mouths, or the main channel border.

Sampling was conducted with a 4'x 8' benthic trawl in non-wadeable habitats at varying depths and distances from shore. A pulse D/C electrofishing system was fitted to the benthic trawl to enhance sampling efficacy. Each trawl site consisted of a minimum of three minutes of downstream trawling, with sample time starting once the trawl was effectively deployed (i.e. on the bottom and opened). Wadeable habitats were further sampled with a backpack electrofisher and 6' x 15' minnow seine with 1/8" mesh. Seine sites typically consisted of ten hauls or kick sets at a site. Less hauls were taken at sites where good habitat was present, but the wadeable area of the site was small. Sampling effort was quantified by time, area, number of seine hauls, and/or number of trawl hauls, to facilitate comparisons among and within sample sections, as well as to future sampling efforts.

Sampling was conducted during September and October 2008, and March and July 2009. Winter and spring sampling was limited due to the prolonged high water event from December to June 2009. Sampling was conducted at night, as well as in the day, as madtoms are nocturnal in their habits and are more readily collected at night (Burr and Stoeckel 1999.)

Non-lethal sampling procedures were used and handling of SGCN was kept to a minimum to avoid mortality. Each Northern Madtom was enumerated, measured to total length, and released. All other species were also enumerated to characterize the fish assemblage associated with the Northern Madtom, and further facilitate monitoring efforts in the lower Ohio River. All vouchered specimens were deposited in the Southern Illinois University Fluid Vertebrate Collection.

Habitats were quantitatively and qualitatively assessed at sites where Northern Madtoms were collected and habitats were qualitatively described for areas where the species did not occur. Habitat parameters measured included water temperature, water velocity, substrate composition, depth of habitat, depth of capture (if discernable), instream cover, and perceived threats. Substrate categories included boulder (>256 mm), cobble (964-256 mm), gravel (2-64 mm), sand (0.06-22 mm), clay, detritus, muck-mud, and marl. Sample sites were georeferenced with a handheld Global Positioning System receiver.

Results

A total of 154 trawl sites and 23 seine sites were sampled to determine the current distribution of the Northern Madtom in lower Ohio River in 2008-2009. The number of sites per sample reach was proportionate to the amount of appropriate habitat. Extensive bars and gravel in main channel border habitat were most prevalent in the lower three sample reaches (below LD 53, Grand Chain area, and Joppa area), so a relatively high amount of effort was expended here. In addition, the recent collections of Northern Madtoms by SIUC, IDNR, and TREA were between Lock and Dam 53 and Lock and Dam 52. The reach in the area of Metropolis is characterized by sandier substrates, as evidenced by the repetitive dredging in this reach, but some gravel habitats are present below the dam and along bars and channel borders. The entire pool from Lock and Dam 52 to Smithland Dam was examined for likely habitats by taking flow measurements and using ponar samples to determine substrates. Flows throughout the pool were sluggish to none, with the exception of the area immediately below Smithland Dam. The bedrock outcrops below the dam, were the only significant rocky substrates encountered throughout the remainder of the pool except revetment or river training structures. Although it is quite likely that Northern Madtoms could thrive in the bedrock outcrops below Smithland Dam, no feasible means could be determined to sample this area. With the relative absence of quality habitat elsewhere, few samples were taken in this reach.

Sampling was conducted during September and October 2008, and March and July 2009. Winter and spring sampling was limited due to the prolonged high water event from early December to June 2009. During this time, water levels never dropped to ideal or even marginal levels for effective sampling, however, during the lowest levels in mid-March 2009, trawling and seining was conducted in near shore habitats.

A total of 3,649 fishes representing 55 species and one hybrid in 13 families were captured during this survey. The most commonly captured fishes were Freshwater Drum (*Aplodinotus grunniens*), Channel Catfish (*Ictalurus punctatus*), Silver Chub (*Macrhybopsis storeriana*), River Darter (*Percina shumardi*), Gizzard Shad (*Dorosoma cepedianum*), and Logperch (*Percina caprodes*).

However, a total of only 28 Northern Madtoms were collected during these sampling trips. Nineteen were captured in the pool between Lock and Dam 52 and 53, and 9 were collected downstream of Lock and Dam 53. No Northern Madtoms were collected between Lock and Dam 52 and Smithland Lock and Dam. Sizes of collected Northern Madtoms ranged from 29-61 mm, with a single gravid female collected on 25 July 2009.

20 of the 28 collected Northern Madtoms were captured in night-time trawls, with only 4 captured in daytime trawls. Two Northern Madtoms were collected during the one nighttime seine sample and two were collected in the other 23 daytime seine samples.

Northern Madtoms were captured in as little as a few inches of water to depths of 14 feet, with sample sites encompassing areas nearly 25 feet deep. The average depth at positive sites (sites where Northern Madtoms were captured) was 5.5 feet, with the shallowest site being a seine site in less than 8 inches of water. The average depth at sites without Northern Madtoms was slightly higher, 7.4 feet, with considerable overlap in sampled depths between sites with and without individuals being collected. Average flows where Northern Madtoms were found did not significantly differ from areas where they were not collected, 0.28 m/sec and 0.32 m/sec, respectively. Northern Madtoms were found in flows as low as 0.03 m/sec and in swift currents as high as 0.68 m/sec.

Nearly all sampled sites contained sand, gravel, and cobble substrates, with less than 10% of sites containing silt, detritus, clay, or boulder. Positive sites always had some combination of sand, gravel, or cobble substrates, but some areas with what appeared to be identical, suitable habitat yielded no Northern Madtoms.

Discussion

A number of reasons were suspected as to why the collections of the Northern Madtom in the lower Ohio River have been so rare. Sampling difficulty is one of the primary barriers to determining the current population status of this cryptic species. Due to the nocturnal habits of madtoms, the number of captured specimens per unit effort was five times higher in nighttime trawl hauls versus daytime trawls (20 captured at night vs. 4 during the day). This is even more significant when considering 105 of the 154 (68%) of the trawl sites during this survey were during the day. On several occasions, a site sampled during the day would yield no Northern Madtoms, but when sampled immediately after sunset, one or two individuals would be captured in the same locality. In addition, the only seine site conducted at night yielded two Northern Madtoms, while the 23 combined day seine sites yielded only two individuals as well. Night trawls and day trawls were conducted in the same areas. The species is likely buried in the substrate during the daylight hours, and the ventures out to forage only at night. Trawl hauls during daytime hours may drag over the top of buried madtoms; the trawl being unable to dig them out of substrates. Night trawling was conducted during this survey on every sample date, but trawling at night is difficult and dangerous in these river channel habitats with sharply varying depths, barge traffic, motor hazards, snags, etc. Night sites were carefully scouted during the day and a course was laid with a Global Positioning System, but snags, shallow humps, and floating debris still proved difficult to maneuver around in nighttime situations.

Sampling ability was also one of the limiting factors in accurately characterizing the population below Smithland Dam. The bedrock outcrops have extensive interstitial spaces, good flow, and abundant aquatic invertebrate colonization. However, the jagged, irregular, configuration of the substrate with abrupt depth changes make sampling for these fishes nearly impossible.

A second factor influencing the lack of information on this species seems to be the paucity of quality habitat. Northern Madtoms typically prefer gravel/cobble substrates with swift flows. The remaining gravel habitats in the lower Ohio are mostly in nonwadeable habitats along the main channel border. These habitats are often the result of dredge material placement for maintenance of the navigation channel, as opposed to naturally forming gravel bars from natural river processes. Reduced flows in much of this stretch of the Ohio River, especially above Lock and Dam 52, has caused habitat to become embedded from sand deposition, leaving only pockets of functional gravel habitats preferred by Northern Madtoms. Locating these isolated pockets is very difficult, causing much of the sample time to be spent over marginal to inadequate habitats.

An earlier concern with the low catch rates of Northern Madtoms was gear selectivity. Capturing these small benthic fish on the bottom of such a large body of water is challenging. The addition of the electrofishing capability to the trawl seemed to be effective, as other catfishes, including Blue and Channel Catfish, were often stunned in the cod end of the trawl. In addition, when examining the most abundant taxa captured in this study, five of the six most prevalent species were benthic. These included two darters, River Darter and Logperch, Channel Catfish, Freshwater Drum, and Silver Chub.

The only non-benthic species found in the top five captured species was the Gizzard Shad. This species is very abundant in the Ohio River, accounting for its high relative abundance in these samples. Given that the relative abundance of captured fishes was so skewed toward the benthic community, a more effective gear type for these conditions may be difficult to design.

The unionid mussel community may play an important role to the Northern Madtom in the lower Ohio River, providing interstitial spaces for hiding and foraging, as well as cavities for spawning. The successful collections of Northern Madtoms made near Joppa, Illinois in the mid 1990's were when water levels were extremely low and the mussel beds typically under many feet of water could be sampled with seines and backpack electrofishers (B.M. Burr pers.comm.). It was among these mussel beds that Northern Madtoms were found. In addition, U.S. Army Corps of Engineers personnel diving for unionid mussels downstream of Olmstead on 5 September 2007, found Northern Madtoms in two different moribund unionid mussel shells. The two shells with madtoms in them were collected in deep water along the main channel border (Steven George pers. comm.) Northern Madtoms tucked into unionid mussel shells buried in the river bottom may further lessen the efficacy of trawls or seines to capture this species.

Artificial substrates such as river training structures or revetment are also utilized by Northern Madtoms in this stretch of river. Two of the sites which specimens were collected in previous years were near Grand Chain and upstream of the Joppa boat ramp. Both of these sites consisted of man-made rock dikes. The Grand Chain specimen, collected by IDNR just downstream of the Grand Chain boat launch, came from a pile of large rocks on the upstream side of a private boat launch. Upstream of the city Joppa boat ramp, the specimen was collected while seining at an old wing dike by TREA personnel. It was collected during high water and had moved up to where the top of the structure keys into the shore. This area is typically far out of the water. Subsequent efforts during this survey to capture individuals at these sites were unsuccessful.

In addition to the sampling conducted during this survey, supplementary data on the current population of Northern Madtoms in the lower Ohio River came from monitoring of the impingement mortality at the Tennessee Valley Authority's Shawnee Steam Plant just downstream of Metropolis, Illinois on the Kentucky shore. Under Section 316(b) of the Clean Water Act, the impingement mortality of fish and shellfish was characterized at all facilities in the United States that, on average, withdraw 50 million or more gallons of water per day from their respective source water body. A total of 38, twenty-four hour samples were collected at the Shawnee Steam Plant from June 2005 to June 2007. From these samples, 82 Northern Madtoms were observed among the impinged fishes (Joe Vondruska pers. comm.). Over two-thirds of the Northern Madtoms impinged on the traveling screens at this facility were during the month of January. The remaining one-third of impinged Northern Madtoms was made up of one to three individuals per date throughout the remainder of the year. Nearly 80% of the Northern Madtoms that were impinged and washed off of the screens were alive and apparently healthy enough to survive as they were collected in the return outlet to the Ohio River.

If a simple extrapolation from these 38 collection dates is done (not taking into account any of the numerous variables affecting impingement rates at this particular facility) an estimate of nearly 2.15 Northern Madtoms per day are impinged. Over the course of a year, using this extrapolation, nearly 800 Northern Madtoms are washed off of the traveling screens per year. At the Shawnee Steam Plant, the outfall channel and the intake channel are also widely separated, so it is unlikely that the same individuals come through the system repeatedly during collection periods. Although this data suggests that the rate of impingement of Northern Madtoms may be high at the Shawnee Steam Plant, it also suggests that the population may be more robust than this study and previous sampling were able to show.

The habitat in the intake channel at Shawnee is largely a silt bottomed canal oriented perpendicular to the Ohio River. This canal fills with sediment to the point it requires periodic dredging to maintain ample depth from the river to the plant. There are large metal bar racks where water first enters the plant. Woody debris, detritus, leafpack, and organic and inorganic matter often collect along these racks. The debris in front of the racks was colonized by many groups of invertebrates, which were observed when pieces broke loose and were washed in with the impingement collection (personal observation). The draw of water to the plant from the river creates nearly constant flow through the debris. The habitat created by the near constant flows, abundant woody debris with interstitial spaces, as well as the available forage colonizing the debris, may actually attract the Northern Madtoms to this site. Reduced swimming ability in the peak winter months may account for increased impingement during this time.

Impinged Northern Madtoms were often larger than those collected during the study, up to 84 mm. To develop a length frequency distribution representative of the population in the lower Ohio River, both data sets were combined. Little has been done on the biology of the Northern Madtom other than reproductive data (Scheibly et. al. 2008). But it appears that the Age-0 Northern Madtoms in the Ohio River reach approximately 50-54 mm, with the Age-1 individuals ranging from 55-75 mm, and Age-2 ranging from 75-85 mm.

This population of Northern Madtoms is most likely not as stable as it was pre-navigation, but it has continued to persist in this stretch of the Ohio River, despite the severe alterations to the hydrology. Traditional sampling methodologies are likely underestimating the population, and any future monitoring of the Northern Madtom in the lower Ohio River should be limited to nighttime sampling.

Management Implications

Threats to the Northern Madtom in the lower Ohio River are likely related to alteration and maintenance of the system for navigation. The reduced flows caused by dams resulting in deposition of fine sediments over rocky habitats and physical dredging of the river bottom appear to be the most consistent factors affecting this population. Much of the available gravel habitat in this stretch of river is heavily embedded with little or no interstitial spaces for benthic dwelling organisms to thrive. Side casted dredge material is often placed on these main channel border habitats, and may quickly cover the few exposed gravel habitats. Exposed gravel and cobble bars give the appearance of abundant rocky structures in this stretch of river. However, wind and wave activity remove all sand and silt on the exposed portion of the bar, just a few feet from shore, under the surface of the water, these rocky substrates are typically buried by sand. The addition of the lock and dam at Olmstead will likely increase the amount of pooled habitat in the river, further reducing suitable gravel areas for this species.

Impingement data from the Shawnee Steam Plant may provide information and a population trend on Northern Madtoms since it is very difficult to sample the natural habitat effectively. Periodic samples should be taken from the Shawnee Steam Plant impingement screens, with focus on the month of January since this is month with the highest number of impinged individuals of Northern Madtoms during this survey.

The preferred habitat of several of the unionid mussels in the Ohio River seems to overlap with that of the Northern Madtom. Monitoring and preserving the remaining habitat with moderate flows and coarse substrates, as well as the unionid mussel populations, would be a critical step for the future preservation of the Northern Madtom.

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Comprehensive Wildlife Conservation Strategy: Appendix 3.9 Class Actinopterygii, Priority monitoring needs by taxonomic class (p. 1).

Genetic Diversity, Structure, and Recolonization Patterns of Black Bears in Eastern Kentucky

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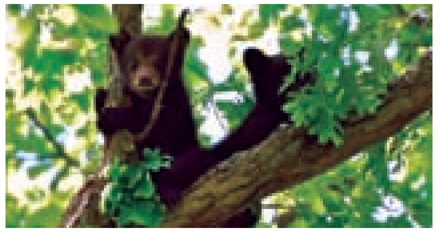
Bear cubs / John Hast

Abstract

Black bears *(Ursus americanus)* are thought to have returned to the Cumberland Plateau of Kentucky as the result of recent recolonization events and from successful establishment of 14 translocated bears released in 1996-1997. Current interest in hunting bears in Kentucky remains an important justification for investigating black bear population dynamics and structure. Microsatellite genetic markers and advanced statistical techniques have become accepted methodologies for investigating population structure, gene flow, and other conservation parameters for many animals, including large carnivores. We used 20 microsatellite markers to determine the genetic diversity, structuring, and relative influence of bears in surrounding states on bears in Kentucky. Black bears in Kentucky occurred as two moderately diverged populations (F_{st} = 0.09); Big South Fork and southeastern Kentucky on or near Pine Mountain. Each of these two populations contained a level of expected heterozygosity similar to that of other well connected black bear populations, yet had a low number of migrants per generation (N_m = 0.97) that indicated little gene flow. Southeastern Kentucky bears were comprised of an equal admixture of West Virginia and Virginia genotypes, while those in Big South Fork were closely related (F_{st} = 0.04) to their translocated source population in the Great Smoky Mountains. We propose that future management decisions be tailored to each of these two distinctive Kentucky subpopulations and that further investigation be conducted to estimate population size and trends.

Introduction

Large carnivores are frequently used as umbrella species (Noss et al. 1996), and there has been increased need to understand their population dynamics, range, and abundance. Biological sampling of large carnivores can be problematic given the inherent risk to both researcher and animal and the fact that species of this group are often cryptic and occur at low densities. These logistical challenges often limit sample size and preclude use of certain statistical tests (Creel et al. 2003). When population dynamics of large mammals are in question, the greatest challenge is often the collection of a statistically robust sample size (Mills et al. 2000).

Genetic techniques have emerged as an effective method for the study of wildlife populations (Taberlet and Luikart 1999). Microsatellite markers in particular have become a leading tool for understanding fine-scale population dynamics (Selkoe and Toonen 2006). The use of microsatellite genetic markers coupled with advances in non-invasive sampling methods have provided new opportunities for increasing sampling efficiency and safety of researchers and study animals (Taberlet and Luikart 1999). Microsatellite genetic markers are relatively resistant to degradation as compared to other DNA, a characteristic that has made them a favorite choice for mark-recapture-based population estimates (Settlage et al. 2008). Microsatellites have been used to investigate changes in population dynamics of black bear populations faced with habitat fragmentation (Dixon et al. 2007a, Dixon et al. 2007b), to determine levels of connectivity and gene flow between bear subpopulations (Smith and Clark 1994, Waits et al. 2000, Csiki et al. 2003), and to evaluate management actions such as conservation corridors and translocation events (Dixon et al. 2007b, Brown et al. 2009).

In the past 20 years, black bears *(Ursus americanus)* in Kentucky have recolonized portions of their historic range in southeastern Kentucky, likely as a result of emigration out of surrounding states from what may be considered a larger regional metapopulation. Additionally, Kentucky's black bear population was augmented via the 1997 translocation of 14 individuals obtained from Great Smoky Mountains National Park (Eastridge and Clark 2001, Clark et al. 2002). Research conducted on bears in Kentucky has thus far focused on habitat use, natality, and population estimation within border counties along the recolonization front (Unger 2007, Fraray 2008, Jensen 2009); a definitive analysis of source population(s) for Kentucky black bear has yet to be conducted. Public interest in initiating a bear hunt in recent years has made understanding the population dynamics of Kentucky bears and their relationship to bears in surrounding states increasingly important to state wildlife managers.

To assess the population dynamics of Kentucky black bears, we established 3 research objectives: (1) identification of subpopulation structure within Kentucky and surrounding states, (2) analysis of migration rate between identified subpopulations, and (3) identification of source populations and their level of connectivity with Kentucky populations to help inform the delineation of management units for black bear in the Commonwealth.

Methods

Hair samples were collected from Kentucky black bear from 2006-2009 by live trapping (IACUC protocol # 626A2003), non-invasive hair snare (Woods et al. 1999), and opportunistically by Kentucky Department of Fish and Wildlife biologists from road kill, nuisance trapping, and poaching events from the Pine Mountain (PM) and Big South Fork (BSF) populations. To investigate source populations, hair samples were also collected from West Virginia (WV) by West Virginia Department of Natural Resources biologists, Virginia (VA) through the use of non-invasive hair snares, and Tennessee (GSMNP) by University of Tennessee researchers conducting a mark-recapture abundance estimation in Great Smoky Mountains National Park. All hair samples were shipped to Wildlife Genetics International (WGI, http://www.wildlifegenetics.ca/) for microsatellite analysis. Individuals were identified by using 8 microsatellite markers having a heterozygosity >0.70 (G10B, G10H, G10J, G10P, G10M, G10L, MU59, and MU23, D. Paetkau, personal communication). All identified individuals were additionally analyzed at 12 microsatellite markers for a full complement of 20 markers (G10B, G10H, G10J, G10P, G10M, G10L, MU59, M223, G1D, G1A, G10X, G10U, MU50, Cxx20, Cxx110, G10C, 145P07, MU51, 144A06, and CPH9). Individuals sampled by non-invasive hair snare were also sexed. In-depth laboratory methods for the analysis of bear microsatellite loci are described by Paetkau and Strobeck (1994) and Paetkau (2003). The Microsatellite Analyzer software (Dieringer and Schlötterer 2003) was used to produce appropriate input files for data analysis. Hardy-Weinberg equilibrium and linkage disequilibrium were tested using Genepop 4.0 (Raymond and Rousset 1995) with a Bonferroni sequential correction applied to the P-values derived from the latter test (Rice 1989). General population structure across the landscape was investigated using the Bayesian clustering program STRUCTURE (Pritchard et al. 2007) and the K-means test in the GenoDive software package (Meirmans and Van Tienderen 2004). The most appropriate K value (number of subpopulations) was determined by applying the Plateau method (Pritchard et al. 2007) to the graph of the log probability of the data [LN P(D)] accompanying the STRUCTURE output and by using the Pseudo-F ranking method (Calinski and Harabasz 1974) in GenoDive. Migration between the identified subpopulations was investigated by using the population assignment test in the GenoDive software package (Meirmans and Van Tienderen 2004) at an alpha level of 0.002. Additionally the number of migrants per generation (Nm) was calculated in a pairwise fashion using the private allele method (Slatkin 1985, Barton and Slatkin 1986, Slatkin and Barton 1989) in Genepop 4.0 (Raymond and Rousset 1995).

An analysis of molecular variance (AMOVA) was conducted in GenoDive to investigate the hierarchical level upon which genetic variation can be attributed using a matrix of squared Euclidian distances set at 999 permutations (Meirmans and Goodnight 2006). As this AMOVA test is based on an analogue of Wright's F statistic (Wright 1965) it is possible to infer measures of population differentiation such as Fst and Phi'st (Meirmans and Goodnight 2006); the latter designed for the high levels of polymorphism found in microsatellite markers. These measures of population differentiation were calculated in a pairwise fashion between the indentified subpopulations. Finally, genetic parameters such as allelic diver-

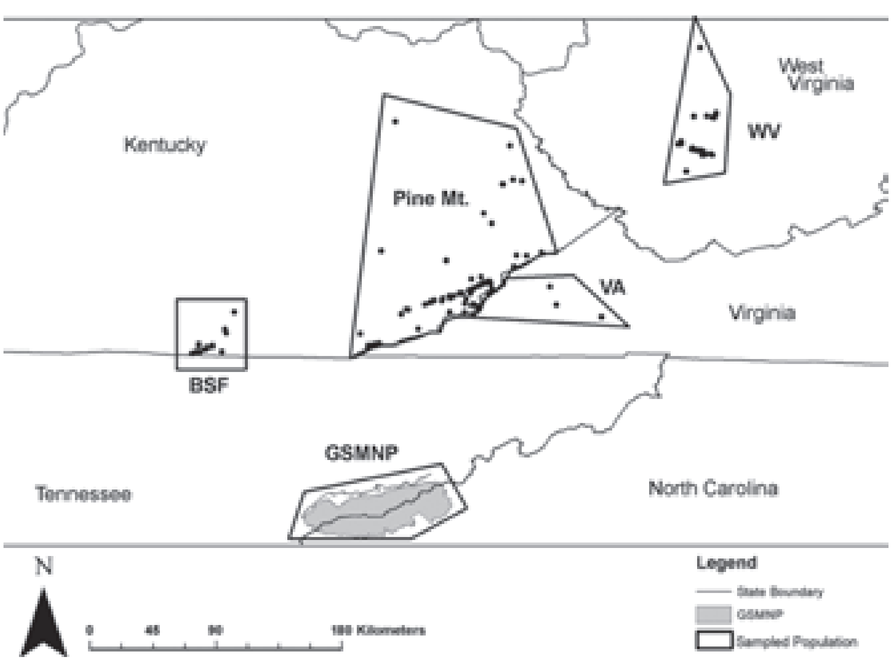

***Figure 1:** Genetic sampling location of black bears in the 2009-10 Kentucky study (BSF: 19, Pine Mt: 84, WV: 29, VA: 8, and GSMNP: 22).*

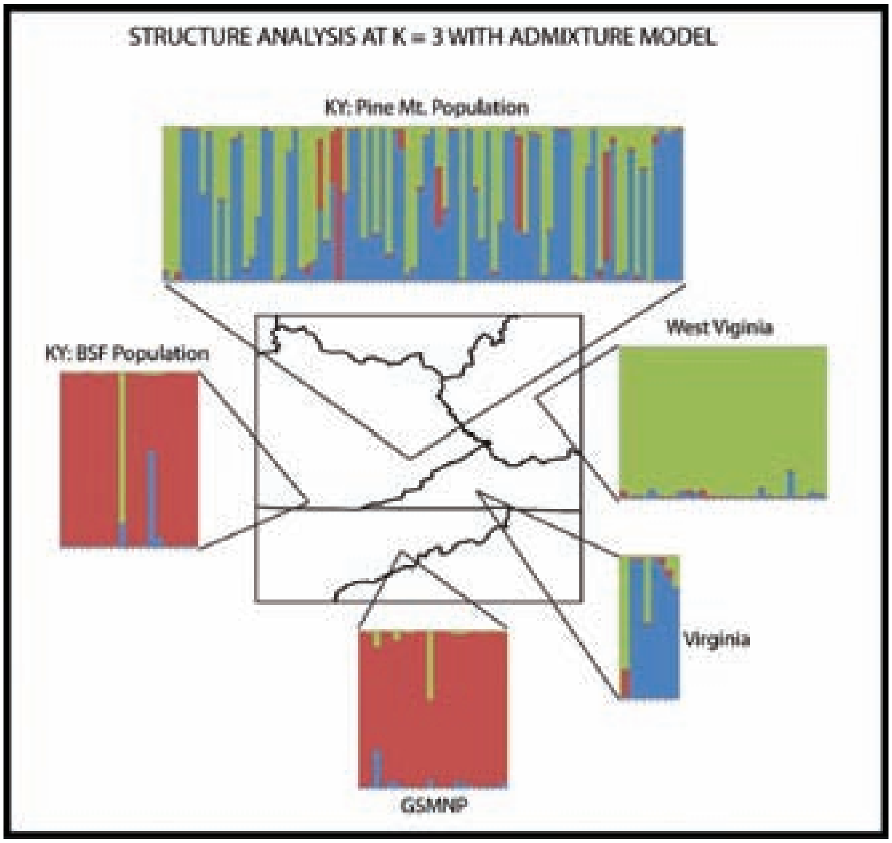

__Figure 2:__ STRUCTURE analysis at a K value of 3 (assumed number of subpopulations) shown for each black bear population sampled in the southern Appalachian Mountains. The bar graphs attached to each population are interpreted whereby the vertical axis represents percent inclusion into three identified bear subpopulations. Individuals were plotted on the horizontal axis.

sity (A) and genetic diversity, described as expected heterozygosity (He), were calculated using Genepop 4.0 and the allele frequency test in the GenoDive software package.

Results

Of the 258 hair samples sent to WGI for microsatellite analysis, 208 were successfully genotyped and attributed to 163 individuals (Figure 1) from the five sampled populations (BSF = 19; GSMNP = 22; PM = 84; VA = 8; and WV = 29). One individual was later removed from the GSMNP sample set for failure to amplify at one marker (MU50), leaving a total of 21 individuals in this sample set. Samples collected by physical handling of the animal were found to have a higher success rate than those collected by non-invasive hair snare (D. Paetkau, personal communication). All samples, both collectively and grouped as five sampled populations, were found to be in Hardy-Weinberg equilibrium ($P<0.05$) with only five pair of loci (<1% of total pairs) showing signs of linkage disequilibrium ($P<0.05$) as a result of non-random mating following Bonferroni sequential correction.

The general subpopulation structure across the sampled populations indicated the presence of two subpopulations when using both the STRUCTURE program set at a K value of 2 and the K-means test in GenoDive. Application of the plateau method to a graph of the log probability of the data [LN P(D)], revealed a K value of 3 would be useful in illustrating population structure. STRUCTURE results at a K value of 3 indicated three distinct subpopulation groupings: (1) BSF and GSMNP, (2) VA, and (3) WV, with the Pine Mt. population being comprised of an admixture of VA and WV (Figure 2). Additionally, population assignment tests detected 19 individuals that were sampled from populations that did not match their genotype, thus these individuals can be considered migrants. After calculating the number of migrants per generation (Table 1), the greatest Nm value occurred between the BSF and GSMNP populations, with 3.09 migrants per generation. The WV and VA populations had the two highest Nm values with 1.47 and 2.15 migrants per generation, respectively. AMOVA analyses indicted that the vast majority of variation was contained at the within individual level (93.0%) with a global Fst of 0.064. Pairwise Fst and Phi'st calculations (Table 2) indicated that the PM population was most closely related to the VA and WV populations and least related to the BSF population. Finally, allelic diversity was found to be greatest in the Pine Mt. population which also contained the highest level of heterozygosity. Conversely, the VA population contained the lowest level of allelic diversity, while the WV population had the lowest heterozygosity.

Discussion

Microsatellite genetic markers have proven themselves useful in the study of wildlife population dynamics by allowing for the use of less invasive sampling methods and the use of field collected sample substrates (Taberlet and Luikart 1999, Woods et al. 1999). In our case, success rates were higher with those samples that were physically pulled from sedated, live-caught black bears, yet non-invasive hair snares proved useful in obtaining samples from areas outside the core research range.

We identified 2 well defined subpopulations that were moderately

	Pine Mt.	BSF	GSMNP	WV	VA
Pine Mt.	----	0.0616	0.0617	0.04511	0.0405
BSF	0.9705	----	0.0454	0.1172	0.1172
GSMNP	0.9419	3.0881	----	0.0983	0.1094
WV	1.4744	0.5087	0.65	----	0.095
VA	2.1534	0.6741	0.6985	0.9510	----

Table 1: *Pairwise comparison of the number of migrants per generation (Nm, bottom diagonal) and the number of private alleles contained in each population (P(1), top diagonal) of identified black bear populations in the southern Appalachian Mountains.*

diverged (Fst = 0.09); BSF and the PM population in southeastern Kentucky. The low number of detected migrants (4 individual male bears) and the low number of migrants per generation (Nm = 0.97) indicated that migration between these two populations was not sufficient enough to dispel the effects of random genetic drift (Frankham et al. 2002). Although radio-collared black bears have been known to cross Interstate 75 (B. Augustine, personal communication), this road could be hampering the migration between these two Kentucky subpopulations. Alternately, the PM population's close proximity to states with growing black bear populations (Pelton & Van Manen 1994; Wooding & Ward 1997) should allow for migrants to enter from multiple alternate populations. The higher levels of Nm between PM and the WV and VA populations indicated gene flow is possible into and out of these populations. This current level of Nm and the fact that the PM population is comprised of an equal admixture of two genotypes suggested that these bears are the result of recolonization from bears in WV and VA. Additionally, the BSF population was found to be solely comprised of individuals of GSMNP origin with the addition of few migrants from the PM population.

Management Recommendations

Our findings indicated the occurrence of 2 genetically distinct subpopulations of bears in Kentucky with limited gene flow between them. We speculate that Interstate 75 may be a barrier that inhibits gene flow between these two populations, but that likely low population densities in the respective core populations may have also reduced dispersal and the potential for interchange of individuals between them thus far. Because we know little about the relative numbers for each, we suggest a very conservative approach in hunting bears in either area until population estimates are conducted. Population estimates in conjunction with collection of demographic data would allow construction of predictive population models that could assess the impacts of various harvest regimes. We further recommend that tag numbers and season regulations should be tailored to each population given the genetic distinctiveness and their relative isolation from each other. Implementation of a conservative harvest strategy would facilitate further population growth of the species and recolonization and establishment of bears throughout the Cumberland Plateau. Measures that promote the establishment of an ecoregional panmictic population of bears would likely enhance the long-term viability of this economically and ecologically important game species.

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	Pine Mt.	BSF	GSMNP	WV	VA
Pine Mt.	----	0.311 (p=0.001)	0.272 (p=0.001)	0.092 (p=0.001)	0.054 (p=0.031)
BSF	0.09	----	0.135 (p=0.001)	0.408 (p=0.001)	0.279 (p=0.001)
GSMNP	0.076	0.042	----	0.331 (p=0.001)	0.227 (p=0.001)
WV	0.027	0.13	0.101	----	0.115 (p=0.001)
VA	0.014	0.081	0.063	0.045	----

Table 2: *Pairwise comparison of F_{st} (bottom diagonal) and Phi'$_{st}$ (top diagonal) for the five sampled populations of black bears in the southern Appalachian Mountains.*

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Bias in GPS Telemetry Studies: A Case Study Using Black Bears in Southeastern Kentucky

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Introduction

Global Positioning System (GPS) telemetry has been increasingly used to study wildlife populations as it offers a way to systematically collect large amounts of relatively accurate animal location data consistently across diel periods and seasons even on remote and inaccessible landscapes (Schwartz and Arthur 1999). However, these data contain errors—both measurement error and missing fixes—that have been shown to bias the analysis of resource selection (D'Eon 2003, Friar et al. 2004, Visscher 2006), home range estimation (Horne et al. 2007), and movement patterns (DeCesare et al. 2005). The magnitude of bias in GPS telemetry datasets is linked to GPS collar performance that is in turn influenced by numerous factors such as the GPS satellite constellation (Moen et al. 1997), ranging errors (satellite clock errors, satellite ephemeris errors, multipath signals, receiver noise, etc.; Parkinson and Spilker Jr. 1996), collar model (Hebblewhite et al. 2007, Hansen and Riggs 2008), fix interval (time between GPS locations; Cain et al. III 2005, Mills et al. 2006), and obstructions between the GPS collar and satellites due to terrain (D'Eon et al. 2002), vegetation (D'Eon et al. 2002, Frair et al. 2004, Hebblewhite et al. 2007, Sager-Fradkin et al. 2007), and animal behavior (D'Eon and Delparte 2005, Graves and Waller 2006, Schwartz et al. 2009). Under optimal GPS operating conditions (i.e. no obstruction between the collar and satellites), the variable GPS constellation and ranging errors create a level of background measurement error that varies through time. These measurement errors are small relative to the grain of typical habitat data (Rempel et al. 1995) and random relative to animal-habitat associations, but they may still introduce bias to resource selection studies through habitat misclassification (Visscher 2006) and can skew movement path distributions due to (DeCesare et al. 2005). Of

Black bear / John Hast

larger concern, however, are the forms of obstruction between the GPS collar and satellites that exacerbate background GPS measurement error and induce failed location attempts, leading to larger, systematic biases. Also of concern are how the collar model and fix interval interact with collar obstructions to determine the degree of bias in GPS data sets.

While sometimes ignored, the magnitude of these biases is not trivial, and resource selection, space use, and movement pattern inferences must be made with caution, especially for forest dwelling species with complex behavioral patterns such as bears (Sager-Fradkin et al. 2007). To better understand the factors contributing to bias in resource selection, space use, and movement pattern inferences, and more specifically, how inferences may be biased in a study using GPS collars to infer black bear resource selection, space use, and movement patterns in eastern Kentucky, the performance of two collar types (Lotek 3300L and 8000MGU) was assessed using stationary collar tests, and GPS performance of animal-deployed collars for four collar types (Lotek 3300S, 3300L, 4400M, and 8000MGU) was analyzed.

***Table 1:** Measurement error landscape covariate models within ΔAICc=7 of top model. n = 36.*

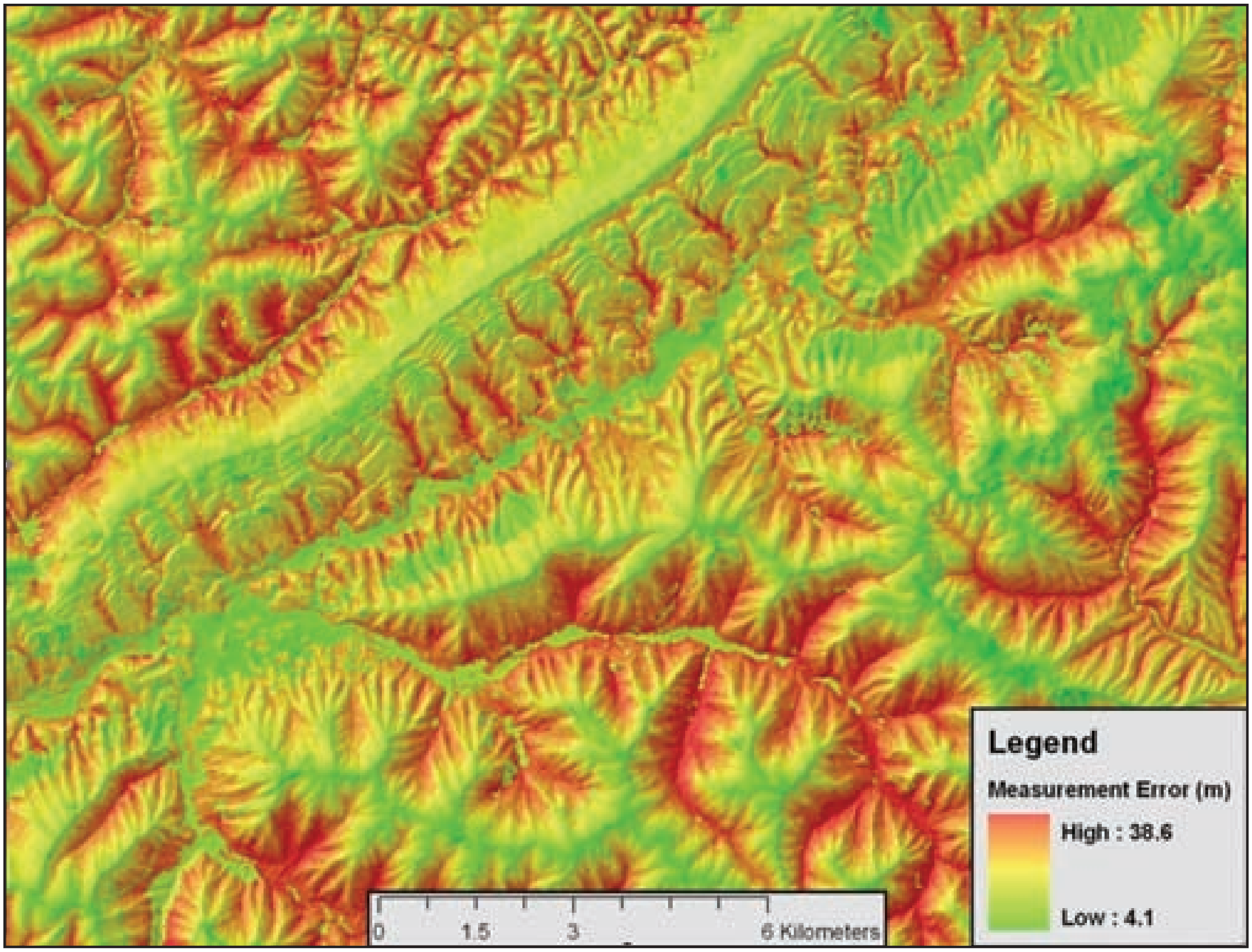
Model	Parameters	K	-2LL	AIC_c	ΔAIC_c	w_i
1	Cmodel Veg AS AS*Cmodel AS*Veg Veg*ASATS	10	-85.19	-56.39	0	0.563
2	Cmodel Veg AS AS*Veg Veg*ASATS	9	-78.88	-53.96	2.43	0.167
3	Cmodel Veg AS AS*Cmodel AS*Veg Veg*ASATS ASATS*Cmodel	11	-85.38	-52.38	4.01	0.076
4	Cmodel Veg AS AS*Cmodel AS*Veg Veg*ASATS Cmodel*Veg	11	-85.34	-52.34	4.05	0.074
5	Cmodel Veg AS AS*Cmodel AS*Veg Veg*ASATS AS*ASATS	11	-85.19	-52.19	4.20	0.069
6	Cmodel Veg AS AS*Veg Veg*ASATS Cmodel*Veg	10	-79.07	-50.27	6.12	0.026
7	Cmodel Veg AS AS*Cmodel AS*Veg ASATS*Cmodel	10	-78.94	-50.14	6.25	0.025

[1]Cmodel = collar model, AS = proportion available sky, Veg = forest or open, ASATS = available satellites

Study Area

Two study areas were delineated for this study—one defined by the area traversed by GPS-collared bears and a second, smaller study area nested within the area traversed by GPS-collared bears in which GPS collar tests were conducted. The study area for bear-deployed collars was delineated by creating a minimum convex polygon around all GPS locations recorded by collars deployed on bears and the study area for stationary test collars was chosen to minimize the time and cost of stationary collar tests while still representing the full range of topographic obstruction and land cover types within the bear-deployed collar study area. The bear-deployed collar study area fell within 3 states—Kentucky, Virginia, and Tennessee—and the majority of GPS locations were located in Bell, Harlan, Perry, and Letcher Counties in Kentucky; Wise and Lee Counties in Virginia; and Claiborne County in Tennessee. The stationary test collar study area contained 53.3% of GPS locations recorded by bear-deployed collars, and was exclusively within the Central Appalachian EPA Level 3 Ecoregion (Woods et al. 1996; Figure 3.3). A very small portion of the bear-deployed collar study area in Virginia and Tennessee fall within the Ridge and Valley Ecoregion, but very few GPS locations fall within the Ridge and Valley Ecoregion (< 0.3%). The Central Appalachian Ecoregion is characterized by high elevations and a dissected topography, and the majority of the landscape is covered by mixed mesophytic forest (Woods et al. 1996). Rugged terrain and infertile soils limit agriculture and human development so the landscape remains largely forested,

Figure 1: *Mean measurement error (m) across a portion of the study area for the 3300L..*



except for areas that have been surface mined (Woods et al. 1996). Open areas within the study area are associated with active and reclaimed surface mining and small areas of human development. Roads and human development are largely limited to valley bottoms and surface mining is prevalent on the Black Mountain complex and the highly-dissected mountains to the north of Pine Mountain. Within the study area, Pine Mountain remains largely unaffected by deforestation, with only a few areas cleared for human settlement and two rock quarries.

Methods

Collar Deployment on Bears

From 2005-2009, GPS collars were deployed on black bears captured during the summer or during den visits in the winter using procedures approved by the University of Kentucky International Animal Care and Use Committee (protocol #626A2003). From May-August, bears were captured using modified Aldrich snares (Johnson and Pelton 1980), passive PVC snares (Reagan et al. 2002), and culvert traps baited with pastries, peanut butter, and/or raspberry extract. Traps were checked twice daily. Den sites of all collared female bears expected to have cubs were investigated in February and March. Den sites were located by aerial telemetry and subsequent ground telemetry. Bears were immobilized using a mixture of tiletamine and zolazepam (Telazol, Ford Dodge Laboratories, Fort Dodge, Iowa) at a dosage of 4.4mg/kg estimated body weight. Telazol was administered via jabstick or dart rifle (Pnuedart, Williamsport, PA). Collar models used in this study include: Lotek 3300S (2005-2007 production; Lotek Wireless, Ontario, Canada), 3300L (2005-2007 production), 4400M (2006 production), and 8000MGU (2008-2009 production), with the 8000MGU having the highest sensitivity and expected to have the best performance.

Stationary Collar Test

Since all collar models varied in

hardware and firmware, it is reasonable to suspect differential performance between each model, but collar availability limited stationary collar testing to the two most commonly used models in this study, the 3300L and the 8000MGU. Stationary collar tests were conducted with a 1 hr fix interval as this is the sampling interval of the majority of previously collected data and data currently being collected. The effect of landscape covariates on GPS collar performance was assessed by placing 8 GPS collars (4 8000MGU and 4 3300L) at 18 test sites within the study area stratified across levels of vegetative and topographic obstruction and recording locations.

Vegetative obstruction was quantified using land cover classes derived from 2001 NCLD (Homer et al. 2004), updated to reflect land cover change between 2001 and 2005 (Kentucky Division of Geographic Information 2007). Land cover types with similar levels of canopy obstruction were combined, creating three categories: 1) deciduous forest, 2) mixed forest, and 3) no canopy (barren land, grassland, pasture, scrub/shrub, and developed). An index of topographic obstruction was quantified by calculating "available sky" (AS; D'Eon et al. 2002) from a digital elevation model (see Augustine 2010 for more detailed methods). Stationary collar testing was performed from 4 June – 12 June, 2009. Test sites were stratified across the three land cover categories and available sky values within the test collar study area. Available sky was discretized into six categories to facilitate adequate sampling across the full range of values. Eighteen test sites were selected with each combination of available sky and land cover represented. One 3300L and one 8000MGU were placed at each test site concurrently and allowed to record locations for > 24 hours. Collars were suspended 1 meter off the ground on a string tied between two trees, or on poles in open land cover types.

The relative effects of landscape covariates on measurement error, and therefore, GPS performance in general, were assessed using linear regression after it was determined that a mixed model with a random intercept for test site did not retain enough inter-site variation to produce nonzero variance estimates. Log-transformed measurement errors were modeled to meet the assumption of normality and separate variance groups were used for each collar model. Two dimensional fixes recorded at a test site before a 3-D fix was obtained were removed as these locations assume the collar is at the elevation of the previously-recorded 3-D fix and can be highly inaccurate (Sager-Fradkin et al. 2007). To account for the fact that collars were not all deployed concurrently, the mean number of satellites in orbit over the test site during each trial was used as a variable in the model. While test sites occurred in two forest types, preliminary investigation revealed the distinction between forest types was relatively unimportant, so the difference between open and forested areas was of most interest. Other variables of interest were collar model, AS, and all two-way interaction terms.

Table 2: *Parameter Importance for measurement error*

Parameters[1]	Importance
Cmodel	1
Veg	1
AS	1
AS*Veg	1
Veg*ASATS	1
Cmodel*AS	0.782
Cmodel*Veg	0.101
Cmodel*ASATS	0.101
AS*ASATS	0.069

[1]Cmodel = collar model, AS = proportion available sky, Veg = forest or open, ASATS = available satellites

Performance of Bear-deployed Collars and Factors Influencing Performance

To better understand the potential for bias in animal-deployed collars across different collar models and fix intervals, the proportion of successful fixes (hereafter, fix proportion) of bear-deployed collars were modeled as a function of collar model, fix interval, and bear size/sex with linear regression model using separate variance groups for the newer 8000MGU and the 3 older models combined. Preliminary investigation demonstrated that these data were linear, despite being proportions (Augustine 2010). First, and most importantly, it was expected that all collar models have differing fix proportions, leading to differential potential for bias between collar models. Second, it was expected that fix proportions decline as the fix interval increases as this has been theoretically justified and demonstrated in the literature (Cain III et al. 2005). Lastly, since a correlation between fix proportion and bear size has been observed (Graves and Waller 2006), this may be influencing fix proportions and 3-D fix proportions in this

Table 3: *Top landscape covariate measurement error model coefficients. Response is log_{10} (measurement error). 8000MGU, Open, and AS*8000MGU are reference categories for Cmodel, Veg, and AS*Cmodel, respectively.*

Parameters[1]	Coeff.	SE	P
Intercept	0.698	1.368	0.615
Cmodel 3300L	.4044	0.078	<0.001
Veg Forest	6.143	1.653	0.001
AS	-0.197	0.111	0.092
AS*Cmodel AS*3300L	-0.315	0.131	0.024
AS*Veg AS*Forest	-0.633	0.132	<0.001
ASATS*Veg ASATS*Forest ASATS*Open	 -.621 0.016	 0.107 0.016	 0.106 0.920

[1]Cmodel = collar model, AS = proportion available sky, Veg = forest or open, ASATS = available satellites

Table 4: *Bear-deployed collar fix proportion models. n = 48.*

Model	Covariates[1]	SK	2LL	AIC_c	ΔAIC_c
1	Cmodel LFIX LNECK	7	-144.69	-125.00	0
2	Cmodel LFIX Sex	7	-143.10	-123.41	1.59
3	Cmodel LFIX	6	-136.94	-120.14	4.86
4	Cmodel	5	-125.50	-111.46	13.54
5	Intercept only	2	-71.23	-64.68	60.32

[1]Cmodel = collar model LFIX = log_{10}-transformed fix interval, LNECK = log_{10}-transformed bear neck size

data set. If this effect is present and of significant size, it should be accounted for in order to compare fix proportions across collars. Since neck size have been found to correlate with fix proportion better than chest girth (Graves and Waller 2006), this variable was used. Because the sex of the bear, rather than the size of the bear, may influence fix proportions if sexes behave differently, an effect for sex was included. Fix interval and neck size effects were also modeled after a log-transformation, as this transformation appeared to provide a slightly better linear relationship to fix proportion (LFIX AND LNECK; hereafter). Differences in least square means between each collar model were tested while controlling for multiple comparisons using the "simulate" method which provides improved inference over the Tukey-Kramer method with unbalanced data and unequal variances (Westfall et al. 1999). Finally, fix proportions for bear-deployed collars at 1 hour fix intervals were compared to fix proportions of stationary test collars deployed at forested sites to see if fix proportions are reduced by bear behavior to the same degree across collar models. Open test collar sites were not included in the estimate of stationary collar performance as black bears spend the majority of their time in the forest. It was expected that fix proportions would differ less between bear-deployed and stationary test collars for the 8000MGU as it should be less sensitive to obstruction, in general.

Results

Performance of Stationary Test Collars

Mean measurement error was 13.9 m (95% CI 10.3-19.0) and 8.4 m (95% CI 6.5-11.0) for the 3300L and 8000MGU, respectively. The 3300L and 8000MGU recorded similar mean fix proportions (0.98, 95% CI 0.98-0.99 and 0.99, 95% CI 0.98-0.99, respectively), but differed in 3-D fix proportions (0.768, 95% CI 0.67-0.86 and 0.97, 95% CI 0.97-1.00, respectively). After the removal of 2-D locations at test sites that were not preceded by 3-D locations, a random intercept model could not be fit, so the model and inferences presented here differ slightly from Augustine (2010) where initial 2-D locations were erroneously not removed. There was considerable model selection uncertainty, with 7 models within 7 AICc units of the best supported model (Table 1). Variable importance values (Posada and Buckley 2004) reflect that collar model, vegetation, available sky, and the interaction between vegetation and available satellites appear in all 7 models and suggest the interaction between collar model and available sky is well supported. Model averaging led to a negligible difference in coefficient es-

Adjusting frequency of antenna / Obie Williams

timates from the best supported model which contains all the variables of high importance, so the coefficients from the best supported model were used for inference and prediction (Table 3). The best supported model explained the majority of the variation between sites for both the 8000MGU (92.1%) and 3300L (83.7%), demonstrating why the random intercept model estimated an inter-site variance of zero.

Measurement error was higher for the 3300L compared to the 8000MGU, higher in forest compared to open areas, and higher in areas with more topographic obstruction. Measurement error increased more quickly with increasing topographic obstruction for the 3300L and within forest. Finally, more available satellites led to smaller measurement errors in the forest, but not in open areas where satellites are less limiting. Predicted mean measurement errors across the study area ranged from 4.1 to 38.6 m and 3.0 to 17.7 m for the 3300L and 8000MGU, respectively. Measurement error was predicted to be lowest on mountaintops, urban areas, and active and reclaimed surface mines (Figure 1). Local measurement error conditions varied widely across the study area due to variation in topographic obstruction. Pine Mountain was predicted to have relatively favorable GPS performance, while Black Mountain and the highly dissected mountains north of Pine Mountain were predicted to have less favorable GPS performance.

Performance of Bear-Deployed Collars

From 2005-2009, 92 bears were captured 138 times and 29 female dens were investigated. 42 GPS collars were deployed on bears with several being redeployed for a total of 61 collar deployments. The following number of data sets was acquired for each model: 3300S – 6, 3300L – 16, 4400M – 7, 8000MGU – 19. Causes of a collar deployment not resulting in an analyzable data set were collar failure (confirmed N = 7, suspected N = 1), store-on-board collars not yet retrieved (N = 1), 8000MGU collars deployed on bears not living within cell phone service and collars not yet retrieved (N = 2), and collars falling off before bears left dens where collars were deployed (N = 1) or collars falling off before 3 weeks of deployment (N = 1).

Table 5: *Top bear-deployed collar fix proportion model. 8000MGU is the reference category for Cmodel.*

Model Term[1]	Coeff.	SE	P
Intercept	1.225	0.115	<0.001
Cmodel			
3300S	-0.307	0.043	<0.001
3300L	-0.165	0.028	<0.001
4400M	-0.340	0.043	<0.001
LFIX	-0.153	0.033	<0.001
LNECK	-0.180	0.033	0.015

[1]*Cmodel = collar model*

Fix proportions ranged from 0.50 to 0.86 for the 3300L, 0.48 to 0.74 for the 3300S, 0.33 to 0.86 for the 4400M, and 0.87 to 0.97 for the 8000MGU. There was very strong support for differential fix proportions across collar models (AICc = 46.78 between models 4 and 5, Table 4). Further, there was substantial support for a fix interval effect (AICc = 8.68 between models 3 and 4), and LFIX was highly significant in the top model ($p < 0.001$, Table 5). The top model predicted a decline in fix proportion of 0.138 between fix intervals of 0.5 and 4 hr with the decline stabilizing near a fix interval of 4 hr due to the log transformation. The bear size effect was moderately supported (AICc=4.86), but the hypothesis of a bear size effect and that of a sex-specific behavioral effect are essentially equally supported (AICc=1.59). Only the model with both a fix interval and neck size effect did not display outliers so this model was used to compare collar models fix proportions. The 8000MGU recorded the highest fix proportion, followed by the 3300L, then the 3300S, and the lowest was the 4400M. Mean fix proportions for all collars were significantly different (p 0.01), except between the 3300S and 4400L, which were marginally significantly different (p=0.055), and between the 3300S and 4400L (p=0.945). Fix proportion reductions due to bear behavior for the 3300L were significantly larger than the 8000MGU and predicted to be ~3 times as large (Table 6).

Discussion

As expected, both forest and topographic obstruction increased measurement error; however, since topographic obstruction is more variable than the presence of forest cover in eastern Kentucky (Figure 1), it is

Table 6: *Fix proportions for bear-deployed 8000MGU and 3300L collars at a fix interval of 1 hour compared with stationary test collars at forested sites only with the same fix interval. Confidence intervals are nonparametric bootstrapped confidence intervals and not adjusted for multiple comparisons.*

Model	Deployment Type	Mean	%95 Lower	%95 Upper
3300L	Stationary in Forest (n=12) Bear (n = 8) Reduction	0.975 0.742 0.233	0.958 0.654 0.154	0.991 0.820 0.322
8000MGU	Stationary in Forest (n=12) Bear (n = 11) Reduction	0.987 0.923 0.064	0.971 0.911 0.044	0.984 0.934 0.084

likely the most important landscape covariate influencing GPS collar performance. Better performance in open areas will lead to more locations being recorded around human development and on surface mines than in the forest and may bias resource selection inferences, especially for more nuisance-prone bears that utilize areas of human development and surface mines. Bias in resource selection inferences may also be induced in factors correlated with topographic obstruction, such as distance to roads (especially major roads), distance to human development, mixed and coniferous forest, distance to streams, elevation, topographic position index, and slope. There was moderate support for the hypothesis that the 8000MGU measurement error is influenced by topographic obstruction to a smaller degree than for the 3300L, suggesting performance across the landscape is more homogeneous for the 8000MGU. The 8000MGU was probably less influenced by topographic obstruction because its greater sensitivity enabled it to achieve higher 3-D fix proportions than the 3300L.

This study supports a fix interval effect on fix proportions and moderately supports a bear size or sex effect, but this analysis did not provide substantial evidence for one over the other. Fortunately, any bear size or sex effect should be less problematic on newer, more sensitive collars which should be less influenced by behavior. This hypothesis is supported by the larger decline in performance between stationary and bear-deployed 3300L collars, compared to the more sensitive 8000MGU. While the decline in fix proportion with increasing fix interval recorded in this study (-0.153, 95% CI -0.226 – -0.081) is not significantly different than that recorded by Cain III et al. (2005; -0.110, 95% CI -0.177 – -0.043), the slightly larger estimate in this study is probably more accurate for animal-deployed collars since Cain III et al. (2005) pooled stationary and animal-deployed collars and did not estimate a separate slope for each. Animal-deployed collars should benefit more from the greater amount of valid ephemeris data stored in the collar provided by shorter fix intervals as ephemeris download should be more frequently interrupted in animal-deployed collars due to animal movement. Using the relationship estimated in this study, researchers should expect a decline in fix proportion of about 0.138 by increasing fix intervals from 0.5 to 4 hr. The magnitude of this decline may be smaller when ephemeris download is less frequently interrupted, such as for animals living in more open habitats or animals whose behavior less frequently obstructs the GPS collar.

It has been previously demonstrated that bedding behavior is the major source of missing fixes on bear-deployed GPS collars (Graves and Waller 2006, Schwartz et al. 2009) and a significant proportion of the large reduction in fix proportions on animal-deployed collars seen in this study is probably due to bedding behavior. Bias can be introduced if behaviors are habitat-specific or if there are interactions between behaviors and habitat, both of which have been demonstrated for GPS-collared bears (Heard et al. 2008). Habitat-specific bedding behavior will lead to fewer locations recorded in the habitats where bears choose to bed, which are likely areas with high cover and farther from human activity and roads. Interactions between bedding and habitat will magnify the effect of landscape covariates on GPS performance. Together, these effects of bedding can lead to substantial bias in resource selection inferences, home range estimation, and the analysis of movement patterns. Fortunately, the newer 8000MGU appears robust to behavioral effects and should limit bias in GPS collar data sets.

Management Reccommendations

Due to extensive forest cover and high levels of topographic obstruction, eastern Kentucky is a challenging environment for GPS telemetry. Further, GPS telemetry is problematic for animals that frequently behave in ways that obstruct the antenna, such as bedding in thick cover or obstructing the antenna with their bodies. This study demonstrates that newer, high sensitivity collars are required to achieve high fix proportions (>90%) and acceptable levels of bias for black bears on this landscape. For species that live in the open or do not behave in ways that obstruct the antenna, such as elk, almost perfect fix proportions (>0.99) are achievable with current technology (Cox, unpublished data). To ensure correct management decisions are made, wildlife researchers should report fix proportions and wildlife managers should interpret these studies with an understanding of the factors inducing bias in these data.

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

Factors Impacting Reproductive Success of Interior Least Terns (*Sterna antillarum athalassos*) in Western Kentucky

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Least tern chick / John Brunjes

Introduction

The interior least tern (*Sterna antillarum athalassos*) was listed as Endangered on June 27, 1985 (USFWS 1985). The interior least tern (hereafter least tern) was formerly a common summer resident along the Colorado, Red, Arkansas, Missouri, Ohio, and Mississippi river systems, but now only breeds in small, local populations (Marks 1996). Least terns require flat sand bars or islands that have little or no vegetation (Hardy 1957 as cited by Renken and Smith 1995, Carreker 1985). These bare substrates are maintained by the scouring action created by regular flooding of river systems.

Early losses of least terns were due to the demands of the millinery trade in the late 19th century, egg collection, random shooting, and human disturbance (USFWS 2006). Currently, the loss of nesting habitat due to channelization, dam and weir construction, irrigation, and reservoir construction is considered the greatest threat to least tern populations (TPWD 2008, USFWS 2006). Changes in flooding regimes due to these alterations have reduced the number of suitable nesting sites available to interior least terns range wide.

Small colonies of least terns are supported along the Ohio and Mississippi rivers from Henderson to Hickman, KY (Cuzio et al. 2005). Natural islands along this stretch of river (approximately 215 km) are being lost due to changes in flooding patterns that allow vegetation to cover some areas, and predators now have access to previously protected sandbars (J. Brunjes, pers. obs.). Least terns on this stretch of river rely increasingly on islands made by the United States Army Corps of Engineers (USACE) from dredged materials (B. Vessels, USACE, Navigation and Dredging Team Leader, Louisville KY office, pers. comm.).

Human disturbance of nesting sites is considered the second greatest threat to least tern populations (USFWS 1990) while other causes of reproductive failure include depredation and flooding (KCWCS 2005). Although the camouflaged eggs are nearly invisible to off-roaders and others using islands and beaches for recreational purposes, predators seem able to easily detect least tern nests (USFWS 2006). In addition, because least terns along this stretch of the river are usually limited to only two larger islands on the Mississippi River and less than ten smaller islands on the Ohio River, some created by the USACOE, they may be more vulnerable to devastating losses than if they were distributed among more sites with smaller colonies (Smith and Renken 1993). New islands, suitable for least tern nesting, have been created each year for at least the last 7 years (beginning 2001) as a part of normal navigation maintenance in the Ohio River (B. Vessels, USACE, pers. comm.).

Our objectives were to (1) record basic reproductive data and compare reproductive success of least terns nesting on man-made versus natural islands, and (2) deter human disturbance at least tern nest sites in Kentucky by posting islands with signs designating area as critical nesting habitat. Little is known about the tern colonies along the Ohio River other than results from general surveys. Reproductive success was calculated to provide information on the value of these islands. By recording factors causing egg mortality we planned to identify management needs such as improvements in content of substrate, placement of driftwood on islands for cover, or possibly direct forms of predator control or additional measures to reduce human disturbance. This project was necessary to establish the status of nesting Interior Least Terns in western Kentucky and to assess the value of current expenditures on habitat protection and creation (including creation of dredge islands). The goal was to produce results upon which to base future efforts with respect to management of this important species in this critical breeding region.

Methods

Our study took place on the Ohio River from Paducah, Kentucky, to where the Ohio and Mississippi rivers converge and from this point to the border of Kentucky and Tennessee on the Mississippi River (Figure 1). Potential nesting sites on this stretch of river were identified from records of previously used nesting sites (2005 and 2007) provided by the Kentucky Department of Fish and Wildlife Resources (KDFWR) and a helicopter over-flight in June 2009. Locations of man-made islands were provided by USACE personnel after deposition sites for each summer had been finalized. Once islands became exposed as rivers approached summer pool, potential nesting sites were posted by KDFWR staff with signs designating each area as a restricted endangered least tern nesting site 1 May through 31 August. Islands created by the USACE (Mound City, Paducah, and Cumberland) were posted immediately upon completion. Alternative (non-island) sites were identified through reports of Interior Least Tern sightings (B. Palmer-Ball, pers. obs.).

Sites were monitored by boat or on foot by using binoculars every 3-7 days for the arrival of least terns and dates of nest initiation recorded. Searches for nest scrapings began on 7 June in 2008 and 10 June in 2009 by using binoculars (Nikon 10X42 Monarch ATB) from a boat within 10 meters of colonies. We avoided landing during initial surveys so that terns were not disturbed or forced to abandon the site (Elliott et al. 2007). To evaluate nesting and hatching success, nests (scrapes which contained eggs) were counted at each site when first identified as a nest and individually marked (after allowing for colony initiation which took less than one week) with a tongue depressor displaying a unique identification number (placed approximately 30 cm from each nest). The fate of each nest was recorded by using evidence observed in and around nest (Szell and Woodrey 2003). Small shell fragments or absence of fragments, chick droppings and tracks, and adult tracks indicated a successful hatch. Large shell fragments and/or presence of tracks from species other than least terns indicated depredation (Rochelle Renken and Jennifer H. Stucker, pers. comm.). Absence of fragments and other evidence at a marked nest was recorded as unknown fate but assumed unsuccessful. During the first season (1 May to 31 Aug 2008), nests were also marked with modified surveyor's flags due to the tall vegetation that quickly overgrew agricultural sites, making tongue depressors impossible to locate. We completed walk-throughs (Parnell et al. 1988) quickly and efficiently before 1000 h to minimize heat stress (Dugger et al. 2000). The walk-throughs were usually less than 15 minutes in duration and no surveys were done when ambient temperature exceeded 90 F, when adults must protect eggs (Elliott et al. 2007). If sites were too large for one or two researchers to complete walk-throughs in 15 minutes (islands on the Mississippi River), adults were observed to ensure they returned to nests within that time period and more time was spent on the site. We recorded clutch size (when nest was complete after 1-3 days, veri-

***Figure 1**. The 2008 and 2009 least tern study area with nesting sites marked and labeled.*

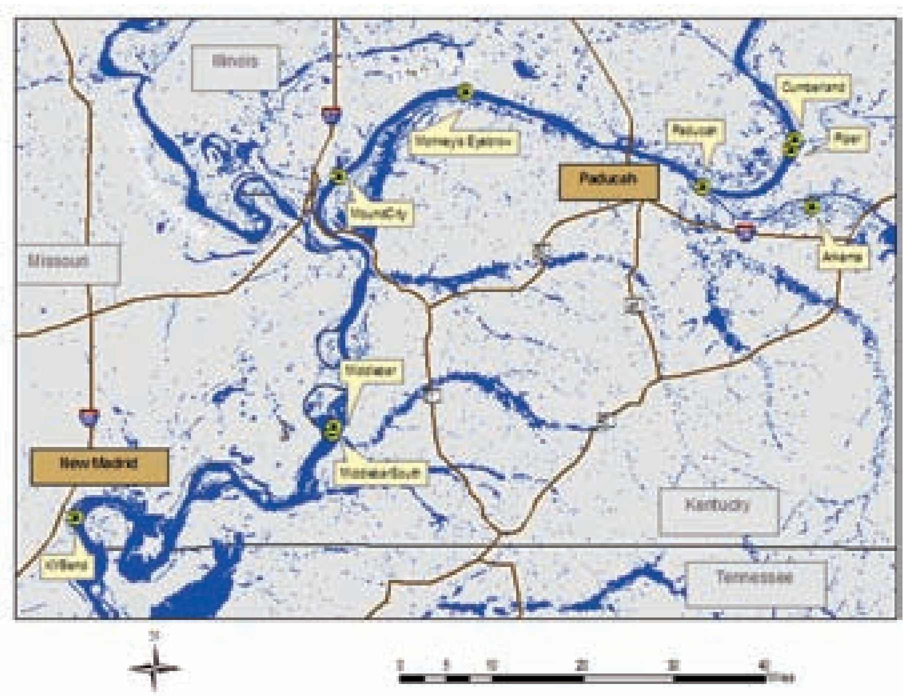

***Table 1:** Summary of results for 2008 and 2009 breeding seasons of least terns in western Kentucky.*

	Site	Date of Site Initiation	Type of Colony	Number Nests	Number Eggs	Hatching Success (%)	Nesting Success (%)	Average Clutch (%)	Causes of Failure
2008	Arkema	24 June	Industrial Pond	14	21	90.5%	92.9%	1.50	Other
	Swan Lake	28 June	0.078	54	80	6.3%	9.3%	1.48	Depredation
	Open Pond	26 June	1.653	89	157	0.6%	1.12%	1.76	Depredation, Plowed under
2009	KY Bend	11 June	Natural Island	316	675	0.0%	0.0%	2.13	Flooding
	KY Bend Renest	29 June	Natural Island	185	350	16.8%	18.8%	1.82	Human Distur-bance, Depreda-tion, Storms
	Middlebar South	30 June	Natural Island	59	98	0.8%	1.6%	2.92	Flooding
	Middlebar	11 June	Natural Island	61	135	0.0%	0.0%	1.66	Flooding
	Middlebar Renest	30 June	Natural Island	52	106	17.9%	19.2%	2.23	Human Distur-bance, Depreda-tion, Storms
	Mound City	22 July	Dredged Island	13	20	0.0%	0.0%	1.54	Flooding
	Monkey's Eyebrow	13 July	Natural Island	10	15	0.0%	0.0%	1.50	Flooding
	Monkey's Eyebrow Renest	22 July	Natural Island	2	4	0.0%	0.0%	2.00	Flooding
	Paducah	30 June	Dredged Island	42	82	2.4%	2.4%	1.95	Human Distur-bance, Depredation
	Piper	10 July	Natural Island	5	11	27.3%	40.0%	2.20	Flooding
	Cumberland	31 July	Dredged Island	1	2	0.0%	0.0%	2.00	Flooding
	Arkema	18 June	Industrial Pond	31	69	76.8%	74.2%	2.26	Minor Flooding, Other

fied by following nest through to fate), nest success, hatching success, and egg status (intact, damaged, missing, depredated, pipped, or hatched; Szell and Woodrey 2003). Nest success was defined as the percentage of nests that had at least one egg hatch, whereas hatching success was the percentage of eggs that hatched out of all eggs on each site. Possible causes of nest failure, such as depredation, were also recorded. Fledging success was not measured because it would have required banding which may have caused increased mortality of chicks (Zickfoose 1985). Walk-throughs were completed every three days at each site when weather permitted.

Results

During the 2008 nesting season (1 May 2008 to 31 August 2008), prolonged flooding prevented terns from nesting on islands on the Ohio and Mississippi rivers for the duration of the season. Only three colonies were found, all at non-island locations: Open Pond, Swan Lake, and Arkema. Nest initiation for all sites occurred during the last week of June (Table 1). Average clutch sizes were 1.7, 1.5, and 1.5, at Open Pond, Swan Lake, and Arkema, respectively. The season average was 1.6 eggs. The average nesting success was 32% and the average hatching success was 32% (n=3 sites). At Open Pond and Swan Lake, the two agricultural sites, there were 143 nests with 237 eggs. The largest colony, Open Pond (89 nests), had a hatching success of only 0.6% (1 egg) and a nesting success of 1% (1 nest). Several nests were accidentally plowed under (24 out of 89 nests) while the remaining nests were depredated (63) or abandoned (2). Swan Lake (54 nests) had a hatching success of 6% and a nesting success of 9%. Of the total nests five hatched, 2 were abandoned, and 47 were depredated. Arkema (14 nests) had a hatching success of 90% while nesting success was 93%. Only one nest failed, crushed by Canada geese (*Branta canadensis*). Arkema had 19 eggs successfully hatch and older chicks were spotted at Arkema as the season progressed. On 9 July 18 chicks were spotted accounting for all chicks hatched by that time.

In 2009, least terns nested on both man-made and natural islands in the Ohio and Mississippi rivers from New Madrid, Missouri, to Smithland, Kentucky. Of nine nesting colonies found, three were on man-made (dredged material) islands (Mound City, Paducah, and Cumberland), five on natural islands (KY Bend, Middlebar South, Middlebar, Monkey's Eyebrow, and Piper), and one was the same industrial pond island

(Arkema) used in 2008. Nesting attempts began on islands of the Mississippi River (KY Bend, Middlebar, and Middlebar South) and one island (Paducah) on the Ohio River in the second week of June followed by nesting on the industrial pond, Arkema (Figure 2). By the third week in June, renesting attempts were being made (following flooding events) and nesting began on the remaining islands of the Ohio River (Mound City, Monkey's Eyebrow, Piper, and Cumberland). Among sites, mean clutch sizes ranged from 1.5 to 2.9 and average clutch size was 2.0 (n=9 sites). Nesting success ranged from 0 to 74%, with an average of 13% for the season. Hatching success ranged from 0 to 77%, with an average of 12% (Table 1). Total number of nests on natural islands was 694 with 1,394 eggs laid. On man-made islands, the total number of nests was 56, with 104 eggs laid. Arkema, the industrial site, had 31 nests and 69 eggs.

KY Bend, Middlebar, and Monkey's Eyebrow all had initial nesting attempts that failed due to untimely flooding events. Renesting on Monkey's Eyebrow was also unsuccessful because of flooding. Middlebar South, Mound City and Cumberland suffered total losses because of flooding. Middlebar South had a hatching success of 18% but no chicks grew old enough for flight and all remaining nests were flooded. On KY Bend 37 nests out of 185 were destroyed by predators, 4 were directly destroyed by 4-wheelers, and 54 were abandoned or failed after several severe storms and periods of blowing sand. All others were either successful (31) or could not be determined to have failed or hatched (59). Based on tracks, predators were found to be avian (10), an unknown canine (26), and ants (1). On Middlebar only one chick hatched while at least 11 out of 61 nests were depredated by a canine and many were abandoned after several storms. The Paducah site was a man-made, dredge-material "island," but actually was attached to land and, therefore, suffered mainly from predation (29 out of 42 nests) by a small mammal. Only one nest had successful hatches (2 chicks), which occurred before the predation event. The remaining nests were likely abandoned (12 nests) due to the heavy pressure from predation and 4-wheelers. Arkema was again the most successful site with a few failures caused by geese crushing 4 nests, 2 instances of flooding, and 2 nests abandoned out of 31 nests. When comparing reproductive success (nesting and hatching success) of least terns on Arkema between 2008 (93%, 90%) and 2009 (74%, 77%) it appears 2008 was more successful, but there were more nests in 2009 (30 versus 14 in 2008), so more young hatched.

Flooding and predation proved to be the main causes of reproductive failure on both natural and manmade islands. In 2009, both average nesting success and average hatching success for the man-made islands were <1% (both were 0.8%). Average clutch was 1.8. Natural islands had a higher average nesting success at 10% and a hatching success of 8%. The average clutch size was 2.1. Because only one man-made island had successful nests, a statistical comparison of success on man-made versus natural islands was not appropriate. Arkema had the highest reproductive success with a nesting success of 74%, hatching success of 77%, and average clutch size of 2.3.

Discussion

During the 2008 season, prolonged flooding and high-water prevented least terns from nesting on islands in the Ohio and Mississippi rivers. Both agricultural sites suffered heavily from predation. Several nests at one site were accidentally plowed under (24 out of 89 nests). The industrial pond had no predation of eggs despite the presence of ring-billed gulls (*Larus delawarensis*) during entire nesting season. Average clutch size (1.6) and nesting success (32%) for these sites were both much lower than found by others elsewhere on islands along the Mississippi river in previous seasons (Smith and Renken 1993, Szell and Woodrey 2003), particularly lower on the agricultural fields because of easy access for predators. Smith and Renken (1993) found average clutch size to be 2.1 to 2.5 eggs and nest success to be 65%. In 1 of 4 years, their nest success was much lower (51%) due to flooding. In another study along the Mississippi River from Tennessee south to Mississippi, nesting success was 97% in 1995, but only 40% in 1996 and 1997 due to flooding and predation (Szell and Woodrey 2003). Our industrial site, with a fenced perimeter and small islands on the pond, provided extra protection from flooding and predators where birds experienced higher reproductive success than on river islands or agricultural sites.

Average nesting success was only

13% in 2009, but with more nests and an average clutch size of 2.0 eggs, this season was more successful than the previous year, but still less successful than reported by others at other colonies during other years as discussed above. Most islands, dredged and natural, suffered heavy losses due to flooding on both the Mississippi and Ohio Rivers.

Middlebar South had some hatching success but was flooded before chicks could have reached flight age. On KY Bend depredation, 4-wheelers, severe storms, and blowing sand were all causes of known failures while other nests there were either successful or could not be determined to have failed or hatched. Because conditions often prevented nest searches, and often storms wiped traces away, it is possible that there was more pressure from predators and human disturbance than could be verified (i.e., listed as unknown fate). Digging traces were found around all debris and many nests, which may indicate that many hatched chicks were depredated. Considering that the island was again underwater before young could have reached flight age, it is certain few young survived. On Middlebar terns suffered from depredation and severe storms. Also, it is possible that terns on this island relocated to nearby Middlebar South after pressures from predators and human disturbance, as has been observed at other sites (Massey and Atwood 1981). Several traces of gull, heron, snake, and canine tracks were found on this island. The Paducah site, a man-made, dredge-material "island" that actually was attached to land, only had one successful hatch. Other nests there were depredated or were likely abandoned due to the heavy pressure from predation and 4-wheelers. Several nests were straddled by 4-wheeler tracks or narrowly missed. In addition, fire pits and trash were found on the islands. In 2009 Arkema was again the most successful site.

According to Marks (1988) natural sites consist of mainly sand and shell with less than 10% silt/clay, which Marks says would make both natural and artificial sites along the Ohio and Mississippi rivers acceptable. This type of substrate would only be acceptable according to Carreker (1985) if high winds do not occur frequently during May and June. Otherwise, the substrate would be too unstable. My islands also were almost bare of vegetation and had more than enough aquatic habitat and disparate wetlands within flight distance of colonies to make them all suitable for nesting (Carreker 1985). One of our original objectives had been to correlate the reproductive success of nesting sites with habitat suitability based on a published Habitat Suitability Index (HSI) model (Carreker 1985) to verify the validity of the model and identify specific habitat characteristics that might be limiting reproduction, but because all islands were plagued with predation, flooding, and human disturbance, other potential factors listed in the model (e.g., percent aquatic habitat and number of disparate wetlands within 1.6-km of the colony, percent vegetation cover, average stem height, and substrate composition) had no measurable impact on island nesting success during the 2009 season.

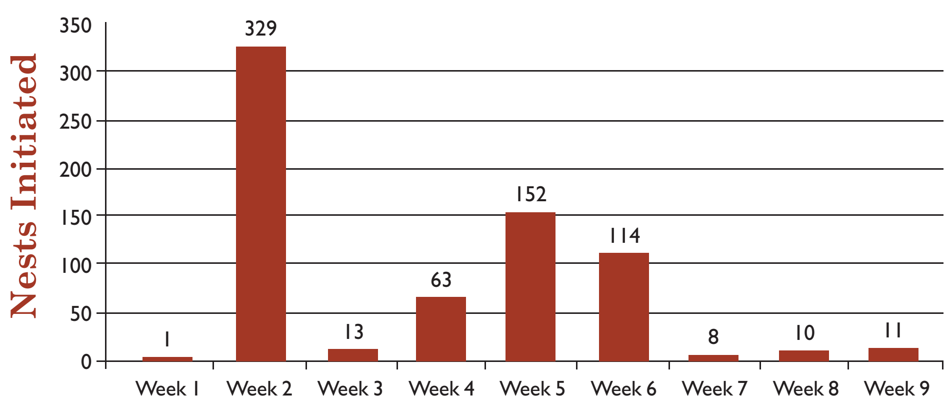

Figure 2: *Timeline of least tern nests initiated in Kentucky in 2009 beginning the first full week of May. These data include renests and are based on day nest was found or, for nests found later in incubation, counting back from hatch date.*

Management Implications

It is necessary to identify the specific predators causing reproductive failure in order to effectively protect breeding colonies (Kruse et al. 2001). Predation was more devastating in 2008 because, while the nesting sites in agricultural fields were protected initially, surrounded by the flooded parts of the field, by the end of the season the entire field was mostly dry, allowing easy access by predators. Depredation of entire colonies occurred during the final week of incubation. Predator fencing would have increased reproductive success for these terns, but because this was an alternative site used only when islands did not appear, it would be difficult to know exactly what area to fence until nests were initiated. Fence construction at that time might disturb nesting terns. In addition, the two agricultural fields were privately owned so fencing would require landowner cooperation. Land should be set aside and protected for terns during flood years and measures taken to attract least terns to these alternative nesting sites. Arkema was an attractive alternative nesting site because it was an island in a pond with fencing surrounding it that kept predators out. The site was also able to support a tern colony presumably large enough to keep ring-billed gulls away from the nesting area and was surrounded by habitat able to support other prey for the gulls. The fencing surrounding this pond was effective because predators were mostly mammals that could be excluded or deterred and not avian predators.

In 2009 flooding was the major cause of reproductive failure for least terns. Only the largest islands remained above water long enough for incubation of eggs (Middlebar, KY Bend, and Paducah). Smaller islands, and man-made islands created later in the season were flooded before chicks had a chance to hatch, sometimes right after nesting was initiated. However, least terns nesting on the larger islands faced more pressure from predators and human disturbance. This agrees with a study by Burger (1984). According to Smith and Renken (1993), islands should be managed so that they are exposed for greater or equal to 100 days to increase reproductive success of least terns. Man-made islands should be made throughout the habitat to make sure that the entire nesting population is not affected by one catastrophic event such as flooding or predation (Kirsch and Sidle 1999). These islands would be more effective if available earlier in the season when flooding is less likely to occur, and late nesters have been found to be less successful than first-wave nesters (Massey and Atwood 1981). Islands should be composed of coarser, lighter-colored substrate, which terns prefer (Thompson et al. 1997). In addition nests on natural islands were often found next to debris. This preference is supported by other researchers (Schweitzer and Leslie 1999) at a different site. Storms are another factor that can cause reproductive failure, so islands need to have shrubs, driftwood, or some other type of shelter (Hadden and Knight 1983). Even though islands were posted, this did not seem to deter 4-wheelers from using islands for recreation. Szell and Woodrey (2003) have found that posting signs on islands is not effective because of how large some island are and the work required to post them. We reached the same conclusions, and found that most nesting sites had been disturbed by recreational users before we could post the islands. Szell and Woodrey (2003) point out that placing signs at boat ramps to educate the public about nesting least terns would have more impact. Public education is important in order to stress how important islands, both natural and artificial, are to least terns.

In summary, interior least terns in western Kentucky face pressures from predation, flooding, and human disturbance. Colonies on both natural and artificial islands faced the same pressures. To protect this population in the future, islands need to be managed so nesting terns are less vulnerable to predators or flooding, and the public needs to be educated on the value of these birds as well as the importance of islands for their nesting. In addition, alternative sites that protect terns during years of severe flooding as well as from predators, such as the fenced pond site (Arkema) in this study, should also be created. Future management is necessary to aid interior least terns in their recovery.

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KDFWR Strategic Plan. Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2; Class Aves: Taxa specific research project #3.

Longear sunfish / Obie Williams

Project Highlights

Alligator Gar Propagation and Restoration in Western Kentucky

Ryan A. Oster, Steve Marple, and Matt Thomas Kentucky Department of Fish and Wildlife Resources

Alligator gar / Matt Thomas

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 inhibits 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.

Sightings of alligator gar in Kentucky have been tied to five areas. These areas include the Cumberland River (3 miles below Dycusburg in 1925), the Ohio River at Shawnee Steam Plant (1975), the mouth of the Ohio River (Ballard/Carlisle County), the mouth of Bayou du Chein (Fulton County), and Kentucky Lake at Cypress Creek embayment (Calloway County, 1977). 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.

During 2009, a total of 4,726 alligator gar were stocked by the KDFWR. Pfeiffer Fish Hatchery produced 4,476 of these fish, while Minor Clark Fish Hatchery produced 250 gar. Size at stocking ranged from 7.3 to 13.6 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; and (9) Mayfield Creek. An additional twelve alligator gar were implanted with telemetry tags to conduct a preliminary movement and habitat evaluation study of recently stocked fish. A more in-depth telemetry study is being planned for 2010. Sampling for this first year-class of stocked alligator gar will begin during the summer/fall of 2010.

Funding Source: *State Wildlife Grant (SWG)*

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

Distribution and Ecology of the Blackfin Sucker (*Thoburnia atripinnis*) in the Upper Barren River, Kentucky

Blackfin Sucker / Matt Thomas

Garrett Stillings and Sherry Harrel, Eastern Kentucky University
***KDFWR Contact:** Ryan Oster*

The highly distinctive catostomid, *Thoburnia atripinnis*, blackfin sucker, is hypothesized to be a relict species endemic to the priority conservation area of the Upper Barren River drainage of Kentucky and Tennessee, spanning four counties in Kentucky (Allen, Barren, Metcalfe and Monroe). Due to its endemic distribution, low historic abundance and human induced impacts, the blackfin sucker is considered a "species of greatest conservation need" by the Kentucky Department of Fish and Wildlife Resources. With the creation of Barren River reservoir in 1964 and the landscapes' heavy agricultural usage, prime habitat for blackfin suckers has greatly declined. Four isolated tributaries are currently known to hold populations of blackfin suckers. Current data on distribution and conservation needs of blackfin suckers in the Upper Barren River is lacking, thus, the purpose of this study is to update this information, with emphasis on changes from historic distribution.

Spatial coordinates of fourteen historic sample sites were provided by Kentucky State Nature Preserves Commission (KSNPC). Current sample sites are representative of prime conditions for blackfin suckers. Each site was sampled using backpack electrofishing gear. Current collections of all fishes in these historic and new sites will aid in: (1) identifying the abundance of blackfin suckers in the Upper Barren River, KY; (2) assessing the fish community structure and comparing the biotic integrity of each tributary of the Upper Barren River; (3) comparing habitat characteristics among tributaries to assess physical habitat alterations; and (4) identifying any correlation with other fishes of the Upper Barren River system

At present, 20 sites have been sampled, including the fourteen historic sites provided by the KSNPC previously holding records of blackfin suckers. Two sites are new records for blackfin suckers. A total of ten families and 46 species, comprised of 6,138 individuals have been collected with only 21 blackfin suckers (0.34%) found at six sites. Blackfin suckers were typically found in low flow runs and pools (<1 m/s), streams 5 to 10 meters in width and typically less than 1 foot deep. Adults were almost always captured in habitats that contained undercut bedrock crevices or large flat rocks. According to the Kentucky Division of Water's Rapid Bioassessment Protocol, Long Creek had more supporting habitat for aquatic life. The Barren River proper has the best water quality and diversity based on the fishes collected. Also, blackfin suckers are positively associated with elegant madtoms and negatively associated with banded sculpins and creek chubs. Sampling is still ongoing, but low numbers of blackfin suckers discovered thus far are cause for concern.

Funding Source: *State Wildlife Grant (SWG) and Eastern Kentucky University*

KDFWR Strategic Plan. Goal 1, Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2; Class Actinopterygii and Cephalaspidomorphi: Priority Research Survey Project #2.

West Creek Fish Barrier Removal – Harrison County, Kentucky

Ryan A. Oster, Kentucky Department of Fish and Wildlife Resources; Alex Barnett, Harrison County Judge Executive; Chris Minor, The Nature Conservancy.

The Licking River is identified as a Tier II Priority Conservation Area and a mussel conservation area in the Kentucky Department of Fish and Wildlife Resources' (KDFWR) Wildlife Action Plan. There are 18 mussel species and two fish species listed in the action plan as "Species of Greatest Conservation Need" (SGCN) in the Licking River watershed. The mussel species include the Elktoe, Slippershell, Fanshell, Elephantear, Butterfly, Catspaw, Northern Riffleshell, Snuffbox, Longsolid, Pocketbook, Round Hickorynut, Sheepnose, Clubshell, Rough Pigtoe, Pyramid Pigtoe, Rabbitsfoot, Salamander Mussell, and Little Spectaclecase. The Clubshell and Fanshell are also federally endangered species. The fish species of "greatest conservation need" include the Northern Madtom and Spotted Darter.

The Licking River conservation area is an important area for conserving aquatic diversity; however, many tributaries of the Licking River have lost

Fish Barrier After / Ryan Oster

connectivity to the main channel due to obstructions such as dams, low-water fords, and poorly designed culverts. As a result of these structures, fish species have lost the ability to migrate throughout large portions of many of these tributaries. In addition, mussel species (that rely upon host fish species in order to reproduce) have also become heavily impacted as a result of the loss of ability for fish migration. The lifecycle of freshwater mussels depends highly upon fish migration as a conduit for dispersal to establish new populations and maintain existing populations. Barriers that block host fish species from upstream reaches prevent fish and mussel species from reaching potentially better habitat. As a result, upstream reaches may become biological islands having little or no gene flow in or out of the stranded populations, thus making these populations more susceptible to catastrophic events, localized disturbances, and disease.

One such area where fish migration has become restricted is West Creek at the location of a low-water ford approximately ¾ mile upstream from its confluence on the Licking River. This low-water ford is one of two maintained by Harrison County, both of which prevent fish migration during part of the year and require considerable maintenance.

In 2009, the KDFWR, in cooperation with Harrison County and The Nature Conservancy funded the removal of this low-water ford and replaced it with a modern bridge crossing. This new bridge crossing allows for adequate fish migration and passage throughout the entire season. Prior to removal of the existing low-water ford, KDFWR biologists conducted a biological assessment downstream and upstream of the site. These assessments will be conducted for two years following removal of the ford to document the response of both the fish and mussel community to this project. Removal of the low-water ford is anticipated to help increase fish and mussel species diversity and abundance within this section of West Creek.

Fish Barrier Before / Ryan Oster

Funding Source: *State Wildlife Grant (SWG) and Harrison County, Kentucky*

KDFWR Strategic Plan. Goal 1, Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.3. Priority Conservation Action #181.

Description and Geography of Restricted Range Kentucky Fish Endemics

Lisa J. Hopman and Brooks M. Burr, Southern Illinois University at Carbondale
***KDFWR Contact:** Matt Thomas*

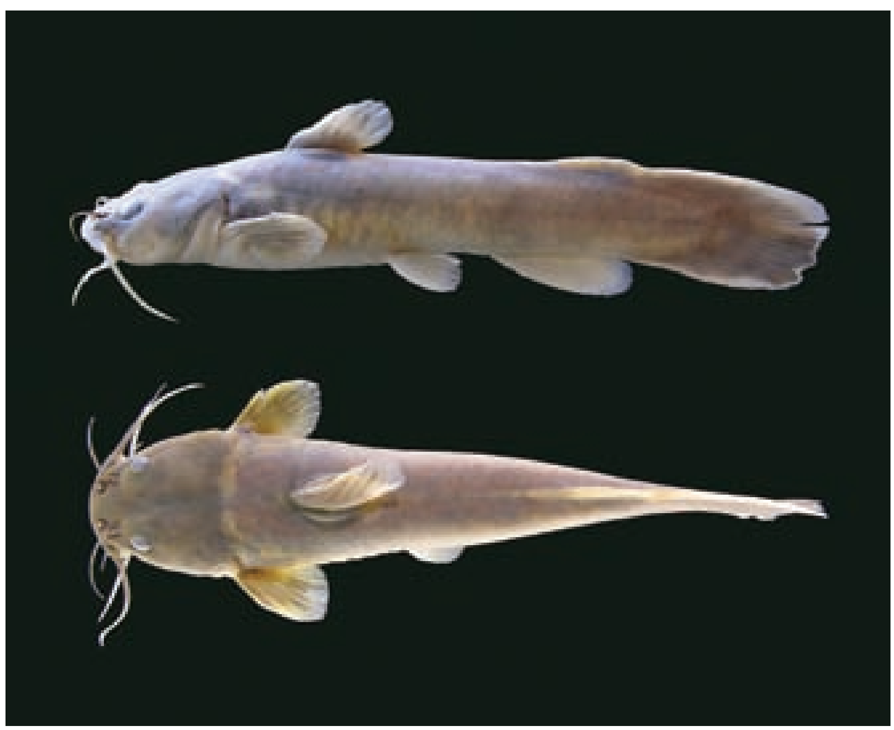
The Stonecat (*Noturus flavus*) is one of the most widely distributed members of the genus *Noturus*, commonly referred to as madtoms (family Ictaluridae). This fish is found throughout Mississippi River tributaries ranging laterally from southern parts of Canada to northern Alabama and longitudinally from Montana to Vermont. In Kentucky *N. flavus* is restricted to the eastern part of the state found within the Ohio River, Licking River, Kentucky River, Salt River, and Cumberland River drainages. Madtoms can be distinguished from other catfishes in Kentucky due to their attached adipose fin, and *N. flavus* is identified by its gray-brown coloration, posterior premaxillary tooth patch extensions, and pale marking at posterior dorsal fin base.

It has been observed that two unique morphs of *N. flavus* exist which differ from the typical Stonecat found elsewhere. Stonecats found in the channels of the Mississippi River (below the mouth of the Missouri River) and Missouri River have smaller eyes than Stonecats taken elsewhere. It is not yet known if Stonecats are found in the Mississippi River below the mouth of the Ohio River and whether or not they also have small eyes. *N. flavus* found within the Cumberland River drainage downstream of Cumberland Falls and part of the Tennessee River drainage have a unique dorsum pattern on the head which is not seen in Stonecats from other regions. These Cumberland River Stonecats also appear more dorso-laterally flattened anteriorly.

It is the purpose of this research to determine the extent of the difference between these two distinct Stonecat populations from typical *N. flavus* and to determine if either warrant elevation to species status. Museum specimens from throughout the geographical range of *N. flavus* have been obtained along with specimens for the two morphs. Trawling for small-eyed Stonecats within the Mississippi River and field trips to collect Cumberland River Stonecats will begin in the spring of 2010. Areas underrepresented by museum collections will be focused on. We will also focus on sampling the Mississippi River below the mouth of the Ohio River. Morphometric analysis will be performed on museum and collected specimens using a 31 measurement truss to determine any differences between typical *N. flavus*, Cumberland River Stonecats, and small-eyed Stonecats. Histological examination of the eyes of *N. flavus* will also be performed, along with genetic analysis. Preliminary data has shown Cumberland River Stonecats to be different enough from typical Stonecats to warrant being described as a new species. This new species of madtom will be endemic to southern Kentucky and northern Tennessee within the upper Cumberland and Tennessee River drainages.

Funding Sources: *State Wildlife Grant (SWG) and Southern Illinois University at Carbondale*

KDFWR Strategic Plan. Goal 1, Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2; Class Actinopterygii and Cephalaspidomorphi: Priority Survey Project #2.



Noturus flavus *Cumberland River Morph / Matt Thomas*

Augmentation of the Slippershell Mussel, *Alasmidonta viridis* in Guist Creek, Kentucky

Juvenile Slippershell Mussel / Monte McGregor

Monte A. McGregor, Adam C. Shepard, J. Jacob Culp, Fritz Vorisek, and Jim Hinkle, Kentucky Department of Fish and Wildlife Resources

In August 2009, the Kentucky Department of Fish and Wildlife released 22 tagged individuals of the rare freshwater mussel, the Slippershell Mussel, into Guist Creek, KY. Currently, the Slippershell Mussel has no special concern listing in Kentucky, but is listed as imperiled or critically imperiled in many surrounding states. The released individuals were propagated at the Center for Mollusk Conservation for approximately 1.5 years and were a mean length of 20.3 millimeters at the time of release.

Before the augmentation, a quantitative survey was completed and 3 species, including the Slippershell Mussel, were found in low densities. A total of 32 m2 quadrats were sampled, yielding 4 individual mussels. Densities at the site were extremely low (.13 per m2 for all mussel species). Only 1 individual of the Slippershell Mussel was found during the quantitative survey. A 5 m x 5 m release area was then chosen based on habitat stability and the presence of Slippershell Mussels. All individuals were released in the area and allowed to bury in the substrate.

This site will continue to be monitored by quantitative surveys on a regular basis. It will be monitored regularly to examine juvenile survival, growth, and reproduction, as well as changes in the entire mussel community in Guist Creek. The KDFWR will use this release of the Slippershell Mussel as a test model for future augmentations of two federally endangered mussels: the Cumberland Elktoe (*Alasmidonta atropurpurea*) and the Littlewing Pearlymussel (*Pegias fabula*).

Funding Sources: *Endangered Species Act (Section 6) funds, U.S. Fish and Wildlife Service*

KDFWR Strategic Plan: Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2, Class Bivalvia. Priority Survey Project #3.

Augmentation of the Snuffbox, *Epioblasma triquetra* in the Rolling Fork River, Kentucky

Monte A. McGregor, Adam C. Shepard, J. Jacob Culp, Fritz Vorisek, and Jim Hinkle, Kentucky Department of Fish and Wildlife Resources

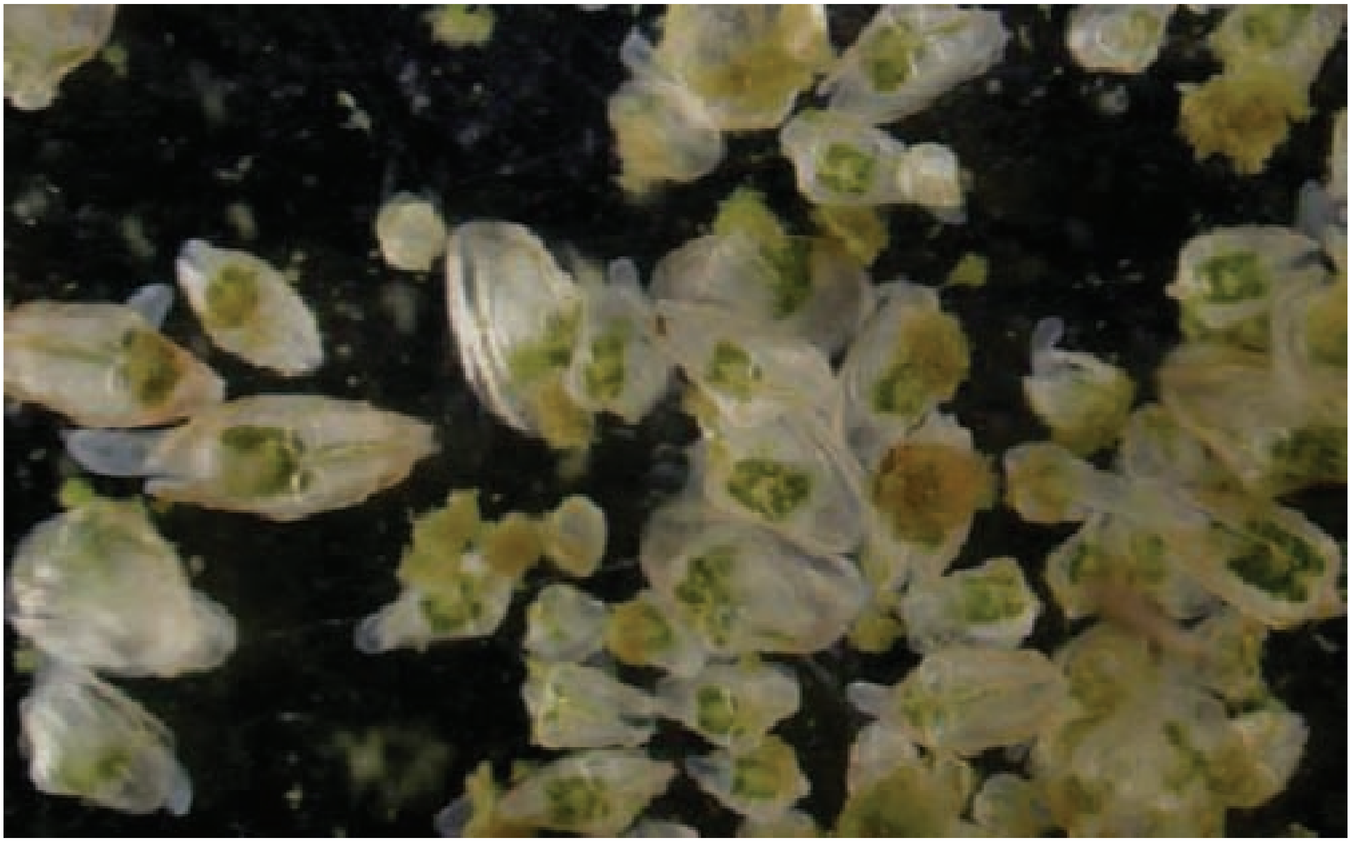
In September 2009, the Kentucky Department of Fish and Wildlife released 50 tagged individuals of the Snuffbox, a freshwater mussel that is listed as a species of special concern in Kentucky, into the Rolling Fork River, KY. The released individuals were propagated at the Center for Mollusk Conservation for approximately 1.5 years and were a mean length of 19.15 millimeters at the time of release.

Prior to the augmentation (September 2007), an extensive quantitative survey was completed at the release site on the Rolling Fork River. Mean mussel densities were high (20.5 per m2 for all species) and a total of 20 species were found during the survey. No Snuffbox mussels were found during the survey, but relict shells of the species were located at the site. Based on the 2007 quantitative data and a qualitative examination of habitat stability, a 5 m x 5 m release area was selected. All juvenile Snuffbox mussels were released in the area and allowed to bury into the substrate.

This site will continue to be monitored by quantitative surveys on a regular basis. It will be monitored regularly to examine juvenile survival, growth, and reproduction, as well as changes in the entire mussel community in the Rolling Fork River. The KDFWR will use this release of the Snuffbox as a test model for future augmentations of federally endangered mussels in the same genus, including the Cumberland Combshell (*Epioblasma brevidens*) and the Oyster Mussel (*Epioblasma capsaeformis*).

Funding Source: *Endangered Species Act (Section 6) funds, U.S. Fish and Wildlife Service*

KDFWR Strategic Plan: Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2, Class Bivalvia. Priority Survey Project #3



10-month-old juvenile mussels / Monte McGregor

Five Year Quantitative Monitoring at Thomas Bend on the Green River, Kentucky

Monte A. McGregor, Adam C. Shepard, J. Jacob Culp, Fritz Vorisek, Jim Hinkle, Kentucky Department of Fish and Wildlife Resources

Quantitative sampling / Monte McGregor

In September 2009, the Kentucky Department of Fish and Wildlife Resources completed the second quantitative survey of the mussel community at Thomas Bend on the Green River, KY. The first survey was completed in September of 2004 and the site will be continually monitored every five years. The purpose of long-term monitoring is to examine changes in mussel communities over time. The KDFWR is especially concerned with state and federally listed species, and long-term monitoring provides an effective method to track densities, growth, and recruitment in these populations.

A total of 177 m^2 quadrats were sampled in 2009, yielding 31 mussel species. Mean mussel density at the site was 6.67 per m^2. Two of the 31 species are federally endangered: the Fanshell (*Cyprogenia stegaria*), and the Rough Pigtoe (*Pleurobema plenum*). The four most common species constituted over 60% of the total number of mussels at the site (see Table 1).

Comparison of 2004 Quantitative Survey to 2009 Quantitative Survey

To examine changes in the mussel community over 5 years at Thomas Bend, species richness and evenness, as well as community densities, were compared between 2004 and 2009. Fanshell (*Cyprogenia stegaria*) densities and size classes were also evaluated. In 2004 the area sampled was 100 meters long, and in 2009 only 20 meters long. This analysis will utilize only the 2004 data from the 20 meter stretch of river that was re-sampled in 2009.

Species richness was greater in 2009 with 31 species found compared to 25 in the same 20 meter sampling stretch in 2004 (Table 1 and Figure 1). Evenness was similar, but slightly greater in 2009, exhibited by Figure 1. In 2004 and 2009, the community was dominated by one species: the Mucket, *Actinonaias ligamentina*. In 2004 Muckets constituted over two-thirds of the entire community and in 2009 Muckets constituted about one-third of

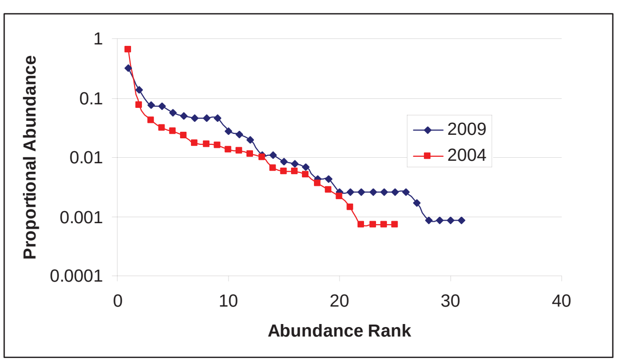


***Figure 1:** Graph of Rank-Abundance Curves of 2004 and 2009 Mussel Communities. Proportional Abundance is log-scaled.*

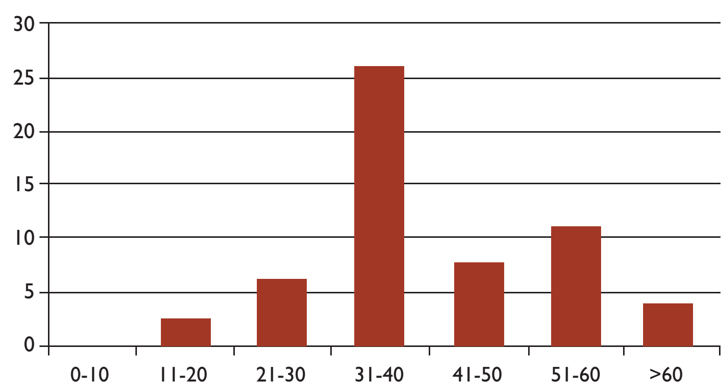


***Figure 2:** Size Classes of Fanshell (*Cyprogenia stegaria*) from 2009 survey data.*

the community. Mean densities of all species were similar for both surveys: 6.67 per m^2 in 2009 and 7.39 per m^2. Fanshell densities were much greater in 2009, with a mean of .31 per m^2 compared to only .08 per m^2 in 2004. There was also a greater range of size classes in 2009 with more obvious recruitment compared to 2004 (Figures 2 and 3).

Overall, there was little variation in the mussel community from 2004 to 2009. The most noticeable differences were the number of species and the mean density of Fanshells. Although there were 6 more species found in 2009 than in the same 20 meter area in 2004, all of those species were found in the entire 100 meter stretch of the 2004 survey. This site will continue to be monitored by quantitative surveys on a regular basis every five years, and trends in the Fanshell populations as well as in the entire mussel community will be examined.

Funding Source: *Endangered Species Act (Section 6) funds, U.S. Fish and Wildlife Service*

KDFWR Strategic Plan: Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2, Class Bivalvia. Priority Survey Project #1and #2.

***Table 1:** Species collected during quantitative sampling in 2009 and 2004 and their relative abundances.*

2004

Species Name	Relative Abundance (%)
Actinonaias ligamentina	66.86
Cyclonaias tuberculata	7.44
Amblema plicata	4.29
Quadrula metanevra	3.08
Megalonaias nervosa	2.72
Fusconaia subrotunda	2.29
Pleurobema sintoxia	1.72
Quadrula pustulosa	1.65
Elliptio dilatata	1.57
Lampsilis ovata	1.36
Ptychobranchus fasciolaris	1.29
Cyprogenia stegaria	1.15
Tritigonia verrucosa	1.00
Lasmigona costata	0.64
Obliquaria reflexa	0.57
Truncilla truncata	0.57
Pleurobema cordatum	0.50
Plethobasus cyphyus	0.36
Quadrula cylindrica	0.29
Leptodea fragilis	0.21
Lampsilis fasciola	0.14
Elliptio crassidens	0.07
Ligumia recta	0.07
Pleurobema plenum	0.07
Strophitus undulatus	0.07

2009

Species Name	Relative Abundance (%)
Actinonaias ligamentina	32.01
Cyclonaias tuberculata	13.63
Elliptio dilatata	7.71
Quadrula metanevra	7.37
Amblema plicata	5.76
Pleurobema sintoxia	5.08
Cyprogenia stegaria	4.57
Megalonaias nervosa	4.57
Quadrula pustulosa	4.49
Fusconaia subrotunda	2.79
Lampsilis ovata	2.46
Tritogonia verrucosa	1.95
Pleurobema cordatum	1.10
Ptychobranchus fasciolaris	1.10
Lampsilis fasciola	0.85
Obliquaria reflexa	0.76
Truncilla truncata	0.68
Lasmigona costata	0.42
Leptodea fragilis	0.42
Alasmidonta marginata	0.25
Elliptio crassidens	0.25
Ligumia recta	0.25
Pleurobema plenum	0.25
Potamilus alatus	0.25
Quadrula cylindrica	0.25
Strophitus undulatus	0.25
Lampsilis cardium	0.17
Ellipsaria lineolata	0.08
Fusconaia flava	0.08
Plethobasus cyphyus	0.08
Quadrula quadrula	0.08

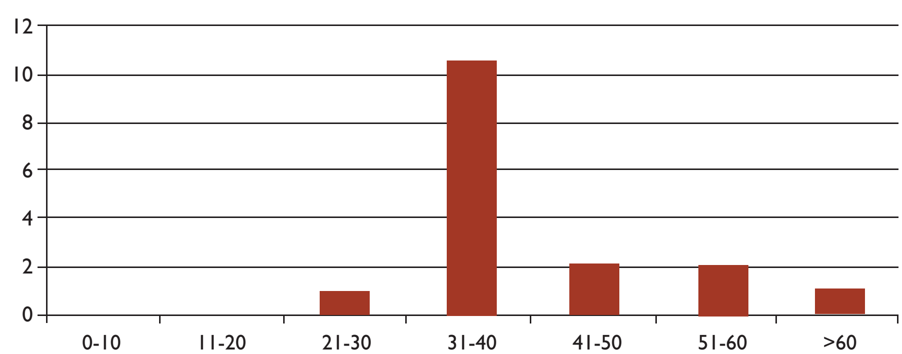


***Figure 3:** Size Classes of Fanshell (Cyprogenia stegaria) from 2004 survey data.*

Augmentation of the Cumberland Bean, *Villosa trabalis* and its host fish, the Striped Darter, *Etheostoma virgatum* in Sinking Creek, Kentucky

Striped darter, host to Cumberland Bean / Matt Thomas

Monte A. McGregor, Adam C. Shepard, J. Jacob Culp, Fritz Vorisek, and Jim Hinkle, Kentucky Department of Fish and Wildlife Resources

The Cumberland Bean is a federally endangered species and is listed as Endangered by the Kentucky State Nature Preserves Commission. It is considered extirpated in three of the states in the species' historic distribution (Natureserve 2009). Sinking Creek, KY harbors one of the last healthy, reproducing populations of the Cumberland Bean. Just like all freshwater mussels, the Cumberland Bean requires a fish host. It has been documented that the fish hosts for the Cumberland Bean are various darter species, including the Striped Darter (Layzer and Anderson 1991). Research done at the Center for Mollusk Conservation has determined that the best fish host for the Cumberland Bean is the Striped Darter, and while it has no special concern listing in Kentucky, it has an important role as the host.

In September 2009 the Kentucky Department of Fish and Wildlife and the United States Fish and Wildlife Service released 42 tagged individuals of the Cumberland Bean and 43 Striped Darters into Sinking Creek. The released mussels were propagated at the Center for Mollusk Conservation for approximately 1.5 years and were a mean length of 16.7 millimeters at the time of release. The released Striped Darters were collected as juveniles in nearby White Oak Creek and held in captivity for 2 years, serving as fish host and propagation study animals. Prior to the augmentation, a quantitative mussel survey was completed and 3 species were found in fairly low densities (mean of .83 mussels per m2). No Cumberland Bean mussels were located during the survey, but 1 individual was found in the survey area after sampling was completed. A 5 m x 5 m release area was then selected based on habitat stability and the presence of multiple Cumberland Bean mussels during previous qualitative surveys. All juvenile Cumberland Bean mussels were released in the area and allowed to bury in the substrate. After the mussel augmentation, all Striped Darters were released upstream.

This site will continue to be monitored by quantitative surveys on a regular basis. It will be monitored regularly to examine juvenile survival, growth, and reproduction, as well as changes in the entire mussel community in Sinking Creek. KDFWR will also continue to survey Sinking Creek to determine the presence and densities of the Striped Darter, a fish host critical to the recruitment of the federally endangered Cumberland Bean.

Funding Source: *Endangered Species Act (Section 6) funds, U.S. Fish and Wildlife Service*

KDFWR Strategic Plan: Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2, Class Bivalvia. Priority Survey Project #3.

Juvenile Cumberland Bean mussels / Monte McGregor

The Conservation Status of *Cambarus veteranus* (Big Sandy Crayfish) in Kentucky

Roger Thoma, Midwest Biodiversity Institute
***KDFWR Contact:** Danna Baxley*

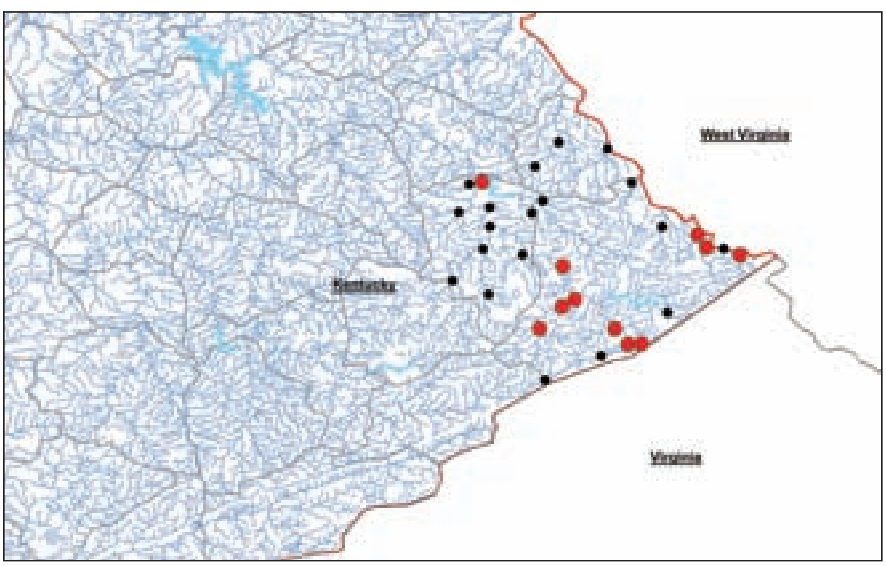
In The Crayfishes of Kentucky, Taylor & Schuster (2004) reported the presence of *Cambarus veteranus* at 4 sites in the Big Sandy River basin. The species is also found in West Virginia's, and Virginia's Big Sandy and Guyandotte River basins. Work outside Kentucky, in Virginia (Thoma, 2008) and West Virginia (Channell, 2004) has shown *C. veteranus* to be under stress with declining populations and distributions. In light of these facts a study was undertaken to determine if Kentucky populations of *C. veteranus* are displaying similar stress responses as VA & WV populations.

C. veteranus / *Roger Thoma*

Four counties (Pike, Martin, Floyd, & Letcher – in part) within the historically documented range (Big Sandy River basin) of *C. veteranus* in eastern Kentucky were sampled. Sampling was conducted with the aid of a 4'X6' seine, hand, and/or shovel. Habitat conditions were recorded at each site sampled.

Cambarus veteranus was found at 11 of 30 sites sampled, an increase of 7 new localities. All four sites previously known to harbor the species continue to retain populations. Only two of the 11 populations were found to be healthy, one of which is considered threatened. The other 9 populations were observed to be very low in abundance and individuals appeared to be stressed. Numerous additional streams were visited but not sampled due to unsuitable conditions and habitat. The two healthy populations were from lower Shelby Creek of Levisa Fork and Russell Fork at Breaks Interstate Park. The Shelby Creek population had the species present at all 3 sites sampled. The Shelby Creek population was the most significant discovery of the project. All other populations were closely associated with the mainstem Tug, Levisa, and Russell Forks.

Heavy sediment loads, a condition not tolerated by *C. veteranus*, impacted many of the streams in the study area. Mining activities resulted in most of these conditions. Numerous stream reaches have also been modified and/or channelized and now provide poor quality habitat that lacks rock/rubble substrates. *Cambarus veteranus* is a large bodied species that requires large flat rocks for its habitation. If such rocks are absent or imbedded in soft sediments the species will be absent from the area.



Cambarus veteranus *wide view*

Funding Sources: *State Wildlife Grant (SWG) and Midwest Biodiversity Institute*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5.

The Conservation Status of *Cambarus parvoculus* (Mountain Midget Crayfish) in Kentucky

Roger Thoma, Midwest Biodiversity Institute
***KDFWR Contact:** Danna Baxley*

In The Crayfishes of Kentucky, Taylor & Schuster (2004) reported the presence of *Cambarus parvoculus* at 13 sites in the upper Cumberland and Kentucky River basins. The species has also been reported from Georgia, Tennessee, and Virginia (Hobbs, 1989). Taylor & Schuster recommended genetic studies of *C. parvoculus* and the closely related *Cambarus jezerinaci* to discern their relationship. A study was conducted (Thoma& Fetzner, 2009) that found the populations considered *C. parvoculus* in the upper Kentucky River and Cumberland River upstream of the Big South Fork were more closely related to *C. jezerinaci* than to *C. parvoculus*. It may be, based on genetic data, that the Kentucky populations deserve full species recognition, but the authors did not address that issue in their study.

In this study, four counties (Whitley, McCreary, Wayne, & Clinton) within and near the historically documented range of *C. parvoculus* in southeastern Kentucky were sampled. Populations east of this area had already been studied and found not to be *C. parvoculus*. Sampling was conducted with the aid of a 4’X6’ seine, hand, and/or shovel. Habitat conditions were recorded at each site sampled.

This study found only one population of *C. parvoculus* in Kentucky (blue pentagon). Most of the sites (17 of 35 sites) harbored *Cambarus distans*, the boxclaw crayfish (red dots), a species closely related to *C. parvoculus* and *C. jezerinaci*, both physically and ecologically. To date no overlapping populations of these three species have been found in Kentucky. The three sites reported by Taylor & Schuster in the Big South Fork basin were sampled and found to harbor *C. distans*. The single collection of *C. parvoculus* came from a small tributary of the Obey River basin in western Clinton County. Three other sites in the Obey basin were sampled (all in Clinton Co.) and none were found to harbor *C. parvoculus* or *C. distans*. The presence of limestone at the surface in Clinton Co. has resulted in few suitable streams for members of the subgenus these species belong to.

Funding Sources: *State Wildlife Grant (SWG) and Midwest Biodiversity Institute*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5.

C. parvoculus / *Roger Thoma*

Response of Crayfish Populations to Restored Stream Habitats in Disturbed Portions of East Fork Little Sandy River Basin, Lawrence & Boyd Counties, Kentucky

Roger Thoma, Midwest Biodiversity Institute
***KDFWR Contact**:*
Danna Baxley


East Fork Little Sandy pre restoration / Joseph Zimmerman

The Kentucky Department of Fish and Wildlife Resources is in the process of restoring much of the East Fork Little Sandy River. The stream was historically impacted by several channel modification efforts. Much of the mainstream is dominated by low quality habitat and shifting beds of excess fine sediments.

A three-year study of crayfish populations in the basin has been instituted. The first year's sampling was conducted this summer (2009). Five sites were sampled, three modified and two restored. The three modified sites are currently being restored and will be sampled again in 2011, after a full year's recovery. 2009 sampling was conducted with a 4'X6' seine or, if waters were to shallow or small, by hand and dip-net.

Four species of crayfish were encountered in the system; *Cambarus bartonii cavatus* (Appalachian Brook Crayfish) all sites, *Cambarus dubius* (Upland Burrowing Crayfish) 1 site, *Cambarus thomai* (Little Brown Mudbug) 3 sites, and *Orconectes cristavarius* (Spiny Stream Crayfish) all sites. A preliminary assessment of resident crayfish communities reveals two general results; juvenile crayfish dominate modified stream sections, and adult crayfish numbers appear to be negatively related to the abundance of sand. Preliminary on site observations indicate conditions for crayfish populations (and fish) could be greatly enhanced with the addition of a slab rock dressing in restored riffles and stream bank areas. Once all areas to be restored are addressed and the system begins to settle down/recover it is anticipated crayfish populations will establish at healthier numbers.


East Fork Little Sandy post restoration / Joseph Zimmerman

Funding Sources: *State Wildlife Grant (SWG) and Midwest Biodiversity Institute*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.3. Priority Conservation Action #80, #120, #164, and #185.

Status Survey of the Alligator Snapping Turtle (*Machrochelys temminckii*) in Kentucky

Danna Baxley and John MacGregor, Kentucky Department of Fish and Wildlife Resources

Alligator Snapping Turtle / U.S. Fish and Wildlife Service

The alligator snapping turtle (*Machrochelys temminckii*) is the largest freshwater turtle in North America and has a limited distribution within rivers draining into the Gulf of Mexico. Unique identifying features of the alligator snapping turtle include a huge head, strongly hooked jaw, and three keels along the carapace. This turtle is considered relatively sedentary and is often found lying motionless on the bottom of slow-moving rivers, oxbow lakes, and slough-like habitats. Radio-telemetry studies have shown that these turtles prefer to spend time in waters shaded by dense forest, in areas with undercut banks, log jams, and ample underwater structure. The alligator snapping turtle is a bottom feeder and uses trickery and deception to outwit prey. While lying motionless underwater, these turtles are known to slowly wiggling a worm-like structure on the upper surface of the tongue. Fish are enticed into the turtle's widely open mouth, tricked into thinking the tongue lure is a worm. Historically, alligator snapping turtles were prized for their meat, and the enormous size of these turtles (up to 300 lbs) made commercial trapping profitable. During the 1960's, Campbell's Soup company produced a canned turtle soup made from alligator snapping turtles. Since this species is long-lived (100+ years) and slow to reproduce, commercial harvest is not sustainable; consequently the species is now protected throughout its range. Status assessments conducted in multiple states have revealed population declines, and Natureserv lists this species as "critically imperiled" in Illinois and Kansas and "Imperiled" in Kentucky, Missouri, Oklahoma, and Tennessee.

In Kentucky, the distribution of the alligator snapping turtle is not well understood, and this species is considered a "Species of Greatest Conservation Need." The first step towards managing and conserving Alligator Snapping Turtles populations in Kentucky is to identify remaining populations, and important habitats used by these populations within the state. Beginning in June of 2009, the Kentucky Department of Fish and Wildlife Resources initiated a state-wide status assessment of the Alligator Snapping Turtle. Although efforts will continue to focus on known historic locations, we also plan to deploy baited hoop nets in areas that are not known to harbor alligator snapping turtles, but appear to harbor suitable habitat for the species. During the 2009 field season, no alligator snapping turtles were detected in Kentucky. Field efforts will continue in 2010 and 2011 in hopes of identifying viable populations of this rare turtle Kentucky.

Funding Source: *State Wildlife Grant (SWG)*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2, Priority Research Project #1, Priority Survey Project #1, #2, and #4.

Effects of Phragmites Removal on Species of Greatest Conservation Need at Clear Creek WMA

Howard Whiteman and Tom Timmons, Department of Biological Sciences and Watershed Studies Institute, Murray State University
KDFWR Contact: *Danna Baxley*

Common reed (*Phragmites australis*) is an aquatic plant native to the United States that has successfully invaded numerous wetland habitats beyond its native range. *Phragmites* has been implicated in dramatic habitat changes, causing shifts in plant and animal communities. Aerial herbicide spraying of *Phragmites* is considered effective for population control, but herbicides can have unforeseen consequences toward non-target organisms and ecosystem processes. Unfortunately, few studies have determined the effects of *Phragmites* eradication on wetland animal communities, although species such as fish, reptiles, and amphibians are likely to be affected.

Phragmites is particularly innocuous at the Clear Creek WMA (CCWMA), where it dominates the landscape, has likely altered wetland hydrology, and has caused numerous access problems, particularly for waterfowl hunters. Numerous SGCN inhabit Clear Creek, and may also be affected by large-scale *Phragmites* removal. However, no formal survey work has been conducted to determine the effects of large scale *Phragmites* eradication on SGCN. Thus, the goal of this study was to use aerial herbicide treatment in an effort to eradicate *Phragmites*, and to understand the effects of such management on SGCN, as well as fish, amphibian, and reptile diversity.

On 22-August-2009 KDFWR and Ducks Unlimited carried out a chemical treatment of *Phragmites* australis on the CCWMA. An aerial application of a glyphosate herbicide was conducted on approximately 300 of the 858 acres at a rate of ten gallons per acre. These 300 acres comprise our experimental site. A site on the WMA that is invaded by *Phragmites* but did not receive chemical treatment serves as a control site. Another site on private land near the WMA where *Phragmites* has not yet been established serves as a non-*Phragmites* control site.


Phragmites / Amy Krzton Presson

Using a variety of sampling techniques, including hoop traps, minnow traps, seines, electroshocking, automated recording devices (frogloggers), and water chemistry analysis, we have sampled these three sites repeatedly since July 2009. Thus far, we have recorded several SGCN within the CCWMA, including western lesser sirens (*Siren intermedia*), bird-voiced treefrog (*Hyla avivoca*), copperbelly water snakes (*Nerodia erythrogaster neglecta*), western cottonmouth (*Agkistrodon piscivorus leucostoma*), the lake chubsucker (*Erimyzon sucetta*), American black duck (*Anas rubripes*) and the American bittern (*Botaurus lentiginosus*). Additionally, we have detected differences in the sizes of turtles inhabiting *Phragmites* versus non-*Phragmites* areas, suggesting that resource limitation in the presence of *Phragmites* may be reducing turtle growth rates. However, understanding the effects of the *Phragmites* treatments on these and other species will require further data collection during 2010-11.

Because removing *Phragmites* via herbicide spraying is a critical management goal with unknown implications on the CC-WMA environment and the SGCN within it, our project will be an important step in understanding the ecological effects of removing *Phragmites* from wetlands where it dominates, and of utilizing herbicides for such manipulations. By understanding the effects of this management on SGCN at Clear Creek, wildlife biologists in Kentucky will have the necessary insight to prescribe future *Phragmites* removal at this site, other WMAs, and other important state lands.

Funding Source: *State Wildlife Grant (SWG), Watershed Studies Institute and Department of Biological Sciences, Murray State University, and Ducks Unlimited.*

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

Investigating local declines of Rusty Blackbirds in Kentucky

Rusty Blackbird / Brainard Palmer-Ball

Kate Heyden, Kentucky Department of Fish and Wildlife Resources; David Evers and Samuel Edmonds, BioDiversity Research Institute; William Barnard, Norwich University; Claudia Mettke-Hofmann, Liverpool John Moores University; Keith Hobson, Environment Canada; and Terry Chesser, National Museum of Natural History

The Rusty Blackbird (*Euphagus carolinus*) breeds in the boreal wetlands of Alaska, Canada and the northeastern United States and spends its winter in the flooded forests of the southeastern United States. Once locally common at several locations in central and western Kentucky, wintering flocks of Rusty Blackbirds have become more spotty and ephemeral in the past 30 years. The resulting conservation concern for this species led to its inclusion as a Species of Greatest Conservation Need in Kentucky's State Wildlife Action Plan. Rangewide, the Rusty Blackbird has been steeply declining with estimates of an 85-99% population drop over the past 40 years. The cause for this alarming decline is not known and the increasingly sparse and erratic winter distribution of the Rusty Blackbird makes it challenging to learn more about as a basis for conservation efforts.

In 2010, KDFWR initiated a project focused on capturing Rusty Blackbirds in order to obtain blood and feather samples for contribution to several analyses going on within the International Rusty Blackbird Technical Working Group (IRBTWG). It is hoped that data collected through this project will further our understanding of Rusty Blackbird declines in Kentucky and throughout their range.

For this project, Rusty Blackbirds were captured during January and February 2010 in baited mist-nets at two locations: Cleaton Baptist Church, Muhlenberg Co. and Surrey Hills Farm, Jefferson Co. Rusty Blackbirds (as many as 100) have been sighted in Cleaton for 10 years or more during Christmas Bird Counts. Although sightings of up to 200 Rusty Blackbirds were common during winters at Surrey Hills Farm in the 1970's and 80's, Rusty Blackbirds were observed there for the first time in over five years in 2010. We mist-netted for 23 hours in Cleaton KY (using 2, 12 m 34mm mesh nets) and 8.5 hours at Surrey Hills Farm (using 2, 3 m 36mm mesh nets). We captured and banded 32 Rusty Blackbirds (25 males, 8 females) and recaptured one male Rusty Blackbird which had been banded at the same site earlier that season (Table 1). We also took blood and feather samples from red-winged blackbirds (*Agelaius phoeniceus*) (3) European starlings (*Sturnus vulgaris*) (4) and brown-headed cowbirds (*Molothrus ater*) (9). Samples taken from non-target species will be used for comparisons of contaminant loads.

Blood samples collected during this project will be contributed for use in genetics, contaminants, diet and blood parasites analyses conducted by various members of the IRBTWG. Feather samples will be analyzed for stable isotopes, genetics and contaminants. This project will continue in 2011 in order to strengthen sample size. We look forward to receiving results which will help direct research, monitoring and conservation attention for this species.

	AGE			
Sex	Second Year	After Hatch Year	After Second Year	Total
Female	3	5		8
Male	9		15	24
Total	**12**	**5**	**15**	**32**

Table 1: *Age and sex of Rusty Blackbirds captured during January and February 2010 in Kentucky.*

Funding Sources: *State Wildlife Grant (SWG)*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2. Priority Survey Project #3.

Evaluating the Effects of Grassland Management on Raptor Habitat Use at Peabody WMA

Kate Heyden and Danna Baxley, Kentucky Department of Fish and Wildlife Resources

Raptor surveys at Peabody Wildlife Management Area (WMA) have been conducted since 2002, first by an Eastern Kentucky University graduate student, Mark Vukovich (2002-2003), and then continued year-round by KDFWR personnel (2004-2007). The data collected from 2002-2007 suggest raptor habitat use may differ between fields which have undergone management for native warm-season grasses (NWSG) and those which have been left unmanaged. However, these surveys were not structured to provide conclusive results on differences in habitat use. Thus, in 2008 we re-evaluated the survey protocol to obtain a dataset with sufficient sample size and standardization to evaluate the effects of grassland management at Peabody WMA on raptor habitat use by determining if raptor habitat use differs between fields managed for warm-season grasses and unmanaged fields. These two habitat types result from a combination of several management actions for which we have digital records: NWSG plantings, burning, strip-disking, and herbicide applications. If a difference in raptor habitat use is found between habitat types, we hope to gain knowledge through this project on determining which habitat-related variable may be influencing raptor habitat use: small mammal abundance or vegetation attributes. Thus, this project will have three components: raptor surveys, small mammal sampling and vegetation sampling. The Northern Harrier (*Circus cyaneus*), a species of greatest conservation need (SGCN) listed in Kentucky's State Wildlife Action Plan (SWAP), has been regularly observed at Peabody WMA with enough frequency to provide a sample size necessary for analysis. Consequently, we structured the revised protocol to ensure we capture ample data for harriers and their prey species. This project began in December of 2008 and we plan to continue it for 3 years.

Raptor surveys are being conducted once each month (December, and January-July). Thirty randomly placed points are stopped at along roads at Peabody WMA which dissect grassland habitat, where a 3-minute, single-observer point count is conducted. Species, age, sex, behavior and location is recorded for each raptor individual and its location is marked on an aerial image. Raptor locations are digitized for each detection and will be used in future analyses along with season-specific management maps provided by the WMA manager to record the habitat available at each survey area. During 2008-2009 surveys, a total of 108 raptors, representing nine species were detected. Four species of greatest conservation need (SGCN) were detected including: Bald Eagle (*Haliaeetus leucocephalus*) (2), Mississippi Kite (*Ictinia mississippiensis*) (1), Northern Harrier (30), and Osprey (*Pandion haliaetus*) (2). Red-tailed Hawk (*Buteo jamaicensis*) (54) was the most common species detected.

Northern Harrier / Kate Heyden

Measurement of vegetation variables occurs at small mammal trapping grids at the time that the traps are picked up for winter and summer. Four vegetation variables, as well as soil compaction are measured at each plot: vegetation height, vegetation heterogeneity, vegetation density, and percent cover of vegetation type (at two levels).

In order to obtain estimates of small mammal abundance, we are conducting small mammal trapping in NWSG fields and fields containing non-native vegetation. Small mammal traps are laid out in randomly placed 7 x 7 grids which consist of 49 double traps placed 10 m apart. Six grids per year are sampled in winter and summer for small mammals: three grids located in each field type. Small mammal trapping took place in March and July 2009. A total of 240 individuals of 10 species were captured. The most common species captured was the Prairie Vole (*Microtus ochrogaster*).

Intensive grassland management continues to occur at Peabody WMA. Since Peabody WMA is inarguably one of the more significant tracts of grassland habitat for breeding and wintering raptors in Kentucky, we hope to learn through this project how widespread grassland management will affect local raptor habitat quality and populations.

Funding Sources: *State Wildlife Grant (SWG)*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2. Priority Research Project #2 and #6, Priority Survey Project #3.

Evaluating the Effects of Grassland Management on Nesting and Migrating Songbirds at Shaker Village of Pleasant Hill

Kate Heyden, Kentucky Department of Fish and Wildlife Resources

During the spring of 2009, KDFWR initiated a songbird banding station at Shaker Village of Pleasant Hill in Mercer County. The station followed the Monitoring Avian Productivity and Survivorship (MAPS) protocol, set forth by the Institute of Bird Populations and operated on eight dates between May 27 and July 30, 2009. The station contains open grass-dominated areas, as well as patches of shrubs and wooded edge. Although a few native grasses, shrubs and forbs are present in small numbers, the vegetation is primarily made up of non-native, old field vegetation. On the landscape, the station is surrounded by hayfields, cornfields and native warm-season grass (NWSG) fields.

Golden crowned kinglet / Ben Leffew

This location was chosen for the MAPS station in order to evaluate the effects on nesting grassland birds by the intensive management continually occurring on the surrounding landscape for the establishment of NWSG fields. A substantial portion (500 acres) of the surrounding area within 2.5 miles of the station was converted to NWSG in 2009, with more conversions expected in the next few years. The area which contains the MAPS station will likely be converted to NWSG sometime in the next 5 years. Thus netting began in 2009 in hopes to obtain baseline data.

During operation, 10 mist nets (32 mm mesh) were opened at sunrise and operated for at least 4 hours. Nets were checked and cleared of birds every 40 minutes, or as needed due to weather conditions. We netted for a total of 340 net hours for an average of 42.5 net hours per day of operation. There were 369 captures of 34 species, for a capture rate of 1.09 birds per net hour. KDFWR personnel, Shaker Village staff and volunteers banded birds with US Geological Survey (USGS) aluminum leg bands. Morphological measurements and plumage characteristics were recorded including breeding condition, wing chord, mass, fat stores, the extent of flight feather and body molt, and the degree of feather wear. When possible, birds were aged and sexed using the degree of skull pneumaticization and/or plumage characteristics, including the presence or absence of molt limits. Eleven individuals of three Species of Greatest Conservation Need (SGCN) as listed in Kentucky's State Wildlife Action Plan (SWAP) were captured during the nesting season, including Grasshopper Sparrow (*Ammodramus savannarum*), Willow Flycatcher (*Empidonax traillii*) and Canada Warbler (*Wilsonia canadensis*).

KDFWR also initiated a migration songbird banding station at Shaker Village of Pleasant Hill in 2009. Songbird banding continued through fall 2009 at the same banding site, using the same mist-net locations. The migration banding station operated during fall on nine dates between 3 September and 5 November to investigate the use of this site by SGCN and neotropical migrants. During operation, eight or nine mist nets (32 mm mesh) were opened at sunrise and operated for at least 4 hours. We netted for a total of 329.94 net hours for an average of 36.66 net hours per day of operation. There were 254 captures of 37 species, for a capture rate of 0.77 birds per net hour. Three SGCN were captured during fall netting including Blackburnian Warbler (*Dendroica fusca*), Brown Creeper (*Certhia americana*) and Northern Bobwhite (*Colinus virginianus*). Not surprisingly, several species were caught in migration at Shaker Village that had not been caught during the breeding season, raising the total species captured at the banding station overall to 55. Field Sparrow (*Spizella pusilla*) and Song Sparrow (*Melospiza melodia*) were the most commonly captured species during the migration season and overall.

Since this banding station captured a diverse and substantial sample of species in 2009, KDFWR would like to continue research at this site, lasting though 2018. The station location and net locations will not change. The large-scale changes occurring on the landscape at Shaker Village offer a unique opportunity for this cooperative project which will provide vital information for conserving grassland birds in Kentucky by quantifying the effects of NWSG conversion on nesting and migrating songbirds.

Funding Source: *State Wildlife Grant (SWG)*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2. Priority Research Project #2 and #6, Priority Survey Project #3.

Monitoring the Effects of WMA Forest Stand Improvements on Songbirds

Kate Heyden, Kentucky Department of Fish and Wildlife Resources, Todd Jones-Farrand, Central Hardwoods Joint Venture; and Shawchyi Vorisek, Kentucky Department of Fish and Wildlife Resources

In 2009, KDFWR worked with the Central Hardwoods Joint Venture (JV) to establish survey routes and protocol for monitoring the effects of future WMA forest stand improvement (FSI) projects (e.g. oak regeneration, edge feathering, cedar removals, removal of invasive/exotic species) on songbirds. Survey locations were established in 2009 for 10 WMAs. Although FSI has not yet occurred at these sites, the 2009 survey will provide valuable baseline data for this long-term monitoring strategy. Data from these surveys were also used to validate Habitat Suitability Index models which had been developed jointly by the Lower Mississippi Valley JV and the Central Hardwoods JV.

In May-June, 2009, KDFWR completed 14 survey transects containing 7-12 points. There were 565 detections of focal species, 178 of which were for SGCN (Table 1).

Funding Source: *State Wildlife Grant (SWG)*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2. Priority Research Project #2 and #6, Priority Survey Project #3.

White-eyed vireo nest / Kate Heyden

Species	Adair WMA	Dr. James R. Rich WMA	Green River WMA	Kleber WMA	KY River WMA	Lloyd WMA	Central KY WMA	Peabody WMA	Taylors-ville WMA	Yellowbank WMA	Total
Acadian Flycatcher	1	2	14	2	1	4			2	4	**30**
Black and White Warbler		1		1							**2**
Bell's Vireo								18			**18**
Blue-gray Gnatcatcher	1		11	1	2	9	1	2	7	6	**40**
Brown Thrasher		4			3		4	5		1	**17**
Carolina Chickadee	1	2	1	2	4	1	3			5	**19**
Cerulean Warbler										1	**1**
Eastern Wood Pewee	5	1	2		6	3	7		1	6	**31**
Field Sparrow		10		3	8		15	35			**71**
Blue-winged Warbler				1	1		1				**3**
Great-crested Flycatcher		2	3			1	3			4	**13**
Hooded Warbler						1					**1**
Kentucky Warbler	7	5	11		1	2				3	**29**
Northern Bobwhite		3		4	1			19			**27**
Northern Parula	1	1	4		1			5		4	**16**
Orchard Oriole					2			1			**3**
Pilieated Woodpecker	2	2	5		1		4				**14**
Prairie Warbler		16	1	13			12	3	8		**53**
Prothonotary Warbler			2					1			**3**
Red-headed Woodpecker							1	1			**2**
White-eyed Vireo			19	2	2		3	8	2	2	**38**
Worm-eating Warbler		1					3			1	**5**
Wood Thrush	8	1	1		2	11	1		1	12	**37**
Yellow-breasted Chat	2	10	16	2	29	2	2	18	3	1	**85**
Yellow-throated Vireo		2	3					1		1	**7**
Total- All Species	**28**	**63**	**91**	**31**	**64**	**34**	**60**	**117**	**24**	**51**	**565**
Total- SGCN	**15**	**26**	**15**	**18**	**5**	**13**	**18**	**42**	**9**	**17**	**178**

Table 1: *Species detections during 2009 FSI surveys. SGCN are highlighted in yellow.*

Sharp-shinned Hawks in Kentucky: Detection, Abundance, Nest-Site Selection, and Breeding Success

Gary Ritchison and Tyler Rankin, Eastern Kentucky University
KDFWR Contact: *Shawchyi Vorisek*

Because so little is known about the abundance of Sharp-shinned Hawks at any level (continental, regional, state, and local), assessing possible effects of forest management practices and habitat loss and degradation on their population status is currently not possible. The reason for this lack of information is that Sharp-shinned Hawks are the most secretive, and most difficult to census, of any of North America's forest-breeding raptors. Based on few studies and small sample sizes, Sharp-shinned Hawks will apparently nest in most forest habitats, particularly those with at least some conifers. However, there is clearly a need to learn more about Sharp-shinned Hawks in Kentucky and throughout its breeding range. Successful management requires information concerning where and how many birds are breeding and their habitat requirements. This study began in 2009 and sought to address the following objectives: (1) survey several areas throughout Kentucky where previous observations indicate that Sharp-shinned Hawks may currently be breeding to determine their distribution and abundance, (2) locate as many nests as possible and quantify those features of habitat apparently important in selection of breeding territories and nest sites by Sharp-shinned Hawks,

Sharp-shinned nest / Mike Matthews

Sharp-shinned nest / Tony Englert

and (3) determine important reproductive parameters for as many nests as possible, include clutch sizes, hatching success, and fledging success. To meet these objectives, road surveys, involving the broadcast of three types of calls, are being conducted in at least ten counties throughout Kentucky between July 2009 – June 30, 2010. Where Sharp-shinned Hawks are detected, areas will be searched for evidence of a nest and, for each nest, clutch sizes, hatching success, and fledging success will be noted. Habitat characteristics of all nest sites will be quantified and analyses conducted to compare the characteristics of successful nests, unsuccessful nests, and random sites. Developing an effective survey method for breeding Sharp-shinned Hawks and providing new information about the habitat requirements of nesting Sharp-shinned Hawks will make this study of importance not only for biologists in Kentucky, but for biologists throughout the breeding range of Sharp-shinned Hawks.

Sharp-shinned chicks / Mike Matthews

Funding Sources: *State Wildlife Grant (SWG)*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2. Priority Survey Project #3.

American Woodcock Nocturnal Field Usage During Spring Migration in Central Kentucky

Andy Newman and Charles Elliott, Eastern Kentucky University; John Brunjes, Kentucky Department of Fish and Wildlife Resources

American Woodcock (*Scolopax minor*) are small migratory shorebirds that range throughout the eastern United States. A majority of woodcock winter in the southeast and coastal states and breed in the northern part of their range. They prefer dense thickets of young growth forest for diurnal cover and nesting. At dusk they fly into fields for roosting, feeding, and courtship during spring. Since the inception of woodcock monitoring in the late 1960's, populations have exhibited long-term declines. Removal of bottomland forest and mechanized farming practices have reduced amount of wintering habitat available. In northern breeding, areas changes in forest management have resulted in fewer tracts of early-successional habitat that woodcock prefer for nesting and roosting.

While woodcock do breed in Kentucky, a majority of the birds pass through the state during migration in early spring and late fall. Limited research documenting habitat preferences for migrating woodcock has been conducted.

During the springs of 2009 and 2010 potential nocturnal roosting habitats were searched for woodcock on the Miller-Welch Central Kentucky WMA and the Blue Grass Army Depot. ATVs equipped with spotlights were used to locate birds. If possible birds were captured, banded, sexed, and aged. Flagging was used to mark locations of birds in fields. Habitat type, dominant vegetation, distance and composition of dense cover, percent cover, and field size were recorded.

In two field seasons, over 400 woodcock were located and 110 were banded. Woodcock were located in a variety of fields, e.g., managed old fields (bush hogged), mowed fields, native grasses, hayed fields, burned fields, and pasture. Highest densities of birds were observed in fields that had overhead cover and sparse ground cover. Dominant species that comprised overhead cover consisted of blackberry (*Rubus spp.*), goldenrod (*Solidago spp.*), dogwood (*Cornus spp.*), and sumac (*Rhus spp.*). Short distances to overhead cover allow woodcock to quickly escape from predators and may also offer thermal protection on cold nights. A majority of birds captured exhibited moist soil on bills, indicating active feeding in the fields.

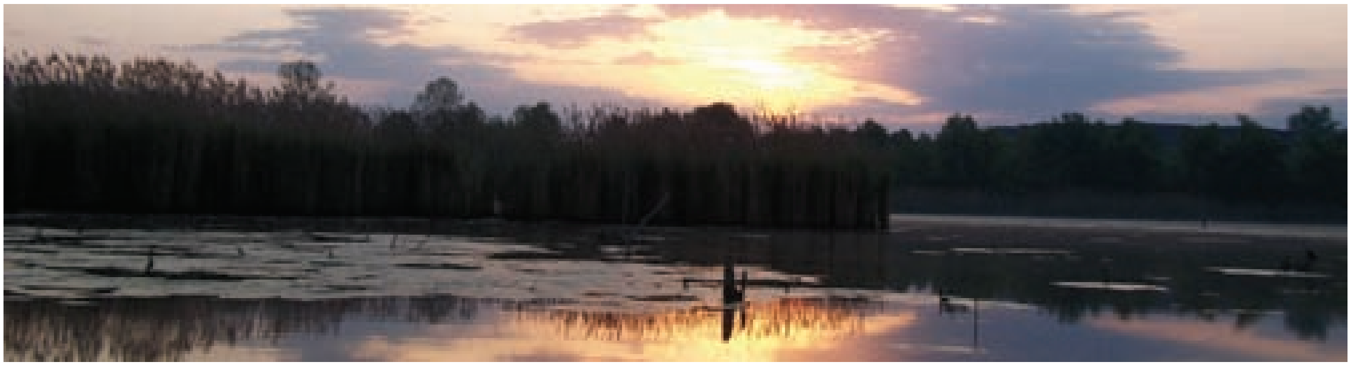
As the remainder of the data is analyzed it should offer insight into woodcock ecology and allow for more efficient management of woodcock on both public and private land. Providing quality stopover sites will allow more birds to reach breeding grounds in better body condition; and hence exhibit higher reproductive potential.

Funding Source: *State Wildlife Grant (SWG) and Eastern Kentucky University*

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

Woodcock / USFWS

Marsh Bird Monitoring in Kentucky



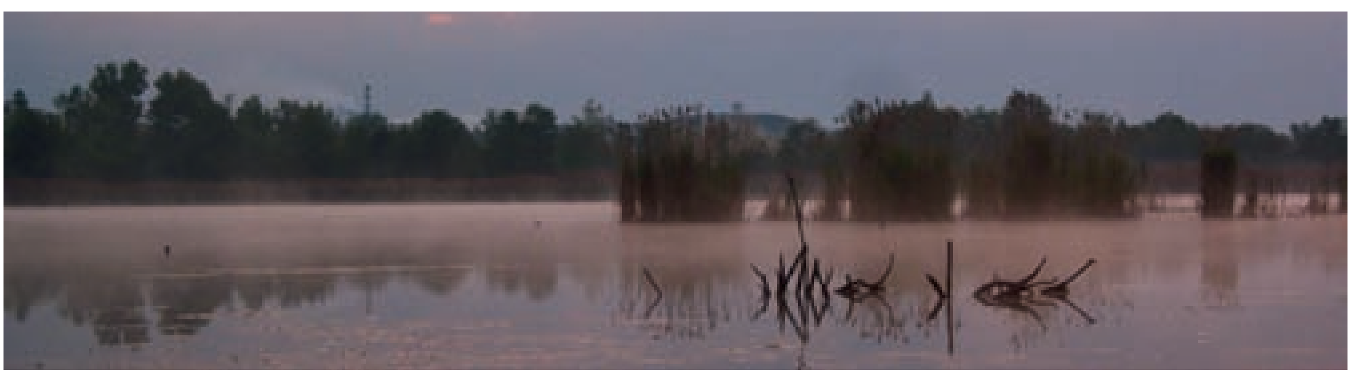
Wetland / Erin Harper

Erin Harper, Kentucky Department of Fish and Wildlife Resources

The loss and alteration of emergent wetland habitat in North America appears to be the cause of declines of marsh bird populations that are dependent on this habitat. There is a general lack of information on status and population trends of marsh birds, so the North American Marsh Bird Monitoring Program was designed to develop standardized protocols used in national monitoring efforts. Marsh bird surveys were conducted in April and May in Kentucky as part of a pilot study. Marsh birds are often secretive, thus rarely seen or heard by observers. Therefore, broadcast vocalizations of target species are used to improve detection probability. Ten focal species migrate through Kentucky, and of those, five species are known to breed in Kentucky, including King Rails (*Rallus elegans*), American Bitterns (*Botaurus lentiginosus*), Least Bitterns (*Ixobrychus exilis*), Common Moorhens (*Gallinula chloropus*), and Pied-billed Grebes (*Podilymbus podiceps*). Because emergent wetland habitat is limited, most of these species are fairly uncommon. Survey locations were random sites chosen by the U.S. Fish and Wildlife Service (USFWS) and based on the National Wetland Index (NWI). Routes used for surveys were located in the Bluegrass and Purchase regions. Sites were surveyed three times between April 15 and May 31. Focal species observed during surveys included Least Bittern (1), Pied-billed Grebes (6), and American Coot (*Fulica americana-1*). Seven non-focal species were observed during surveys. The most abundant were Wood Ducks (4 broods with a total of 33), Great Blue Herons (24), Great Egrets (13), and Little Blue Herons (11). Surveys will continue next year with a few changes. More sites will be surveyed to increase the probability of observing focal species. Many sites were located on private lands and/or inaccessible, thus, next year sites will be focused more on Wildlife Management Areas, since they contain much of the state's emergent wetlands and are more accessible.

Funding Source: *State Wildlife Grant (SWG)*

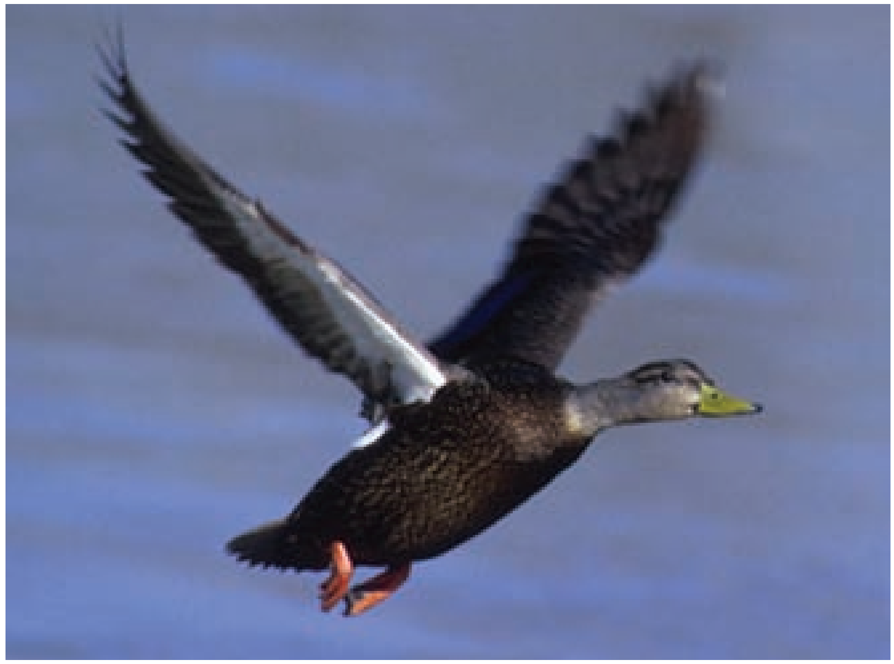
KDFWR Strategic Plan. Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2. Class Aves. Priority Survey Project #3 and #4.



Wetland / Erin Harper

Pilot Study- Post-Season Banding of American Black Ducks in Kentucky

Rocky Pritchert, Kentucky Department of Fish and Wildlife Resources



American black duck / U.S. Fish and Wildlife Service

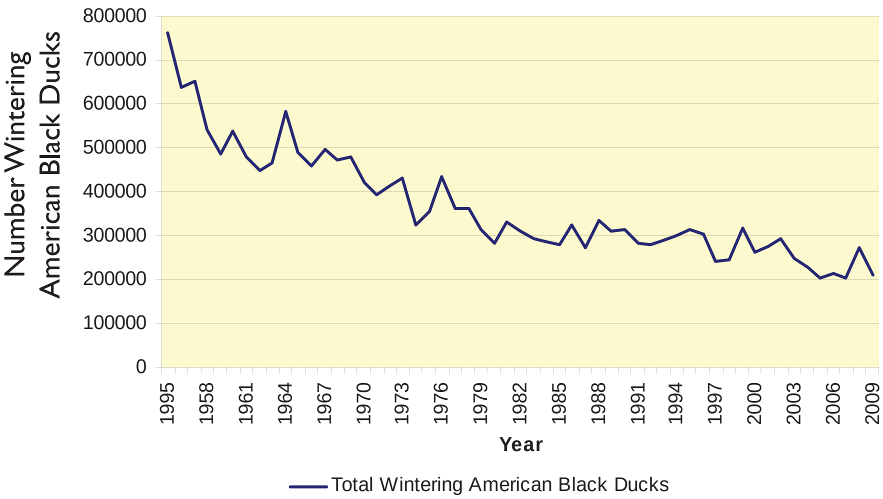
Eastern The American black duck (*Anas rubripes*), is a fairly common species found throughout eastern North America sometime during its annual cycle (Longcore et al. 2000 b). Occasionally called "black mallard", this species nesting range extends from the Maritime Provinces in eastern Canada, the New England states westward through Quebec and most of Ontario in Canada as well as Michigan and Wisconsin in the northern United States. Black ducks primarily winter in the mid-latitude states of the eastern United States. Major wintering areas extend from the coastal regions of New Jersey southward to the Carolinas and westward into Kentucky and Tennessee.

In Kentucky, American black ducks are commonly observed from December through March in backwater sloughs and embayments of major rivers, beaver ponds, flooded timber and other isolated wetlands across the state. While black ducks may be encountered anywhere in Kentucky then, the species is proportionately more common as one moves from west to east. The largest concentrations are reported along the Ohio River from Cincinnati east to Ashland. Other areas having good numbers of black ducks include; the region around Cave Run Lake in Bath and Rowan counties, Green River Lake in Adair and Taylor counties and the wetlands on Bluegrass Army Depot in Madison County.

Black ducks are an important species for waterfowl hunters especially in the Atlantic Flyway. In many areas, they are second only to mallards (*Anas platyrhyncuous*) in dabbling ducks encountered along the eastern seaboard (Fronczak, 2009). Through the years a very rich waterfowl heritage has developed around pursuit of black ducks to the point where some hunters set out exclusively just to hunt this species. This heritage created a great deal of interest in black duck hunting and the species in general. In the Mississippi Flyway, black ducks have not received the same degree of attention as seen among waterfowl hunters on the eastern seaboard. Although not actively pursued by Mississippi Flyway waterfowl hunters, it is still considered a major species of interest especially by the eastern half of the flyway where over 74% of the total black duck harvest occurs (Fronczak, 2009).

While black ducks are common throughout their range, winter numbers have declined sharply in the two flyways. Since the late 1950's, the number of black ducks counted on wintering areas during the mid-winter waterfowl survey has declined about 60%. The greatest decline occurred from the late 1950's through the mid 1970"s. Since then, the trend has slowed in the Atlantic Flyway region but continues in the western areas in the Mississippi Flyway (Fronczak, 2009). The causes of this decline are not well understood. Researchers and managers proposed several hypotheses to explain the decline of black ducks including possible over-harvest, competition and hybridization with mallards, decrease in quality and quantity of wintering and breeding habitat, environmental contaminants and recently climate induced changes (Conroy et al. 1989, Rusch et al. 1989, Longcore et al. 2000 a, Nudds et al. 1996, Zimpfer and Conroy 2006). Research into each of these hypotheses has provided valuable insight into black duck ecology and management. However, the population remains below desired levels and recent data paint a mixed picture of population growth making the status and sustainability of the American black duck uncertain.

Total number of American black ducks observed on major wintering areas from 1995-2009



In response to this decline the black duck was identified as a "species of international concern" by the U.S. and Canadian federal governments and a "species of greatest conservation" need by 23 states in the Mississippi and Atlantic Flyways. The Black Duck Joint Venture (BDJV) was established in 1989 as the first species joint venture under the North American Waterfowl Management Plan (NAWMP) to lead a coordinated monitoring, research, and communications program to restore the population to 640,000 breeding black ducks.

In 2008, the Black Duck Joint Venture along with its Federal (i.e., US Fish and Wildlife Service and Canadian Wildlife Service) and State and Provincial Partners in the Atlantic and Mississippi Flyways have agreed to conduct a 5-year pilot effort to assess the usefulness of a 2-season banding program to monitor changes in black duck vital rates over time. The Mississippi and Atlantic Flyway Councils passed a Joint Resolution encouraging Federal, State, and Provincial partners to participate in the pilot effort through in-kind contributions of personnel time and equipment. Each state or province was issued a banding objective based upon their respective winter numbers. Kentucky's objective is 25 black ducks for the 2009-10 wintering period.

KDFWR biologist initiated trapping efforts after the waterfowl season in February 2010 in areas where black ducks were documented during the 2009-10 aerial winter surveys. We attempted to band at Sloughs and Yellowbank WMAs adjacent to the Ohio River in west-central part of the state on private lands along the Ohio River near Lewisport in northeast Kentucky. A permanent swim in trap was used at Sloughs WMA and portable swim-in type traps were used at all other locations. A rocket net was also tried on selected locations in the northeast part of the state. Traps sites were extensively baited and monitored through February.

Biologists reported black ducks present at all trap sites. However, heavy snow and ice limited our ability to travel to sites in the northeast and set traps during the most opportune times. Capture and banding efforts were only successful at Sloughs WMA this past year where we banded 84% of Kentucky's quota. While we had very limited success this past year because of weather, we did learn a great deal from our efforts which should improve banding success during the remaining years of this pilot study.

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Funding Sources: *State Wildlife Grant (SWG)*

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

Avian Response to Production Stands of Native Warm-Season Grasses

Andrew West and Patrick Keyser, Center for Native Grasslands Management, University of Tennessee

***KDFWR Contact:** John Morgan*

Grassland birds such as the Henslow's sparrow, dickcissel, and northern bobwhite have declined more than any other guild of birds in the United States. Much of this is due to the loss of habitat resulting from the conversion of native warm-season grasses (NWSG) that once dominated the prairies and savannahs of the Midwest and Mid-South. Large crop fields, pastures, or urban areas now cover much of the birds' former range. The Farm Bill has restored some habitat for these birds through the Conservation Reserve Program (CPR), but populations continue to decline; the scale of this and other Farm Bill programs is too small on most landscapes to impact breeding bird populations. Other uses for NWSG such as haying, grazing and biofuels may have the potential to affect substantially more area due to market-based incentives they provide to landowners. Although these production practices and their effect on grassland birds have been studied to a limited extent in the Great Plains, they have not been evaluated in the East or South.

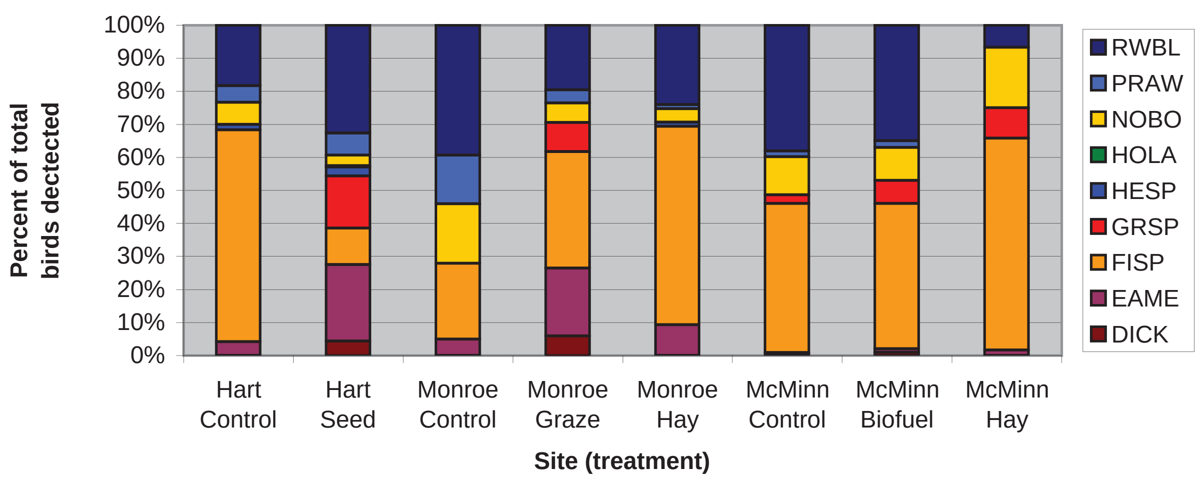
Therefore, this project will examine production stands of NWSG in Kentucky and Tennessee. Treatments that we are evaluating are control (fallow), forage (grazing and haying), seed, and biofuel production fields of NWSG. In 2009, we monitored 95 fields across three sites: Hart (seed production and control) and Monroe Counties (haying, grazing, and control) in Kentucky, and McMinn County (biofuels, haying, and control) in Tennessee. Each field was visited four times, three for 10-minute point counts to assess presence of 9 target species (northern bobwhite, eastern meadowlark, prairie warbler, field sparrow, Henslow's sparrow, grasshopper sparrow, red-winged blackbird, horned lark, and dickcissel), and a fourth time to measure vegetation (species composition, density, height, and litter cover and depth).

Seed production fields in Hart County had the highest species richness having all nine target species, while the grazed fields in Monroe Co. and control fields in McMinn Co. had more birds per field (14). Northern bobwhite was detected in all treatment types. Field sparrows were the most abundant species detected with 40% of total; red-winged blackbirds and eastern meadowlarks were the next two most abundant. Surveys will continue in 2010 on the same fields. Statistical models are being developed and will be finalized following the 2010 field season.

Funding Sources: *Pittman Robertson (PR) 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 #8.

Percent of species detected over three visits for each treatment by location site. Species code: red-winged blackbird (RWBL), prairie warbler (PRAW), northern bobwhite (NOBO), horned lark (HOLA), Henslow's sparrow (HESP), grasshopper sparrow (GRSP), field sparrow (FISP), eastern meadowlark (EAME),and dickcissel (DICK).



Northern Bobwhite Population Ecology on Reclaimed Mined Land

Radio-tagged bobwhite being released on Peabody WMA / Evan Tanner

Evan Tanner and Patrick Keyser, Center for Native Grasslands Management, University of Tennessee
KDFWR Contact: *John Morgan*

Region-wide declines of northern bobwhite (*Colinus virginianus*) populations have become more pronounced and widespread throughout the species' range with an annual decrease of -3.0% between 1966-2007, based on the Breeding Bird Survey. This decline can largely be attributed to the loss of useable habitat as a result of increased use of clean farming practices, reliance on non-native forage grasses, and loss of early successional habitat.

One opportunity for increasing bobwhite habitat is management of reclaimed mine sites. Under the Surface Mining Control and Reclamation Act of 1977, early successional habitats have been established to minimize the impact that surface mining has on wildlife populations and unique habitat types; over 200,000 hectares of potential habitat have been created in Kentucky. However, establishment of dense stands of sericea lespedeza and other exotic species is common on reclaimed sites, and has led to unfavorable habitat for bobwhite quail. Research regarding the dynamics of bobwhite populations on reclaimed mined lands – and other habitat types in the Mid-South – is lacking, and information on how this important game species responds to management on these sites is needed.

Two units (Sinclair and Ken) of the Peabody Wildlife Management Area, a reclaimed mine site, were chosen for this study. Both units were assigned control and treatment areas encompassing roughly equal amounts of key habitat types. Management of treatment areas will include prescribed fire, disking, spraying, and establishment of food plots. This project will investigate bobwhite population responses to these habitat improvements including mortality rates (hunting/non-hunting) by sex and age class and fecundity, including nest success, nest productivity, and brood survival. These parameters will be monitored along with hunting pressure and changes in habitat condition resulting from the experimental habitat manipulations. Analysis will include evaluation of survival in relation to habitat quality for winter home ranges, nest sites, and brood ranges.

We are trapping using funnel traps baited with cracked corn and milo. Trapped birds are being banded with aluminum leg-bands, and fitted with necklace-style radio transmitters (6.0 g). To estimate home ranges, document habitat use, and estimate survival rates, radiotagged birds are being located 3 times/week. Fall population estimates are being obtained using a fall covey census and telemetry data. Hunting mortality will be estimated through band recovery during quota hunts and radio telemetry. Nest success, nest productivity, and brood survival will all be evaluated via telemetry. Habitat quality will be monitored in both winter and breeding seasons through vegetation sampling across all sites.

Being the first year of this project, preliminary data analysis has not been completed. Since trapping first started in mid-September 2009, a total of 59 birds have been caught on the Sinclair unit and 151 on the Ken unit. Crude mortality rates are 80% and 77% (Sinclair), and 56% and 39% (Ken) for the treatment and controls, respectively.

Funding Source: *Pittman Robertson (PR) 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.

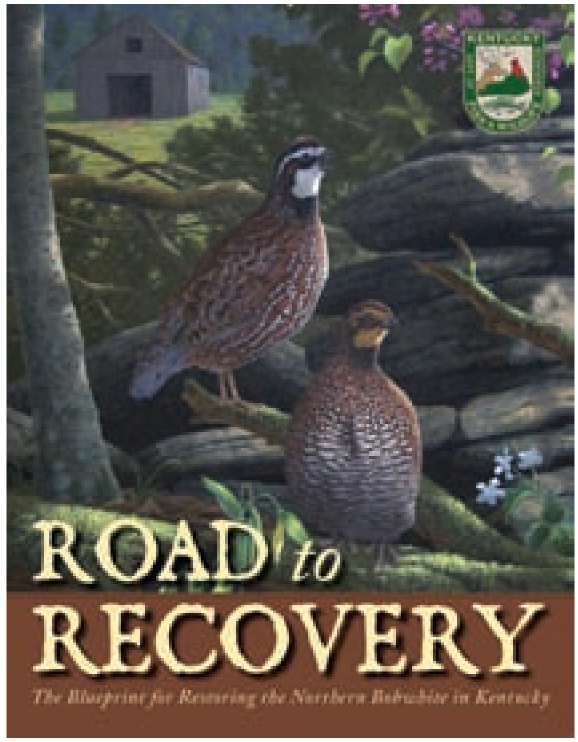
Bobwhite Focal Area Activity and Monitoring in Kentucky

John Morgan and Ben Robinson, Kentucky Department of Fish and Wildlife Resources

Northern Bobwhite (*Colinus virginianus*) have experienced dramatic declines across large portions of their range, including Kentucky. In April 2008, "Road to Recovery: The Blueprint for Restoring the Northern Bobwhite in Kentucky" was published by the Kentucky Department of Fish and Wildlife Resources (KDFWR). This plan set the course for focused habitat restoration efforts on public and private lands. The goal is to generate a template for broader restoration activities in the Commonwealth.

To date, 6 of the 11 focal areas identified in the plan are engaged in monitoring for population levels of bobwhite and a suite of grassland songbirds. They include Livingston County, Peabody WMA, Sinking Creek, Hart Co, Bluegrass Army Depot, Clay WMA, and Straight Creek. Although formal data analysis will not take place for several more years, bobwhite are present in every focal area. Livingston County presents the best opportunity for success in the short-term, because it has the strongest population of wild bobwhite compared to the other areas.

Quail pair / Joe Lacefield



In 2009, monitored focus areas were categorized by habitat type. The effort required local biological staff to classify every acre of the area to a standardized list of habitat types. Biologists visually documented each acre from the road or on foot. In circumstances where access was impossible, we deployed a helicopter to visually inspect the location. Data were transferred from large printed maps into a geodatabase using ArcGIS. Over time, local biologists will update the habitat classification based on restoration activity and track maintenance work on existing habitat. Ultimately, we will evaluate bird response to changes in habitat in a 5-7 year period. Some focal areas may be evaluated for longer periods of time if little restoration activity has occurred.

This year marked the first significant investment of KDFWR dollars for 3 focal areas. Peabody WMA, Clay WMA, and Straight Creek were given funds to expand their capacity to manage habitat. Peabody and Clay WMA monitoring data will be analyzed in 5 to 7 years for progress with respect to bobwhite and grassland birds. Although monies were invested on Straight Creek, questions regarding future mining activity have eliminated the site from significant investment in habitat in the future.

The next phase of focal area implementation is area-specific plans. Private land areas will set 5-year habitat goals including 2 year benchmarks. They will be strategic in nature as work requires access to private lands. Therefore, management activities cannot always be planned explicitly, because staff do not have access to all properties. Public land focal areas provide the platform for specific management actions. They will follow KDFWR's WMA Plan which includes field level planning over a 5-year period. Peabody WMA has a completed management plan and Clay WMA has a draft plan nearly complete.

Funding Source: *Pittman Robertson (PR) and Kentucky Department of Fish and Wildlife*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.3. Priority Conservation Action #19, #63, #80, and #120.

Efficacy of Surrogate Propagation™ As a Quail Restoration Technique in Central Kentucky

Ben Robinson, Danna Baxley, Joe Lacefield, and John Morgan, Kentucky Department of Fish and Wildlife Resources

Quail restoration has emerged as one of the most difficult problems in wildlife conservation today. Although the solution to this problem is not yet clear, the cause of quail population declines across the southeast is well understood. Decreases in quail numbers are a direct response to widespread habitat changes throughout the southeast. Historically, much of Kentucky was characterized by woodlots and small farms with fallow fields and brushy fencerows of shrubs, briars, native grasses, and forbs. Today, our landscape is much different as Kentucky farms have become larger and cleaner with very little cover for quail. Fallow fields are now rare and fescue has replaced native grasses. These changes decreased quail brood rearing and foraging habitat and created a landscape where predators easily detect and prey upon quail chicks and adult birds. Over the past 15 years, state fish and wildlife agencies across the southeast have collectively moved towards a habitat-based restoration initiative to improve quail populations. Simultaneous with the shift of the public sector away from pen-reared quail restoration efforts, a new technology for quail restoration-The Surrogate Propagation™ system- emerged from the private sector and quickly gained momentum as a restoration tool. The Surrogator™, designed by Quail Restoration Technologies is a self-contained field unit that is marketed as a way to establish huntable populations of game birds, which will survive, reproduce, and provide hunting opportunities well after release (www.quailrestoration.com). The Surrogator™ unit houses a heater, food, and water and houses 125 day-old quail chicks until the chicks are 5 weeks old. Surrogate Propagation™ is based on the idea that quail chicks develop their natural survival instincts within the Surrogator™ unit, imprint on the area, and have limited human contact, creating an ideal situation for birds to survive and reproduce (www.quailrestoration.com).

The goal of this project is to assess the efficacy of the SurrogatorTM as a quail restoration technique on two privately owned farms totaling approximately 750-acres in Woodford County, Kentucky. This multi-year project will follow protocols in the Quail Restoration Technologies Surrogator™ System Guide to release a target of 300 quail per year. All released birds will be banded. Fall covey counts, spring whistle counts, callback trapping, and controlled hunt surveys will be conducted to collect data on survival and recruitment of Surrogator™ birds. Although limited in scope (one study site), the data from this project will be used to determine the efficacy of this system to restore quail on isolated Bluegrass Region farms, where habitat restoration may not be effective due to a lack of a "source" population.

Funding Sources: *Kentucky Department of Fish and Wildlife*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5(vol. III - pgs. 63-65).

Surrogator / Ben Robinson

Foraging and Roosting Ecology of Rafinesque's Big-eared bat in Kentucky

Joseph S. Johnson and Michael J. Lacki, University of Kentucky
KDFWR Contact: *Brooke Slack*

Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) is one of North America's rarest bat species, and is listed as a species of concern by the state of Kentucky. Due to the species' rarity, there is an increasing need to identify habitat features which are important to reproductive populations during the summer maternity season. Two of the basic needs of summer colonies are roosting and foraging habitats. Previous research has shown that Rafinesque's big-eared bat roosts in hollow trees, caves, buildings and other man-made structures. Rafinesque's big-eared bat, like other big-eared bat species, primarily feeds on moths and possesses several adaptations that help it capture preferred moth prey. Forest types known to be used for roosting and foraging activities are diverse, and include bottomland as well as upland forested habitats.

While much has been learned about these bats, the majority of studies have focused on populations in regions south of Kentucky where available habitats, and therefore habitat use, likely differ from that present in the Commonwealth. In light of these differences, we embarked on a three-year study, funded by the Kentucky Department of Fish and Wildlife Resources, to help land managers better understand the behaviors and habitat requirements of Rafinesque's big-eared bat in central and western Kentucky. Beginning in May of 2009, we began capturing and fitting Rafinesque's big-eared bats with miniature radiotransmitters at two study locations. The study area in western Kentucky is centered on the Ballard Wildlife Management Area and is comprised primarily of bottomland hardwood forest. The study area in central Kentucky is Mammoth Cave National Park. The Park is topographically diverse, and represents upland forests that starkly contrast with the seasonally flooded forests of western Kentucky.

Rafinesque's big-eared bat / Joe Johnson

Our work at both locations encompasses many facets of the species' ecology. By following bats tagged with radiotransmitters to day-roosts across the summer season we are gathering data on the characteristics of these roosts, including features of the roosts themselves, characteristics of adjacent forests, and conditions (including temperature, humidity and light levels) inside the roosts. We are also tracking bats during their nighttime foraging bouts and investigating connections between the habitats used while foraging and the abundance of available insect prey in habitats used and not used by bats. This task includes a dietary analysis of fecal samples coupled with sampling of insect populations with light traps distributed across the landscape.

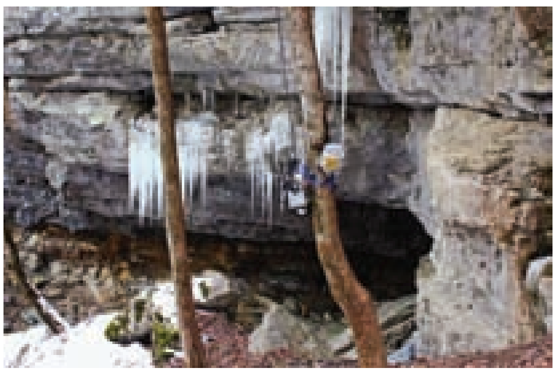
While it is too early to make strong conclusions from data gathered in the 2009 field season, some of our findings from western Kentucky show bats' strong association with forested habitats, and the diversity of day-roosts we located will be published in the proceedings from the Symposium on Conservation and Management of Big-eared Bats in the Eastern United States. At the end of our three years of research, we hope to understand the daytime and nighttime habitat requirements of Rafinesque's big-eared bat in central and western Kentucky. This knowledge will result in recommendations for habitat management for the species, including how to protect or enhance roosting and foraging habitats, and recommendations on how to design artificial roosts.

Funding Sources: *State Wildlife Grant (SWG) and University of Kentucky*

Comprehensive Wildlife Conservation Strategy: Appendix 3.2, Class Mammalia, Prioritized Research Projects 1 and 4, and Survey Project 1

Surveillance and Monitoring of Cave Roosts for Abnormal Emergence Behavior by Rare and Endangered Bats in Kentucky

Michael Baker and Mylea Bayless, Bat Conservation International; David Redell, Wisconsin Department of Natural Resources; and Brooke Slack, Kentucky Department of Fish and Wildlife Resources



Surveillance bats / Bat Conservation International

In light of the alarming geographic spread of White-nose Syndrome (WNS), a disease responsible for the deaths of more than one million bats in hibernacula of the Eastern United States since 2006, BCI is working closely with KDFWR and other partners to utilize technology to provide information regarding abnormal emergence behavior by Indiana myotis (*Myotis sodalis*), Gray myotis (*M. grisescens*), and Virginia big-eared bats (*Corynorhinus townsendii virginianus*) at priority hibernacula in Carter, Edmonson, and Lee counties, Kentucky. Clinical signs of WNS include "abnormal winter bat behavior" including bats moving to cold areas nearer the entrances of hibernacula and bats emerging in large numbers from hibernacula during winter months. This project uses the beam-break "GateKeeper" system to conduct continuous monitoring of the bats at prioritized sites and to automatically alert state and other biologists to the possible presence of abnormal bat behavior, enabling "early detection" of potential WNS symptoms. Additionally, BCI biologists and volunteers are assisting KDFWR with deployment and maintenance of AnaBat acoustic detection systems at a number of priority hibernacula to determine the efficacy of this technology as yet another potential "early warning" indicator.

Cave and mine hibernating bats face many threats. At present, the paucity of unbiased population census information and the lack of year-round data regarding bat behavior at priority roosting sites frustrate conservation efforts. The GateKeeper system developed by David Redell (Bat Ecologist for the Wisconsin Department of Natural Resources) is a measure to overcome these challenges to conservation and to provide surveillance for the imminent threat posed by WNS. Once installed and calibrated, this system allows for automated monitoring of bat entry/exit behavior at hibernacula through the use of paired infrared beams aimed across cave and mine site entrances. GateKeeper systems can be used to electronically index bat activity levels without large travel and time commitments or the biases associated with using human observers for traditional bat exit counting. With occasional maintenance, the system will function full time, year-round, and can be used to study relationships between environmental variables and bat emergence behavior. The system is limited by its inability to distinguish among bat species. To address this limitation, Anabat acoustic detection systems can be used at selected sites to provide an index to the percentage of each species present by analyzing the frequency range and shape of recorded bat calls and assigning them to the appropriate species groupings. Results from the GateKeeper and AnaBat systems currently operating are not yet available.

GateKeeper systems will provide additional long-term benefits, outside of their potential utility as an "early warning" system of WNS in Kentucky. Benefits include, but are not limited to, estimates of population sizes (with associated measures of error), measures of overwinter mortality (natural and otherwise), information regarding "normal" (and "abnormal" in the event that a site becomes affected by WNS) year-round bat behavioral ecology with regard to entry and exit from hibernacula, information on the peak timing of fall entry and spring emergence into/from sites, and nightly emergence timing and bat numbers from sites used as maternity sites in summer months (including measures of fecundity). If the AnaBat acoustic detection portion of this project proves to be efficacious, BCI and KDFWR may continue this effort, pending availability of funding.

Funding Source: *State Wildlife Grant (SWG) and Bat Conservation International*

Comprehensive Wildlife Conservation Strategy: Appendix 3.2, Class Mammalia, Prioritized Research Projects 1, 3, and 4, and Survey Project 1.

Implementation of Habitat Restoration and Improvement Practices on Kentucky Wildlife Management Areas in the Bluegrass Region

Josh Lillpop and Jacob Stewart, Kentucky Department of Fish and Wildlife Resources

Although only 7% of Kentucky is publicly-owned, these areas are significant in terms of long-term resource conservation. The Kentucky Department of Fish and Wildlife Resources (KDFWR) owns or leases 77 Wildlife Management Areas (WMAs) comprising well over one million acres of public land. WMAs in Kentucky are managed with multiple goals in mind; specifically, resource managers seek to maximize the value of these areas for both game and non-game wildlife species while optimizing the recreational opportunities for Kentuckians. Since these areas are in long-term public trust, and are not directly threatened with many of the problems associated with privately-owned lands such as development pressure, they serve as ideal areas for long-term habitat restoration and improvement efforts. Implementing management and restoration practices in these areas will benefit multiple species of greatest conservation need (SGCN) and will address nearly a dozen conservation actions listed in Kentucky's Wildlife Action Plan. Although these public lands have associated land managers and biologists, current levels of funding and personnel are oftentimes not adequate to achieve goals outside of routine management, particularly goals specific to Kentucky's Wildlife Action Plan. To address this problem, KDFWR established a habitat restoration and improvement team to implement Wildlife Action Plan Actions on public lands within the Bluegrass Region of Kentucky.

During 2009, the Habitat Improvement Team focused on the Bluegrass Region of Kentucky and accomplished multiple management goals. The team marked approximately 125 acres for forest stand improvement efforts and removed invasive bush honeysuckle from 100+ acres at Curtis Gates Lloyd Wildlife Management Area. Five vernal pools were created on this management area to provide breeding habitat for the Northern Leopard frog. On the Blue Grass Army Depot, the team removed thirty acres of cedar trees in efforts to re-establish native short grass prairie habitat. Approximately 200 acres of fescue were sprayed on Central Kentucky Wildlife Management Area, and there are plans to plant warm season grass/forbs on this area in 2010. The team also created 25 brush piles on WMAs in the Blugrass region, and created and installed over 55 nesting structures including: rocket bat houses, barn owl boxes, American kestrel boxes and bluebird boxes.

The team plans to continue habitat improvement efforts on public lands in 2010, moving to the Northeast region of Kentucky. In subsequent years, the team will rotate throughout the state to assist land managers and biologists with projects aimed at improving habitats for species of greatest conservation need.

Cedar tree removal / Ben Robinson

Funding Sources: *State Wildlife Grant (SWG)*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.3, Priority Conservation Action #14, #32, #62, #99, #101, #118, #120, #129, #156, #185.


Quail pair / Dave Baker

Project Updates

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

Urban fishing / Marc Johnson

Dane Balsman, Kentucky Department of Fish and Wildlife Resources

In an effort to boost declining fishing license sales in recent years, and increase fishing opportunities, the Kentucky Department of Fish and Wildlife Resources (KDFWR) has expanded the Fishing in Neighborhoods (FINs) program. The FINs program began in 2006 with five lakes in Louisville, Frankfort, and Northern Kentucky, but in 2009 expanded to 29 lakes in 17 counties. There are now quality fishing opportunities in most large cities across the Commonwealth as well as many smaller cities around the state, courtesy of the FINs program. Many of the lakes in the FINs program are owned by city and county municipalities. As part of a cooperative agreement between KDFWR and local governments, the lake owners have committed to cover 25% of the cost of fish stockings. With the cooperative agreement, KDFWR works with the local parks departments to provide technical guidance, arrange fish stockings, and promote fishing in the park lakes. The KDFWR is also working with local parks departments to host clinics and fishing derbies. A rod loaner program is being implemented at many of these lakes to provide equipment at no cost to novice anglers that may not yet own equipment.

These lakes are conveniently located near large populations of people without the need to travel far from home to find good fishing. In 2010, approximately 90,000 trout and 70,000 catfish will be stocked in the FINs lakes to provide fishing opportunities to lakes that in the past were overfished due to their size and fishing pressure exceeding the resources capabilities. These lakes will 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 (13-16”) and up to three times annually in the cool months with rainbow trout (8-12”). Bass and sunfish populations are continually monitored to ensure natural reproduction is meeting the needs of the anglers. A standard set of creel limits was established for all FINS lakes to assist in spreading out angler harvest of fish 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 the program. Additionally, the program has been intensively marketed through press releases, social media, radio, television, license vendors, boat shows, and the KDFWR website. Stocking rates and fishing pressure will be continually monitored. Attitude and creel surveys are ongoing at several FINs lakes. An exploitation study is planned to begin in the fall 2010 to assess fishing harvest and stocking rates. The goals of the FINs program include increasing fishing access, recruiting new anglers and retaining existing anglers, and providing quality fishing opportunities to a large population of people close to their homes.

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

KDFWR Strategic Plan. Goal 2, Strategic Objective 3.

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

Dane Balsman, 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 and stocking of blue catfish to consume overabundant sunfish. Unfortunately, these management actions have proven unsuccessful in terms of decreasing the density of overabundant, small sunfish and largemouth bass.

In 2007, the KDFWR stocked 417 flathead catfish that ranged in length from 8.4 to 36.0 inches in an attempt to reduce overabundant sunfish numbers and improve growth of sunfish and largemouth bass populations. Again in 2009 the KDFWR stocked 308 flatheads that ranged from 3.0 to 25.4 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. The hypothesis of the project was that the stocking of a top-level predator would reduce densities of overabundant, slow growing 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.

Prior to 2009, sampling efforts had yielded low numbers of flathead catfish. To ensure that flathead catfish were not being harvested by anglers, a catch and release only regulation was implemented September 1, 2009. This regulation was critical to ensure that the stocked flathead catfish remain in the lake. Sunfish and largemouth bass sampling are conducted annually during the spring and fall to determine abundance, size structure, age, and growth. Additionally, channel catfish are sampled in the fall with tandem hoop nets to determine abundance, size structure, age, and growth. Sampling of 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. Trot lines and jug lines have also been used for sampling. Little information exists on effective ways to sample for flathead catfish in small impoundments. Restrictive harvest on flathead catfish, looking for improved flathead catfish sampling methods, and continued monitoring of sunfish and largemouth bass populations should determine if flathead catfish are affecting sport fish populations.

Flathead catfish / Kathryn Emme

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

KDFWR Strategic Plan. Goal 1, Objective 5.

Evaluation of Trophy Brown Trout Regulations and Stocking Strategies in the Lake Cumberland Tailwater

Dave Dreves and David Baker, Kentucky Department of Fish and Wildlife Resources

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 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.

The Kentucky Department of Fish and Wildlife Resources (KDFWR) implemented new regulations in 1997 to take advantage of the trophy growth potential. The brown trout minimum size limit was set at 20 in and the creel limit was 1 fish. Starting in 1997 and continuing through 2009, fall electrofishing has been used to collect data on brown trout distribution and relative abundance. Trout have also been batch marked in the hatchery with microwire tags and/or fin clips to facilitate mark-recapture population estimates and growth rates. Monthly sampling has been used to track seasonal growth rates. Wolf Creek National Fish Hatchery (WCNFH), the sole source of trout for Kentucky, is currently at their maximum production of catchable-size (8.0 in) trout. Though smaller trout can be produced at WCNFH in greater quantities and at a lower cost, it is necessary to determine if stocking smaller fish is an effective fisheries management strategy. Since 1997, the KDFWR evaluated the use of fingerling (3.0 in) brown trout stockings to determine if their survival was high enough to warrant stocking more, smaller fish in the Lake Cumberland tailwater.

The implementation of the trophy regulations resulted in increased numbers of brown trout in four length categories: 1) all sizes, 2) fish less than 15 in., 3) fish between 15 and 20 in., 4) fish greater than 20 in. There was very low return of stocked fingerling brown trout in later electrofishing samples. However, it is possible that difficulties associated with marking small fish may have confounded the results. After completion of this research, the KDFWR will gain further information necessary to optimally manage the Lake Cumberland tailwater brown trout fishery.

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

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

Trophy brown trout / John Williams

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

Dave Dreves and David Baker, 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. What was not known historically was that these native walleye are a genetically distinct stock adapted for lotic (river) environments. 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 Kentucky Department of Fish and Wildlife Resources (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, what we now know as "Lake Erie strain" walleye. 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.

Rockcastle walleye / John Williams

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 (180 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.

To date, all walleye captured in the free-flowing section of the Rockcastle River have been 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 six consecutive years of stocking, native walleye stocking was discontinued to determine the effect of stocking on the production of natural year-classes. No stocking will continue for three consecutive years.

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

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

Evaluation of White Bass Stocking to Enhance Existing Reservoir Populations

Dave Dreves and David Baker, Kentucky Department of Fish and Wildlife Resources

White bass / Dave Dreves

The white bass (*Morone chrysops*) is native to the southern Great Lakes, Mississippi River basin, and Gulf Coastal drainages and is notorious for having highly variable recruitment. However, the factors affecting recruitment in reservoirs are not yet completely understood. Since the 1980's, many Kentucky reservoirs have experienced severe declines in white bass populations, especially Barren River Lake and Dewey Lake. The cause of the declines in white bass fisheries at either lake are not completely understood, but may be related to a number of factors including increased siltation and deficiencies in physical parameters such as rainfall and/or reservoir inflow during consecutive years.

Typically, resource agencies have expended very little effort managing white bass populations. Realizing that white bass populations were going to undergo variable recruitment and the popularity of the fishery was often seasonal, fisheries managers preferred to live with the cyclic nature of the fishery and focus management efforts on other species. Current angler dissatisfaction over poor white bass populations in Kentucky reservoirs that historically had very popular fisheries has resulted in the need to try to develop new management strategies.

This study aims to determine if the stocking of white bass fingerlings at Barren River and Dewey Lakes can enhance the existing white bass populations and recruit to the reproductive stock, ultimately leading to the restoration of a self-sustaining high quality fishery. Concurrent monitoring of white bass population changes in relation to other biotic and abiotic variables over a number of years will give insight into factors affecting recruitment in Kentucky white bass populations. Beginning in 2003 and continuing through 2007, white bass fingerlings were stocked at a density of 30 fish/acre, and all stocked white bass were marked as fingerlings with OTC (oxytetracycline) to facilitate mark-recapture population estimates and analysis of growth rates. White bass were sampled, using experimental gill nets, with a preferred minimum catch of 100 age-1 white bass. In addition, spring electroshocking was conducted in the headwaters of each of the study reservoirs to allow the determination of the contribution of stocked white bass to the reproductive stock. Contributions of stocked fish have been variable but in general the contribution was higher at Dewey Lake. Beginning in 2008, white bass fingerlings were no longer stocked at both Barren River Lake and Dewey Lake to allow the monitoring of the impact of no stocking on the production of natural year-classes. The study will continue for an additional 4 years with no stocking to follow the impacts of previously stocked year-classes and evaluate the strength of natural year-classes in the absence of stocking.

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

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

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 David Baker, Kentucky Department of Fish and

Cumberland River rainbow trout / Dave Dreves

Over the last decade, the Kentucky Department of Fish and Wildlife Resources (KDFWR) has 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 to be implemented on March 1, 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 will be monitored 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 will be evaluated by relative abundance estimates from fall nocturnal electrofishing surveys. Periodically during the project, we will clip 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. This analysis near the end of the study will show if growth rates have slowed down, indicating the trout population has reached the carrying capacity in the tailwater. 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. Initial results of 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. Results of this research will be used to guide management of this important Kentucky tailwater.

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

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

Preliminary Assessment of Bluegill and Redear Sunfish Populations in Small Impoundments

Dave Dreves and David Baker, Kentucky Department of Fish and Wildlife Resources

Department-owned small impoundments in central Kentucky are noted for providing good fisheries for both bluegill (*Lepomis macrochirus*) and redear sunfish (*L. microlophus*). One technique employed by the KDFWR to manage for bluegill fisheries is to not stock shad in these waters or selectively remove them from impoundments to be managed for sunfish, thus eliminating a potential competitor and leaving bluegill as the primary prey of largemouth bass. The direct and indirect effects of gizzard shad have been shown to negatively affect both bluegill growth and population size structure. No size limits and very limited creel limit restrictions (Cedar Creek Lake and Greenbo Lake) for bluegill have ever been imposed by KDFWR.

When considering harvest restrictions such as length limits, estimates of exploitation, natural mortality, and growth rates are more valuable than other measures such as size structure or angler catch rates. Preliminary data is necessary to calculate growth and mortality rates for bluegill and redear sunfish in these small impoundments before those fisheries can be managed effectively with length limits. Given the absence of data to support harvest restrictions, the goals of this study are to: 1) determine the growth, mortality, and exploitation of bluegill and redear sunfish in three central KY impoundments (Beaver, Elmer Davis, and Corinth Lakes); 2) calculate a recruitment index; and 3) monitor the seasonal physicochemical characteristics of each lake and relate these characteristics to population dynamics.

Beginning in spring 2006 and continuing through 2009, we collected bluegill and redear sunfish by electrofishing gear during May in each of the 3 study lakes. Fall electrofishing was also conducted to calculate relative weights of both species. We visited each lake at least monthly from May through October to monitor physicochemical conditions. Several stations were established at each study lake where we measured monthly temperature/dissolved oxygen profiles at 2 ft. intervals and turbidity was measured with a Secchi disk. We plan to compare the fish population data with the physical observations made at each lake and trends will ultimately be analyzed. A number of bluegill and redear sunfish greater than 6 inches were tagged at Beaver Lake in 2008 and Elmer Davis Lake in 2009 for year-long angler exploitation studies. A similar study will be conducted on Corinth Lake in 2010. These data will then be used to model various regulation schemes to determine if minimum size limits or creel limits can be used to enhance the bluegill or redear sunfish populations in the study lakes and/or applied to other lakes across the state. The expectation is that the conclusions generated by this research will result in increased quality of bluegill and redear sunfish fisheries in small impoundments in Kentucky, thereby leading to increased angler satisfaction.

Bluegill sunfish / Dave Dreves

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

KDFWR Strategic Plan. Goal 1, Objective 5.

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

Dave Dreves and David Baker, 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 known 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 the Barren River is impounded, there are approximately 31 miles of unimpounded mainstem of the Barren River above the reservoir. The broad goal of this project is to re-establish a reproducing native strain walleye population to the Barren River upstream of Barren River Lake. 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, we collected native strain walleye from Wood Creek Lake in the spring and transported these fish to Minor Clark Hatchery to be used as broodfish. Walleye were spawned and resulting fish reared to fingerling size (1.5 in.) in ponds, then stocked in the Barren River in late May or early June. We used a stocking rate of a minimum of 20 fingerlings/acre (180 fingerlings/mile), and we plan to continue these efforts for up to five years. In addition to 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 pulse DC electrofishing gear, and a sample of walleye are collected such that weight and length measurements and sex ratios can be recorded. In 2008, we began marking stocked fingerlings with oxytetracycline (OTC) such that recruitment and growth rates of stocked fish may be determined. Walleye sampling in the Barren River is slated to continue for up to 8 years to allow the reproductive potential of the stocked walleye population to reach a point where natural recruitment is possible and detectable.

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

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

Barren River walleye fingerlings / Dave Dreves

The Evaluation of a 40-in Muskellunge Minimum Length Limit at Buckhorn Lake

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

The muskellunge *Esox masquinongy* is an ecologically and economically important sportfish in many states with temperate fresh water ecosystems. Fisheries management strategies for this species are most often directed towards establishing trophy fisheries through the use of highly-restrictive regulations. In Kentucky, the muskellunge population at Buckhorn Lake was first established in 1996. It is sustained solely through annual stockings by the Kentucky Department of Fish and Wildlife Resources (KDFWR), as there is no natural reproduction of muskellunge in the lake. In 2003, an attempt to establish a premier muskellunge fishery at the lake resulted in the development of a more restrictive regulation that replaced the original 30-inch minimum and 2 fish daily limit. The new regulation increased the size limit of muskellunge to 40 inches and reduced the creel limit to one fish per day. This new regulation was the first of its kind for muskellunge in Kentucky, and there were several goals that researchers were expecting from its implementation. Most of the expected benefits were centered on a noticeable increase in the numbers of large muskellunge (30 inches) at Buckhorn Lake, as well as a boost in the anglers' catch and their satisfaction with the fishery.

Big musky pulled from Buckhorn Lake / Chris Hickey

The muskellunge population has been monitored from the first year that the fish were introduced into Buckhorn Lake, which provided reliable information on the fishery while it was still protected by the original size and creel limits. With the implementation of the new trophy regulation, it was essential to continue with the same sampling protocol in order to recognize any changes to the population that could be attributed solely to the new regulation. Each year muskellunge were stocked at the same density, and the individual year-classes were marked with a unique fin clip so that researchers could identify the age of the fish without having to sacrifice them for otolith examination. The primary sampling for the project was conducted annually via electrofishing in late winter/early spring and lengths and weights were taken on all fish that were sampled. Stomach contents were also examined on over 200 muskellunge to determine if the new regulation resulted in an increased consumption of other sportfish. In addition to the annual sampling, a creel survey was conducted in 2005 and 2008. The creel surveys were used to find out if the new trophy regulations had a positive impact on the anglers' catch and to determine their level of satisfaction towards the fishery.

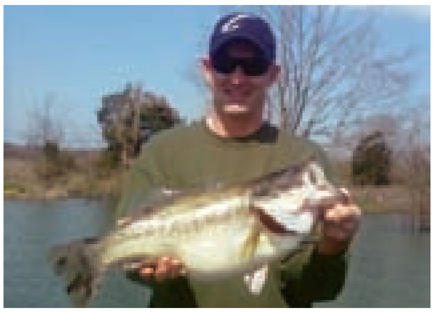
The muskellunge population at Buckhorn Lake experienced several changes as a result of this trophy regulation. When compared to data from prior to the regulation change, there were substantial increases observed in the number of fish that were 30 and 40 inches. The average length of muskellunge that was harvested from the lake had increased for 36 inches to 42 inches. And the examination of stomach contents indicated that the trophy regulation did not result in an increase of muskellunge preying on other sportfish populations. In some degree, the 40-inch minimum size limit had accomplished what it was enacted to do. Unfortunately, during the final years of the study, anglers experienced a lower catch rate for muskellunge. Even though the drop in catch was not directly related to the 40-inch minimum size limit, angler satisfaction and support for the trophy regulation had decreased substantially by the time the final creel survey was conducted in 2008. Unrelated to results of this study, Buckhorn Lake's muskellunge population has undergone another regulation change. In 2010, Buckhorn lake joined the 2 other reservoir muskellunge fisheries in Kentucky, which are all now regulated by a 36 inch minimum size limit. A new project is in effect that will monitor the changes that all three of these muskellunge fisheries could experience due to the new regulation.

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

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

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



A trophy from Cedar Creek Lake / photo submitted

Black bass are the most sought after game fish in Kentucky. Although ample opportunities exist for quality bass angling around the state, a true "trophy bass" lake in Kentucky previously did not exist. Successful creation of a trophy bass lake depends on many factors including: largemouth bass growth rates, bass condition, available forage base, degree of competition with other predatory species, and complete regulatory control by the state agency. Cedar Creek Lake, the newest of Kentucky's reservoirs, was the state's best chance of creating such a trophy bass fishery. The KDFWR realizes that this is a very unique opportunity in that the construction of a new reservoir is extremely limited in both Kentucky and throughout North America. The construction of Cedar Creek Lake, which was completed in 2002, also gave the department a perfect opportunity to strategically place fish habitat throughout the lake. Once this 784 acre lake was allowed to fill with water, it reached full pool very quickly by the spring of 2003. Historically, the productivity of a reservoir is its highest for the first few years following impoundment, and this was to be the start that the largemouth bass fishery needed to reach its trophy potential. In order to encourage the creation of a trophy fishery even further, the KDFWR placed a highly restrictive 20-inch minimum size limit and 1 fish a day creel limit for all largemouth bass at Cedar Creek Lake.

Sportfish were initially stocked into Cedar Creek Lake during the first two years following the completion of the construction phase. Every spring and fall, the largemouth bass fishery is sampled via nocturnal electrofishing to assess largemouth bass density, length frequency, size structure, condition, and recruitment success. An additional sampling for largemouth bass is conducted each summer to examine their stomach contents in an effort to keep track of their diet, and document any changes in their food habits as the reservoir gets older. A subsample of largemouth bass was collected in the spring of 2007 for age and growth analysis via otolith examination. Creel surveys were conducted in 2005 and 2009 to determine fishing pressure, the anglers' catch rate, and their satisfaction with the fishery. And finally, early summer diurnal electrofishing is used each year to assess forage quality by collecting data on the density, length frequency, and size structure of bluegill and redear sunfish.

The 20-inch minimum length limit at Cedar Creek Lake appears to be successfully protecting largemouth bass as they grow to be larger fish. The number and corresponding catch rate of 20 in largemouth bass has increased every year since the first one showed up during sampling in 2006. In 2009, a total of 18 largemouth bass 20 in were observed during spring sampling alone, which is the most that were sampled since the reservoir was impounded. In contrast, the catch rate of largemouth bass < 20 in. has been more variable from year to year as their numbers are much more dependent on the success of each largemouth bass spawn. Stomach contents of the largemouth bass sampled in the summer indicate that they are feeding primarily on fish and crayfish. The initial fish forage of largemouth bass was bluegill and redear sunfish. But as different forage species, i.e. Brook silversides and gizzard shad, have become more abundant in Cedar Creek Lake, they have showed up in the stomach contents of largemouth bass with more consistency. The age and growth analysis from the 2007 subsample indicated that the largemouth bass at Cedar Creek Lake were growing, on average, 3 – 4 in. a year. And finally, the comparison of the two creel surveys is an excellent indicator as to how popular Cedar Creek Lake has become with anglers. When compared to 2005, the creel survey of 2009 showed a 350% or more increase in at least 6 categories including total fishing effort, total catch of all sportfish, the number of fishing trips, and the catch of largemouth bass. It was also determined in 2009 that 80% of bass anglers were satisfied with the current status of the fishery. The largemouth bass population will continue to be monitored very closely at Cedar Creek Lake, and another age and growth analysis will be used in the near future to determine if their growth rates have started to slow down as the reservoir gets older. But the developing presence of different forage species in the food habits of largemouth bass could provide the fishery with more potential of achieving trophy status.

Funding Source: *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

In Kentucky, 80-100 public fishing lakes and small impoundments are stocked annually with approximately 150,000 hatchery-reared channel catfish. These annual stockings are necessary to maintain catchable populations of channel catfish, as a result of poor natural reproduction, low survival, and high harvest rates. These channel catfish are commonly stocked at a length of 6.0-12.0 in and at densities of 10-25 fish/acre. Limited creel data indicates that anglers harvest anywhere between 30% and 63% of the channel catfish during each stocking year. Prior to 2004, there were no size and/or creel limits on these channel catfish, and the small size at harvest and low catch rates that were characteristic at many of Kentucky's small impoundments was a good indication of overharvest. Beginning in 2004, a 12.0-in minimum size limit was implemented at eleven state-owned small impoundments to help improve populations of channel catfish. This research project was developed to measure the effectiveness of the 12.0-in minimum size limit, and determine if it can be used at other small impoundments throughout the state to improve the quality of the channel catfish fishery.

In this project, four state-owned lakes with the new 12-inch minimum size limit were chosen to be monitored for any changes in their channel catfish populations as a result of the new regulation. Unfortunately, during the years prior to the implementation of the 12-inch minimum size limit, there is very little data concerning channel catfish populations in Kentucky's small impoundments. As a result, two additional lakes that were not among those that had the new 12-inch minimum size limit were sampled concurrently as control lakes. The study began looking at variety of methods (i.e. late spring hoop nets, fall gill netting, and fall hoop nets) to sample channel catfish. Ultimately, tandem hoop nets in the fall were chosen as the most effective method to catch a representative sample for each lake. The channel catfish at all six lakes were sampled with 5 sets of baited tandem hoop nets that were soaked for 72 hours before being pulled. In the beginning, all channel catfish were counted, measured, and released back into the lake. Later in the project, weights were taken to determine the condition of this fish, and in the upcoming year, 2010, a subsample of channel catfish will be collected at each lake for age and growth analysis via otolith examination. Largemouth bass and bluegill were also monitored in each study lake to determine if the 12-inch minimum size limit on channel catfish had any noticeable impact on sportfish populations in the lake.

The sampling for this project began in 2006, but because the protocol for tandem hoop nets had not been established yet, the year was more of a learning period for researchers. It was determined that a lot of variability in sampling with tandem hoop nets from one year to the next is often explained by a difference in sampling conditions. By 2007, channel catfish at all the study lakes were being sampled proficiently. It was soon determined that the new 12-inch minimum size limit at two of the experimental lakes was protecting the smaller catfish too well. These lakes had very high numbers of channel catfish below the 12-inch mark, which led to concerns that more fish could result in stunted growth. The stocking rates of these two lakes were decreased by more than a half in order to prevent any further back up of channel catfish < 12.0 in. The other 2 experimental lakes contain channel catfish populations that have been relatively stable since the study began with a relative density and length frequency of established catfish populations. The control lakes in this project contained catfish populations that would have been expected in lakes with a lot of angling pressure and no regulations to protect the fish. The overall amount of catfish sampled at the control lakes was substantially lower than any of the experimental lakes and the length frequencies of the channel catfish were erratic. A good indication that the high harvest rates of channel catfish in these lakes was indiscriminate in terms of size of the fish. Other sportfish appear to be unaffected by the presence or absence of the regulation, as there has yet to be any trends in the sportfish populations that have been correlated with the 12-inch minimum size limit on channel catfish.

Channel catfish / Chris Hickey

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

Fin clipping a bass fingerling / Chris Hickey

Stocking of largemouth bass is an extremely common management practice throughout the continental United States. In Kentucky, stocking has long been used as a management tool to enhance largemouth bass fisheries, but limited space at the state's two hatcheries requires the smart use of largemouth bass production. For instance, stocking largemouth bass fingerlings on top of a strong natural spawn is not only an inefficient use of resources, but the stocked fish could compete too much with the natural year-class possibly resulting in poor condition of all fish involved. It would be ideal to have a system in place that would be used to identify the year-class strength of age-0 largemouth bass before any stocking takes place. In this system, any lakes that exhibit strong to average natural reproduction of largemouth bass would not be stocked, which allows for limited largemouth bass resources to be stocked only at those lakes that need it because of the below average natural production (year-class). Kentucky's Largemouth Bass Stocking Initiative (BSI) attempts to do just that by developing a protocol that identifies what lakes are in need of bass stocking because they exhibit signs of a weak age-0 year-class.

The BSI, which began in 2005, takes a proactive approach of identifying weak year-classes of largemouth bass by indexing densities and sizes of age-0 fish in the fall and relating these densities to age-1 fish of the same year class collected the following spring. Two predictive equations and the mean year-class strength were developed for each of the 34 lakes in the project using historical data. The first predictive equation was based on the overall age-0 CPUE of largemouth bass and the second equation came from the age-0 CPUE of largemouth bass 5.0 inches. The equation that yielded the most accurate prediction, based on p-values, was to be used for that lake. When field biologists conduct routine fall sampling for largemouth bass, they report the catch rates of age-0 fish to researchers. This value is plugged into the equation and the result is checked against the mean year-class strength for the lake. If the predicted value is above or equal to the mean, then that lake is left alone. But if that same value is below the mean, then it is stocked with largemouth bass fingerlings. The amount of fish that are stocked (fish/acre) is based on how far below the mean the predicted value falls. Any hatchery produced largemouth bass that are used in the BSI receive a fin clip to distinguish them from naturally produced fish and to identify the year at which they were stocked.

The BSI has been used to determine where largemouth bass are stocked in Kentucky each year since 2005, and in some years the larger high priority lakes and reservoirs received the majority of the fish. But in 2009, most of these reservoirs did not experience the weaker year classes that they had in the past, and in return, more (smaller) lakes benefitted from this. That year 14 different lakes were stocked as part of the BSI, which was the most lakes that have been stocked since the inception of the program. Not only were more lakes stocked, but the rate at which largemouth bass were stocked increased as well. In the past, the most that any lake could receive was 10 fish/acre. But this rate usually meant that field biologists were less able to accurately determine the contribution that the stocked largemouth bass made to the year-class because very few were being recaptured in the following spring. The new stocking rate at 15 fish/acre will hopefully lead to increased recaptures of stocked largemouth bass, which would make it easier to quantify what contribution they made to the natural population. As the BSI continues over the next few years, the equations that are used to predict year class strength will likely become more accurate. This increased accuracy will make the BSI a stronger tool, which helps with the management of largemouth bass fisheries, makes for even more efficient use of limited hatchery resources, and, ultimately, benefits the angler by decreasing the likelihood of the weak year classes that lead to a reduction in their catch rates.

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

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

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

Blue catfish / Chris Hickey

In Kentucky, blue catfish have started to provide for some important fisheries outside of the banks of its major rivers. Several small lakes and reservoirs that were only recently stocked with blue catfish have developed into high quality sport fisheries, and some with trophy potential. But the population dynamics of these relatively new fisheries have only recently been studied and are still not well known. One reservoir in particular was first stocked with blue catfish in 2002 and yet the fishery has already gained a great deal of popularity with anglers from all over the state. With what appears to be a limitless gizzard shad population and an annual stocking of 8 fish/acre, the blue catfish population at Taylorsville Lake was rapidly reaching the status of a high quality fishery. The purpose of this study has been to collect data on the blue catfish population at Taylorsville Lake and to determine any suitable management options that can be used to create and sustain a high quality fishery with the potential for a trophy component.

The data that was collected at Taylorsville Lake prior to this study indicated that the blue catfish population was doing well with growth rates of 3 – 5 inches a year, and most fish reaching 20 inches in only 5 years. In 2008, an angler exploitation was conducted by tagging 1,000 blue catfish and releasing these fish back into Taylorsville Lake. The exploitation study lasted one year and a reward system was used to encourage anglers to report any tagged fish that were caught. By the summer of 2009, a creel survey was underway, and the blue catfish population was sampled in the same manner as it was previously.

The initial sampling in 2007 indicated that the blue catfish population at Taylorsville Lake was in good shape. From both the upper and lower ends of the lake, a total of 590 blue catfish were sampled for a catch rate of 236.0 fish/hour. The sampling in 2008 was only used to collect fish to be tagged for the exploitation study, which had 120 tags reported over the 1 year period. Of the 120 blue catfish reported, 97 (or 81%) were harvested by the anglers. It was during this time period that several anglers began to express concerns about their decreasing catch rates and the possibility of over-harvest of blue catfish. Numerous anglers petitioned the KDFWR to implement a size and creel limit to help reduce harvest of blue catfish. In conjunction with the results of the exploitation study and decreasing catch rates of blue catfish, the KDFWR implemented a 15 catfish per day/person with only one fish allowed over 25 inches. This regulation will become effective in March 2011 and will pertain to both channel and blue catfish. The blue catfish at Taylorsville Lake will continue to be stocked and monitored in 2010, and otoliths from the 2009 sample will be examined for age and growth analysis.

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

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

Evaluation of the Growth of Two Different Stocking 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 stocking in some of Kentucky's small impoundments initially began as a possible tool to improve bluegill fisheries. Although the blue catfish was not the ideal predator in Kentucky lakes to control the bluegill populations, they themselves soon became a popular fishery at small impoundments where they were stocked. Unfortunately, the growth rates of these fish were erratic, and many of these blue catfish populations had some fish that were the same age but differed in length by as much as 15 inches. This large disparity in growth was not easily explained but there was a possibility that the size at stocking was an early factor that dictated how large the blue catfish would grow in these small impoundments. A literature review indicated that no studies existed that have evaluated survival and growth of blue catfish in small impoundments based solely on their size at stocking. And since it is known that their growth does not rapidly increase until they start feeding primarily on fish, it was hypothesized that blue catfish that are already large enough to consume fish when they are stocked may have greater growth potential. The purpose of this study is to evaluate the growth of two different stocking sizes of blue catfish.

In order to answer this question, two distinct size classes (10 inches and 12 inches) of blue catfish were stocked into three small impoundments at a rate of 10 fish/acre for each size class. These impoundments previously contained blue catfish populations that exhibited the disparity in growth rates for fish of the same age class. Since 2007, age-1 blue catfish are stocked annually during late summer at each study small impoundment. All stocked blue catfish are marked with coded micro-wire tag to identify which stocking size-class they belong to during future sampling efforts. Sampling of blue catfish is conducted annually during late summer using low-pulse electrofishing. All blue catfish collected are measured and checked for the presence of coded micro-wire. Relative abundance of each size-class is monitored to determine which size class survives, grows, and contributes to the anglers catch. This is a long-term project slated to continue through 2012, at a point when there is enough data to make management decisions regarding optimal stocking sizes of blue catfish in Kentucky's small impoundments.

Marking blue catfish prior to stocking / Chris Hickey

Surprising in 2008 and 2009, nearly 80% of the micro-wire tagged blue catfish collected were from fish stocked at the smaller size class; suggesting that smaller sized blue catfish survive better than the larger size class. The mean length of these fish had increased to just over 10 inches, indicating little growth had occurred in this size class. There was no noticeable growth of fish from the larger size class that was stocked in 2007, or in any of the blue catfish that were stocked in 2008. It is unlikely that stocking mortality was higher for blue catfish in the larger size class, and there is considerable research that comes to the same conclusion. It has been considered that the fishing pressure on the blue catfish at these lakes is much higher than was initially anticipated. With the substantially lower sampling rate of fish that were stocked at 12 in., as well as, those blue catfish stocked prior to this study, it is feasible that these catfish are being harvested by anglers. There are currently no regulations on blue catfish at these lakes and there has even been anecdotal evidence from anglers about catching (and harvesting) fish that have a fin clip. More data will be collected to clearly define the size at stock that is best suited for the growth and survival of blue catfish in small impoundments.

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

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

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

Doug Henley and Nick Keeton, Kentucky Department of Fish and Wildlife Resources

Electrofishing data from previous studies indicated that a relatively poor largemouth bass population exists in Meldahl Pool (Maysville area) as compared to other pools in the river. For example, in previous years, Markland Pool (Cincinnati area) had largemouth bass catch rates that were 2.3 fold greater than those found in Meldahl Pool. In addition, largemouth bass year-class strength was also 2.5 fold greater in Markland than in Meldahl Pool. Young-of-the-year (YOY) surveys indicate that largemouth bass year-class production may be limited by the lack of suitable spawning habitat. Spawning substrates, such as gravel and cobble, in tributaries and embayments have been covered with silt. The occurrence of cover in these embayments has also declined. The possibility exists that largemouth bass spawning success could be enhanced through introduction of high quality supplemental spawning structures and cover. Two embayments received supplemental spawning structures and habitat (Bracken Creek and Big Snag Creek); while 2 other embayments were used as controls with no addition of spawning structures or cover (Big Turtle Creek and Big Locust Creek).

Approximately 100 supplemental spawning structures were placed in Bracken and Big Snag Creek in 2005. These structures have been monitored for activity each spring since that time. Nursery habitat (evergreen trees and blocks) have been placed in each embayment near the nesting boxes to provide habitat for young bass once hatched. Each of the four embayments (2 experimental and 2 controls) has been monitored each spring and fall with nocturnal electrofishing surveys to evaluate the success of the nesting boxes and habitat. Black bass have utilized the nesting structures each spring since 2006 in varying degrees each spring. Catch rates of different age groups of bass in each experimental embayment indicate that providing artificial nesting structures can enhance recruitment. However, preliminary analysis suggests that factors such as weather, water levels, and temperature may play a more important factor in determining reproductive success of bass in Ohio River embayments.

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

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

Spawning habitat project / Doug Henley

River Sport Fish Surveys – Ohio River

Ohio River blue catfish / Doug Henley

Doug Henley and Nick Keeton, Kentucky Department of Fish and Wildlife Resources

The Ohio River Fish Management Team is a working group of 6 states that border the Ohio River. The list of states includes Illinois, Indiana, Kentucky, Ohio, West Virginia, and Pennsylvania. Administrators from these states have been working in unison to manage fisheries issues on the Ohio River common to each state. Biologists conduct field surveys annually to monitor select species that are important to each state and its users. The list of species monitored includes black bass, sauger, paddlefish, and catfish.

Population data is collected on target species for a variety of reasons along the length of the Ohio River. All states are concerned with the status of both black bass and sauger because of their importance to sport anglers. Monitoring of these species helps each agency and the partnership as a whole to keep track of population trends that may need special actions to ensure their viability over time. Other species such as blue, channel, and flathead catfish are important to multiple user groups. Ohio and West Virginia manage these species as sport fishes, whereas Indiana, Kentucky, and Illinois must split the importance of catfish between sport anglers and commercial fishers. Monitoring commercial catch in the Ohio River has been done since 1999. Collection of population data of each species began in 2004 in the lower reach and in 2009 in the upper reach of the Ohio River. Paddlefish is a species of inter-jurisdictional importance in the Ohio River. The three upper states of Pennsylvania, Ohio, and West Virginia consider this fish a species of special concern. They have programs that stock or protect paddlefish populations. The lower three states allow commercial harvest of paddlefish populations within their reach.

Work will continue in the Ohio River through the auspices of the Ohio River Fish Management Team. This is to ensure that fish issues common to each state are addressed in a uniform manner for the benefit of the resource and the user.

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

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

River Sport Fish Surveys – Kentucky River

Doug Henley and Nick Keeton, Kentucky Department of Fish and Wildlife Resources

The Kentucky Department of Fish and Wildlife implemented a percid (sauger and walleye) study along the entire reach of the Kentucky River in the winter/spring of 2002-2003. Several fishery districts were responsible for sampling specific tailwater areas during this period. From that survey, four mid to upper river tailwaters were chosen for further monitoring. The goal of this study is to provide and evaluate the potential to establish a self-sustaining sauger and white bass recreational fishery through time-limited stockings in select pools of the upper Kentucky River. Hybrid striped bass were also stocked to provide an additional game fish species in the Kentucky River.

Trophy blue catfish / Doug Henley

In 2006, the Kentucky Department of Fish and Wildlife began stocking sauger fingerlings into the Kentucky River. The initial stocking of sauger was 76,320 fingerlings (1.5 – 2.0 inch). Since then a total of 435,830 sauger have been stocked in the Kentucky River. Both white and hybrid striped bass stockings have occurred during this same period with the exception of 2007 for white bass. To date, nearly 254,722 white bass fingerlings and 3,078,798 hybrid striped bass fry or fingerlings have been stocked. Sauger and white bass fingerlings were marked with oxytetracycline (OTC) at the hatchery and this mark is used to differentiate between stocked and naturally reproduced fish.

For the fourth year, spring nocturnal electrofishing surveys were conducted in 2009 in the tailwaters of Dams 5, 10, 11, and 12. Sauger catch rates this spring were much greater than those observed the previous spring. Surveys were also conducted in the Kentucky River in the fall. These surveys consisted of 6 nocturnal electrofishing transects in the upper and lower pool areas below each dam surveyed in the spring. The catch rate of sauger continues to increase as walleye catch rates decline. OTC marks on fish collected indicate that the majority of sauger sampled are stocked fish. Reproduction of stocked sauger at a level to sustain a population has not been documented to date.

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

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

Ohio River Supplemental Stocking Survey

Doug Henley, Christopher W. Hickey and Nick Keeton, Kentucky Department of Fish and Wildlife Resources

Angler concerns over the decline in largemouth bass in the Ohio River became apparent to the Kentucky Department of Fish and Wildlife in 1997. Research was initiated to document largemouth bass populations in specific pools of the Ohio River in an effort to identify causes for these declines. Largemouth bass reproduction is thought to be negatively influenced by a number of variables including water levels, limited spawning habitat, and extreme siltation in spawning areas. Largemouth bass year-class production in the Ohio River appeared to be primarily impacted by habitat degradation through embayment siltation and loss of cover for young bass.

Supplemental stocking in large riverine systems has been shown to benefit largemouth bass population levels. Because these stockings are complex, the exact contribution of these fish depends upon natural production, carrying capacity, and the relative survival of stocked and naturally produced fish. However, stocking appears to be the next logical step in largemouth bass management options for the Ohio River. Supplemental stocking may be a means to enhance year-class strength of largemouth bass in some embayments of the Ohio River. This would in turn result in the improvement in the largemouth bass fishery in that pool, which may result in increased angler satisfaction.

Markland Pool has a total area of approximately 27,874 surface acres of water with an estimated 3,177 acres of backwater areas. In order to attempt to make a difference through supplemental stocking, it was determined that we would stock approximately 2,041 acres (16 embayments) on both the Indiana and Kentucky sides of the river. The surface area of these 16 embayments represents 64% of the total backwater area and 7% of the total area of the pool. A stocking rate of 100 fingerling bass per acre was the target for each embayment. Stocking embayments ranged from 0.5 miles above Markland Dam to approximately 64 miles upstream. A total of 206,200 largemouth fingerlings that ranged from 1.7 and 2.0 in (mean=1.8 in) were stocked in June, 2009. The 2009 stockings represent the third year that fingerling bass were stocked into Markland Pool embayments.

Surveys conducted since 2007 indicate that stocked largemouth bass are contributing to the total bass population. Catch rates of fingerlings the first fall after being stocked have been high. During the fall of 2007, 74% of the fingerling largemouth bass sampled were stocked fish. Stocked fingerlings contributed between 59% and 62% to the samples observed during the falls of 2008 and 2009. These fingerlings will be monitored as they grow into harvestable sized fish in the future.

Stocking largemouth bass in the Ohio River / Chris Hickey

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

KDFWR Strategic Plan. Goal 1, Strategic Objective 5.

Black Bass Tournament Results in Kentucky

Bass tournament ready to weigh in / Chris Hickey

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

The KDFWR routinely samples black bass populations in reservoirs and small impoundments throughout the state and each year performs creel surveys on a limited number of water bodies. The current databases, particularly with respect to angler success and angler catch rates, are very limited. The high cost of conducting creel surveys for consecutive years to assess relationships between bass populations and angler catch often makes it unfeasible. Thus in 1999, the KDFWR began to tap into another source of angler success and catch rates when it began to collect data from black bass tournaments in Kentucky. This invaluable data on fishing pressure, catch, and success rates of tournament anglers will be used to build a long-term database to monitor trends in black bass fisheries by lake and on a statewide basis. These data, in combination with survey data collected by biologists during routine sampling, will increase the ability of resource managers to explain and forecast changes in black bass population abundance throughout the state. In addition, the summarized data will also be useful to bass anglers when planning future fishing trips and help them understand that normal fluctuations (small increases or decreases) that occur in bass populations.

When the program first started, researchers sent packets containing information about the project to bass clubs and other known tournament organizers from all over Kentucky. Over time an online system of scheduling tournaments and reporting catch data has made the process much more efficient. Participation in the project has grown exponentially since it began in 1999 because of information passed on by tournament organizers and the ongoing efforts of researchers. The tournament data is analyzed at the end of each year after reminders are sent out to anyone who scheduled a tournament. The catch data is analyzed in such a way that it provides tournament anglers with invaluable information, and still gives resource managers further data on the black bass fisheries in their lakes and rivers. These results are published in an annual report, which is mailed to all participating tournaments, along with new tournament catch report cards that are to be used during the current year. The annual reports are also made available to the public via the department's website. In 2010, a couple changes were made to the catch data that is reported to researchers. This was the first time that any major changes were implemented since the project began, but these changes will reduce that amount of data the tournament organizers need to keep track of and help clear up any confusion experienced by the researchers who analyze the data.

The number of tournaments participating in the project has generally increased each year from the start, and in 2009, 355 tournaments reported their catch data. This is a substantial increase from the first year of the project in 1999, when only 110 tournaments participated. In 2009, 61% of all scheduled tournaments reported their catch data, which was the highest reporting rate ever and an excellent indicator of the project's popularity considering that participation is voluntary. Tournament catch data was reported from 29 different water bodies throughout Kentucky. From the 355 tournaments that reported catch data, it was determined that 15,456 anglers brought in 22,587 bass that weighed a total of 54,883 lbs. The number of bass caught by tournament anglers decreased from 2008, but the total weight it took to win a tournament actually increased. The mean winning weight for a tournament in 2009 was 13.30 lbs, which was up from 13.14 pounds in 2008. The highest winning weight was 29.0 lbs at Kentucky Lake and the biggest bass caught in a tournament was 8.51 lbs from Guist Creek Lake. This project produces a lot of different results that are presented in the annual report, and much of this data is used to identify trends in angler catches at several popular tournament lakes and rivers in Kentucky. This project will likely continue for years to come as it becomes more popular with tournament anglers, and the data that is collected continues to be a good tool for resource managers.

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 David Baker, Kentucky Department of Fish and Wildlife Resources

A trophy brown trout from the Lake Cumberland tailwater / Dave Dreves

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 trout stocking in the state 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 a previous rainbow trout strain analysis, the PR strain is a more "domesticated" hatchery strain while the SC strain is considered to be relatively "wild". 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. An evaluation of the relative survival, growth and susceptibility to angling of two additional stockings of PR and SC strains of brown trout is needed to optimize the stocking practices of brown trout and meet angler expectations of the Lake Cumberland tailwater trout fishery. 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.

Status, Life History, and Phylogenetics of the Amblyopsid Cavefishes in Kentucky

Benjamin M. Fitzpatrick and Matthew L. Niemiller, University of Tennessee
KDFWR Contact: *Ryan Oster*

Over 95% of subterranean species in North America are considered vulnerable or imperiled, mainly because of habitat degradation and restricted geographic ranges. Unfortunately, data on the distribution and status of cave-obligate species is incomplete or lacking entirely, making conservation and management decisions difficult. Additionally, species with large distributions are often thought to represent species complexes, consisting of multiple, morphologically indistinguishable species. Therefore, a need exists to document subterranean diversity, diagnose cryptic lineages, and identify threats that impinge upon the continued survival of these species.

Three species of Amblyopsid cavefishes occur in Kentucky: Spring Cavefish (*Forbesichthys agassizii*), Northern Cavefish (*Amblyopsis spelaea*), and Southern Cavefish (*Typhlichthys subterraneus*). Although these species have been known to science since the early 1840s, little is known about the demography and persistence of local populations and the systematic relationships among species and among populations within species. Here we investigate the status, distribution, ecology, and threats to populations of these cavefishes. In particular we are conducting surveys and status assessments for each species within the state including both searches of historic and new localities, while obtaining life history data and acquiring tissue samples for genetic analyses. We also are using molecular techniques to investigate cryptic diversity, particularly in *Typhlichthys*, where preliminary data now suggest the existence of two undescribed species that are unique to Kentucky. Finally, we are conducting surveys and collecting specimens of invertebrate cave organisms to determine species distributions and community associations.

Surveys over the past year have focused on determining the status, distribution, and abundance of the Spring Cavefish in surface springs, spring runs, and streams in central and western Kentucky. A spring and spring run in Warren County that has been the subject of repeated research and surveys over the past 50 years continues to support a large (>10,000 individuals/hectare) population of Spring Cavefish despite significant agricultural development in adjacent habitat during the last 20 years. Cave surveys were discontinued until further notice in March 2009 after the U.S. Fish & Wildlife Service and KDFWR issued cave advisories to slow the spread of White Nose Syndrome afflicting millions of bats in the Northeast United States. This research will provide KDFWR with important data regarding the status, distribution, life history, and genetics of these species. In addition, data acquired on other cave fauna can also be used when making conservation and management decisions.

Spring cavefish / Matthew Niemiller

Funding Source: *State Wildlife Grant (SWG), University of Tennessee*

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

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.

The Kentucky Arrow Darter, *Etheostoma sagitta spilotum*, has a limited range in the upper Kentucky River drainage, all of which is in Kentucky. Recent analyses of morphological and genetic data have shown that *E. s. spilotum* and *E. s. sagitta* (Cumberland River drainage) represent distinct evolutionary lineages and should be treated as separate management units for conservation management purposes. A status survey of *E. s. spilotum* in the Kentucky River basin has shown that populations have declined considerably during the past two decades. Kentucky Arrow Darters were detected in only 29 of 50 historic streams sampled in 2007 and 2008. This has led the U.S. Fish and Wildlife service to consider this taxon as a candidate for listing as threatened or endangered. Conservation Fisheries, Inc. (CFI), with support from Kentucky Department of Fish and Wildlife Resources (KDFWR), is developing captive propagation protocols for reintroduction of the Kentucky Arrow Darter into streams within its native range to restore populations that have been extirpated. Reintroduction sites are being chosen where habitat conditions are suitable and there is some level of protection (e.g., within wildlife management area or national forest boundaries). Survival and movement patterns of released fish will be assessed through mark-recapture methods and through periodic monitoring using non-invasive methods, including visual census techniques.

On December 18, 2008, a total of five (n = 5) individuals, including 2 males, 2 females, and 1 juvenile were collected as broodstock from Big Double Creek, Red Bird River drainage, in the upper Kentucky River basin. At CFI, these fish were initially held in isolated aquaria to undergo quarantine and aquarium acclimation. Fish were then transferred to three tanks: adult males and females were divided among two 30 gallon tanks and the juvenile in a separate 20 gallon tank. Cover was provided in the form of slab rocks, PVC pipes, and black plastic slabs on a mixed gravel substrate. Fish were provided live blackworms, redworms, mealworms and live Daphnia as a first food. Live glassworms (dipteran larvae) and frozen bloodworms (chironomids) and other frozen foods were also provided as the fish became acclimated to captivity. Winter conditioning included reduction of water temperatures to as low as 4-5°C and photoperiod shortened to 9 hours of light. Reproductive condition was then induced by gradually increasing water temperatures, photoperiod, and food quantity offered, in concert with natural seasonal changes.

On March 11, 2009, two mature females were added to the 70 gal tank with the dominant male and two smaller females. The male immediately began courting the largest female. Spawning commenced the next day (March 12), with the female burying the eggs in the sand substrate. Spawning behavior was captured on video. On March 16, eggs (n = 71) measuring approximately 1.6-1.8 mm diameter were collected and photographed. Eggs developed quickly, as evidenced by eyed embryos, and were slightly adhesive. Larvae hatching from eggs remaining in the substrate were captured in an overflow apparatus. During the remainder of the week of March 16-20, additional spawning episodes were observed. Between March 20 and April 15, additional eggs and larvae were collected from tanks and placed into grow-out tubs. Cannibalism of smaller/younger larvae by larger/older juveniles was suspected as a reason for reduction in numbers. Newer larvae were subsequently placed a tub separate from larger/older individuals.

By the end of May, a total of approximately 150 juveniles survived out of approximately 450 larvae, amounting to about 33% larval survivorship (typical of that observed for other species). On July 15, a total of 110 immature individuals (average 50.8 mm total length) were tagged with fluorescent pink visible elastomer implant (VIE) marks and released in Sugar Creek, a tributary of Red Bird River that lies within the Daniel Boone National Forest in Leslie County, Kentucky. Despite monthly follow-up survey attempts, no tagged fish were recaptured, suggesting that either they did not survive or moved beyond the area of stream surveyed. Another attempt at reintroducing individuals in Sugar Creek is anticipated for late summer 2010, depending on success of spring captive spawning efforts.

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

KDFWR Strategic Plan. Goal 1, Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2; Class Actinopterygii and Cephalaspidomorphi: Taxa specific 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. A proposed rule is currently in review to federally list this species as endangered, because of recent range curtailment and fragmentation resulting from habitat degradation. Conservation Fisheries, Inc. (CFI), with support from Kentucky Department of Fish and Wildlife Resources (KDFWR), is developing captive propagation protocols for reintroduction of this species into streams within its native range to restore populations that have been extirpated. Because of the apparent rarity of this species, captive propagation and reintroduction is considered an appropriate tool for its recovery and eventual delisting. Artificially propagated individuals are being released within the watershed from which brood stock are taken, to avoid mixing potentially unique evolutionary lineages. Reintroduction sites are being chosen where habitat conditions are suitable and there is some level of protection (e.g., within wildlife management areas or national forest boundaries). Survival and movement patterns of released fish will be assessed through mark-recapture methods and through periodic monitoring using non-invasive methods, including visual census techniques.

On December 18, 2008, a total of 31 individuals were collected as brood-stock from Barren Fork, Indian Creek watershed, in the upper Cumberland River basin. At CFI, these fish were initially held in isolated aquaria to undergo quarantine and aquarium acclimation. Fish were then transferred to three 20 gallon tanks, each containing n = 10, 10, and 11 individuals, respectively. Cover was provided in the form of slab rocks, PVC pipes, and black plastic slabs on a mixed gravel substrate. Fish were provided live blackworms, redworms, mealworms and live *Daphnia* as a first food. Live glassworms (dipteran larvae) and frozen bloodworms (chironomids) and other frozen foods were also provided as the fish became acclimated to captivity. Winter conditioning included reduction of water temperatures to as low as 4-5°C and photoperiod shortened to 9 hours of light. Reproductive condition was then induced by gradually increasing water

Cumberland darter / Matt Thomas

temperatures, photoperiod, and food quantity offered, in concert with natural seasonal changes. On April 7, 2009, males and females were observed to be in breeding condition. Several spawning events subsequently occurred in the aquaria and seven clutches ranging from 7-80 eggs were produced, each guarded by a single male. On April 25, many eggs were lost when temperatures quickly rose to over 70°F.

By the end of July, 2009, 60 juveniles were alive and being maintained in six 20 gallon tanks. These individuals were marked with visible implant elastomer (VIE) tags and released into Cogur Fork (Indian Creek-upper Cumberland basin) on August 25. Total length (TL) of these darters averaged approximately 30-50 mm at the time of release. A follow-up survey to determine survivability of tagged darters was conducted on October 13. The section of stream in which the darters were released on August 25 was surveyed using a backpack electrofisher for 3,776 seconds. Two tagged darters (42 and 45 mm TL) were recaptured in a pool at the upstream end of the release section. Capture depth was 0.5 m, with little or no current over sand with patches of silt and detritus. A single larger individual (54 mm TL) without a tag was captured further downstream in a pool at a depth of 0.5 m in gentle current over sand with patches of leaves. The larger size of this individual and lack of any evidence of a tag suggest it was not one of the released fish, but rather a native individual that immigrated into Cogur Fork from Indian Creek. Another attempt at reintroducing individuals in Cogur Fork is anticipated for late summer 2010, depending upon success of spring captive spawning efforts.

Funding Source: *State Wildlife Grant (SWG), University of Tennessee*

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

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 the Rockcastle River and Big South Fork.

Since 2007, fertilized eggs have been obtained annually from the Wisconsin Department of Natural Resources taken from the upper Mississippi basin stock (Wisconsin River). These eggs are hatched at the Pfeiffer Fish Hatchery in Frankfort, Kentucky, and the young are reared to an average of 7.5-8.5 inches total length. 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 and 2,004 fish (average 7.5 inches) in 2009. The Big South Fork Cumberland River at the Alum Creek access area received 716 fish (average 7.4 inches) in 2008 and 1,973 fish (average 7.5 inches) in 2009. Young lake sturgeon were differentially marked by sequentially removing two adjacent scutes in the lateral series to distinguish year classes: left anterior scutes 1-2 for 2007, right anterior scutes 1-2 for 2008, and left anterior scutes 3-4 for 2009. Local print media (Times Tribune, Corbin, KY) and Corbin High School students have been present at the lake sturgeon release events. Kentucky Afield television has also featured the reintroduction effort for this rare species in the Cumberland River.

Two reports of lake sturgeon captured by anglers were received in 2009, both of which were in the upper reaches of Lake Cumberland (mouth of Buck Creek and near Jasper Bend). Active and passive sampling procedures aimed at recapturing stocked lake sturgeon to estimate survival and movement patterns will commence in 2010.

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 #8.

Juvenile lake sturgeon reared at Pfeiffer Fish Hatchery / Steve Marple

Analysis of the Environmental Requirements for the Ashy and Olive Darters in the Rockcastle River

Michael C. Compton and Christopher M. Taylor, Texas Tech University
KDFWR Contact: *Ryan Oster*

The integrity of rivers and the persistence of aquatic life are under constant pressure from agricultural practices, urban sprawl, road development, deforestation, and mining activities. The effects of these disturbances upon the landscape have a direct and indirect impact on the aquatic biota and their environment. The Rockcastle River is no exception to these threats and is of immense concern given that it has an exceptionally high aquatic biodiversity and contains numerous unique species to Kentucky. Two species, the ashy darter and the olive darter, are of particular interest given their presence within the Rockcastle River watershed and their overall rarity within the Commonwealth.

Historically the ashy and olive darters inhabited numerous stream systems within the Cumberland and Tennessee River drainages among six southeastern states, but their distribution has become fragmented overtime and their populations have declined. Although various aspects of life history are known for both species, many aspects are not fully understood, such as habitat preferences, tolerance to impacts, or a current conservation status. In Kentucky, it is perceived that the Rockcastle River contains the best populations of the two species; therefore, the watershed provides an excellent setting to model habitat preferences and environmental conditions for the target species. Occupancy estimation models will be developed based on presence-


Rockcastle River / Michael Compton

absence data of the two species within 30 stream reaches of the Rockcastle River. Data will be collected during the summer months of 2008-2010 to determine what stream reaches within the Rockcastle River watershed are inhabited by the species, and within those stream reaches, what microhabitats are used by the species. In addition, fish community data will be collected to determine the overall health of the watershed and to determine if any species association exist between the ashy and olive darters and any other species within the river.

In 2009, thirty randomly selected sites within the larger river sections of the Rockcastle River were sampled. Using a backpack electrofisher, fishes were sampled from 3 x 10 m plots that were systematically distributed throughout each site. Environmental variables such as water quality, substrate, depth, and flow were measured, to associate with target species occurrences. A total of 482 plots were sampled within the 30 sites. A total of 98 ashy darters were collected within 50 plots at 18 sites. A total of 5 olive darters were collected from 4 plots at 2 sites. Development of occupancy estimation models is near completion. A cluster analysis of the abiotic variables for each plot identified 4 general habitat types. The habitat types varied based on the degree of differences in substrates, flow, depth, and the presence of large woody debris. An Indicator Species Analysis suggested both of the target species were associated with habitat type 'C', which can be characterized primarily as cobble/boulder substrates with a fair amount of sand present (roughly 20%), moderate flow, large boulders present (typically with a B-axis greater than 0.75 m), and a mean depth of 0.31 m. Currently over 60 fish community collections have been made and a total of 56 species have been collected. Field work in 2010 will focus on target species data collection to validate the occupancy models and to complete the remaining fish community surveys throughout the watershed. The importance of the data is to ultimately identify and model the environmental conditions and habitat preferences of the target species, which will provide KDFWR the needed information to ensure the species existence within the Rockcastle River but also to enhance conservation efforts in other watersheds that contain or historically have contained ashy and olive darters.

Funding Source: *State Wildlife Grant Program (SWG), Texas Tech. University*

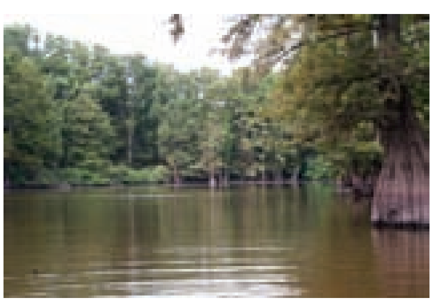
KDFWR Strategic Plan. Goal 1, Strategic Objective 5. Comprehensive Wildlife Conservation Strategy: Appendix 3.2; Class Actinopterygii and Cephalaspidomorphi: Taxa specific research project #1.

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

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

Species of Greatest Conservation Need (SGCN) were recognized in the Kentucky Wildlife Action Plan, 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. Currently, 59 of the state's 241 native species are on this list, many of which are also on the current List of Rare and Extirpated Biota of Kentucky managed by the Kentucky State Nature Preserves Commission (KSNPC), and five species listed by the U.S. Fish and Wildlife Service (USFWS) as threatened or endangered.

Compiling a list of SGCN was a fundamental step towards formulating a comprehensive conservation strategy for fishes under Kentucky's Wildlife Action Plan (*http://fw.ky.gov/kfwis/stwg/*); however, there remains a need to acquire new data on distributions, population size and structure, and habitat conditions to accurately assess the current status of these species in Kentucky. This information will be critical to future efforts aimed at recovery and restoration of these species. Furthermore, given the dynamic nature of Kentucky's fish fauna in response to a rapidly changing ecosystem, periodic surveys are needed to establish data for long-term trend assessment.



Three Ponds Nature Preserve, Hickman County / Matt Thomas

From top to bottom, left to right: Northern Starhead Topminnow, Redspotted Sunfish, Taillight Shiner, Inland Silverside, Central Mudminnow, and Swamp Darter / Matt Thomas

Within Kentucky, a large portion (38%) of fish SGCN are either entirely distributed or have the largest portion of their distributions west of the Green River basin. More than 80% of the available records for these species (based on vouchered specimens) are now more than ten years old, justifying the need for new surveys to determine the current status of populations.

Beginning in 2007, survey efforts with the following objectives were initiated: 1) update information on distributions of SGCN, estimate the current status and size of populations, and establish baseline data where needed; and 2) document locations and condition of critical habitat and provide information on potential recovery and management measures for these species. Baseline data on new populations and updated information on the distribution and status of SGCN and their habitats is essential to developing effective conservation policies and management practices. All new data are initially entered into the EDAS (Ecological Data Application System) database, then transferred and maintained in the KFWIS (Kentucky Fish and Wildlife Information System) database.

Sample localities are based on records available in databases (i.e., KDFWR, KSNPC, and others) and other areas where habitat conditions might support those species. The rarest species and those most in need of updated distributional and abundance data are prioritized. Species identification, gender (when possible), total lengths (when >20 individuals), and habitat condition are recorded and compared with previous records. Photographs and/or vouchers of specimens are taken from each sample event for verification. Habitat variables are correlated with presence/absence and abundance data to assess levels of imperilment of populations of each species. This information will be used to make decisions on where to implement conservation measures and establish fixed long-term monitoring sites at areas supporting large concentrations of SGCN.

Funding Source: *State Wildlife Grant (SWG)*

Comprehensive Wildife 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.

Development of *In Vitro* (Artificial) Laboratory Culture Methods for Rearing Juvenile Freshwater Mussels.

Christopher Owen, Kentucky State University; James Alexander, University of Louisville; Monte McGregor, Kentucky Department of Fish and Wildlife Resources

Propagation of freshwater mussels has been somewhat limited to species in which we know the host. For these species, host fishes may be unknown or difficult to handle and/or collect in adequate numbers for conventional fish-host propagation methods. Despite availability of glochidia and hosts, even under the best laboratory conditions, transformation rates to the juvenile stage are variable and mostly unpredictable.

Over the years, *in vitro* metamorphosis of glochidia has been successful with only a few common species, including *Ligumia recta*, *Lampsilis siliquoidea* and *Utterbackia imbecillis*, all of which are host-generalists that utilize a broad spectrum of fish hosts. Host-specific or threatened and endangered species had not been successfully metamorphosed *in vitro*. In addition, no literature existed describing the 'fitness' of individuals metamorphosed in vitro, using various metrics as percent transformation, lipid reserves, and survival rate for comparison.

Control of microbial contamination composes the single largest hurdle with *in vitro* mussel culture. Improvements to the in vitro culture medium and protocol have proved effective in controlling microbial contamination and resulted in the successful metamorphosis of sixteen mussel species. Of the sixteen species to metamorphose, eight represent new species to be successfully metamorphosed *in vitro*. These eight species include: *Anodonta suborbiculata* (Flat Floater), *Alasmidonta viridis* (Slippershell mussel), *Cyprogenia stegaria* (Fanshell), *Epioblasma capsaeformis* (Oyster Mussel), *Lampsilis abrupta* (Pink Mucket), *Lasmigona costata* (Fluted-shell), *Strophitus undulatus* (Creeper), Toxolasma parvus (Lilliput) and *Villosa taeniata* (Painted Creekshell). Of these eight species, C. stegaria, E. capsaeformis and L. abrupta are the first reports of federally listed endangered species to successfully metamorphose in vitro.


In vitro *L. siliquoidea / Christopher Owen*

Successful artificial culture techniques will allow KDFWR wildlife managers and other mussel propagators a new and more effective method for the conservation of freshwater mussels. The development of an *in vitro* culture technique not only allows mussel propagators to bypass the need for a fish host, but the technique has the potential to create significantly more juveniles than does propagation techniques involving fish hosts. This ability is important particularly for species of the most dire conservation need, including endangered or threatened mussel species found in limited population size, with threatened or endangered fish hosts or skewed sex ratio (availability of gravid females).

With the elimination of deleterious effects of microbial contamination, research is now focused on the nutritional requirements of the culture medium with various species. Brood stock condition, which may play a significant role in overall success of in vitro cultured juveniles, is also being investigated.

Funding Source: *State Wildlife Grant (SWG), Kentucky State University, University of Louisville*

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

Genetic Characteristics of Restored Elk Populations in Kentucky

2009 elk hunt / Gabe Jenkins

Virginia Dunn, Steve Demarais and Bronson Strickland, Mississippi State University; Randy DeYoung, Texas A&M University; Tina Brunjes, Kentucky Department of Fish and Wildlife Resources

Eastern Kentucky currently has a thriving elk (*Cervus elaphus*) population, thanks to restoration efforts by the Kentucky Department of Fish and Wildlife Resources (KDFWR) beginning in 1997. Retention of genetic diversity is important to the success of wildlife populations, including elk. Genetic diversity is important to individual and population survival, adaptiveness, growth and reproductive potential. Future management decisions, such as hunting season regulations, need to be made with the genetic structure of the population in mind.

Last year the KDFWR and Mississippi State University began a project to evaluate the genetic makeup and physical characteristics of the eastern Kentucky elk herd. During fall and winter 2008 and 2009, biologists, guides and hunters sampled tissue or hair and body and antler measurements from harvested elk. We will use DNA taken from these samples to evaluate the genetic makeup of the elk across the restoration area and compare this to their source populations in western states. Comparing physical measurements allows us to evaluate the health of the population as it relates to genetic potential in restored and source populations.

A preliminary genetic analysis shows eastern Kentucky elk with high levels of genetic diversity throughout the restoration zone. A preliminary analysis of physical comparisons shows that eastern Kentucky elk seem to be larger than some of the source state elk. During summer of 2010, the remainder of the genetic samples will be processed and all analyses completed. This information will allow the KDFWR to make future management decisions that will promote elk population health.

Funding Source: *Pittman Robertson (PR), Mississippi State University, Texas A&M University*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5.

Status of the River Otter in Kentucky

Erin E. Barding & Michael J. Lacki, University of Kentucky
***KDFWR Contact:** Steven Dobey*

In an effort to restore self-sustaining populations of otters throughout suitable habitat in Kentucky, KDFWR released 355 river otters (*Lontra canadensis*) among 14 sites in the central and eastern part of the state during 1991-1994. In 2006, the high frequency and quantity of reports of river otter occurrence and activity throughout the state prompted KDFWR to implement a statewide trapping season. There has never been a comprehensive effort to research the Kentucky otter population before or after the reintroduction. Therefore, it is imperative to determine the status of the river otter throughout Kentucky in order to implement appropriate management strategies for this species in the state. The objectives of our research are to 1) determine the distribution and relative abundance of otters in Kentucky; 2) determine population demographics, including reproductive characteristics of otter populations in Kentucky; 3) describe food habits of river otters in Kentucky; 4) create habitat models for river otters in Kentucky; 5) create a river otter population model.

A total of 78 river otter sign surveys were conducted from Sept. 2006 - June 2008. When survey data is combined with trapping data, river otters were reported in every major basin in the state. Riparian and landscape measurements were collected during the 2007-08 surveys, which will be used to create a predictive habitat model for otters in Kentucky.

We have performed 170 necropsies on trapper-donated river otter carcasses from the 2006-08 trapping seasons. We found signs of reproductive activity in over half of the females. Population models for otters in Kentucky will be constructed based on reproductive measurements taken from carcass analysis including pregnancy rates and average litter sizes. The model will predict and estimate population growth in the state.

River otter / Tim Daniel

Stomachs were removed from all otters and dissected to identify contents for the food habits portion of this study. Fish and crayfish were the main prey items, occurring in 86 and 27 percent of all stomachs examined which contained food, respectively. Six species of crayfish in 4 genera have been identified, none of which are listed as threatened or endangered in Kentucky. We identified 8 families of fish in the diet of river otters. The most frequently consumed fish family was Centrarchidae (66%), with sunfish (*Lepomis, Ambloplites* spp.) and crappie (*Pomoxis* spp.) (51%), rather than black bass (*Micropterus* spp.) (9%), important items in the diet. We recommend that KDFWR monitor sportfish populations in areas with high river otter densities to determine whether otters are negatively impacting fish populations. If sportfish populations, such as *Micropterus* spp., exhibit declining trends, this may warrant adjustments to river otter harvest protocols, such as a zone system with larger bag limits in areas where concern for bass populations overlap with areas of high otter densities.

Funding Source: *Kentucky Department of Fish and Wildlife*

FWR Strategic Plan. Goal 1, Strategic Objective 5b.

Pregnant tract of female otter / Erin Barding

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

Will Bird and Phil Peak, Kentucky Herpetological Society
KDFWR Contact: *John MacGregor*

Scarlet kingsnake / Will Bird

In the course of developing Kentucky's Comprehensive Wildlife Conservation Strategy (CWCS) 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.

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 CWCS and continue to gather information and data for species of interest.

Funding Source: *State Wildlife Grant (SWG)*

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

Northern leopard frog / Will Bird

Bottomland Hardwood and Riparian Restoration in Obion Creek/Bayou de Chien Watersheds

Shelley Morris and Jeff Sole, The Nature Conservancy
KDFWR Contact: *Danna Baxley*

The Obion Creek/Bayou de Chien watersheds have been identified by multiple agencies and organizations as high-priority conservation areas. The majority of the bottomland hardwood forests within these two watersheds have been negatively impacted by incompatible forestry or agricultural practices; consequently, most of the streams have very little riparian vegetation and are in need of restoration attention. Beginning in 2008, we sought to achieve the following conservation objectives on private lands within these two watersheds: restore four miles of riparian cover, promote implementation of streambank stabilization projects such as grade stabilization, cedar revetments, and rock veins, plant 150 acres of bottomland hardwoods, conduct prescribed burns to improve habitat in target areas, and create ephemeral pools for pond-breeding amphibians.

In November of 09, TNC hosted a SWG landowner outreach event in Clinton, Ky. With assistance from KDFWR, invitations were sent to approximately 70 local landowners and an invitation was also printed in the local paper. The event was held at a local restaurant with free lunch for attendees. Attendance was rather low, only about a dozen people. However, given the area, this was considered a success by the partners. Partners in attendance were TNC, KDFWR, USFWS, and NRCS. A presentation was given that was an overview of the project area, conservation practices, and cost share programs, including SWG. Partners then also spoke briefly about how they fit into the conservation picture for the area. This event did not result in any SWG projects; however, there were a few individuals that expressed interest in other conservation programs, primarily WRP.

Currently, projects are being developed with USFWS to work on headcut repair in the headwaters of Bayou du Chien. This would serve to reduce sedimentation caused by bank erosion. The endemic Relict Darter is known from this area and it is a key conservation target for the project area. Habitat loss due to sedimentation is noted as a key threat to this fish. Also, one landowner adjacent to the Obion WMA has expressed interest in doing a tree planting as part of a developing wetland mitigation bank project.

We plan to continue this project through 2010 and hope to continue our partnerships with federal, state, and local partners to restore habitat, improve water quality, and abate threats to species of greatest conservation need within the Obion Creek/Bayou de Chien Watersheds.

Future restoration site / Shelly Morris

Funding Source: *State Wildlife Grant (SWG), The Nature Conservancy*

Comprehensive Wildlife Conservation Strategy: Appendix 3.4, Prioritized taxa-specific conservation actions, Class Mammalia; Appendix 3.3, Conservation Action # 7, #14, #32, #80, #97 #120, and #129.

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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

Bats

Reptiles and Amphibians

Mollusks

Crayfish

Fishes

Habitat Restoration / Management

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More information regarding the project summaries within this publication can be obtained by contacting the KDFWR authors or contacts listed below.

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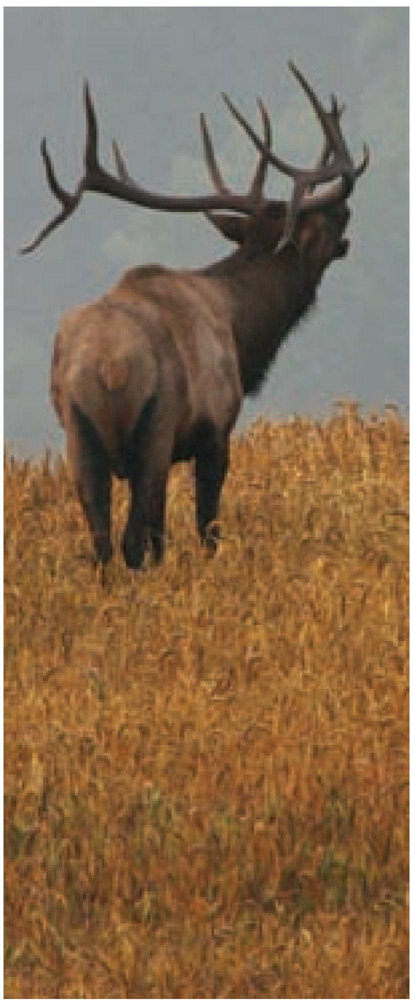

Bugling elk / Dan Crank

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