Kentucky Department of Fish and Wildlife Resources

Annual Research Highlights 2015

Volume IX, Nov. 2016

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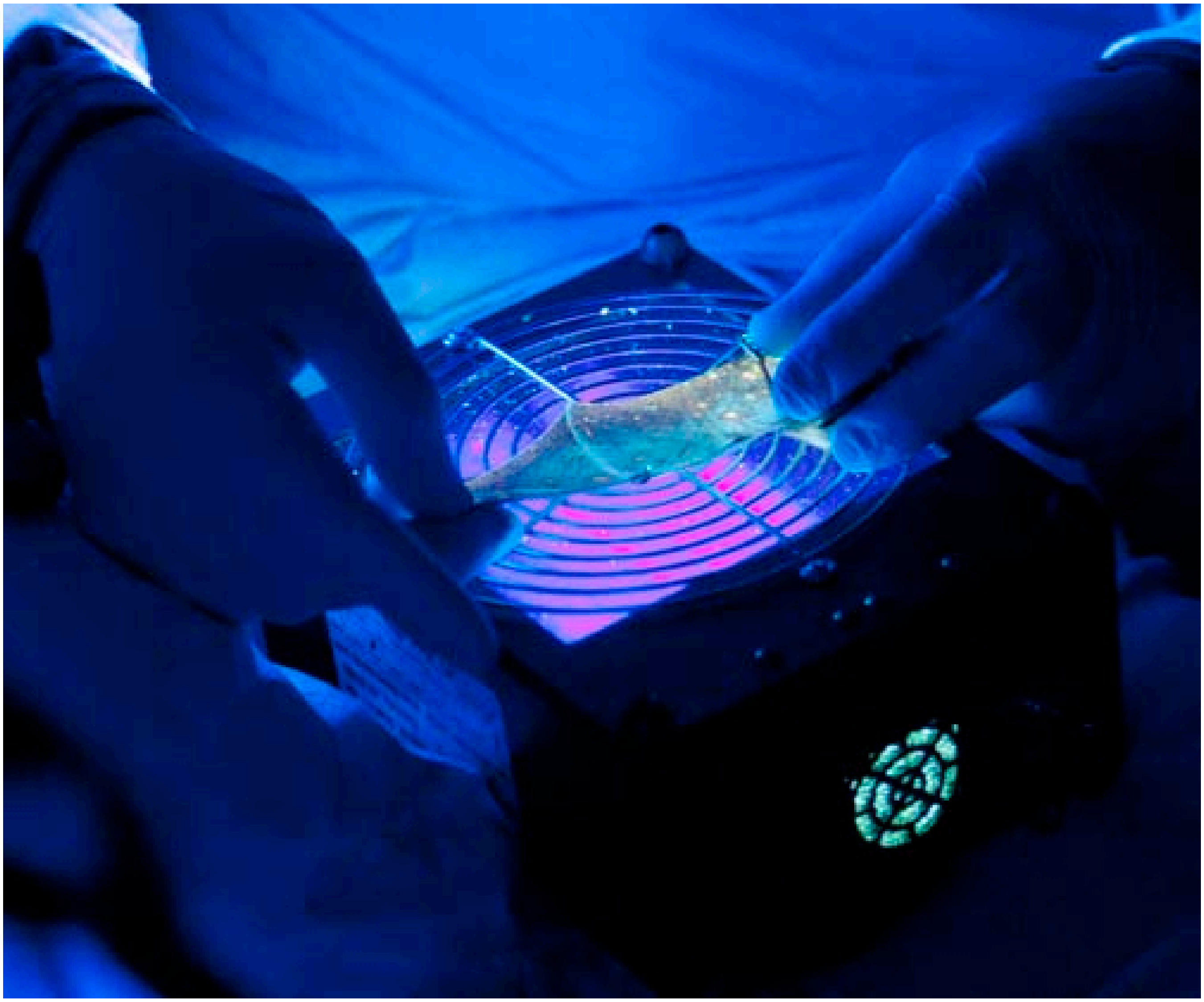
Our Mission:

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

COVER: *Catfish shocking at Taylorsville Lake / Obie Williams*

Foreword



Ultraviolet light examination of bat in Saltpeter Cave reveals wing damage caused by white-nose syndrome / Kevin Kelly

Research and monitoring are key steps towards conserving and enhancing fish, wildlife, and habitat resources throughout the Commonwealth. In order to effectively manage a species it is vital to fully understand its ecology and behavior along with its responses to management activities. As stewards of Kentucky's fish and wildlife, it is our job to ensure seasons and bag limits are sustainable and to determine if management actions are achieving desired goals. The following project summaries serve as a testament to KDFWR's vigilance in the conservation of the fish and wildlife resources that we hold in trust for the public. The 2015 KDFWR Research Highlights document represents targeted efforts by KDFWR and partners to fulfill statewide conservation goals.

Funding Sources and Guide to Federal Programs

KDFWR receives no general fund taxpayer dollars. As a result, the Department relies on hunting and fishing license fees, boat registration fees, and federal programs to fund the seven divisions within KDFWR. Nearly all of the projects included in this document are partially or fully funded by federal programs including the Wildlife Restoration Act (Pittman-Robertson), the Sport Fish Restoration Program (Dingell-Johnson), the State Wildlife Grant Program (SWG), 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/

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

Deer tissue being monitored for CWD / Obie Williams

or habitat conservation. Brief descriptions of each of these programs are as follows:

These federal programs provided approximately 15.3 million dollars to KDFWR in 2015, while the sale of hunting and fishing licenses provided 27.4 million dollars, over half of KDFWR's budget (see Figure 1). For reference, we have included the state and federal funding sources for each project; however, these projects may be additionally supplemented by outside funding provided by non-profit organizations or universities. For each project summary, we also identify the specific goals addressed by either Kentucky's Strategic Plan or Kentucky's State Wildlife Action Plan, the two guiding documents for our agency.

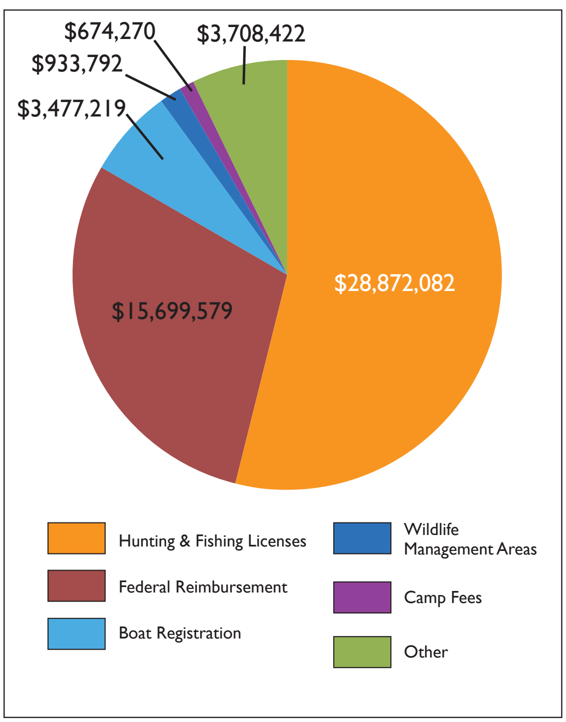


Figure 1. Kentucky Department of Fish and Wildlife Resources Funding Sources 2015. Total revenues for 2015 were $53,365,365.

How to Use This Document

This document is divided into **four main sections**: published research, completed projects, new projects, and project updates. Citations for all **published research** with Kentucky Department of Fish and Wildlife involvement are included in the Table of Contents. For projects that have been completed and not yet published, a detailed summary will be included in the first portion ("**completed projects**") of the document. For projects that began in 2015, a brief 1-page overview of the project is included in the second portion ("**new projects**") of the document. For select ongoing projects, brief status updates are included in the last section ("**project updates**") of this document. This will facilitate looking up detailed summaries of completed projects in later years. A comprehensive **project reference guide** lists all projects included in Research Highlights documents, beginning with publication year 2007.

Please use the following citation when referencing this document:

Kentucky Department of Fish and Wildlife Resources Annual Research Highlights, 2015. Volume IX. Publication of the Wildlife and Fisheries Divisions. November, 2016, 85 pp.

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Published Research

Contact Program Coordinator, Paul Wilkes (paul.wilkes@ky.gov) for reprints of these publications.

Bird, W.M., P. Peak, and D.L. Baxley. 2015. Natural history and meristics of an allopatric population of red cornsnakes, Patherophis guttatus (Linnaeus, 1866) in central Kentucky, USA. Journal of North American Herpetology 2015:6-11.

Brooke, J.M., D.C. Peters, A.M. Unger, E.P. Tanner, C.A. Harper, P.D. Keyser, J.D. Clark, and J.J. Morgan. 2015. Habitat manipulation influences northern bobwhite resource selection on a reclaimed surface mine. Journal of Wildlife Management 79:1264-1276.

Murphy, S.M., J.J. Cox, J.D. Clark, B.C. Augustine, J.T. Hast, D. Gibbs, M. Strunk, and S. Dobey. 2015. Rapid growth and genetic diversity retention in an isolated reintroduced black bear population in the Central Appalachians. Journal of Wildlife Management 79:807-818.

Near, T.J., and Thomas, M.R. 2015. A New Barcheek Darter Species from Buck Creek (Cumberland River System), Kentucky (Percidae: Etheostomatinae: *Catonotus: Oopareia*). Bulletin of the Peabody Museum of Natural History 56(2):127-146.

Peters, D.C., J.M. Brooke, E.P. Tanner, A.M. Unger, P.D. Keyser, C.A. Harper, J.D. Clark, and J.J. Morgan. 2015. Impact of experimental habitat manipulation on northern bobwhite survival. Journal of Wildlife Management 79:605-617.

Thomas, M.R. and S.L. Brandt. 2016. Surveys for the Diamond Darter (*Crystallaria cincotta*), an endangered species known historically from the Green River in Kentucky. Proceedings for Celebrating the Diversity of Research in the Mammoth Cave Region: 11th Research Symposium at Mammoth Cave National Park. April 18, 2016 50-58

Unger, A.M., E.P. Tanner, C.A. Harper, P.D. Keyser, F.T. VanManen, J.J. Morgan, and D.L. Baxley. 2015. Northern bobwhite seasonal habitat selection on a reclaimed surface coal mine in Kentucky. Journal of the Southeastern Association of Fish and Wildlife Agencies 2015: 235-246.

Yeiser, J.M., D.L. Baxley, B.A. Robinson, J.J. Morgan, J.N. Stewart, and J.O. Barnard. 2015. A comparison of coal mine reclamation seed mixes in Kentucky: Implications for grassland establishment in Appalachia. International Journal of Mining, Reclamation, and Environment 2015:2-11.

Completed Projects and Monitoring Summaries

Wildlife

Fisheries

New Projects

These projects began in 2015

Fisheries

Project Updates

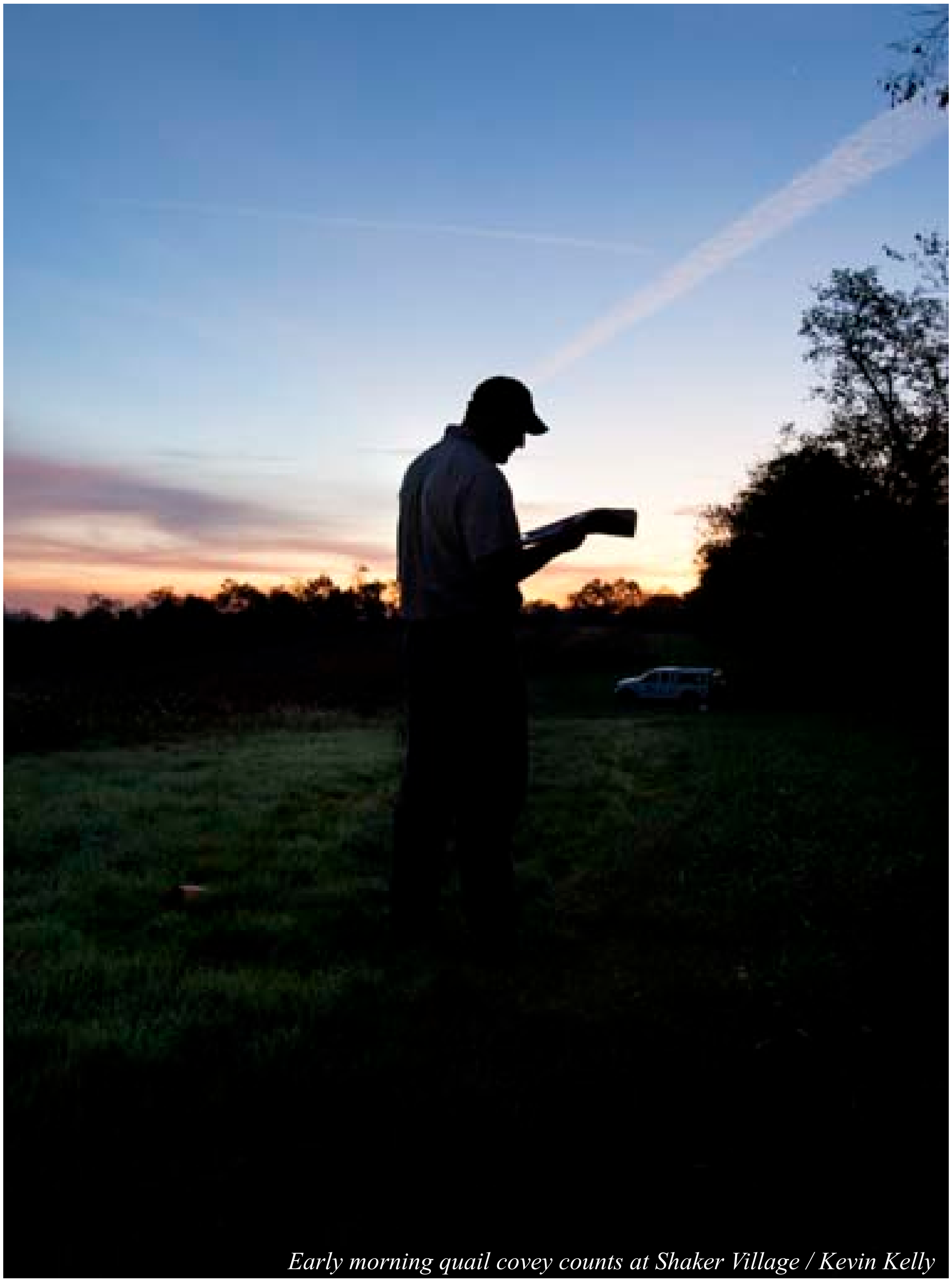
This section includes brief updates for selected projects that began prior to 2015.

FISHERIES

WILDLIFE

Appendix

KDFWR Contacts



Early morning quail covey counts at Shaker Village / Kevin Kelly

Completed Projects

Effects of Native Grassland Restoration on Raptor Habitat Use and Prey Abundance on Peabody Wildlife Management Area

Kate Slankard, Danna Baxley and Gary Sprandel
Kentucky Department of Fish and Wildlife Resources

Introduction

Grassland habitat is declining at rapid pace in North America and populations of many grassland birds are plummeting along with it (Brennan and Kuvlesky 2005). Restoration and management of native grasslands is cited as a top objective for grassland bird recovery and the Northern Bobwhite Conservation Initiative, Conservation Reserve Program (CRP) and other multi-state programs have led to much effort and expense for this purpose in recent years. Large, contiguous tracts of endemic grasslands are hard to find, but reclaimed surface mines can provide expansive areas of grassland habitat in Kentucky and elsewhere. Consequently, restoring native grasses on reclaimed mine sites has become more popular in recent years.

The Northern Harrier (*Circus cyaneus*) is a species of conservation concern throughout much of its range in North America, including Kentucky (KDFWR 2013). The consistent nesting range of Northern Harriers in Kentucky is nearly limited to reclaimed mine areas in the west-central part of the state, including Peabody Wildlife Management Area (PWMA) (Palmer-Ball 2003). Much of PWMA has been intensively managed for native grass, but little was known about how these habitat management actions affect harriers and other grassland raptors at the time we began this project.

The diet of most grassland raptor species is typically high in small mammals. Northern Harriers, in particular, are known to eat mostly voles and other small mammals throughout their range and on PWMA (Stewart 2004, Vukovich and Ritchison 2006). Variables influencing nest site selection for Northern Harriers have also been well documented, especially the preference to nest in idle grasslands (not recently managed) (Toland 1986, Herkert et al 1999).


Northern harrier / David Roemer

Recent research has proven that increasing available grassland habitat results in quick increases of wintering grassland raptors. These success stories leave us to pose the question on where we should focus monetary resources for grassland raptors: the conversion of land under other uses to grassland habitat or the management of existing grasslands, many of which contain non-native vegetation.

The goal of this study was to evaluate the relationships among raptor and small mammal communities where native grass restoration and other management activities were ongoing. We structured our study design in hopes to obtain a dataset with sufficient sample size and standardization to look at the relationships between raptor habitat use, small mammal abundance and vegetation structure. Although we were interested in all raptors that use grassland habitat, we were particularly interested in the Northern Harrier since it is a species of greatest conservation need (SGCN) listed in Kentucky's State Wildlife Action Plan (KDFWR 2013).

Methods

Study Site

Our study site was the KDFWR-owned portions of PWMA in Muhlenberg and Ohio counties in western Kentucky. KDFWR has been restoring native warm season grass (NWSG) at PWMA since 1997. We conducted our study on 2 separate regions of PWMA. "The eastern units"- named Sinclair and Ken (9476 ha) - contained much area that was undergoing intensive manage-

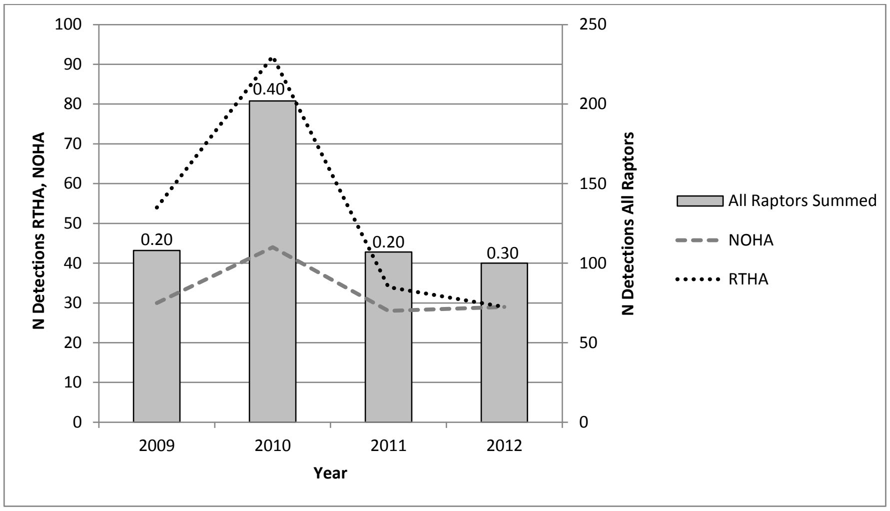


Figure 1. Number of detections for all raptors, Northern Harrier (NOHA) and Red-Tailed Hawk (RTHA) surveyed at Peabody Wildlife Management Area 2009-2012. Annual density estimations (N/km2) are shown for all raptor species.

ment for NWSG before and during the study. "The western units"- Vogue and River Queen (6415 ha) - served as the control since they contained unmanaged, reclaimed mine land, planted in non-native vegetation. PWMA was identified as a Kentucky Quail Focus Area in 2008 (KDFWR 2008) and a special grant to restore Northern Bobwhite (*Colinus virginianus*) habitat was the driving force behind most of the management activities on the eastern units. KDFWR intensively managed the open areas on the eastern units, using herbicide, block disking, strip disking and prescribed fire. Most of the managed areas were planted in NWSG at some point before or during the study. Detailed records were kept on management actions using a GPS in the field (often attached to the tractor) and GIS software.

Raptor Surveys

Raptor surveys were conducted once each month from December 2008-July 2012. Months included in the survey (December-July) targeted wintering and nesting birds. To minimize weather impacts on raptor behavior, surveys were not conducted on days with precipitation or fog, when wind speeds were greater than 24 kph or snow depth was greater than 3 cm.

A distance sampling, roadside, point count survey methodology was employed for replicability and the ability to calculate density estimates. Accessible roads at PWMA which dissect grassland habitat were surveyed for raptors in a single day beginning at least ½ hr after sunrise and ending at least ½ hr before sunset. Twenty-nine randomly placed points were sampled along the roads via a single-observer point count.

To minimize observer bias, all raptor data was collected by the same observer. At each point, the observer got out of the vehicle and watched for raptors for 3 min. For each individual detected, the following information was recorded: species, age, sex, behavior, time and location. All information recorded was based on the first detection of the individual. The approximate location of each raptor was marked on a map with aerial imagery. The detection locations were later digitized for analysis in ArcGIS.

Small Mammal Trapping

To obtain estimates of small mammal relative abundance, we conducted small mammal trapping, using snap-traps. Trapping was conducted at six grid locations for two consecutive trap nights in late winter and mid-summer each year from 2009-2012. New grids were sampled each year, leading to a total of 24 grids sampled; 50% of grids sampled each season were within areas managed for NWSG and 50% were in unmanaged areas. To minimize the effects of weather, small-mammal trapping did not occur when there was more than 3 cm of snow on the ground or on days/nights where there was substantial rainfall or temperatures below -12°C.

Random grid locations were generated for each habitat type. At each grid location, small mammal traps (laid within 1 m of each other in sets of two) were set in 7 x 7 grids which consisted of 49 double traps placed 10 m apart. Traps were baited with peanut butter and oatmeal and set on the dirt by kicking up litter layer if necessary. When traps were checked, captured mammals were collected and placed in a bag which was labeled with the grid number and date. Once brought back from the field, the specimens were assigned a unique specimen ID number, identified, measured and, when possible, aged and sexed.

Quantitative Soil and Vegetation Measurements.

Vegetation measurements were taken at each small mammal trapping grid during mammal sampling periods in both winter and summer. Soil compaction and four vegetation variables were measured at each plot: vegetation height, vegetation heterogeneity, vegetation density, and percent cover of vegetation composition (at two levels). Vegetation composition was estimated within a 10 m radius of the plot center from eye level looking down and from 20 m looking down (the bird's eye view). The observer estimated the percentage of cover in each of the following categories: trees, shrubs, bare ground, forbs, NWSG, cool-season grass and sericea.

Statistical Analysis. We compared raptor density data in Program Distance (Laake et al. 1993, Buckland et al. 2001). For broad seasonal analysis, we considered December – February the wintering season, while we considered March- July to be the breeding season. Although there were several observations for Bald Eagle (*Haliaeetus leucocephalus*), Osprey (*Pandion haliaetus*), and Mississippi Kite (*Ictinia mississippiensis*), these species were removed for the analysis since they are unlikely to respond to grassland habitat management.

To evaluate density associations of raptor use and NWSG, we used GIS to calculate the percentage of each survey area (within 500m of the survey point) that had been planted in NWSG. Distance-based metrics were then used to assess habitat use relationships between raptor species and management activities. In ArcGIS, we calculated the distance between each raptor location and four different management classes: block disk, prescribed burn, NWSG planting, and strip disk/fire break. We then created random points in ArcGIS to characterize the PWMA landscape for comparisons.

Analysis of small mammal relative abundance and analysis of vegetative characteristics between managed and un-managed mammal trapping grids were conducted in JMP Statistical Software.

Results

Raptor Surveys

We documented 516 detections of ten species during the 2008-2012 raptor surveys. We calculated total raptor densities as well as annual densities for Red-tailed Hawk (*n* = 209, total density = 0.31/km^2) and Northern Harrier (*n* = 131, total density = 0.25/km^2). There were too few observations to calculate densities for Merlin (*Falco columbarius*, *n* = 5), Cooper's Hawk (*Accipiter cooperii*, *n* = 10) and Rough-legged Hawk (*Buteo lagopus*, *n* = 4).

Overall raptor detections were consistent in 2009, 2011 and 2012, but nearly doubled in 2010. Mammal capture was also highest in 2010, but not much more than 2009 and 2012. A mammal population crash occurred in 2011, which was also the year of lowest density estimation for raptors on Peabody WMA (Figures 1 and 2).

Density estimates for all species combined indicated highest densities in the winter when compared to the breeding period. Northern Harrier and Red-tailed Hawk densities were also higher in winter than the breeding season. Northern Harriers and Red-Tailed Hawks had highest densities within survey areas categorized as high-density availability of NWSG (Northern Harrier 0.66/km^2 compared to 0.18/km^2 in low density areas).

Northern Harrier, American Kestrel, and Red-tailed Hawk observations were also significantly closer to areas that had been planted in NWSG when compared to random points. Northern Harrier, American Kestrel and Red-shouldered Hawk detections were significantly closer to strip disk/fire break areas than random points, and all species but Red-tailed hawks were significantly closer to burned areas than random points. American Kestrel was the only species found significantly closer to block disk than random points. A seasonal analysis done especially for Northern Harriers revealed that they utilized all managed areas more frequently than expected during the breeding season. During the winter, Northern Harriers avoided strip disk areas and firebreaks.

Small Mammal Trapping

During 2,352 trap-nights, we captured 745 individuals representing ten species. Prairie vole (*Microtus ochrogaster, n* = 318), house mouse (*Mus musculus, n* = 94) and prairie deer mouse (*n* = 92) were the most frequently captured species respectively, representing 68% of total captures. We also captured Least Shrew (*Cryptotis parva*, *n* = 55), Eastern Harvest Mouse (*Reithrodontomys humulis*, *n* = 49), White-footed Mouse (*n* = 42), Pine Vole (*Microtus bavaricus*, *n* = 38), Southern Bog Lemming (*Synaptomys cooperi*, *n* = 32) Northern Short-tailed Shrew (*Blarina brevicauda*, *n* = 8) and Meadow Vole (*Microtus pennsylvanicus*, *n* = 1). Although not statistically significant, more mammals were captured in summer (*n* = 498) than winter (*n* = 247). Total captures of mammals was consistent in 2009-2010 and 2012; however, mammal abundance was sig-

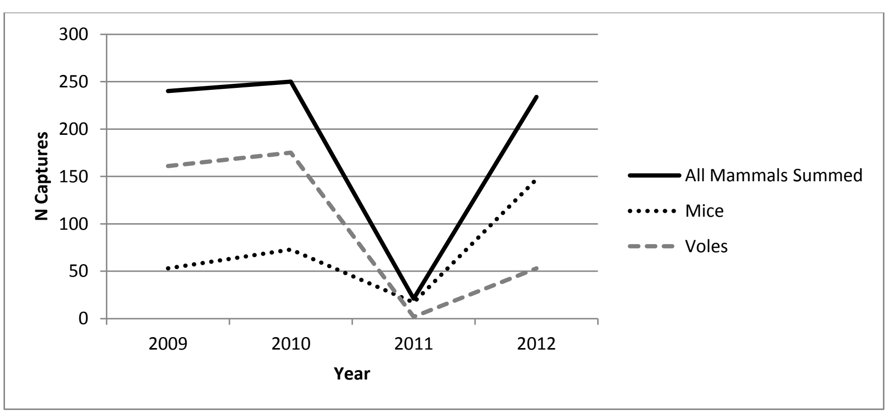


Figure 2. Total number of captures for mice, voles, and all mammals combined on Peabody Wildlife Management Area 2009-2012.

nificantly lower in 2011 than in other years of the project (Figure 2). Voles comprised most of the captures (67-70%) in 2009-2010, but mice provided the greatest proportion of the captures (63-81%) in 2011-2012. The average number of voles per trap grid was 26.7 and 28.7 in 2009 and 2010 respectively, and only 0.3 and 9.0 in 2011 and 2012, respectively.

Overall capture totals for all mammals did not differ between grids managed for NWSG and non-native grids. Managed plots had slightly higher small mammal diversity when compared to unmanaged plots, but this difference was not statistically significant. Vole capture rates per trap grid were somewhat higher in unmanaged versus managed grids, though this difference was not statistically significant. *Peromyscus maniculatus* was captured significantly more in unmanaged stands compared to managed stands ($P = 0.004$).

Vegetation Characteristics

Managed and unmanaged grids exhibited significant differences in percent cover of NWSG ($P = 0.0001$) and percent cover of cool-season grass ($P = 0.001$). No statistical differences existed for other fine-scale vegetation variables including: soil compaction, percent forbs, percent shrubs, percent trees, percent bare ground, light penetration, and vegetation height.

Discussion

Except for documenting *Peromyscus maniculatus'* preference for unmanaged areas, we were not able to determine any effects on small mammal communities by habitat management actions. It is possible that the dense nature of native warm season grass plantings provided similar vegetative structure to non-managed habitats; consequently, there were no real differences in relative abundance between habitat types.

Although no clear patterns existed with small mammals and habitat management or ground-level vegetative characteristics at the study plot level, larger scale associations between raptors and small mammals were evident. At the study area (temporal) scale, small mammal relative abundance and raptor relative abundance were correlated, particularly during the small mammal crash documented in 2011. This indicates a clear relationship between raptors and small mammals at Peabody Wildlife Management Area that is likely influenced by landscape-level factors like weather and cyclical mammal cycles, more so than small scale vegetative or management factors. Furthermore, our study reiterated the link between grassland raptor populations and vole numbers. Despite the rebound in overall small mammal abundance in 2012, vole abundance remained relatively low and an increase in mice accounted for most the general upsurge that year (Figure 2). The lull in vole numbers and increase in mice was countered by a modest increase in overall raptor density in 2012, and stagnant numbers of Red-tailed Hawk and Northern Harrier (Figure 1).

Despite the fact that we documented increased habitat use in burned areas for most raptor species, we found no significant differences between the small-scale vegetation structure in managed vs. non-managed vegetation plots that might explain raptor preference for these areas. However, we also found increased occurrence for all raptor species near linear disturbances (strip disk lanes and firebreaks). Thus, our results suggest that larger scale habitat variables, such as linear disturbances, may be driving raptor habitat use more than micro-habitat variables or prey abundance. Firebreaks were concentrated in the eastern units, managed for NWSG. Hence, while burning no doubt keeps these areas suitable grassland habitat, presence of firebreaks may be even more important because they create important openings in the vegetation, improving the sightability of prey.

Block-disking has become a popular management tool for Northern Bobwhite on PWMA and is known to increase food availability by increasing coverage of bobwhite food plants (Brooke 2015). Block-disking occurs during the fall and winter and American Kestrels were the only species that showed a positive response to this management action for all seasons. We did not document a positive all-season response from other raptor species to block-disking and recommend that this practice be used sparingly where high priority raptor species occur. Brooke (2015) found that quail were found closer to disked areas regardless of shape (block or linear). Our results suggest that strip (linear) disking may provide benefit to more species of grassland raptors, while also encouraging Northern Bobwhite. Northern Harriers were found closer than expected to strip-disked areas and firebreaks during the nesting season, but further than expected during the winter. This suggests the Northern Harrier avoids freshly disked areas, while preferring vegetated linear disturbances. Perhaps disking firebreaks less often- only if needed for an upcoming fire - may provide better harrier habitat.

Conservation strategies for birds of prey often focus on increasing prey abundance. However, our study suggests that larger scale vegetative structure may be more important than prey abundance and likely affects the availability of prey to raptors. Preston (1990) had similar results in Arkansas, noting no direct relationship between raptor foraging distribution and prey biomass. The same study suggested that raptors were more responsive to a complex combination of prey density and plant cover variables, than to either factor alone.

Our results show that habitat management including NWSG conversions, prescribed fire, and installing firebreaks can improve habitat use for Northern Harriers and other grassland species. However, we know from past studies that it is important to leave some idle grassland for nesting harriers (Herkert et al. 1999, Toland 1986). Our study did not take into account the locations of nests, but the increased harrier habitat use we found in disturbed areas suggests that more recently managed habitats are preferred for hunting during the nesting season. Meanwhile, based on past research, we assume idle fields are preferred for nesting. In the past, it has been recommended that no more than one-third of large areas (>40 hectares) should be burned in a given year (Sample and Mossman 1997) and that treatment units be kept small (100-200 ha) and in a mosaic to avoid disturbing too much nesting habitat in one area (Dechant et al. 2003). Our study seems to reaffirm these recommendations, while emphasizing the need for regular habitat management to maintain high quality foraging habitat for nesting and wintering Northern Harriers and other grassland raptors on reclaimed mine grasslands. Furthermore, our study shows the compatibility of native grass restoration with habitat management for grassland raptors and most management actions for Northern Bobwhite.

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Funding Source: *State Wildlife Grants (SWG)*

KDFWR Strategic Plan. Goal 1. Strategic Objective 5.

Ohio River Supplemental Stocking Survey-Markland and Meldahl Pools

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

Introduction

Black bass *Micropterus salmoides* are among the most popular sport fishes pursued by recreational anglers across the United States and make up an important part of the sport fishery in Kentucky. Hale et al. (1992) found that 51.1% of anglers questioned in a statewide survey fished regularly for black bass, and that 80.0% of anglers considered black bass one of the top three species to fish for. Largemouth bass are traditionally lacustrine species, but nearly half of Kentucky anglers fished for them in the state's large rivers (Hale et al. 1992). Angler concerns over the decline in largemouth bass in the Ohio River became apparent 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. Survey results indicated that Ohio River largemouth bass abundance was low but growth rates were fast (Xenakis 2005). Largemouth bass reproduction was found to be negatively influenced by a number of variables including water levels, limited spawning habitat, and heavy siltation in spawning areas.

Management agencies have stocked bass in an effort to populate new water bodies, supplement existing

Ohio River bass stocking / Doug Henley populations, and counter increased fishing pressure. Several studies have indicated that stockings contribute very little to black bass fisheries (Loska 1982, Boxrucker 1986). However, Copeland and Noble (1994) found stocking to be effective when populations lacked sufficient nursery habitat and when recruitment was low. In Kentucky, long-term stocking has been shown to increase population abundance (Buynak and Mitchell 1999).

Supplemental stocking in large riverine systems has been shown to benefit largemouth bass population levels; however, because the population dynamics are complex, the exact contribution of these fish depends upon natural production, carrying capacity, and the relative survival of stocked and naturally produced fish (Heitman et al. 2006). Heitman et al. (2006) stocked 2.0 in fingerling largemouth bass directly into the Arkansas River to counter poor recruitment. They found that stocked fish did contribute to year-class strength at age-0 and age-1. Contributions of stocked young-of-the-year (YOY) largemouth bass in the fall ranged between 15.0 and 20.0% of age-0 fish sampled. By the following spring, stocked largemouth bass made up 9.0 – 13.0% of the age-1 year-class.

The objectives of this study were to: 1) determine if stocking 2.0 in largemouth bass fingerlings could significantly increase catch rate of age-0 fish, catch rate of age-1 fish the following spring, and catch rate of fish entering the fishery (12.0 in statewide minimum size limit), 2) compare growth and catch rates of stocked and natural largemouth bass, and 3) determine factors responsible for good year class survival of largemouth bass in the Ohio River.

Methods

The Ohio River extends along the entire northern border of Kentucky, and drains 39,210 mi^2 of the state. The Kentucky portion of the Ohio River is comprised of 8 high-lift dams and 2 wicket dams that form a series of pools and tailwaters along the river. The Markland Pool runs from Ohio River Mile (ORM) 436 to 531 (95 mi). Up to 16 embayments were stocked throughout the Markland Pool in both Kentucky and Indiana waters. Craig's Creek, Big Bone Creek, Paint Lick Creek, Gunpowder Creek, Woolper Creek, and the Licking River were sampled from 2004 – 2010, and Steele's Creek replaced the Licking River for annual sampling from 2011 – 2014 due to concerns over water quality. The Meldahl Pool runs from ORM 341 to ORM 436 (95 mi). Six embayments in the Meldahl Pool were sampled. Big Snag Creek, Big Locust Creek, Big Turtle Creek, and Bracken Creek were sampled from 2003 – 2014 with Lee's Creek and Lawrence Creek being added once stocking began in the Meldahl Pool in 2011.

Stocking

Largemouth bass fingerlings were spawned and reared to 2.0 in at Minor Clark Fish Hatchery in Morehead, KY. Largemouth bass were stocked into select embayments in the Markland Pool from 2007 – 2014 and in the Meldahl Pool from 2011 – 2014 at various stocking rates. Stocking rates were augmented in certain embayments throughout the study to determine what stocking rate produced the best results.

Sampling

Nocturnal, pulsed DC electrofishing was used to monitor largemouth bass populations in the spring and fall of each year from 2004 – 2014 in the Markland Pool and 2003 – 2014 in the Meldahl Pool when water temperatures were 60.0 - 70.0°F. Up to six 10-minute transects were made in each of the study embayments. During spring sampling all largemouth bass collected were measured (nearest 0.1 in), and otoliths were removed from a subsample of all fish collected. During fall sampling all largemouth bass collected were measured (nearest 0.1 in), weighed (nearest 0.01 lbs), and otoliths were removed from a subsample of fish through the 11.0 in class (age-0 fish).

Age structure and stocked fish contribution

Fingerling largemouth bass were marked with oxytetracycline (OTC) at Minor Clark Fish Hatchery prior to stocking. Otoliths were removed during spring and fall sampling to estimate age structure and checked for OTC marks to estimate the contribution of stocked fish to the population.

Data analysis

All data was analyzed using SAS v 9.2. Population parameters such as CPUE, CPUE by length and age group, and relative weight were calculated using KDFWR's KFAS and KSLO software. All data was checked for normality using the PROC UNIVARIATE procedure in SAS. Catch rate distributions were found to be non-normally distributed and have non-constant variance. Additionally, sample sizes were unbalanced for pre-stocking and post-stocking data. As a result, nonparametric analysis of variance (PROC NPAR1WAY) was used to analyze much of the data. This procedure was used to determine if stocking 2.0 in largemouth bass fingerlings could significantly increase catch rate of YOY fish, catch rate of age-1 fish the following spring, and catch rate of fish entering the fishery (12.0 in statewide minimum size limit), as well as to compare growth and catch rates of stocked versus natural largemouth bass. Additionally, multiple linear regression was used to determine if environmental factors were related to natural year-class production in the Ohio River. All data pertaining to river conditions/environmental factors were gathered from gauges maintained by the U.S. Geological Survey. All tests were conducted at $\alpha = 0.05$.

Results

Stocking

A total of 1,403,825 largemouth bass fingerlings were stocked in the Markland Pool, and 134,218 fingerlings were stocked in the Meldahl Pool throughout the course of this study. Stocking rates in the Markland and Meldahl pools of the Ohio River occurred at various rates. Additionally, rates within embayments changed on occasion due to evolving project objectives.

Spring sampling

The Markland Pool received 57.1 hr of effort in throughout the pool. A total of 2,284 largemouth bass were collected for a total project catch rate of 32.0 fish/hr. Mean catch rate during pre-stocking years was 10.6 fish/hr, while mean catch rate in post-stocking years was 44.2 fish/hr. Additionally, PSD and RSD of largemouth bass were calculated each spring, but showed no conclusive trends throughout the study. Catch rates were also calculated for four specific length groups. CPUE of largemouth bass <8.0 in ranged from 1.0 fish/hr in 2004 to 18.7 fish/hr in 2012 throughout the study with a mean pre-stocking CPUE of 1.1 fish/hr and mean post-stocking CPUE of 8.1 fish/hr. Mean pre-stocking CPUE of largemouth bass in the 8.0 – 11.9 in length group was 3.7 fish/hr, while mean post-stocking CPUE was 19.9 fish/hr. CPUE for the 8.0 – 11.9 in length group ranged from 1.7 fish/hr in 2005 to 40.7 fish/hr in 2012 throughout the study. Mean pre-stocking CPUE of largemouth bass in the 12.0 – 14.9 in length group was 3.2 fish/hr, and mean post-stocking CPUE was 12.1 fish/hr. CPUE of the 12.0 – 14.9 in length group ranged from 0.6 fish/hr in 2005 to 21.3 fish/hr in 2012 and 2013. CPUE of largemouth bass ≥15.0 in ranged from 1.3 fish/hr in 2006 to 7.6 fish/hr in 2012 throughout the study with a mean pre-stocking CPUE of 2.6 fish/hr and mean post-stocking CPUE of 4.1 fish/hr.

The Meldahl Pool received 51.8 hr of effort in throughout the pool. A total of 1,175 largemouth bass were collected for a total catch rate of 15.9 fish/hr. Mean catch rate during pre-stocking years was 20.5 fish/hr, while mean catch rate in post-stocking years was 21.2 fish/hr. PSD and RSD showed no noticeable trends throughout the study. Catch rates for four length groups were calculated each spring. CPUE of largemouth bass <8.0 in ranged from 0.3 fish/hr in 2007 to 15.9 fish/hr in 2008 with a mean CPUE of 4.2 fish/hr with a mean pre-stocking CPUE of 3.1 fish/hr and mean post-stocking CPUE of 6.2 fish/hr. Mean CPUE of largemouth bass in the 8.0 – 11.9 in length group was 8.4 fish/hr and ranged from 1.7 fish/hr in 2005 to 25.6 fish/hr in 2008. Mean pre-stocking CPUE of fish in the 8.0 – 11.9 in length group was 8.4 fish/hr and mean post-stocking CPUE was 7.9 fish/hr. Mean pre- stocking CPUE of largemouth bass in the 12.0 – 14.9 in length group was 6.8 fish/hr and mean post-stocking CPUE was 5.5 fish/hr. CPUE of largemouth bass ≥15.0 in ranged from 0.3 fish/hr in 2004 to 9.0 fish/hr in 2008 with a mean pre-stocking CPUE of 2.2 fish/hr and mean post-stocking CPUE of 1.6 fish/hr.

Fall sampling

A total of 3,128 largemouth bass were collected in 54.6 hr of electrofishing in the Markland Pool throughout the study for a mean CPUE of 57.2 fish/hr. Mean pre-stocking CPUE was 30.1 fish/hr, and mean post-stocking CPUE was 59.6 fish/hr. Catch rates were calculated for four specific length groups. CPUE of largemouth bass <8.0 in ranged from 3.0 fish/hr in 2004 to 38.4 fish/hr in 2012 with a mean CPUE of 17.2 fish/hr throughout the study with a mean pre-stocking CPUE of 5.1 fish/hr and mean post-stocking CPUE of 19.1 fish/hr. CPUE of largemouth bass in the 8.0 – 11.9 in length group ranged from 6.7 fish/hr in 2004 to 54.3 fish/hr in 2012 throughout the study with a mean pre-stocking CPUE of 16.7 fish/hr and mean post-stocking CPUE of 26.4 fish/hr. Mean pre-stocking CPUE of largemouth bass 12.0 – 14.9 in was 6.0 fish/hr and mean post-stocking CPUE was 11.2 fish/hr. Catch rates of the 12.0 – 14.9 in length group ranged from 4.7 fish/hr in 2004 to 22.0 fish/hr in 2014 for the entire study. CPUE of largemouth bass ≥15.0 in ranged from 1.2 fish/hr in 2013 to 5.2 fish/hr in 2009 throughout the study with a mean pre-stocking CPUE of 2.3 fish/hr and mean post-stocking CPUE of 2.9 fish/hr. Relative weights (Wr) were calculated each fall to see if stocking had any effect on condition of largemouth bass. Overall Wr of largemouth bass in the Markland Pool ranged from 92 in 2013 to 114 in 2005. Wr of four specific length groups were examined. In nearly all years, both pre and post-stocking, Wr of these groups exceeded 100 indicating excellent condition. Wr in 2013 was low for all length groups and exhibited the lowest total Wr of the study.

A total of 2,202 largemouth bass were collected in 49.2 hr of electrofishing in the Meldahl Pool throughout the study for a mean CPUE of 44.8 fish/hr. Mean pre-stocking CPUE was 35.6 fish/hr, and mean post-stocking CPUE was 56.4 fish/hr. Catch rates were calculated for four specific length groups. CPUE of largemouth bass <8.0 in ranged from 3.1 fish/hr in 2003 to 37.3 fish/hr in 2011 throughout the study with a mean pre-stocking CPUE of 10.1 fish/hr and mean post-stocking CPUE of 23.7 fish/hr. CPUE of largemouth bass in the 8.0 – 11.9 in length group ranged from 5.3 fish/hr in 2010 to 31.0 fish/hr in 2008 throughout the study with a mean pre-stocking CPUE of 14.1 fish/hr and mean post-stocking CPUE of 21.2 fish/hr. Mean pre-stocking CPUE of largemouth bass 12.0 – 14.9 in was 10.2 fish/hr and mean post-stocking CPUE was 9.7 fish/hr. Catch rates of 12.0 – 14.9 in largemouth bass ranged from 3.9 fish/hr in 2013 to 17.6 fish/

hr in 2007. CPUE of largemouth bass ≥15.0 in ranged from 0.7 fish/hr in 2004 to 2.9 fish/hr in 2007 and 2011 with a mean pre-stocking CPUE of 1.2 fish/hr and mean post-stocking CPUE of 1.8 fish/hr.Relative weights (Wr) were calculated each fall to see if stocking had any effect on condition of largemouth bass. Overall Wr of largemouth bass in the Meldahl Pool ranged from 92 in 2013 to 112 in 2014. Wr of four specific length groups were examined. In nearly all years, Wr of the 8.0 – 11.9 in and 12.0 – 14.9 in length groups exceeded 100 indicating excellent condition. The ≥15.0 in length group displayed relatively lower Wr in the pre and post-stocking years, but still displayed acceptable levels. As was the case with the Markland Pool, Wr in 2013 was low for all length groups and the lowest total Wr of the study.

Age 1+ spring subsample

Otoliths were removed from a subsample of largemouth bass from each embayment every spring except for 2011 when sampling occurred much later than normal due to high water. Up to 10 fish per in class from each embayment were sacrificed, aged, and checked for OTC marks. A total of 765 largemouth bass were aged and checked for OTC marks in the Markland Pool. Composition of stocked fish decreased each year after stocking, and stocked fish accounted for 47.7% of largemouth bass collected each spring.

A total of 243 largemouth bass were aged and checked for OTC marks in the Meldahl Pool during the study. Stocked fish accounted 39.1% of largemouth bass collected each spring, but did not follow the same trends as the Markland Pool.

Young-of-year fall subsample

Otoliths were removed from a subsample of YOY largemouth bass from each embayment each fall. Up to 10 fish per in class from each embayment were sacrificed, aged, and checked for OTC marks. A total of 825 YOY largemouth bass were collected in the Markland Pool throughout the study. Marked fish accounted for at least 38.6% of YOY largemouth bass examined each year and on average accounted for 56.0% of the sample. Based on OTC mark results, catch rates were estimated for both natural and stocked YOY largemouth bass. CPUE of natural YOY largemouth bass in the Markland Pool ranged from 0.9 fish/hr in 2013 to 20.9 fish/hr in 2014 with a mean CPUE of 12.2 fish/hr. Mean CPUE of stocked YOY largemouth bass was 13.1 fish/hr, and ranged from 0.9 fish/hr in 2013 to 30.4 fish/hr in 2007.

A total of 208 YOY largemouth bass were collected in the Meldahl Pool throughout the study. Marked fish accounted for at least 45.3% of YOY largemouth bass examined each year and on average accounted for 58.2% of the sample. CPUE of natural YOY largemouth bass in the Meldahl Pool ranged from 0.9 fish/hr in 2013 to 18.7 fish/hr in 2014 with a mean CPUE of 11.5 fish/hr. Mean CPUE of stocked YOY largemouth bass was 17.3 fish/hr, and ranged from 4.5 fish/hr in 2013 to 26.2 fish/hr in 2011.

Catch rate

Fall CPUE of YOY largemouth bass in both the Markland (P=0.04) and Meldahl (P<0.01) pools were significantly higher after stockings occurred than in pre-stocking years. Spring CPUE of Age-1 largemouth bass was significantly higher after stockings in the Markland Pool (P=0.03), but the Meldahl Pool (P=0.12) showed no significant changes in catch rates as a result of stocking. Catch rates of largemouth bass entering the fishery (statewide 12.0 in minimum size limit) significantly increased in both the spring (P=0.03) and fall (P=0.03) in the Markland Pool, but remained indifferent in both the spring (P=0.74) and fall (P=0.97) in the Meldahl Pool.

Growth and condition

Wr of largemouth bass in the Markland (P=0.20) and Meldahl (P=0.23) pools was not affected by stocking. Survival of natural YOY largemouth bass was also not affected by stocking in either the Markland (P=0.10) or Meldahl (P=0.11) pools. Growth rates of natural and stocked YOY largemouth bass were not significantly different in the Markland Pool (P=0.31), but stocked fish grew significantly faster in the Meldahl Pool (P<0.01).

Environmental factors

Mean, minimum, and maximum April – June discharge, mean, minimum, and maximum April - June temperature, and mean, minimum, and maximum April – June dissolved oxygen were all regressed against fall CPUE of natural YOY largemouth bass to determine if environmental factors had any effect on natural year class production in both the Markland and Meldahl pools. Minimum April – June discharge was the only environmental factors that had any significant correlation with strong natural year class production (P=0.05).

Discussion and Management Implications

Fall catch rates of YOY largemouth bass in the Markland and Meldahl pools of the Ohio River showed significant increases as a result of stocking. Spring catch rates of age-1 fish were significantly higher after stocking in the Markland Pool. This agrees with the earlier findings of Buynak and Mitchell (1999), Heitman et al. (2006) and Colvin et al. (2008) that stocked fish can help supplement YOY and age-1 year classes. The Meldahl Pool did not have increased spring catch rates of age-1 largemouth bass. Catch rates of largemouth bass entering the fishery (≥12.0 in) significantly increased in the spring and fall in the Markland

Pool, but not in the Meldahl Pool. These differences in results between pools indicates that there are limiting factors not directly related to stocking affecting the survival of both stocked and natural largemouth bass. Herrala (2013) indicated that high levels of siltation may likely be impacting survival of stocked and natural YOY and age-1 largemouth bass in Ohio River embayments. High siltation can negatively affect spawning success as well as make foraging more difficult, leading to poor survival of YOY and age-1 largemouth bass (Kemp et al. 2011).

Interactions between stocked and natural fish have important implications for stocking success. Terre et al. (1995) found that stocked largemouth bass were more successful in areas with weak natural year classes than in areas with strong natural year classes, likely as a result of competition. Natural year classes in the both the Markland and Meldahl pools are often weak, and may have helped lead to strong contributions to year classes. Stockings did not affect Wr in either the Markland or Meldahl pools, and growth rates were not different between natural and stocked YOY largemouth bass in the Markland Pool.

Herrala (2013) found environmental factors such as discharge, flood pulse length, siltation, and dissolved oxygen likely play a role in the spawning success of largemouth bass in the Ohio River, and suggested that above average spring flows resulting in high levels of siltation were associated with weak natural year class production. The current study found that natural year class production was inversely related to minimum April – June discharge in the Markland and Meldahl pools, (i.e., low spring flows during the spawn lead to successful natural year class production). This corroborates the findings of Bettoli and Maceina (1998) who found that largemouth bass year class strength was inversely related to late spring discharge on the Tennessee River, and weaker year classes were associated with high flow events after spawning. Conversely, Raibley et al. (2007) found that an extended flood pulse provided stronger year classes on the Illinois River, and that spawning success was associated with prolonged inundation of floodplain habitat that was more conducive to spawning. Inundation of the floodplain in the Markland and Meldahl pools does not provide the habitat as described by Raibley et al. (2007) as indicated by Herrala (2013).

Stocking YOY largemouth bass fingerlings in the Markland and Meldahl pools of the Ohio River was successful. Catch rates of age-0 fish have increased, while catch rates of ≥12.0 in fish have remained stable providing a viable recreational fishery for Ohio River anglers. It is evident that some of the same factors limiting survival of natural YOY largemouth bass also affect stocked YOY largemouth bass (discharge, extended flood pulse, etc.). Many of these factors limiting survival can be combatted by fall stockings after high water has receded (Hoxmeier and Wahl 2002; Neal et al. 2002).

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KDFWR Strategic Plan: Goal 1.

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

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Introduction

Blue catfish *Ictalurus furcatus* are native to Kentucky, and are primarily found in larger river systems including the Mississippi, Ohio, lower Cumberland, lower Tennessee, Green, Licking and Kentucky rivers (Burr and Warren 1986). These fisheries provide valuable sport fish and commercial opportunities throughout the state (Graham 1999). In Kentucky, catfish angling ranks second in popularity only behind largemouth bass, creating a demand for quality catfishing opportunities throughout the state (USDI 2001). The Kentucky Department of Fish and Wildlife Resources (KDFWR) response has been to stock channel catfish into many of the Commonwealths lakes and reservoirs (Kinman 1995). In more recent years, KDFWR has selected several lakes to stock with blue catfish due to their increasing popularity amongst anglers and for their trophy potential.

Growth rates of blue catfish in reservoirs are dependent on variables such as length of growing season and water temperature (Graham 1999). Dynamics such as competition, lake fertility and available forage may be the driving forces behind blue catfish growth in Kentucky. When adequate densities of forage are available the growth rates of blue catfish in reservoirs can rival those found in the large river systems (Jenkins 1956; White and Lamprecht 1990).

Taylorsville Lake is a 3,050 acre flood control lake completed in 1983 by the U.S. Army Corp of Engineers (USACE). The Taylorsville Lake drainage covers 2,920 square miles and 15 counties. The drainage is largely comprised of limestone soils and agricultural operations which provide high levels of phosphorus input to Taylorsville Lake. These conditions create a hyper-eutrophic environment that benefits shad production and growth rates; however, these conditions also create water quality issues with low oxygen levels, increased abundance of blue-green algae and reduced average life expectancy of fish.

In Kentucky, the utility of blue catfish stockings into public lakes and reservoirs for developing quality fisheries with trophy potential is not well known. The purpose of this study was to collect critical population statistics on the blue catfish stocked into Taylorsville Lake to determine suitable management options for obtaining a high quality and trophy fishery.

Methods

Blue catfish stocking began in 2007 at a standardized rate of 7.7 fish/acre (23,500 total fish). Blue catfish are stocked annually during August after the completion of summer electrofishing to aide in the detection of naturally spawned age-1 fish. Blue catfish raised at the Peter W. Pfeiffer Fish Hatchery in Frankfort, KY were stocked at age 1+ and typically averaged 7.0-14.0 inches.

Summer sampling using DC, low-pulse (15 pulses/sec) electrofishing equipment was completed each July. Six 15 minute transects were sampled in both the upper and lower portions of the lake. Sampling consisted of one boat shocking and an additional chase boat to aide in collecting fish. All fish collected were measured to the nearest 0.1 in with that data used to determine abundance and size structure of the population. Otoliths were removed from 10 fish per inch class during 2006, 2009, and 2013 to determine and compare age, growth and estimate total mortality throughout the stocking period from 2007-2014.

During the fall, DC, low-pulse (15 pulses/sec and 3-5 amps) electrofishing was conducted in effort to collect fish for relative weight calculations. All fish collected were measured to the nearest 0.1 in and weighed to the nearest 0.01 lbs. Catch rate data was not collected at this time, rather emphasis placed on collecting a representative sample of the population.

An exploitation study was conducted during 2008. During July 2008, approximately 1,000 fish were tagged using Carlin Dangler tags attached with stainless steel wire posterior to the first dorsal spine and between the pterygiophores. Data collected from all tagged fish included, length, weight, and area released. An award system was used to encourage anglers to remove and report tagged fish during this 12 month study. A corrected exploitation was then calculated addressing tag loss, nonreporting and tagging mortality. Tag loss estimate for Carlin Dangler tags is reported from 0.0% (Graham 1999; Travnichek 2004) up to 15.7% (Sullivan and Vining 2011) in catfish. Nonreporting estimate ranged from 8.0-33.3% (Balsman 2014; Dreves 2009; Dreves 2010; Dreves 2011). These values were based upon previous exploitation studies conducted across several years, on multiple lakes and four different species in Kentucky.

These nonreporting estimates were from exploitation studies that implemented the same reward system as used at Taylorsville Lake and are representative of the rate at which Kentucky's anglers report tagged fish. Tagging mortality was reported from 0.0% (Balsman 2014) up to 3.0% (Zack Ford, personal communication).

Gill nets were evaluated during winter 2014-2015 at selectively targeting blue catfish ≥30.0 in. Six- gill nets measuring 20' x 200' with 5 in bar mesh were fished in both the upper and lower sections of the lake for 24 hr sets. All catfish collected were measured to the nearest 0.1 in and weighed to the nearest 0.01 lbs. Data collected provided catch rates, abundance, size structure and winter relative weights. Furthermore, the effectiveness of winter gill netting will be evaluated as a useful tool for providing additional information on this fishery that will be beneficial for future management.

Results

Blue catfish have been stocked into Taylorsville Lake since 2002 with the stocking rates varying from 5.5 fish/acre to 29.0 fish/acre until 2007 when a standardize stocking rate was set at 7.7 fish/acre. Since 2002, 363,097 fish have been stocked that ranged from 4.0-16.0.

Summertime sampling during 2007 recorded the highest catch rate throughout this project. Fish were collected at 236.0 fish/hr, ranging from the 9.0-28.0 in size class. During the next three years catch rates continually decreased through 2011 when catch rates dropped to 27.1 fish/hr. Due to this dramatic drop in catch rates and angler input, a new regulation went into effect March 2011 that allowed anglers to only keep 1 blue catfish ≥25.0 and set a daily creel limit of 15 catfish (blue and channel catfish combined). Since the implementation of this regulation, catch rates have improved. Catch rates in 2012 rebounded to 104.0 fish/hr with fish present up to the 39.0 in size class. Catch rates fell to 60.0 fish/hr in 2013, but increased to 167.1 fish/hr in 2014, making it the second highest catch rate

KDFWR biologists hold up two trophy blues from Taylorsville Lake / Nick Keeton recorded during this project. From 2007-2014, except for 2013, catch rates on the lower half of the lake were consistently higher than those observed in the upper half of the lake.

Additional size class break downs show the 12.0-19.9 in size class catch rates followed the same pattern of the overall catch rates. However, the 20.0-24.9 in size class catch rates post-regulation have remained lower than the 8 year average of 10.0 fish/hr for three of the past four years. The reason this size class has not rebounded is probably due to the increased harvest this size range receives due to the new regulation. Blue catfish catch rates of 25.0-29.9 in size class have remained relatively stable from 2010-2014 remaining above the 8 year average of 3.2 fish/hr. Fish ≥30.0 in size class have continued to increase each year with catch rates ranging from 0.0 fish/hr in 2007 to 5.2 fish/hr in 2014.

Age and growth was collected in 2006, 2009, and 2013 from otoliths. During 2006, data was collected after stocking resulting in age 1 fish being present in the sample. However, in the 2009 and 2013 samples, data was collected prior to stocking, resulting in no age 1 fish being present in the sample, which indicates that no reproduction is contributing to the population at this time. In all three samples blue catfish reached the 20.0 in size class by age 5. According to 2013 growth data, fish reach 25.0 in size class at age 7 and 30.0 in size class at age 10. Average growth rates ranged from 1.6 in/yr (2009) - 3.5 in/yr (2006). In 2013, growth averaged 2.4 in/yr; however, growth increased once the fish reached the 23.0 in size class. Growth from age 7 (23.2 in) - age 12 (36.5 in) averaged 3.3 in/yr compared to the 2.1 in/yr for age 2 (12.9 in) - age 6 (21.3 in). Total annual mortality was 0.23 in 2006 increasing to 0.34 in 2014.

During the fall catfish were collected for relative weight (Wr) calculations. Overall, the condition of the blue catfish population was good, averaging 93 from 2007-2014. Wr ranged from 89 (2007) to 97 (2013) indicating Taylorsville Lake is adequately supporting this new fishery. Relative weights were good across all size groups, with the ≥30.0 in size group being in excellent condition averaging 102 throughout this project.

During the 12 month exploitation study, 119 tagged blue catfish were reported with 81.5% of the reported tagged fish being harvested. Anglers reported harvesting blue catfish ≥12.0 in class however, 94.8% of the harvested fish were ≥15.0 in class. Blue catfish reported average 19.0 in, while fish harvested averaged 19.6 in. Only 22 tagged blue catfish were released ranging from 10.0- 20.0 in size class that averaged 13.8 in. The uncorrected 12 month exploitation was 9.6%, however after compensating for estimated tag loss, nonreporting and tag induced mortality, a corrected 12 month exploitation ranged from 8.6-14.0%. Based on this range of exploitation, fishing mortality comprised 25.3-41.2% of total mortality while natural mortality comprised 58.8- 74.7% of total mortality.

Gill netting was conducted during January and February 2015 in the upper and lower portions of the lake to targeting fish ≥30.0 in. A total of 42 blue catfish were collected in the lower lake in 10 net nights ranging from 19.0-46.0 in. One hundred and thirty-three fish were collected in the upper lake in 6 net nights ranging from 16.0-42.0 in. Overall, 175 fish were collected at a rate of 11.0 fish/nn. Seventy-six percent of the sample consisted of fish ≥30.0 in, with 23.4% of the sample consisting of fish ≥35.0 in (trophy size). Weights were recorded from all the blue catfish collected in gill nets in 2015 to evaluate winter relative weight values. Both the 20.0-29.9 in and ≥30.0 in size groups were in excellent condition with Wr values of 121. The 20.0-29.9 in size group condition improved from the Wr collected during the summer (95), while the ≥30.0 in size group Wr remained at 121.

Discussion and Management Implications

Growth rates reported during this study were good when compared to other well-known blue catfish fisheries, such as Santee-Cooper Reservoir in South Carolina, Lake Texoma in Oklahoma and the Rappahannock River in Virginia. During 2009, blue catfish at Taylorsville Lake average 30.0 in at age 10. This is better than Lake Texoma which averages 23.0 in at age 10 (Boxrucker and Kuklinski 2005) and the Rappahannock River in Virginia which averages 24.0 in at age 10 (Greenlee 2011). Taylorsville Lake’s average growth is more similar to Santee-Cooper Reservoir which reports 31.5 in average at age 10 (Lamprechet and White 2006). As the blue catfish population at Taylorsville Lake ages, growth will need to be continually monitored along with abundance and size structure in effort to maintain current growth rates. Both, Lake Texoma and Rappahannock River blue catfish populations have slow, undesirable growth rates while reporting extraordinarily high catch rates. Catch rates at Lake Texoma were approaching 700 fish/hr (Boxrucker and Kuklinski 2005) while Rappahannock River catch rates were 4,698 fish/hr (Greenlee 2006). Electrofishing catch rates at Taylorsville were the highest during 2007 at 236.0 fish/hr and densities should be manage so not to negatively impact growth and reduce the trophy potential of this population as seen in Lake Texoma and the Rappahannock River.

Age frequency data imported into Fisheries Analysis and Simulation Tools (FAST) calculated the total annual mortality at Taylorsville Lake in 2014 at 34%. However, this estimate may be biased due to underestimation of large blue catfish collected in low-frequency electrofishing samples as reported in Virginia (Greenlee 2006).

Buckmeier and Schlechte (2009) reported that blue catfish are only fully vulnerable to low-frequency electrofishing between 250- 855mm (9.8- 33.7 in). Based on these findings, winter gill netting was conducted during 2014-2015 to determine if these larger blue catfish were not represented in summer electrofishing data. Only 8 blue catfish were collected ≥35.0 in from 2007-2014 electrofishing data with fish represented up to the 39.0 in size class, while one year of winter gill netting resulted in 41 fish being collected ≥35.0 in with fish present up to 46.0 in size class. This revealed the importance of implementing a variety of sampling methods to capture a representative sample of the entire population in order to effectively manage this fishery.

Corrected exploitation of blue catfish ranged from 8.6-14.0% after accounting for tag loss, nonreporting and tag induced mortality. Exploitation at Taylorsville Lake is at a level acceptable to fisheries managers. Marshall et al. (2009) explains that length limits made no differences in yield when exploitation is less than 7.0%; however, greater yields can be achieved at exploitation rates of 10.0-20.0%. Managing exploitation can be more important than length limits at regulating length distribution, but high maximum size limits will help maintain a greater portion of the large blue catfish in the population. Daily creel limits and maximum size limits are a valuable tool since most catfish anglers do not practice catch and release. Eighty-one percent of all blue catfish caught at Taylorsville Lake were harvested, which is comparable to 87% of tagged fish that were harvested from Lake Wilson (Marshall et al 2009).

As this population continues to age and more fish reach trophy size, managers will need to evaluate management strategies that will focus on protecting size classes and manipulating overall abundance to benefit this resource. Taylorsville Lake is currently managed with a 1 fish ≥25.0 in and a 15 fish daily creel (channel and blue catfish combined). Other agencies have implemented blue catfish regulations that limit daily harvest, limit harvest of certain size classes (slot limit), maximum size limits, no harvest and unlimited harvest to meet the goals of the fishery. Taylorsville Lake blue catfish is a new fishery that needs continued monitoring with the ability to change management strategies to meet the goals of providing a quality fishery with trophy fish.

Blue catfish stocking at Taylorsville Lake have been very successful at creating a put-grow-take fishery. Size structure, abundance, growth rates, and relative weights have remained at acceptable levels throughout the study period. It appears that the current special regulation implemented in March 2011 has created a balance of stabilizing the fishery for consumptive anglers while effectively protecting fish to maximize the trophy potential of this fishery. It is recommended that blue catfish stocking at Taylorsville Lake continue at 7.7 fish/acre (23,500 fish/year) and allow time to evaluate the fisheries response to the current regulations. Age and growth estimates are needed every 5 years to ensure that growth rates remain at their current level, while creel survey data is need to follow exploitation. These two parameters will be essential for making future management recommendations.

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KDFWR Strategic Plan: Goal 1.

Evaluation of Sauger Stockings in the Kentucky, Green, Barren, and Salt Rivers

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Kentucky sauger / David Baker

Introduction

In Kentucky, sauger *Sander canadensis* are found in the Ohio and Mississippi rivers and their major tributaries (Burr and Warren 1986). Sauger are a top-level predator that inhabit the main channel areas of large turbid rivers (Hesse 1994; Maceina et al. 1996; Amadio et al. 2005; Jaeger et al. 2005; Bellgraph et al. 2008; Kuhn et al. 2008). During the spring, sauger congregate below dams and near the mouth of creeks to spawn, creating an important seasonal fishery in many of Kentucky's rivers. While recreational fishing for sauger is extremely popular and expanding (LaJeone et al. 1992), it is important to evaluate the success of natural reproduction and determine the appropriate level of sustainable harvest.

Sauger year-class strength can be highly variable. Pitlo (1989) found that environmental factors govern reproductive success of sauger, ultimately relating to year-class strength. Populations may exhibit long-term declines due to high exploitation (Hesse 1994; Pegg et al. 1997; Sullivan 2003), community changes (Bellgraph et al. 2008), or habitat loss (Hesse 1994; Macenia et al. 1996; Pegg et al. 1997; McMahon and Gardner 2001). Loss of spawning habitat due to channel alteration and barriers to migration are cited as some of the most commonly identified factors contributing to the decline of sauger populations (Graeb et al. 2009). In systems where reproduction is highly variable and less than desirable, the population may be enhanced by supplemental fingerling stockings (LaJeone et al. 1992).

In 2010, the Kentucky Department of Fish and Wildlife Resources (KDFWR) began stocking sauger fingerlings into the Green, Barren and Salt rivers. The goal of this study was to evaluate the potential of establishing a self-sustaining sauger fishery through supplemental stockings in select pools of each system, most of which have been isolated from the Ohio River due to lock and dam infrastructure resulting in the loss of this fishery.

Study Area

Green River

For this study, only Pools 5 and 6 were stocked with sauger. Pool 6 extends from the tailwater of Green River Lake downstream to Lock and Dam 6 located about 1.8 miles downstream of the confluence with the Nolin River. This pool is approximately 125 mi in length offering a good diversity of riffle-run-pool habitat and a diversity of aquatic vegetation and substrate. Stream flow in this pool is heavily impacted by releases from Green River Lake.

Pool 5 is approximately 13.5 miles long and extends from Brownsville, KY downstream to Lock and Dam 5. The entire reach of this pool is completely impounded and is dominated by muddy banks with woody debris and bank slips. There is little in the way of habitat diversity; however, some back water areas are available in the three major tributaries in this pool. Stream flow in this pool is heavily impacted by releases from Green River Lake and Nolin River Lake.

Barren River

From Barren River Lake, Barren River flows to Bowling Green, KY, where the Bowling Green Municipal Utilities (BGMU) have constructed a low-head dam near their water intakes in an effort to store water and keep their intakes submerged. This dam is frequently inundated, therefore not creating an impassable fish barrier. Near the community of Greencastle, KY the USACE owns Lock and Dam 1 which is currently in caretaker status. Lock and Dam 1 creates a fish barrier that prevents fish from Green River and the lower section of Barren River from migrating upstream beyond this point. Extreme high water events are the only time Lock and Dam 1 historically has been inundated.

Sauger were stocked in the section of Barren River from the tailwater of Barren River Lake downstream to Lock and Dam 1. From the Barren River Lake Tailwater downstream to the river has a complex of riffle-run-pool habitat until it is impacted by BGMU dam. Throughout this impounded section, habitat complexity is poor and is comprised of muddy banks and woody debris. Below the BGMU dam, habitat again returns to riffle-run-pool habitat which continues downstream to until it again becomes pooled due to the effects of Lock and Dam 1. Once again, habitat diversity becomes limited and is dominated by muddy banks and bank slips.

Water levels and flows in this study area are directly impacted by the releases from Barren River Lake. Barren River Lake lacks the ability to manipulate the discharge temperature, like Green River Lake, which could negatively impact the aquatic communities.

Salt River

From Taylorsville Lake Tailwater, the Salt River flows freely to its confluence with the Ohio River at West Point, KY.

The study area for stocking sauger extended from the tailwater of Taylorsville Lake downstream to Shepherdsville, KY. This section of the Salt River is low gradient, full of woody debris and muddy banks. The Salt River typically remains turbid and has issues with heavy siltation. This section of the Salt River is heavily impacted by the outflows of Taylorsville Lake, Brashears Creek and Floyds Fork. A wide diversity of big river fish species are present throughout the study areas, with anecdotal information from anglers of periodic sauger spawning runs upstream to the Taylorsville Lake Tailwater when conditions are favorable. Migration of stocked fish into and out of the study is a strong possibility since no physical barriers are present in this section of river, making Salt River unique when compared to Green and Barren rivers.

Methods

Sauger broodstock were collected each winter from the Ohio and Kentucky rivers and hauled to the Peter W. Pfeiffer Fish Hatchery in Frankfort, KY to be spawned, and then stocked at 1.5-2.0 in at rate of 10 fish/acre. Stocking success is contingent on many factors, most important of which may be water quality at time of stocking and food abundance (Paragamian 1992). Furthermore, stocking sites were selected when possible at tributary confluences and upper reaches of the study site in areas where sauger would be expected to naturally spawn. Sauger fingerlings were scheduled to be stocked from 2010-2016 with each stocked year class receiving oxytetracycline (OTC) marks to assist in detecting the presence of natural reproduction. Annual monitoring was planned to continue until the spring of 2020 to determine if the sauger stocking would produce a self-sustaining population.

Nocturnal spring sampling was conducted when water temperatures ranged from 45-50F. Four 15-minute transects, two on each shoreline, were conducted in each tailwater. All sauger observed were collected, measured to the nearest 0.1 in and weighed to the nearest 0.01 lb. Otoliths were removed from a minimum of 5 fish per inch class to estimate contribution of stocked fish to each year class and determine age structure. CPUE data was used to index abundance of stocked and natural year classes.

In the fall, diurnal electrofishing surveys were completed in Green, Barren, and Salt rivers. Diurnal electrofishing surveys were warranted due to shallow water hazards that had to be navigated to effectively sample each system. Sampling was conducted when water temperatures ranged from 65-700F. A minimum of six- 15 minute transects were completed in the upper and lower reaches of each stocked pool. All sauger collected were measured to the nearest 0.1 in and weighted to the nearest 0.01 lb.

Results

Green River

From 2010-2014, Pools 5 and 6 of the Green River were stocked with 365,093 sauger fingerling that ranged in size from 1.5-2.0 in. Only the 2012 and 2014 year classes were OTC marked. Spring sampling began in 2012, and 14 sauger were collected from three tailwaters with an overall catch rate of 4.7 fish/hr. Fish sampled ranged from 6.0-14.0 in and represented both stocked year classes. Catch rates improved during spring 2013 to 12.0 fish/hr as the size structure continued to show improvements. Catch rates fell during 2014 to 3.0 fish/hr which was to lowest collected during this project with no fish present <9.0 in indicating possible failure of the 2013 stocked year class. Overall, the tailwater of Lock and Dam 6 had the best catch rates of 7.7 fish/hr, followed by and Lock and Dam 5 (6.3 fish/hr) and Green River Lake (5.7 fish/hr) tailwaters. Spring catch rates continued to remain lower than expected based on the number of year classes and fish stocked. In spring 2012, otoliths removed from a subsample of sauger indicated that growth rates were good. Sauger on average reached 8.7 in at age-1 and 12.6 in at age-2. No additional age and growth data was collected during this project. During 2013, twelve age-1 sauger from the 5.0-9.0 in size classes were collected for OTC verification. One of the twelve fish collected was not OTC marked, indicating a possibility that low levels of reproductive success did occur.

Fall catch rates were low across all years, 2012 recorded the best catch rate of 4.2 fish/hr with 2013 and 2014 being very comparable at 2.4 fish/hr and 2.9 fish/hr, respectively. Young of the year (YOY) sauger were only present during the 2014 sample with a few fish collected below the 10.0 in class. Relative weight (Wr) on average was fair in the 8.0-11.9 in size group (88) but decreased with an increase in size. The 12.0-14.9 in size group had an average Wr value of 77 and the ≥15.0 in size group averaged 75.

Barren River

Barren River was stocked with 101,612 sauger fingerlings that averaged 1.5- 2.0 in from 2010-2014. Additionally, 600,000 surplus sauger fry were stocked during April 2010. Only sauger fingerling stocked in 2012 and 2014 were marked with OTC.

Spring electrofishing surveys were conducted from 2012-2014. Catch rates during this period ranged from 0.3 fish/hr (2014) to 5.5 fish/hr (2013). The average spring catch rate was 2.1 fish/hr with fish collected from the 6.0-17.0 in size classes. Spring catch rates during the 5-year stocking period remained poor with little to no improvement in size structure or abundance. During spring 2013, otoliths were collected from six age-1 sauger ranging from the 7.0-11.0 in size class. All otoliths had a visible OTC mark indicating that all these fish were stocked and that no natural reproduction was detected from this sample.

Fall electrofishing conducted from 2012-2014 yielded poor catch rates. Even with poor catch rates, CPUE data slightly improved each year. During 2012, sauger were collected at 0.6 fish/hr and improved to 0.8 fish/hr in 2013 and 1.6 fish/hr in 2014. Overall, fall catch rates averaged 1.1 fish/hr with fish collected from the 9.0-17.0 in size class. Relative weight values were the highest during 2012 at 84, followed by 77 in 2014 and 76 in 2013. Fish were only collected during 2012 in the 8.0-11.9 in size group with a Wr value of 91. The 12.0-14.9 in size group average Wr was poor at 76 and the ≥15.0 in size group average Wr was poor at 78.

Salt River

Salt River received 67,610, 1.5-2.0 in fingerling sauger from 2010-2014. Additionally, 563,000 sauger fry were stocked during April 2010. Only sauger fingerling stocked in 2012 and 2014 were marked with OTC.

Spring sampling during 2012 recorded the highest catch rate of sauger at 29.0 fish/hr with fish collected from the 7.0-11.0 in classes. Each subsequent year, spring catch rates dropped. In 2013, fish were collected at 11.0 fish/hr and 1.0 fish/hr in 2014. Otoliths were collected from three age-1 sauger during 2013 that were in the 9.0-10.0 in size class for OTC verification. None of the otoliths were marked indicating that these were not stocked fish, but more than likely migrants from the Ohio River population.

Fall electrofishing surveys conducted from 2012-2014 also resulted in poor catch rates. Catch rates were the lowest during 2014 at 0.3 fish/hr and the highest in 2013 at 5.7 fish/hr. During this period the average catch rate was 2.7 fish/hr with fish collected from the 8.0-18.0 in size class. Overall, relative weight values were fairly consistent ranging from 81 to 84.

Discussion and Management Implications

From 2010-2014 fingerling sauger were stocked averaging 1.7 in at a rate of 10.0 fish/acre. These stocking rates and size fish were unsuccessful at establishing populations in any of the study areas. In comparison, a five year stocking program in the Kentucky River, stocking 1.5-2.0 in fingerling at 10.0 fish/acre, was used to successfully created a put-grow-take fishery (Herrala 2014). Paragamian and Kingery (1992) recommended that fingerling sauger be stocked at 2.0 in noting survival seemed less dependent on the size of the fingerlings stocked and more dependent on environmental conditions such as water temperature and stream flow. However, Paragamian and Kingery (1992) did stock fingerlings from 1.8-5.5 in, averaging 3.3 in which resulted in increased densities in the study areas. Increasing average size of sauger stocked may have potentially improved stocking success and negated some of the post-stocking mortality.

Stream flows at stocking also play a crucial role in post-stocking survival. High, muddy water conditions make it difficult for fingerlings to find food and migrate to areas with suitable habitat (Paragamian and Kingery 1992). There is a need for flexibility of stocking times so that stocking can occur when river conditions are appropriate in an effort to increase survival. Stockings in the Green, Barren and Salt rivers commonly occurred during periods of high flows due to releases from USACE lakes, creating conditions that were not conducive to survival. These conditions probably negatively impacted two year classes stocked into the Green River, three year classes in Barren River, and one year class in Salt River. LeJeone et. al (1992) reported success with establishing stocking sites in the upper portions of each study area so that stocked fish were in areas with habitat that are targeted for spawning activities. Stocking sites in the Green, Barren and Salt rivers were moved to tributaries in the upper sections of the study areas to avoid main river stockings when possible.

Kentucky River stockings resulted in catch rates of 0.0 fish/hr during year one of stocking and by the fourth year of stocking, overall spring catch rates improved to 54.3 fish/hr, ranging from 39.0-86.0 fish/hr (Herrala 2014). By the fourth year of stocking, the Green (12.0 fish/hr), Barren (5.5 fish/hr) and Salt (11.0 fish/hr) river catch rates were less than expected. Kentucky River stocking resulted in a good distribution and density of fish from the 5.0-19.0 in, with strong year classes resulting from stockings. Meanwhile, stockings in the Green, Barren and Salt rivers resulted in low densities with good distribution of fish from 5.0-17.0 in. The low densities may be due to poor year class survival based on river conditions at stocking. However, another concern was that Wr in the Green (80), Barren (77), and Salt (79) rivers were lower than observed on the Kentucky River (83). Since the densities in the Green, Barren, and Salt rivers were less than collected on the Kentucky River, it would have been expected to see higher Wr values of these fish if post stocking survival was the only issue. This is another indicator that the study areas did not adequately support this fishery at a comparable level as seen in the Kentucky River. Even though this stocking rate did produce a fishery in the Kentucky River, it may not have been appropriate for the study rivers. LeJeone et. Al (1992) looked at three fingerling stocking rates (4.4 fish/acre, 10.9 fish/acre, and 12.1 fish/acre) and determined that 10.9-12.1 fish/acre was the appropriate stocking rate to enhance a low density population. Additional research is needed to better evaluate appropriate stocking rates and the timing of stocking for reestablishing sauger populations in Kentucky's rivers.

Sauger typically inhabit large, turbid rivers in Kentucky. Stockings in the Kentucky River were likely more successful based on the large average channel width, depth and turbidity. Green, Barren and Salt rivers have substantially narrower channels and shallower average depths. The study areas are mainly comprised of riffle-pool complex, compared to the long deep pools of the Kentucky River. Major tributaries are more readily available throughout the Kentucky River, providing fish refuge during high water, when compared to the Green, Barren and Salt rivers. Small gizzard shad are primary prey for sauger which are abundant in the Kentucky River, but present in significantly lower densities in the Green, Barren and Salt rivers.

Sauger stocking in each of the three river systems have resulted in less than desirable catch rates, year class strength and relative weight values. Stocking has not resulted in creating an additional recreational fishery at any of the study areas. Therefore, sauger stocking in each of the Green, Barren and Salt rivers was concluded without further attempt to reestablish this species in all the study areas. At this point, there are not foreseeable alterations in habitat or water quality that would improve the likelihood of successfully establishing or enhancing sauger populations through supplemental stocking in these river reaches.

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KDFWR Strategic Plan: Goal 1.

Figure 1: Live adult Diamond Darter from Elk River / WV. Conservation Fisheries, Inc.

Surveys for the Diamond Darter (*Crystallaria cincotta*), an Endangered Species Known Historically from the Green River in Kentucky

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Introduction

The Diamond Darter is the second and most recently described member of the genus *Crystallaria* (Welsh and Wood 2008). It is a small, slender perch (maximum size 77mm [3inches]) having a somewhat translucent yellow-tan body marked with four wide brown dorsal saddles and 12-14 mid-lateral blotches (Figure 1). The species once had a widespread but spotty distribution the Ohio River basin, but is now restricted to the lower 37 km (22 mi) of the Elk River, Kanawha County, West Virginia (Welsh et al. 2013, Ruble et al. 2014).

In the Elk River, no Diamond Darter population estimates are available and despite concerted sampling efforts, less than 50 individuals have been collected since it was first discovered there in 1980 (Cincotta and Hoeft 1987, Welsh et al. 2009, Ruble et al. 2014). The species was federally listed as endangered due to its decline and continued threats to its existence (USFWS 2013). Because of its rarity, little is known about the life history and ecology of the Diamond Darter.

In Kentucky, the Diamond Darter is known only from six historic records, three of which are in the Green River (Table 1). It was last collected in the Green River near Cave Island (now within Mammoth Cave National Park), Edmonson County, in 1929 (Burr and Warren, 1986). Despite extensive sampling for fishes in the middle and upper Green River during the past 30 years, the Diamond Darter has not been reported. However, conventional sampling gears such as seines and electrofishers have not been consistently effective at detecting this species. Furthermore, fish sampling is typically conducted during daytime hours. In the Elk River, sampling at night has proven more effective in capturing the species because of its apparently increased crepuscular and nocturnal activity (Welsh and Wood, 2008; Welsh et al. 2013).

The upper Green River contains patches of habitat similar to that occupied by the Diamond Darter in the Elk River; these include deep riffles, runs, and flowing pools over sand and gravel. A 152.1 km (94.5 mi) section of the Green River from Roachville Ford (River Mile 294.8) to the downstream end of Cave Island (River Mile 200.3) has been designated as a critical habitat unit (CHU) for the Diamond Darter (USFWS 2013). The Green River CHU is being treated as unoccupied, pending a systematic survey using gear appropriate for capturing the species. This paper summarizes results of an intensive survey (2012-2015) for the Diamond Darter within the Green River CHU.

Methods

The study area includes the section of the mainstem Green River designated as critical habitat for the Diamond Darter (Figure 2). A total of 41 fish sampling sites were selected arbitrarily throughout the CHU based on accessibility, depth, flow, and presence of sand and small gravel substrates. Special emphasis was placed on areas having extensive flowing pools, runs, and deep riffles. These included locations where Shoal Chub (*Macrhybopsis hyostoma*), Streamline Chub (*Erimystax dissimilis*), and Stargazing Minnow (*Phenacobius uranops*) have been collected; both species have habitat preferences similar to those described for the Diamond Darter (Osier 2005, Welsh et al. 2013).

Between 19 September 2012 and 22 September 2015, boat-assisted trawling using an 8’ modified trawl (i.e., Mini-Missouri Trawl [Herzog et al. 2005]) was conducted during daylight hours at 38 sites. The trawl was pulled through pool and riffle/pool transition areas at depths ranging 0.2-2.0 m and current velocities ranging 0.03-1.8 $m \cdot s^{-1}$. Multiple hauls were performed at each site; the number of hauls per site varied (1-5) depending on the amount of habitat present, stream width and depth, and presence of obstructions (e.g., snags). In addition to trawling, we used a 15’ X 6’ (1/8” mesh) seine at six sites (1, 6, 7, 20, 36, and 40 [Figure 2]) after dusk (8:30-12:30 p.m.) aided by headlamps and hand-held spotlights. Seining and spotlight searches generally followed methods used in the Elk River by Osier (2005) and Welsh et al. (2013).

Most fish collected were identified on site, enumerated, photo-documented, and released. A limited number of voucher specimens were retained and archived at Kentucky Department of Fish and Wildlife Resources (KDFWR), Frankfort, and the biological collection maintained by Mammoth Cave National Park (MCNP). At each site, stream width, average depth, current velocity, water temperature, pH, and conductivity were recorded. Substrate composition, riparian zone, and canopy coverage were estimated qualitatively.

Results and Discussion

A total of 106 species of fish have been reported from the mainstem Green River within the Diamond Darter CHU (Table 2). This list is based mostly on vouchered collection records reviewed and compiled by Burr and Warren (1986). We also reviewed and included records from a large volume of post-1986 fish collections available in the Kentucky Fish and Wildlife Information System (KFWIS) database, which includes data from state and federal agencies, academic institutions and private consultants. Terminology in Table 2 follows Smith (1965) as used

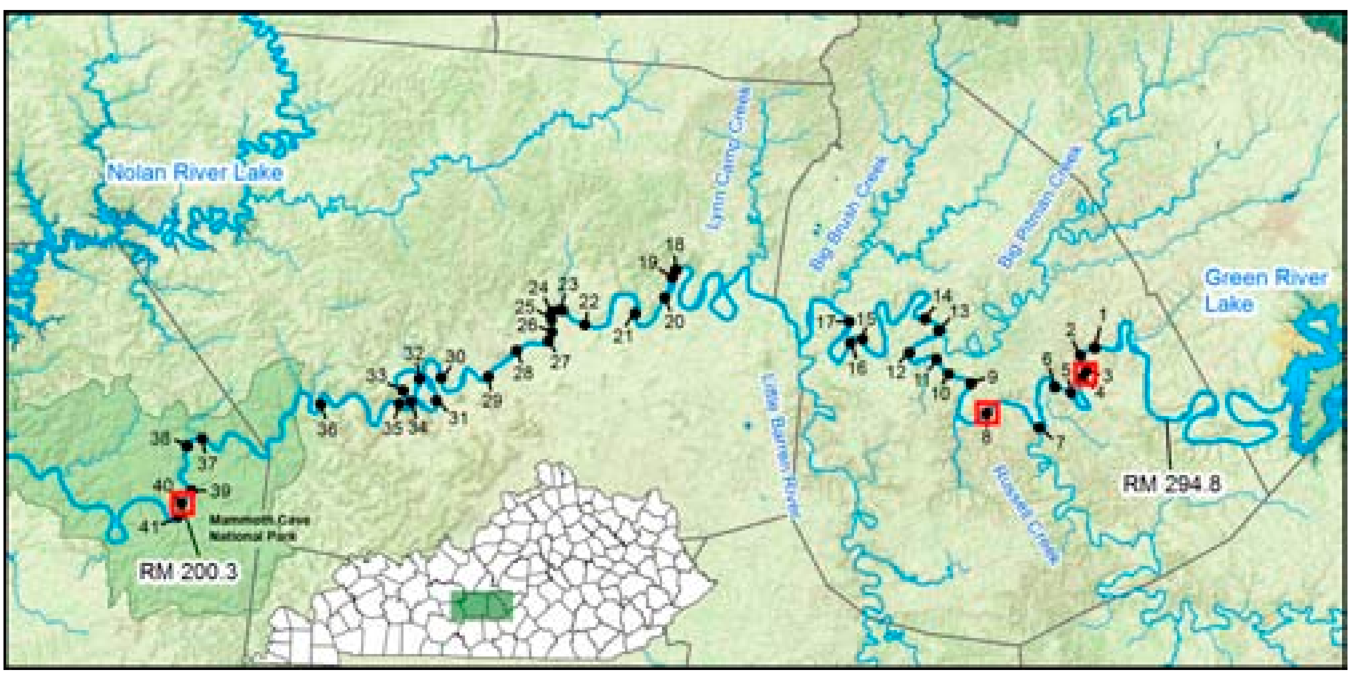

Figure 2: Fish sampling sites in the Green River within the Diamond Darter CHU. Squares = historic localities for Diamond Darter. RM = river mile.

by Burr and Warren (1986). "Generally distributed" implies that suitable habitat should be expected to yield specimens with a reasonably thorough search. "Occasional" implies that suitable habitat may or may not yield specimens even after a prolonged search. "Sporadic" implies that encountering specimens of a given taxon cannot be predicted.

Our sampling effort at 41 sites in the mainstem Green River within the CHU produced 55 fish species representing 12 families (Table 2). Approximately 60% of the species captured were darters (family Percidae, 18 species) and minnows (family Cyprinidae, 15 species). These results demonstrate the effectiveness of the Missouri trawl in capturing small-bodied, benthic fishes in deeper riverine habitats, as described by Herzog et al. (2005). It did not effectively capture larger species and active swimmers (e.g., pelagic species). Despite our effort to resample historic localities and additional sites with appropriate habitat using specialized gear during day and night, the Diamond Darter was not detected in the CHU.

Most (89%) of the species we captured during our survey are considered occasional to generally distributed and often abundant in suitable habitat. A large portion (43%) of the 106 species known from the CHU are sporadic, several of which are rare and based on fewer than five occurrences. We captured 4 of 11 species within the CHU that have a state conservation status (KSNPC 2012, KDFWR 2013) and 3 of 5 species considered "at-risk" (i.e., have been petitioned for federal listing, USFWS 2012). Information on the distribution and habitat of these species within the CHU is briefly summarized in the following accounts. Collection site numbers (Figure 2) are presented for each species, followed by number of specimens collected in parentheses.

Notropis ariommus (Cope). Popeye Shiner. Sporadically distributed in rock-bottomed riffles and flowing pools from the upper Green River eastward (Burr and Warren 1986). Cicerello and Hannan (1991) collected 33 specimens from 10 sites in MCNP and reported it to be uncommon and difficult to collect because it frequents deep water habitats. We collected individuals in a long sand and gravel-bottomed run immediately below Cave Island during the day with the trawl and at night with a seine. Trawl site: 40(4). Nocturnal site: 40(2).

Phenacobius uranops Cope. Stargazing minnow. Occasional and locally common in the upper Green and Barren River systems where it inhabits clean pebble and gravel-bottomed riffles and runs (Burr and Warren 1986). The Streamline Chub was always captured with the Stargazing Minnow, but the former species was much more common and generally distributed. Trawl sites: 7(2), 19(1), 23(2), 38(2). Nocturnal sites: 6(6) and 7(4).

Ammocrypta clara Jordan and Meek. Western Sand Darter. Rare in Kentucky, having been known from only three localities: upper Green River, middle Cumberland River, and Big Sandy River drainages (Burr and Warren 1986). In the Green River, it was known only from a single 1890 collection record (Woolman 1892) until rediscovered in MCNP by Cicerello and Laudermilk (1996). Additional occurrences have been documented between MCNP and Munfordville during the past 20 years. We consider the species to be occasional, particularly from the vicinity of Munfordville downstream to Green River Ferry (MCNP), where the substrate has a higher preponderance of sand. Trawl sites: 23(12), 27(1), 32(6), 33(1), 35(2), 37(12), 39(11), 40(7), 41(2). Nocturnal site: 40(2).

Etheostoma maculatum Kirtland. Spotted Darter. Sporadic and uncommon in the state except for the mainstem Green River from Roachville Ford to the downstream-most shoal in MCNP, where it is relatively common and evenly distributed (Cicerello 2003). The Spotted Darter is found predominantly in swift shoals or

Table 1: Historic collection records for Diamond Darter in Kentucky. UMMZ = University of Michigan Museum of Zoology. USNM = U.S. National Museum of Natural History (Smithsonian Institution). FMNH = Field Museum of Natural History. OSUM = Ohio State University Museum of Zoology.

Locality	Date	Source
Green River, 5 mi SW of Greensburg, Green Co.	7 August 1890	Woolman (1892), UMMZ 197713 (1)
Green River, 0.5 mi E of Greensburg, Green Co.	8 August 1890	Woolman (1892), USNM 63786 (1)
Green River, near Cave Island, Edmonson Co.	31 August 1929	Giovannoli, L., USNM 89467 (2)
Cumberland River, at Kuttawa, Lyon Co.	unknown	FMNH 6825 (1)
Ohio River, near Rising Sun, IN, Boone Co.	1887	Jordan (1899), USNM 39619 (1)
Ohio River, at Russell, Greenup Co.	31 May 1899	OSUM 9688 (1)

Table 2: Fishes recorded from the mainstem Green River within the Diamond Darter CHU during 1890-2015. Species collected in 2012-2015 and number of sites present are indicated. Distribution: G = generally distributed, O = occasional, S = sporadic (from Smith 1965). Kentucky State Nature Preserves Commission (KSNPC) and U.S. Fish and Wildlife Service (USFWS) conservation status: E = endangered, T = threatened, S = special concern, Ex = presumed extirpated, P = petitioned species. * unsubstantiated; needs verification. ** likely extirpated from the CHU.

Scientific Name	Common Name	Distribution in CHU	No. of sites: 2012-2015	Status	
				KSNPC	USFWS
Ichthyomyzon bdellium	Ohio Lamprey	S	2		
Ichthyomyzon greeleyi	Mountain Brook Lamprey	S		T	
Lampetra aepyptera	Least Brook Lamprey	S			
Lampetra appendix	American Brook Lamprey	S		T	
Lepisosteus oculatus *	Spotted Gar *	S			
Lepisosteus osseus	Longnose Gar	O	3		
Amia calva *	Bowfin *	S			
Hiodon tergisus	Mooneye	O			
Anguilla rostrata	American Eel	S			P
Dorosoma cepedianum	Gizzard Shad	G			
Campostoma oligolepis	Largescale Stoneroller	G	15		
Carassius auratus *	Goldfish *	S			
Cyprinella spiloptera	Spotfin Shiner	G	10		
Cyprinella whipplei	Steelcolor Shiner	S			
Cyprinus carpio	Common Carp	O			
Erimystax dissimilis	Streamline Chub	G	20		
Erimystax x- punctatus **	Gravel Chub **	S		Ex	
Hybognathus nuchalis **	Mississippi Silvery Minnow **	S			
Hybopsis amblops	Bigeye Chub	G	15		
Hybopsis amnis **	Pallid Shiner **	S		E	
Hypophthalmichthys molitrix	Silver Carp	S			
Luxilus chrysocephalus	Striped Shiner	G	5		
Lythrurus fasciolaris	Scarlet Shiner	G	1		
Macrhybopsis hyostoma	Shoal Chub	S			
Macrhybopsis storeriana **	Silver Chub **	S			
Nocomis effusus	Redtail Chub	S			
Notemigonus crysoleucas	Golden Shiner	S			
Notropis ariommus	Popeye Shiner	S	1		P
Notropis atherinoides	Emerald Shiner	O	1		
Notropis boops **	Bigeye Shiner **	S			
Notropis buchanani	Ghost Shiner	S			
Notropis micropteryx	Highland Shiner	G	22		
Notropis photogenis	Silver Shiner	G	11		
Notropis volucellus	Mimic Shiner	G	22		
Opsopoeodus emiliae **	Pugnose Minnow **	S			
Phenacobius uranops	Stargazing Minnow	O	5	S	
Pimephales notatus	Bluntnose Minnow	G	14		
Pimephales promelas *	Fathead Minnow *	S			

Table 2: *Continued*

Scientific Name	Common Name	Distribution in CHU	No. of sites: 2012-2015	Status	
				KSNPC	USFWS
Pimephales vigilax	Bullhead Minnow	O	1		
Semotilus atromaculatus	Creek Chub	S	2		
*Carpiodes carpio**	River Carpsucker *	S			
Carpiodes cyprinus *	Quillback *	S			
Carpiodes velifer *	Highfin Carpsucker *	S			
Hypentelium nigricans	Northern Hog Sucker	G	30		
Ictiobus bubalus	Smallmouth Buffalo	O			
Minytrema melanops	Spotted Sucker	O			
Moxostoma anisurum	Silver Redhorse	S			
Moxostoma breviceps	Smallmouth Redhorse	O	2		
Moxostoma carinatum	River Redhorse	O	1		
Moxostoma duquesnei	Black Redhorse	O	4		
Moxostoma erythrurum	Golden Redhorse	G	7		
Ameiurus melas	Black Bullhead	S			
Ameiurus natalis	Yellow Bullhead	S			
Ictalurus punctatus	Channel Catfish	G	12		
Noturus elegans	Elegant Madtom	O	3		
Noturus eleutherus	Mountain Madtom	G	9		
Noturus exilis **	Slender Madtom **	S		E	
Noturus flavus **	Stonecat **	S			
Noturus miurus	Brindled Madtom	G	17		
Noturus nocturnus	Freckled Madtom	S			
Noturus stigmosus **	Northern Madtom **	S		S	
Pylodictis olivaris	Flathead Catfish	O	1		
Esox masquinongy	Muskellunge	S			
Labidesthes sicculus	Brook Silverside	G	3		
Fundulus catenatus	Northern Studfish	G	5		
Fundulus notatus	Blackstripe Topminnow	S			
Gambusia affinis	Western Mosquitofish	G	2		
Cottus carolinae	Banded Sculpin	G	26		
Morone chrysops	White Bass	O			
Ambloplites rupestris	Rock Bass	G	8		
Lepomis cyanellus	Green Sunfish	S			
Lepomis gulosus	Warmouth	S			
Lepomis macrochirus	Bluegill	G	1		
Lepomis megalotis	Longear Sunfish	G	11		
Micropterus dolomieu	Smallmouth Bass	G	17		
Micropterus punctulatus	Spotted Bass	G	6		
Micropterus salmoides	Largemouth Bass	G			

Table 2: *Continued*

Scientific Name	Common Name	Distribution in CHU	No. of sites: 2012-2015	Status	
				KSNPC	USFWS
Pomoxis annularis	White Crappie	O			
Pomoxis nigromaculatus	Black Crappie	S			
Ammocrypta clara	Western Sand Darter	O	9	E	
Ammocrypta pellucida **	Eastern Sand Darter **	S			
Crystallaria cincotta **	Diamond Darter **	S		Ex	E
Etheostoma bellum	Orangefin Darter	G	28		
Etheostoma blennioides	Greenside Darter	G	25		
Etheostoma caeruleum	Rainbow Darter	G	14		
Etheostoma flabellare	Fantail Darter	O	6		
Etheostoma jimmycarter	Bluegrass Darter	G	29		
Etheostoma kennicotti	Stripetail Darter	O	6		
Etheostoma lawrencei	Headwater Darter	S			
Etheostoma maculatum	Spotted Darter	G	22	T	
Etheostoma nigrum	Johnny Darter	S	1		
Etheostoma rafinesquei	Kentucky Darter	O	1		
Etheostoma tippecanoe	Tippecanoe Darter	G	18		P
Etheostoma zonale	Banded Darter	G	36		
Percina caprodes	Logperch	G	8		
Percina copelandi	Channel Darter	G	17		
Percina evides	Gilt Darter	G	25		
Percina macrocephala	Longhead Darter	S	2	E	P
Percina maculata	Blackside Darter	S	1		
Percina phoxocephala	Slenderhead Darter	O	1		
Percina sciera	Dusky Darter	O			
Percina shumardi **	River Darter **	S			
Percina stictogaster **	Frecklebelly Darter **	S			
Sander canadensis	Sauger	G			
Sander vitreus	Walleye	G			
Aplodinotus grunniens	Freshwater Drum	G	1		
Total species		**106**	**55**	**11**	**5**

riffles with large cobble, slabs, and boulders. Although our effort did not focus on shoals or riffles, we captured the species throughout the CHU at 22 of 41 sites and it was among the top 75% most abundant species in our trawl samples. Most specimens were young-of-year or immature (<40 mm total length) captured in riffle/pool transitional areas and runs with substrates of gravel, cobble, and organic debris. Trawl sites: 1(3), 2(1), 3(4), 4(2), 5(1), 7(2), 8(4), 11(7), 12(8), 13(4), 18(5), 21(2), 22(2), 23(117), 25(5), 27(3), 29(6), 30(3), 33(1), 38(65), 41(1). Nocturnal sites: 7(2), 36(1).

Etheostoma tippecanoe Jordan and Evermann. Tippecanoe Darter. Occurs in the upper Green River, South Fork Cumberland River, upper Kentucky River, and Licking River drainages, where it has been considered sporadic and generally uncommon (Burr and Warren 1986). It was listed as a species of special concern by the Kentucky Academy of Science and the Kentucky State Nature Preserves Commission (Warren et al. 1986) but was later delisted (KSNPC 1997). The Tippecanoe Darter was present throughout the CHU at 18 of 41 sites. It was frequently captured with the Spotted Darter as both species occupy similar habitat. Trawl sites: 1(4), 3(1), 7(1), 16(2), 17(7), 18(6), 19(10), 21(11), 22(1), 23(22), 25(7), 27(4), 28(11), 30(3), 34(2), 37(2), 38(15), 41(1). Nocturnal sites: none.

Percina macrocephala (Cope). Longhead Darter. Sporadically distributed and rare in the upper Green and Barren rivers and Kinniconick Creek (Burr and Warren 1986). The species is locally common in the upper Barren River and Kinniconick Creek (Cicerello 2003, Eisenhour et al. 2011). Cicerello (2003) identified three populations in the Green River basin, one of which occurs in a 25-mile reach of the Green River from the vicinity of Green River Dam downstream to at least Russell Creek and in the lower portion of Russell Creek. We collected individuals in the trawl in flowing pools (<1.5 m deep) over cobble and gravel immediately downstream of the mouth of Russell Creek and approximately 3 miles downstream of Russell Creek. Trawl sites: 7(1), 8(7). Nocturnal sites: none.

Conclusions and Management Recommendations

The Diamond Darter is one of 13 species that may be extirpated from the Green River within the CHU (Table 2). These species have not been collected in the CHU in over 50 years and are known from fewer than five occurrence records. This suggests that they may have been uncommon in the upper Green River historically. Regarding the Diamond Darter in the Green River, Woolman (1892) noted that it was "[n]ot widely distributed, nor common anywhere". The ability to ascribe Diamond Darter extirpation to potential threats is hampered by insufficient quantification of populations (Grandmaison et al. 2003). Habitat degradation from impoundment, excessive siltation, and stream flow modification are main factors believed to be responsible for the widespread extirpation of Diamond Darter populations and are the main threat to its continued persistence (Welsh et al. 2009). How the large reservoir and series of locks and dams on the Green River have impacted the Diamond Darter is uncertain; however, one of the reasons the species may have been able to persist in the Elk River is because it remains largely unimpounded except for a single dam approximately 100 miles upstream of its confluence (Strager 2008).

Sites that appeared most promising for rediscovering the Diamond Darter were near Greensburg (site 6), mouth of Russell Creek (site 7), Sims Bend northeast of Munfordville (site 23), and in MCNP (sites 37-41). These sites offered the best potential in terms of high species richness and habitat diversity, including large expanses of clean sand and gravel. Sites near Greensburg and in MCNP were locations where the species had been collected historically (Table 1). Species with habitat requirements similar to the Diamond Darter such as Streamline Chub and Stargazing Minnow were present in all four areas. The substrate becomes noticeably more sandy from the vicinity of Munfordville downstream, which coincides with the presence of Western Sand Darter.

Protection of existing free-flowing riffle-pool-run habitat in the Green River is highly important to maintain the diverse array of fishes and other aquatic organisms that occur there. This could only serve to benefit the Diamond Darter, if it still exists, and would be necessary for any attempt to re-establish the species in the Green River through captive propagation and reintroduction. The proposed removal of Lock and Dam No. 6 at the western edge of MCNP, if implemented, would restore the natural flow regime to an estimated six miles of the Green River (Stantec Consulting Services, Inc. 2015). Ongoing efforts to restore natural flow and temperature regimes through reoperation of Green River Dam (i.e., Sustainable Rivers Project, Konrad 2010) should be continued in conjunction with long-term biological monitoring.

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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 project.

Survey of the Fish Fauna of the Laurel River Drainage with Emphasis on Species of Greatest Conservation Need

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Introduction

The Laurel River is a fifth-order tributary of the Cumberland River (Lake Cumberland) in southeastern Kentucky. Fish collections from the Laurel River drainage have been sparse and limited to a few locations. Early collections made by Jordan and Brayton (1878) were followed much later by pre-impoundment surveys by Carter and Jones (1969), and assessments of aquatic organisms and water quality (Harker et al. 1979, 1980). Fish distribution records for the Laurel River drainage obtained through these efforts were compiled, reviewed, and presented in Burr (1980) and Burr and Warren (1986). Since the publication of Burr and Warren (1986), fishes were collected at six locations in 1993-1994 by the Kentucky State Nature Preserves Commission (KSNPC) to document the location and status of rare, threatened, or endangered species (Laudermilk and Cicerello 1998); additional sampling was conducted at nine locations between 1996 and 2010 by the U.S. Forest Service and Kentucky Division of Water (KDOW) for fish community assessment.

Historical records for three fish species of greatest conservation need (SGCN) are available for the Laurel River drainage: *Chrosomus cumberlandensis* (Blackside Dace), *Hemitremia flammea* (Flame Chub), and *Percina squamata* (Olive Darter). None of these species has been seen in the Laurel River drainage in over 35 years. Collecting effort at historic localities for these species has been sparse and the distribution of sampling within the Laurel River system has been limited.

The objectives of this project are: 1) provide an inventory of the fish species at sites chosen systematically throughout the Laurel River drainage, including sites with prior fish collection data as well as new locations; and 2) document distributional status, relative abundance, and habitat conditions for fish SGCN. This study will provide information essential to developing effective conservation policies and management practices aimed at the recovery of fish SGCN and the restoration of their habitats.

Methods

Study Area

The Laurel River originates in eastern Laurel County near the Clay-Knox County line and flows to the southwest through the Cumberland Plateau entering Laurel River Lake, which impounds 19.2 miles of the lower Laurel River before it confluences the Cumberland River (Figure 1). Most of the watershed is in Laurel County, but it also drains northern portions of Whitley and Knox counties to the south. The lower watershed, which is mostly impounded, lies within the Cumberland Plateau Escarpment where the terrain is well-dissected with narrow ridges, cliffs, and gorges. Streams in this area have steep gradients, riffles, pools, and boulder or bedrock substrates. The escarpment is a transitional zone between the Cumberland Plateau and the Mississippian Plateau (Woods et al. 2002).

Upstream (east) of Laurel River Lake in the upper watershed, the mainstem Laurel River is formed by three major tributaries; Little Laurel River to the north, Robinson Creek to the east, and Lynn Camp Creek to the south. The upper watershed is on the Cumberland Plateau Ecoregion, which consists of low hills, rolling uplands, and tributary valleys that open into level, expansive floodplains (Woods et al. 2002). This area is less rugged, dissected, and forested than the lower watershed around Laurel River Lake. The Laurel River in the upper watershed is a low-gradient stream with steep, muddy banks, long, deep pools, and relatively few riffle areas. Pools are laden with logs, detritus, and silt. Riffles contain mostly pebble, cobble and rubble, often imbedded by silt. Two small impoundments, Dorothae Lake and Corbin City Reservoir, located upstream of Laurel River Lake are used as water supply reservoirs for Corbin and the surrounding area.

Recent estimation of land use for the upper watershed is 35-40% agriculture, 35% natural hardwood forest, and 30% housing and development (KDOW 2002b; Third Rock Consultants, Inc. 2007). The lower watershed, including Laurel River Lake and its tributaries, is mostly forested and within the Daniel Boone National Forest. Agriculture, although still prevalent in much of the upper watershed, has declined in recent decades; however, large animal feeding operations are common along the Laurel River and Little Laurel River in Laurel County (KDOW 2002b). A large portion of the upper watershed is

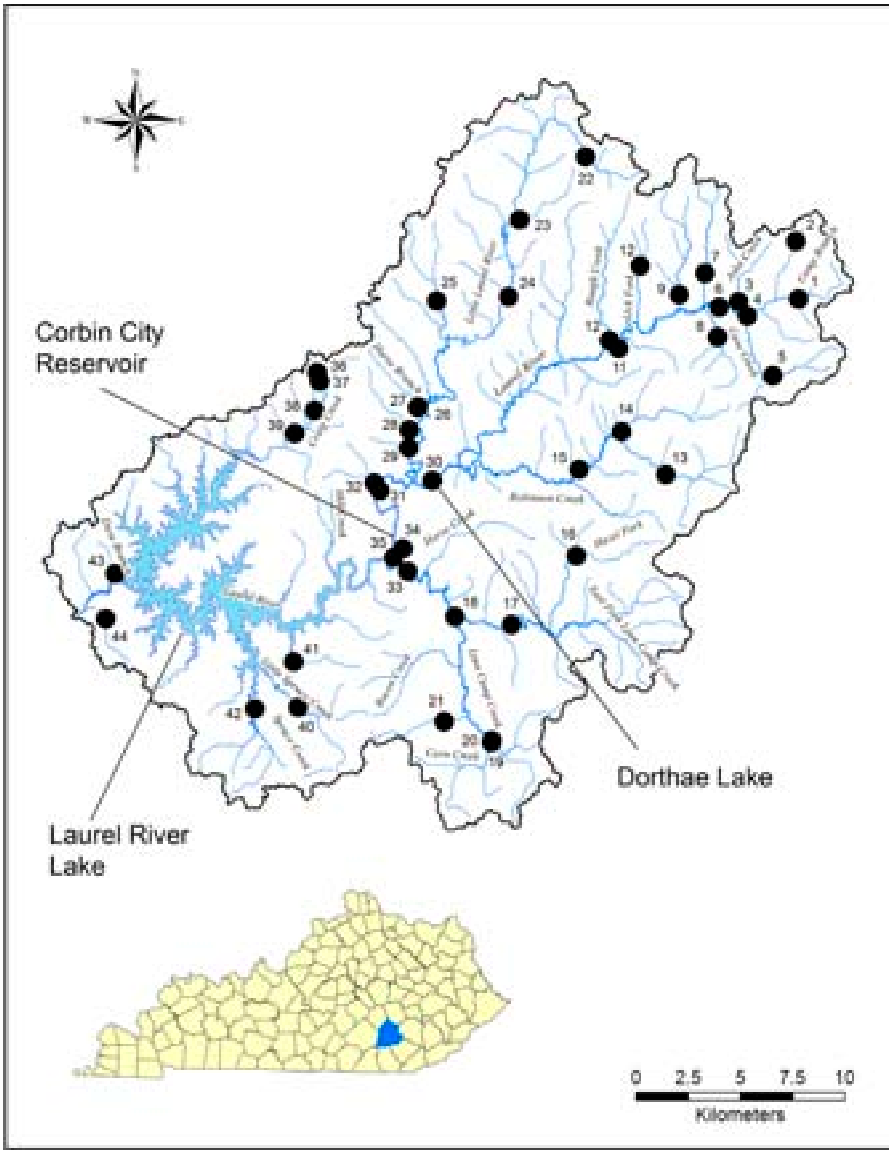

Figure 1. *Sites sampled for fishes in the Laurel River drainage during 2014.*

sandwiched between the urban areas of London (north) and Corbin (south). A dense network of roads crosses the drainage, including Interstate 75, US 25, and KY 80. According to the U.S. Census Bureau, Laurel County is one of the most rapidly growing counties in Kentucky, with a population of nearly 56,000 in 2004. As development and population density increases in this area, pressures on the streams and reservoirs will intensify (Third Rock Consultants, Inc. 2007).

A total of 63.9 miles of streams in the Laurel River drainage does not support or only partially supports designated uses for warm-water aquatic habitat, fish consumption, primary contact recreation, or secondary contact recreation. Corbin City Reservoir, a 139 acre impoundment in the Little Laurel River watershed is impaired from organic enrichment (sewage) (KDOW 2012). In 2004, Third Rock Consultants was contracted by KDOW to develop a watershed plan for the Corbin City Reservoir, and in 2011, the City of London began implementation of the plan. The Laurel River has been identified as a remediation priority watershed due to impacts from nutrients, pathogens, siltation, habitat alteration, low dissolved oxygen, turbidity, and pH caused by construction and development, silviculture, mining, and agriculture (KDOW 2002b; Carey 2009).

Data Acquisition and Field Methods

Sample localities were established throughout the Laurel River drainage based, in part, on previous fish collection records by Jordan and Brayton (1878), Carter and Jones (1969), Harker et al. (1979; 1980), Laudermilk and Cicerello (1998), and fish community sampling by U.S. Forest Service and KDOW. Additional sites were chosen arbitrarily based on accessibility and ability to sample all available habitats effectively within a measured section of stream (Figure 1). Field sampling was conducted between March and September 2014 following wadeable stream sampling protocols (KDOW 2002a). Fishes were collected using a backpack electrofisher, dip nets, and 6 X 10’ or 6 X 15’ (1/8” mesh) seines. At each site, all habitats within a 100-200m reach were worked thoroughly to ensure a representative sample. Additional emphasis was placed on specific habitats known to support targeted SGCN. Each site was electrofished for 500-2000 seconds, depending on the size of the stream and available habitat. In larger streams, electrofishing was followed by 10-20 seine hauls/sets to effectively work the same area and available habitat. Deep channel and impounded sections of the lower mainstem Laurel River and Lynn Camp Creek were sampled using boat electrofishing. Most fish collected were identified on site, enumerated, and released. A limited number of representative specimens were retained as vouchers that were fixed in 10%

Figure 2. *Whitetail Shiner (top), Southern Redbelly Dace (middle), Stripetail Darter (bottom)/ Matt Thomas*

formalin, then transferred to 70% ethanol. These specimens will be archived at KDFWR. For each SGCN collected, gender (when possible), total lengths (when >20 individuals), and habitat conditions were recorded. Digital photographs were also taken to document species and habitats at all sample sites.

Results and Discussion

Composition, Abundance, and Distribution of Fishes

Harker et al. (1980) remarked that the fish fauna of the Laurel River had been relatively neglected. Since that time, additional fish sampling has occurred infrequently and at relatively few locations within the drainage. Our sampling effort combined with other records revealed 45 species in 10 families in the Laurel River drainage (Table 1). This represents approximately 31% of the 144 species known from the combined middle and upper Cumberland River basins in Kentucky (Burr and Warren 1986).

In spring and summer 2014, we sampled 44 sites in 30 streams distributed throughout the drainage and collected a total of 37 species representing eight families. Minnows (Cyprinidae) and sunfish and bass (Centrarchidae) accounted for 61% of the species present in our samples. Only two species, *Chrosomus erythrogaster* (Southern Redbelly Dace) and *Cyprinella galactura* (Whitetail Shiner) are classified as intolerant to pollution and habitat disturbance (Compton et al. 2003). Both species (Figure 2) were found to be uncommon in the Laurel River drainage, with *C. erythrogaster* present at three sites and *C. galactura* present at only one site. Of the remaining species collected, 12 are classified as tolerant to pollution and disturbance (Compton et al. 2003) and all are considered common and generally distributed over a large geographic area.

No species of fish are endemic to the Laurel River drainage; however, preliminary analysis of genetic and morphological data suggests that the Laurel River population of *Etheostoma kennicotti* (Stripetail Darter, Figure 2) is a unique lineage within the Stripetail Darter complex and may warrant distinct species recognition in the future (T. Near, Yale University, pers. comm.). Although darter species richness was strikingly low within the Laurel River drainage compared with other tributaries of the middle Cumberland River sub-basin, *E. kennicotti* was the fourth most common species in our survey, and was present at 25 of 36 (69%) sites sampled. This species, as well as the other three darters collected (Table 1), are not as dependent on riffle habitat as are most of the other darters belonging to the subfamily Etheostomatinae (Harker et al. 1979; pers. obs.). Most streams in the upper watershed are low-gradient with little or no riffle development (see description of Study Area, above), which may explain the relatively low diversity (and abundance) of benthic fishes, particularly darters.

A single record of *Etheostoma spectabile* (Orangethroat Darter) was originally reported by Distler (1968) as a dot on a distribution map located on the Little Laurel River;

however, other details of this record could not be ascertained. Ceas and Burr (2002) described Orangethroat Darter populations in the middle Cumberland River drainage, including the Rockcastle River, as *E. lawrencei* (Headwater Darter); however the Laurel River drainage was not included in the range of *E. lawrencei*. Certain species occurring in large river and reservoir habitats that were not encountered during our survey (e.g., buffalofishes, carpsuckers, and redhorses) likely enter the short section of the mainstem Laurel River below Laurel River Lake dam from the impounded headwaters of Lake Cumberland.

Conspicuously absent from the Laurel River drainage are numerous species occurring in neighboring Cumberland River tributary watersheds (e.g., Rockcastle River and other smaller drainages) below Cumberland Falls. It is possible that many of these species occurred historically in the deeply entrenched lower portion of the Laurel River and some of its larger tributaries (e.g., Spruce Creek) prior to impoundment. Carter and Jones (1969) documented fishes collected at two sites as part of a pre-impoundment sport fishery survey; however both sites were located in the upper watershed. The only pre-impoundment records available from the lower Laurel River were from a single collection made by W. Turner (KDFWR) in 1961 at the mouth of Spruce Creek (see below). The exact location visited by Jordan and Brayton (1878) is uncertain. Unfortunately, the composition and quality of the historical stream fish community of the lower Laurel River is a matter of speculation (Harker et al. 1980).

Species of Greatest Conservation Need

The following accounts discuss the historical distribution and current status of fish SGCN known from the Laurel River drainage. General distribution and habitat comments are based on Burr and Warren (1986) and our field observations.

Chrosomus cumberlandensis (Starnes and Starnes). Blackside Dace.—Federally listed as Threatened, this species is endemic to the upper Cumberland River drainage in Kentucky and Tennessee. The species currently occupies about 110 named streams across its range, while numerous populations have been extirpated since its discovery in the late 1970s (M. Floyd, USFWS, pers. comm.).

The presence of this species in the Laurel River drainage was reported by Harker et al. (1980) based on a single specimen (WCS 1163-01) collected in Craig Creek at the KY 312 bridge on 9 October 1979 (Starnes 1981). Despite other repeated attempts at this location (Starnes 1981; O'Bara 1985; Laudermilk and Cicerello 1998), it was never collected again. On 20 March 2014, we sampled four locations in Craig Creek and did not encounter Blackside Dace. Although conductivity levels were low (34-42 µS/cm), suitable habitat conditions in this stream appeared to be limited. Forested riparian corridors were patchy and residential development was scattered throughout the drainage. Only the lowermost site (#39, Figure 1) had moderately deep pools with boulder and large woody debris interspersed by shallow gravel/cobble riffles. The three sites located further upstream (#s 36-38) had pools that were more shallow and over bedrock with overall less habitat diversity. Wooded riparian corridor development was most extensive downstream of site #38, but as O'Bara (1985) indicated, stream size in this lower reach is larger than what Blackside Dace typically inhabit.

A second population was reported from Whitman Branch, based on four individuals captured and released on 19 June 1996 during fish surveys by the U.S. Forest Service (M. Compton, KSNPC, pers. comm.). Whitman Branch was also surveyed on 5 May 1994, but no Blackside Dace were reported (Laudermilk and Cicerello 1998). On 2 April 2014, we sampled Whitman Branch from approximately 0.4-1.2 km upstream from the Laurel River confluence. No Blackside Dace were encountered; however, Southern Redbelly Dace were abundant (n = 61). The Whitman Branch watershed is completely forested with dense stands of hemlock and rhododendron. Stream habitat consisted of long bedrock glides with occasional shallow pools with some marginal woody debris and patches of pebble, cobble, and boulder.

Both Craig Creek and Whitman Branch have been isolated by impoundment. Craig Creek drains into an arm of Laurel River Lake, while Whitman Branch confluences the Laurel River tailwater before it confluences the impounded Cumberland River. Based on the two collection records, it appears that Blackside Dace had a tenuous existence in the Laurel River drainage and it is doubtful that either population continues to exist.

Hemitremia flammea (Jordan and Gilbert). Flame Chub.—This minnow was presumed extirpated in Kentucky because there had been no reported occurrences anywhere in the state since the late 1880s (Burr and Warren 1986). Its status changed in 2011 when a new population was discovered in Spring Creek, a small spring-fed tributary of the upper Red River in the lower Cumberland River drainage, Simpson County (Thomas and Brandt 2011). It was reported to be abundant in Big Laurel River, Laurel County by Jordan and Brayton (1878), but the exact location of their collection is uncertain. Brooks Burr examined a single specimen (USNM) labeled as this species from Jordan's Big Laurel River site; however, the specimen was desiccated making positive identification impos-

Table 1. Fish species reported from the Laurel River drainage based on historic collections (Jordan and Brayton 1878; Carter and Jones 1969; Harker et al. 1979, 1980; Burr and Warren 1986), collections made by KSNPC, KDOW, and USFS (1993-2010), and the present study (2014). Number of localities from which each species was collected is indicated. Species of greatest conservation need are in bold print.

Scientific name	Common name	Historic (pre-1986)	Recent (1993-2010)	Current (2014)
Dorosoma cepedianum	Gizzard Shad		1	3
Dorosoma petenense	Threadfin Shad	3		
Campostoma oligolepis	Largescale Stoneroller	1	3	5
Chrosomus cumberlandensis	**Blackside Dace**	**2**	**1**	
Chrosomus erythrogaster	Southern Redbelly Dace	2	3	3
Cyprinella galactura	Whitetail Shiner	2		1
Cyprinus carpio	Common Carp	1	1	2
Hemitremia flammea	**Flame Chub**	**1**		
Luxilus chrysocephalus	Striped Shiner			1
Lythrurus fasciolaris	Scarlet Shiner	2	4	4
Notropis buccatus	Silverjaw Minnow	1	1	1
Notemigonus crysoleucas	Golden Shiner			1
Pimephales notatus	Bluntnose Minnow	4	4	24
Pimephales promelas	Fathead Minnow	2		1
Semotilus atromaculatus	Creek Chub	4	10	31
Catostomus commersonii	White Sucker	3	5	11
Hypentelium nigricans	Northern Hog Sucker	2	6	12
Moxostoma erythrurum	Golden Redhorse			2
Ameiurus melas	Black Bullhead	3		
Ameiurus natalis	Yellow Bullhead	1	1	4
Ictalurus punctatus	Channel Catfish			1
Pylodictus olivarus	Flathead Catfish	1		2
Gambusia affinis	Western Mosquitofish		1	1
Labidesthes sicculus	Brook Silverside			3
Morone chrysops	White Bass	1		
Ambloplites rupestris	Rock Bass		3	8
Lepomis auritus	Redbreast Sunfish		1	7
Lepomis cyanellus	Green Sunfish	5	5	34
Lepomis gulosus	Warmouth	1	2	14
Lepomis macrochirus	Bluegill	5	9	33
Lepomis megalotis	Longear Sunfish	1	6	17
Lepomis microlophus	Redear Sunfish		1	2
Micropterus dolomieu	Smallmouth Bass	3	1	2
Micropterus punctulatus	Spotted Bass	3	4	6
Micropterus salmoides	Largemouth Bass	4	5	14
Pomoxis annularis	White Crappie	2		1
Pomoxis nigromaculatus	Black Crappie	1		
Etheostoma blennioides	Greenside Darter	2	3	8
Etheostoma kennicotti	Stripetail Darter	6	9	25
Etheostoma spectabile	Orangethroat Darter	1		

Table 1. *Continued*

Scientific name	Common name	Historic (pre-1986)	Recent (1993-2010)	Current (2014)
Percina caprodes	Logperch	1	2	5
Percina maculata	Blackside Darter	3	2	2
Percina squamata	**Olive Darter**	**1**		
Sander vitreus	Walleye			1
Aplodinotus grunniens	Freshwater Drum			1
Number of species:	**45 (total)**	**33**	**27**	**37**
Number of sampling sites:		**17**	**15**	**44**

sible. Jordan and Swain (1883) also reported collecting the species from Clear Fork and Wolf Creek, Whitley County. Because Jordan and his co-workers collected Flame Chubs from other localities, many of which were verified, the early Kentucky records were accepted as valid (Burr and Warren 1986). The species was not encountered anywhere in the Laurel River drainage in 2014; therefore, the early record by Jordan and Brayton (1878) remains unsubstantiated.

Percina squamata (Gilbert and Swain 1887). Olive Darter.—In Kentucky, this species is sporadic and rare, with a limited distribution in the Cumberland River drainage below Cumberland Falls. Burr and Warren (1986) reported this species only from the Rockcastle River and Big South Fork Cumberland River; however, during a pre-impoundment survey, a single specimen (KDFWR 1513) was collected by W. Turner on 23 August 1961 in the Laurel River at the mouth of Spruce Creek, which is now inundated by Laurel River Lake. This is the only location where vouchered specimens represent a record of the historic fish community of the lower Laurel River before impoundment. During preparation of the fish atlas (Burr and Warren 1986), the authors were unaware of the KDFWR specimen (B. Burr, pers. comm.). The Olive Darter requires free-flowing riverine conditions; it occupies main channels and deep cobble and boulder-strewn riffles. This habitat would have only been present in the lower Laurel River along the Pottsville Escarpment of the Cumberland Plateau before impoundment. Currently, only short sections of this habitat can be found in lower Spruce Creek before it becomes embayed by Laurel River Lake and in the Laurel River between the confluences of Adams Branch and Little Laurel River. Sites 42 (Spruce Creek) and 31 (Laurel River at Adams Branch confluence) did not produce Olive Darters in 2014. Harker et al. (1980) observed that despite having an abundance of available cover and varied current regimes, these short free-flowing sections are isolated by dams, which may severely limit immigration of stream fishes into the area.

Conclusions and Management Recommendations

Fish community sampling at 44 sites in the Laurel River drainage from March to September 2014 detected a total of 37 species. Eleven of these species (30%) are classified as tolerant, while only two (5%) are intolerant of pollution and habitat disturbance. All species in our samples are common and generally distributed in the region; the Laurel River drainage has no endemic fishes. Three fish SGCN, Blackside Dace, Flame Chub, and Olive Darter, historically present in the Laurel River drainage were not detected in our samples and are likely extirpated from the drainage. The upper watershed has low-gradient streams with steep, muddy banks, long, deep pools, and relatively few riffle areas, while nearly 20 miles of the lower watershed is impounded to form Laurel River Lake. Stream habitat at most sites was moderately to severely degraded. A few short free-flowing sections of the Laurel River had an abundance of available cover and varied current regimes, but low fish diversity and abundance. These sections were isolated by dams, both upstream and downstream, which may severely limit immigration of fishes into the area. This could explain the absence or scarcity of many benthic species, particularly darters, found elsewhere in the middle Cumberland River drainage.

As development and human population density increases in Laurel County, pressures on the streams and reservoirs will intensify. Watershed monitoring programs aimed at identifying main sources of water pollutants, then developing and implementing solutions to improve water quality should be a top priority. In addition to remediation solutions to reduce urban impacts on streams, such as those developed by Third Rock Consultants, effort should be made to protect any remaining forested riparian zones within the upper watershed.

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

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

Stringer of hybrids and white bass in the headwaters of Taylorsville Lake / Obie Williams

New Projects

Survey and Assessment of the Fish Fauna of the Clarks River National Wildlife Refuge in Marshall, McCracken, and Graves Counties, Kentucky

Blizzard Pond drainage canal (above); Western Creek Chubsucker, (lower left); Bowfin, (lower right) /Matt Thomas

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

The Clarks River drainage, a major tributary system in the lower Tennessee River basin, occupies nearly a quarter of the Jackson Purchase Region in western Kentucky. It is a low-gradient system consisting of two major forks that meander through a broad floodplain containing areas of contiguous bottomland hardwood forest, wetland complexes, overflow ponds, and meander cut-offs formed by the Clarks River. In 2015, we began fish surveys to determine species composition, abundance, and distributions to establish a credible species list, assess historical and recent changes to the fauna, and provide recommendations for future monitoring of the fish community within the Clarks River National Wildlife Refuge (NWR).

Prior fish collection data from the Clarks River drainage were compiled and reviewed to produce a comprehensive list of species by watershed unit. We accept records as valid for 106 species in the entire drainage. This diversity is distributed among the lower mainstem (52 species), Clarks River including East and Middle forks (84 species), and West Fork (52 species). No federally listed fish species are present in the Clarks River drainage, but 15 are considered rare or of conservation concern at the state level. Five exotic species occur or have occurred in the drainage.

Between 3 August and 17 September 2015, fish collections were made from 23 sites in the Clarks River and West Fork Clarks River drainages within the Clarks River NWR and proposed expansion area boundary. Sites were distributed in Riverine and Palustrine Systems to include all aquatic habitat types and representative fish species. Our sampling effort produced a total of 77 species in 18 families, representing 72% of the species known from the entire Clarks River drainage and 38% of the lower Tennessee River basin fish fauna. The Clarks River upstream of the West Fork had the highest diversity (63 species), followed by the West Fork (57 species) and lower mainstem (32 species).

We report new occurrences for Striped Shiner, Red Shiner, Grass Carp, and Silver Carp. The Striped Shiner was previously unknown from the Clarks River drainage. Five state-listed (at-risk) species were present within the study area: Taillight Shiner (1 site), Black Buffalo (2 sites), Central Mudminnow (2 sites), Dollar Sunfish (5 sites), and Cypress Darter (5 sites). Multiple new occurrence localities were documented for Central Mudminnow, Dollar Sunfish, and Cypress Darter. Three exotic species were collected: Common Carp, Grass Carp, and Silver Carp. Multiple new occurrence localities were documented for Grass Carp and Silver Carp. High densities of young-of-year observed at multiple locations indicate successful reproduction in both species within the Clarks River and West Fork Clarks River drainages.

Field work is about 80% complete. We plan to make a final trip to the Clarks River drainage during spring (April-May) 2016 when water conditions are favorable for fish sampling. Our final field effort will include at least one additional Riverine site and four Palustrine sites. A final report will be completed by September 30, 2016.

Funding Source: *U.S. Fish and Wildlife Service National Wildlife Refuge Inventories and Monitoring Program*

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

Distribution and Status of the Goldstripe Darter, *Etheostoma parvipinne*, in Kentucky

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

The Goldstripe Darter (*Etheostoma parvipinne*) belongs to a unique and diverse community of aquatic species inhabiting wetlands, springs, and spring runs in the Coastal Plain of western Kentucky. Many of these habitats have been lost or degraded and the species is known to exist at only four locations: Terrapin and Powell creeks, Graves County, and Sugar Creek and Billie Branch, Calloway County. Available collection records for Goldstripe Darter in western Kentucky are sparse (fewer than 20), taken from 1978-2002. It has a status of endangered on the current List of Rare and Extirpated Biota of Kentucky (Kentucky State Nature Preserves Commission) and is a Species of Greatest Conservation Need (SGCN) in the Kentucky Wildlife Action Plan.

Goldstripe Darter habitat in Blood River Bottoms WMA (top), Goldstripe Darter breeding male observed May 7, 2014 (bottom)/ Matt Thomas

Although the Goldstripe Darter has an extensive range in the lower Mississippi River and Gulf Coastal drainages, occurrences in western Kentucky represent peripheral populations. Such populations may be somewhat or entirely separated from the rest of their taxon and subject to different evolutionary or ecological forces; therefore, they can contain unique genetic structure and have an important role in the evolutionary potential of the species. Monitoring peripheral species, such as Goldstripe Darter (and several others in Kentucky) is necessary to achieve the larger goal of sustaining genetic variability. Also, shifts in the distributional boundaries of these species and changes in abundance trends may also reflect changing environmental conditions, ranging from local habitat loss or disturbance to the pervasive effects of climate change.

The objectives of this project are: 1) determine the current distribution and abundance of the Goldstripe Darter in western Kentucky; 2) assess spawning activity, general habitat usage, and current habitat conditions within the known range of the species; and 3) document fish community composition with emphasis on other fish SGCN in small stream and wetland habitats supporting populations of Goldstripe Darter.

Between 15 April 2014 and 11 June 2015, fish sampling was conducted at 37 sites in the lower Tennessee River and Terrapin Creek drainages for the Goldstripe Darter and other fish SGCN. We recorded a total of 36 species of fish, including three SGCN: Central Mudminnow (*Umbra limi*), Cypress Darter (*Etheostoma proeliare*), and Goldstripe Darter. The Goldstripe Darter was known to exist in only four streams in Graves and Calloway counties; we documented it for the first time in Blood River Bottoms Wildlife Management Area (WMA). The Cypress Darter has a sporadic existence in small creeks and sloughs of western Kentucky. Prior to our survey, it was last reported in the Blood River 30 years ago at only two locations. The Central Mudminnow only occurs in Coastal Plain spring-fed wetlands in the Jackson Purchase, including a few locations in the Blood River floodplain south of the WMA. Individuals captured in the Blood River Bottoms represent a new locality record. Surveys for fish SGCN in small, lowland stream and wetland habitats in the lower Tennessee River drainage and northern tributaries of the Obion River will continue in 2016.

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

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

Evaluation of Stocking Original and Reciprocal Cross Hybrid Striped Bass in Three Kentucky Impoundments

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

Angler with hybrid striped bass / Randall Hardin

The Kentucky Department of Fish and Wildlife Resources (KDFWR) began stocking hybrid striped bass in 1979. The original cross of hybrid *Morone* spp. consists of crossing the male white bass *Morone chrysops* with the female striped bass *Morone saxatilis,* while the reciprocal cross consists of using a female white bass and male striped bass. Over the past three decades both original and reciprocal crosses of hybrid striped bass have been stocked in Kentucky reservoirs. However, since the mid 1990's KDFWR has been stocking almost entirely reciprocal cross hybrids. Little is known on the differences in growth, recruitment or maximum age and size of original versus reciprocal cross hybrid striped bass in reservoirs.

The objective of this study is to determine which cross of hybrid striped bass performs better in three Kentucky impoundments (Rough River Lake, Herrington Lake, and Taylorsville Lake). This will be determined by comparing growth, recruitment to age-1+, 2+, and 3+, condition, and relative abundance of the two crosses of hybrid striped bass. We will not be examining age-0 fish due to concerns raised over misidentification with cohabiting white bass in the study reservoirs, and because hybrids seem to be recruiting to age-1 without issue in all three impoundments. At age-1+ we have a high confidence in differentiating between white bass and hybrids. This study is most interested in examining age 1+-3+ fish as they recruit to the 15-inch size class. This study is not designed to determine maximum age or maximum size, due to study length, but a future study may be warranted to examine if one cross is longer lived or reaches a larger maximum size.

Currently, fall gillnet samples are capturing low numbers of reciprocal hybrid striped bass older than age-3 and low numbers of fish larger than 22 inches at Taylorsville and Herrington Lakes. Conversely, Rough River Lake seems to have a stable population of reciprocal hybrid striped bass with maximum age of 10 years old being observed. However, despite being long lived, very few of the reciprocal hybrids in Rough River Lake exceed 22 inches. Creel surveys from the lakes in recent years have also documented low angler catch of fish over 22 inches.

During the first two weeks in June, 10 fish/acre of each of the reciprocal and original cross hybrid striped bass will be stocked annually in the three study impoundments. Original hybrid striped bass will be marked with oxytetracycline (OTC) as fingerlings before being stocked. Reciprocal cross hybrid striped bass will not be marked with OTC. Both crosses of hybrid striped bass will be stocked for three years, 2015-2017 at three stocking sites at each lake. Stocking and hauling mortality will be calculated by placing approximately 100 fish in 30-gallon holding drums with fine mesh panels floated at the stocking sites for 24 hours. Each lake will have three holding drums for each cross of hybrid striped bass. At the end of the holding period, fish will be counted and mortality rates calculated.

Monofilament gill nets will be used to sample hybrid striped bass populations in the three study lakes in late October-November when water temperatures are 55-60°F and after destratification has occurred. A minimum of 18-net nights or 250 hybrid bass ≥ 12 inches will be required for each lake. Hybrid striped bass lengths to the nearest 0.1 inch and weights to the nearest 0.01 pound will be taken on all captured fish. Otoliths will be removed from up to 30 hybrid striped bass per inch class ≥ 12 inches collected each sampling year to determine cross and age and growth information. To determine if there are differential growth rates between sexes and crosses of hybrid striped bass sex will be determined by dissection and examination of sexual organs in a laboratory setting for those fish having otoliths removed for aging.

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

KDFWR Strategic Plan. Goal 1.

Status Survey of the Redside Dace, *Clinostomus elongatus*, in Kentucky

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

The Redside Dace (*Clinostomus elongatus*) has a discontinuous distribution in the northeastern United States and Southern Canada. The species is generally rare and reaches the southern limit of its range on the Western Allegheny Plateau of northeastern Kentucky. It was first reported from Kentucky in 1940 from Lick Fork, a tributary of the North Fork Licking River in Rowan County. A second collection was made in 1982 from Edwards Branch, a tributary of the Red River in Menifee County. The most recent and comprehensive assessment of the Redside Dace in Kentucky was conducted during 1984-1986, when it was found to be occasional to locally common in several tributaries of the North Fork Licking River, Beaver Creek, and Red River.

The Redside Dace is a Species of Greatest Conservation Need (SGCN) in the Kentucky Wildlife Action Plan. Population declines throughout much of the range have been attributed to urbanization and various land use activities resulting in water quality deterioration and excessive siltation. Streams supporting Redside Dace in Kentucky are cool and clear, have near neutral pH, and are in forested watersheds with canopy cover. Recent phylogeographic analyses indicated high genetic diversity levels within the Red and Licking River drainage populations relative to other Ohio River basin populations. Such high levels of diversity within these isolated southern peripheral populations in Kentucky may reflect successful local adaption and long-term persistence in high quality forested watersheds that remain mostly within the Daniel Boone National Forest.

Since 1986, additional Redside Dace occurrence records have been reported by different collectors from the Licking and Red River drainages; however, a concerted effort to sample all historic localities and other streams potentially supporting undiscovered populations has not been done. Currently available data suggest that populations are small and isolated, which makes them vulnerable to habitat loss and degradation. Updated information on distribution, abundance, and habitat conditions is needed to assess the overall stability of these populations.

The objectives of this project are: 1) determine the current distribution and abundance of the Redside Dace in northeastern Kentucky; 2) assess spawning activity, general habitat usage, and current habitat conditions within the known range of the species; and 3) document fish community composition with emphasis on other fish SGCN in small stream habitats supporting Redside Dace populations.

We began fish sampling historic and additional localities in the Red River drainage and White Oak Creek, Kentucky River drainage. Redside Dace were present in 11 of 27 streams sampled, including White Oak Creek, which is outside of the known range in the Kentucky River drainage. Sampling will continue in 2016 and will focus on tributaries of the North Fork Licking River and Beaver Creek (Licking River).

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

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

Redside Dace habitat in Haunted Cave Branch, Menifee County (top), Redside Dace breeding male observed May 19, 2015 (bottom)/ Matt Thomas

KDFWR biologist inspects juvenile lake sturgeon before release into the Cumberland River

Project Updates

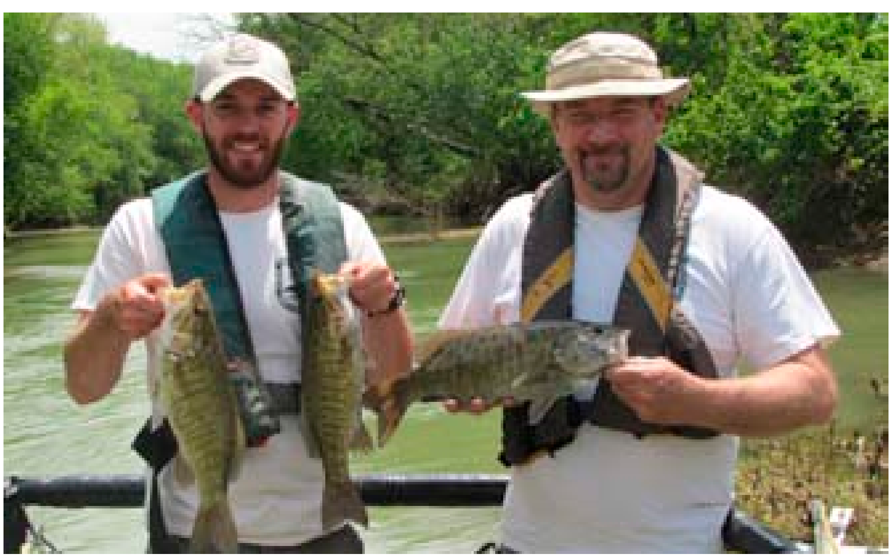
Warm Water Stream Sport Fish Surveys

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

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

During 2015, general sport fish surveys were completed in the Green River, Barren River, Kentucky River, Salt River, South Fork Licking River, Tygart's Creek, Drake's Creek, North Fork Kentucky River, and Stoner Creek. Information was collected from these systems in effort to gain a better understanding of sport fish composition, size structure, relative abundance and condition. These sites were selected based on public input received primarily from Fisheries District Offices. New sites are continually being added with streams scheduled to be sampling on a 3-5 year rotation in effort to develop trend data. The purpose of collecting this data is to help KDFWR make informed management decisions in effort to further promote stream fishing in Kentucky, inventory current access sites and identify new areas that could benefit from future management.

Many of the streams sampled had "excellent" and "good" populations of a variety of sportfish species. In Pool 6 of the Green River, both smallmouth bass and rock bass received an "excellent" population assessment rating with trophy (≥20.0 in) size smallmouth bass present. Smallmouth bass, largemouth bass and rock bass all received a "good" assessment rating in the Salt River. Smallmouth bass and rock bass populations in the South Fork Licking River continue to remain stable with assessment ratings of "excellent" and "good", respectively. Largemouth bass numbers in Salt River have improved as a result of stocking during 2014. Nine species of sport fish were collected from Tygarts Creek with this sample mainly comprised of rock bass, smallmouth bass, channel catfish, spotted bass, and muskellunge. Trophy size rock bass (≥10.0 in) and channel catfish (≥28.0 in) were collected in Barren River. Catch rates of rock bass have improved while smallmouth bass catch rates have been on the decline since 2007. Drakes Creek sample was mainly comprised of rock bass, spotted bass, bluegill, and smallmouth bass. Based on catch rates, the three most abundant species collected in both Pool 3 and 5 of the Green River where spotted bass, largemouth bass and bluegill. Sport fish densities in Pool 6 and 7 of the Kentucky River were relatively low. Spotted bass were the most sampled species with fish collected from the 2.0-13.0 in size classes. Flathead catfish were the second most abundant species collected with fish collected from the 8.0-17.0 in size classes. Channel catfish, spotted bass and smallmouth bass dominated the sample in the North Fork Kentucky River. Trophy size (≥28.0 in) channel catfish were collected, with spotted bass up to the 14.0 in size class and smallmouth bass up to the 18.0 in size class. Muskellunge were also present up to the 44.0 in size class. Bluegill and largemouth bass comprised most of the sample in Stoner Creek.



Healthy stream smallmouth / David Baker

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

KDFWR Strategic Plan: Goal 1.

Green River trophy smallmouth / Ryan Kausing

Assessment of Statewide Size and Creel Limits on Smallmouth Bass in Pool 6 of Green River

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

Warm water stream fisheries are a valued resource in the southeastern United States. These streams provide excellent sport fishing opportunities for many species including smallmouth bass. In Kentucky, smallmouth bass are generally distributed in upland streams throughout the eastern two-thirds of the state. Smallmouth bass are a popular sport fish among both Kentucky anglers and anglers across the country. As a result of high angler interest, management agencies are beginning to implement stream specific strategies to improve and enhance stream smallmouth bass fisheries.

Pool 6 of the Green River (125 miles in length) is part of the Blue Water Trails Adventure Tourism Initiative and is located from immediately below Green River Lake downstream to lock and dam 6 near Mammoth Cave National Park. The majority of this pool is unimpounded and provides free flowing habitat to support a quality smallmouth bass fishery. Public boat ramps and canoe carry-down sites are located throughout this pool, Mammoth Cave National Park reports that recreational canoeing, kayaking and boating has increased 18.8% from 2003-2012 in Pool 6 of Green River.

During May 2015, black bass sampling was completed at four sites in Pool 6. Smallmouth bass were collected at 31.8 fish/hr and ranged from the 2.0-20.0 in size class. Twenty-two percent of the sample was above quality size (≥12.0 in) while trophy size (≥20.0 in) fish have been present in the spring sample each year since 2012. The smallmouth bass fishery received an assessment score of 18, representing an “excellent” rating.

Fall electrofishing was conducted during October 2014 at three sites in Pool 6 of the Green River for black bass. Smallmouth bass were collected at 22.8 fish/hr with fish ranging from the 2.0-18.0 in size class. Twenty-three percent of the sample consisted of quality size fish (≥12.0 in) and no trophy size (≥20.0 in) smallmouth bass collected. Relative weight of smallmouth bass was 77—the lowest since 2013.

Otoliths were collected from additional smallmouth bass to supplement the sample collected in 2014 to improve the age/growth data set. With this additional data, smallmouth bass were represented from age-1 through age-11 and the 2.0-20.0 in size classes. Mean length at age indicated good growth, with smallmouth bass, on average, reaching the 12.0 in minimum statewide size limit at age-4+, 13.8 in at age-5 and 16.4 in at age-6.

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

KDFWR Strategic Plan: Goal 1.

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

Dave Dreves, David Baker, Jason Herrala, and Bobby Widener, Kentucky Department of Fish and Wildlife Resources

Upper Barren River walleye / Dave Dreves

Walleye is a freshwater fish native to most of the major watersheds in Kentucky, including the Barren River. 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 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. 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. Another walleye stocking attempt in the Barren River occurred in 1966, in response to low population numbers, shortly after the river was impounded in 1964. A lack of recent reports of walleye from the Barren River or Barren River Lake, indicates that the "northern" strain fry stockings in 1917 and 1966 were not likely successful and the native population in the river has been lost.

There is approximately 31 miles of unimpounded mainstem of the Barren River above Barren River Lake. The broad goal of this project is to establish a reproducing native "southern" strain walleye population to this section of the Barren River. An established population of native walleye in the Barren River will serve as potential broodstock source and provide an additional fishing opportunity. Beginning in 2007, native strain walleye were collected from Wood Creek Lake and the Rockcastle River in the spring and transported to Minor Clark Hatchery to be used as broodfish. Walleye were spawned and the resulting fry were reared to fingerling size (1.5 in.) and then stocked in the Barren River in late May or early June. The stocking rate was a minimum of 50 fingerlings/acre or about 600 fingerlings/mile. In 2008, we began marking stocked fingerlings with oxytetracycline (OTC) to determine recruitment of stocked fish. Beginning in 2013, small walleye were sacrificed to examine otoliths for OTC marks. Good electrofishing catch rates of adult walleye in 2014 led to the recommendation to cease stocking and begin the natural recruitment monitoring phase.

A total of 22 walleye were collected during 10.0 hrs of electrofishing (2.2 fish/hr) during March 2015. Fish ranged from the 7.0-29.0 in size classes with majority of the sample comprised of the 7.0-9.0 in size classes. Catch rates in Barren River are relatively low with catch rates averaging 3.6 fish/hr from 2010-2015. Catch rates in 2015 were similar to those collected in 2014 for the <10.0 in size group, while catch rates in the 10.0-14.9 in and 15.0-19.9 in size groups were the lowest collected since 2010. No fish were collected from the 20.0-24.9 in size group, while catch rates of fish in the ≥25.0 in size group were similar to collected in 2013.

Overall, catch rates remain low and it appears that there has yet to be any one particular year class with superior survival. Otoliths removed from walleye collected in spring 2015 indicated that 11.8% of those fish were naturally produced fish—the first documentation of natural reproduction since the onset of the project. Sampling/natural recruitment monitoring is will continue through 2019.

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

KDFWR Strategic Plan: Goal 1.

Evaluation of Muskellunge Stockings in the Kentucky River

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

The Kentucky River has been stocked for many years with multiple species including largemouth bass, blue and channel catfish, walleye, sauger, white and hybrid striped bass, and muskellunge. Electrofishing studies along various pools of the river have shown that the return on stocked fish is often low and some species can only be maintained through stocking. Of particular interest is the muskellunge. While stockings of this species do occur, they are in low numbers (up to 50 fish/per pool for pools 4-9) and infrequent—only occurring when hatcheries have excess production. Despite low-density and infrequent stockings, routine electrofishing surveys conducted by the Kentucky Department of Fish and Wildlife (KDFWR) on the Kentucky River during late winter and fall regularly yield low but consistent numbers and sightings of muskellunge. Low stockings with noticeable returns are one indicator that the stocking of muskellunge is likely effective in bolstering population numbers in the Kentucky River.

While limited habitat and prey base could be negatively affecting the survival of other stocked sport fish that have not seen elevated success in the Kentucky River, this may not be true for muskellunge. Studies have shown that the preferred habitat of musky is submerged woody debris, which is common in the Kentucky River. Additionally, the river also offers a diverse forage base for the stocked muskelluge as it supports a large population of rough fish such as common carp, drum, and redhorse.

In 2014, stocking rates were augmented in pools 2 and 3, and initial sampling began to monitor the impacts of these stockings and document any natural reproduction. Before being stocked all fish were fin clipped to distinguish between stocked year classes. Additionally, all 13.0 in musky received a microwire tag to identify stocking size. Pools 2 and 3 received a total of 298 fingerlings (50% 9.0 in fingerlings and 50% 13.0 in fingerlings) at a rate of 9.0 fish/mi. in 2014 and 2015. Pool 4 was a control site and did not receive any stockings.

Kentucky River muskie / Jason Herrala

Spring electrofishing sampling was conducted in March 2015. Eight 15-min transects were completed in each pool. Musky were collected in all pools; however, only 4 fish total were collected. Catch rates of musky ranged from 0.5 fish/hr in pools 2 and 4 to 1.0 fish/hr in Pool 3, with a total CPUE of 0.7 fish/hr. All musky collected were relatively large and lengths ranged from 37.6 – 48.3 in with a mean length of 44.7 in.

A second sample was conducted in October 2015 following the same protocol as spring sampling. A total of 3 musky were collected during fall sampling, one from each pool. Catch rates were 0.5 fish/hr in each pool. Fish ranged in length from 38.3 – 41.0 in with a mean length of 39.5 in. No age-0 or age-1 fish from last year's stockings were observed. Relative weights (Wr) were low, ranging from 75 in Pool 2 to 79 in Pool 4, and all pools were below Wr values observed in 2014.

Initial sampling efforts have been successful in targeting large adults, however, fish < 35 in are not routinely captured. Sampling efforts will continue in the coming years to evaluate the success of the stockings.

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

KDFWR Strategic Plan: Goal 1.

Evaluation of New Commercial and Recreational Regulations on Catfish in the Ohio River

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

Commercial fishing for catfish in the Ohio River has recently shifted from primarily harvest for flesh to harvesting trophy-sized fish for pay lakes. A high quality, recreational catch and release trophy catfish fishery also exists in the Ohio River. This has led to conflict between the two groups. On December 1, 2014 the following regulation was implemented:

> Recreational fishermen on the main-stem Ohio River will be allowed 1 blue catfish ≥ 35.0 in, 1flathead catfish ≥35.0 in, and one channel catfish ≥28.0 in. The majority of commercial fishermen fishing in the Ohio River and its tributaries where commercial fishing is allowed will be allowed 1 blue catfish ≥35.0 in, 1 flathead catfish ≥35.0 in, and one channel catfish ≥28.0 in per day. However, 50 commercial will be allowed to harvest 4 (in aggregate) blue and flathead catfish ≥40.0 in and channel catfish ≥30.0 inches in Kentucky's portion of the Ohio River and its tributaries open to commercial fishing below Cannelton Lock and Dam. Harvest of fish below their respective length limits will not be regulated for recreational or commercial anglers.

In order to continue to monitor catfish populations in the Ohio River population data will be gained through

Ohio River blues / Derek Rodgers

trotline and electrofishing samples, ride-alongs with commercial fishermen, and monitoring of recreational catfish tournaments. Trotlines were used to sample catfish, and catch per-unit effort (CPUE) of all species of catfish increased from 2014; however, blue catfish and channel catfish catch rates were still lower than their historical averages (3.0 fish/line and 1.4 fish/line, respectively). Trophy catfish accounted for 4.8% of the total catfish catch (up from 4.5% in 2014 and 1.2% in 2013).

Ride-alongs with commercial hoop net fishermen and Department hoop netting was also conducted to gather data. Blue catfish mean CPUE was <0.1 fish/net-night and was below historical average hoop net catch (0.3 fish/net-night). Flathead catfish CPUE decreased from 2.6 fish/net-night in 2013 to 0.9 fish/net-night in 2014 to 0.5 fish/net-night in 2015 and was below historical average hoop net catch (1.3 fish/net-night). Overall trophy catfish accounted for 5.6% of the total catfish catch in hoop nets (up from 4.3% in 2014).

Electrofishing was conducted in June 2015. A total of 24.0 hr of electrofishing effort was conducted across all pools resulting in a total catch of 455 blue catfish, 225 channel catfish, and 902 flathead catfish. CPUE of blue catfish was 19.0 fish/hr, similar to 2014 (19.3 fish/hr), but was well above the historical average of 10.3 fish/hr. CPUE of channel catfish was 9.4 fish/hr (up from 8.8 fish/hr in 2014) but was similar to the historical average catch rate (9.6 fish/hr). Flathead catfish CPUE was 37.6 fish/hr. Only 2.8% of all catfish sampled were trophy size.

Nine tournaments were attended with 694 boats weighing in catfish. Catfish tournament anglers weighed in 1,009 blue catfish, 378 channel catfish, and 162 flathead catfish, with a total CPUE of 2.2 fish/boat (down slightly from 2.5 fish/boat in 2014). Of catfish weighed in, 10.8% were trophy catfish as defined above. Blue catfish had a mean CPUE of 1.5 fish/boat, channel catfish a mean CPUE of 0.5 fish/boat, and flathead catfish a mean of CPUE of 0.2 fish/boat. Catch rates of blue catfish and flathead catfish increased from 2014 levels, and mean lengths of all species of tournament catfish increased from 2014 to 2015.

Monitoring efforts will continue in 2016 to evaluate the success of the regulation.

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

KDFWR Strategic Plan: Goal 1.

Lake Sturgeon Restoration in the Upper Cumberland River Drainage in Kentucky

2014 Lake Sturgeon trotline sampling on Cumberland River near mouth of Laurel River

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

The Lake Sturgeon (*Acipenser fulvescens*) is considered critically imperiled in Kentucky, where it currently limited to the Ohio and Mississippi rivers. In 2007, Kentucky Dept. of Fish and Wildlife Resources (KDFWR) initiated a long-term (20+ years) project to restore a self-sustaining population of Lake Sturgeon to the upper Cumberland River drainage, where the species occurred historically. The project area extends from Wolf Creek Dam, upstream to Cumberland Falls, including major tributaries such as Rockcastle River and Big South Fork Cumberland River. To date, a total of 29,839 fish have been stocked into the Cumberland River above Lake Cumberland.

Since 2007, fertilized eggs have been obtained annually from the Wisconsin Dept. of Natural Resources taken from upper Mississippi basin stock (Wisconsin River and Yellow River). These eggs are hatched at the KDFWR Pfeiffer Fish Hatchery in Frankfort and the young are reared to an approximate average of 7.5-10.2 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 in 2008, 2,004 fish in 2009, 4,539 fish in 2010, 2,150 in 2011, 2,964 fish in 2014, and 3,860 (ranging 5.5-10.4 inches) in 2015. The Big South Fork Cumberland River at the Alum Creek access area received 716 fish in 2008, 1,973 fish in 2009, 4,063 fish in 2010, 2,766 fish in 2014, and 3,845 (ranging 4.5-8.5 inches) in 2015. Prior to release, young Lake Sturgeon are differentially marked by sequentially removing two adjacent scutes in the lateral series to distinguish year classes: right anterior scutes 2-3 for 2007, left anterior scutes 2-3 for 2008, right anterior scutes 3-4 for 2009, left anterior scutes 3-4 for 2010, right anterior scutes 5-6 for 2011, left anterior scutes 7–8 for 2014, and right anterior scutes 7-8 for 2015. Stocking did not occur in 2012 or 2013. Local print media (Times Tribune, Corbin, KY) and Corbin High School students have been present at the Lake Sturgeon release events each year. Kentucky Afield television, magazine, and radio have also featured the reintroduction and sampling efforts for this rare species in the Cumberland River.

Thirty six reports of Lake Sturgeon captured by anglers were received in 2009-2015. Most fish were captured from various locations in the impounded portion of the river (Lake Cumberland) and below Wolfe Creek Dam. The individuals below the dam either passed through the turbines of Wolf Creek Dam from the reservoir or migrated upstream from Tennessee. The size range of fish captured was 13-15 inches weighing 1 lb or less (11 reports) and 20-30 inches weighing 2-5 lbs. (13 reports). A variety of sampling techniques are being evaluated to determine survival, habitat use, and movement patterns of stocked fish and will continue in 2016.

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

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

Cumberland River sturgeon / Matt Thomas

Assessment of the Lake Sturgeon Restoration in the Cumberland River

Jason Herrala, David Baker, Matt Thomas, Stephanie Brandt, Nick Keeton, and Ryan Kausing, Kentucky Department of Fish and Wildlife Resources

In Kentucky, lake sturgeon were once native to the Mississippi, Ohio, and Cumberland River drainage, but since the 1950's lake sturgeon have been extirpated from the Cumberland River. In 2008, KDFWR began reintroducing lake sturgeon back into the Cumberland River and committed to a 20 year restoration effort. Since 2007, a total of 22,134 lake sturgeon fingerlings have been stocked; 12,616 in the Cumberland River and 9,518 in the Big South Fork. One major component to the success of reintroduction programs is to assess the survival of stocked sturgeon.

Trotline sampling occurred in the Big South Fork of the Cumberland River in December 2015 and January 2016. A total of 18 trotlines were set and retrieved during each sampling season. Sampling in Winter 2014/2015 on the main stem of the Cumberland River yielded a catch rate of 2.6 fish/line (54 total fish collected). No lake sturgeon were collected during sampling in the Winter of 2015/2016 on the Big South Fork

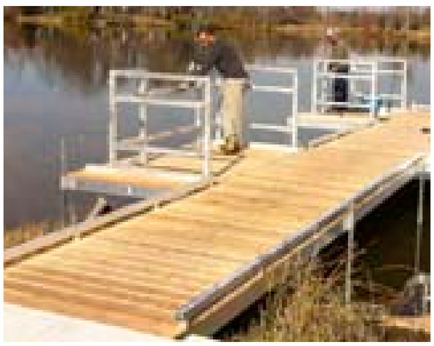
Although river, weather conditions, and habitat were similar on both the Big South Fork and the main stem of the Cumberland River sampling efforts there is currently no conclusive evidence that indicates why there was such a vast difference between catch rates at the two sites. Preliminary sampling data on the main stem Cumberland River is encouraging, however future sampling efforts and documented reproduction are needed to declare the restoration a success Trotlining will continue to occur annually for the foreseeable future on an alternating schedule between the Cumberland River and Big South Fork to evaluate the success of the restoration efforts.

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson) State Wildlife Grant Program (SWG)*

KDFWR Strategic Plan: Goal 1. Comprehensive Wildlife Conservation Strategy; Appendix 3.9; Class Actinopterygii and Cephalaspidomorphi: Taxa Specific Project.

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

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



Fishing at a FINs lake / Lexington Park and Recreation

In an effort to boost license sales and increase fishing opportunities, the Kentucky Department of Fish and Wildlife Resources (KDFWR) initiated the Fishing in Neighborhoods (FINs) program in 2006. The FINs program currently provides quality fishing opportunities at 40 lakes in 25 counties around the Commonwealth. Many of these lakes are located near large population centers, where fishing opportunities would otherwise be lacking. Anglers do not have to travel far from home to find good fishing at a FINs lake. The FINs program thrives on partnerships between KDFWR and local municipalities. As part of a cooperative agreement, lake owners provide 25% in-kind match of services to maintain and promote fishing access at these lakes. This in-kind match helps cover the cost of fish stockings.

In 2015, 135,500 rainbow trout and 112,131 catfish were stocked in the FINs lakes. The catfish stockings were a combination of channel and blue catfish as well as channel-blue catfish hybrids. These routine fish stockings of "keeper-size" fish provide angling opportunities to a diverse group of anglers. In the past, many of these lakes were overfished due to their size and location. Lakes are stocked up to four times annually with catchable-size catfish (12 – 20 inch) and three times annually in the cool months (October – March) with rainbow trout (8 – 12 inch). Bass and sunfish populations are routinely sampled to ensure natural reproduction is meeting the needs of the anglers. In 2015, 29,950 (5 – 8 inch) hybrid sunfish were stocked in June at lakes that had poor sunfish numbers, heavy fishing pressure, or fishing events. A standard set of creel limits is in place at all FINs lakes to help spread out fish harvest and ensure fishing opportunities can be enjoyed by as many people as possible. Daily limits for each angler fishing a FINs lake includes five rainbow trout, four catfish, one largemouth bass over 15 inches, and 15 bluegill or other sunfish.

Since 2010, creel surveys have been conducted at five FINs lakes and fish tagging studies to determine exploitation were conducted at four lakes. These studies have shown angling effort and utilization of stocked fish to be high. However, these studies were costly to administer and time consuming. Additionally, the study lakes were all located in the central part of the state. To assess angling pressure at FINs lakes statewide, 30 remote cameras were mounted at 20 FINs lakes in 2015. These remote cameras will capture angling effort through time lapse photography for a 12-month period, as well as daily and seasonal trends. This data will aid in assessing if current stocking strategies are adequate for the amount, and timing of angling effort.

An angler attitude survey conducted in 2012 at 27 FINs lakes indicated that the FINs program is attracting families as 29% of anglers fishing at FINs lakes are ≤ 15 years old. The program is also recruiting and retaining license buyers with 12% of anglers reporting they had never bought a license and 28% reporting they had not bought a license the previous year. Minorities were also well represented at FINs lakes with a higher proportion observed fishing at the lakes than expected when compared with the Kentucky general population in the 2010 U.S. Census. The overwhelming majority (94%) of anglers traveled ≤ 30 minutes to get to the lake. Angler satisfaction was extremely high at the FINs lakes with 85% of anglers reporting their overall trip as "good" or "excellent."

Information kiosks are present at the majority of the FINs lakes. Informational posters designed by KDFWR inform the public about fish stockings, license requirements, fish identification, poacher hotline, basic knot typing instructions, rod loaner equipment and the mission statement of the FINs program.

Funding Source: *Sport Fish Restoration Program (Dingell-Johnson, In-kind match provided by lake owners*

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

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

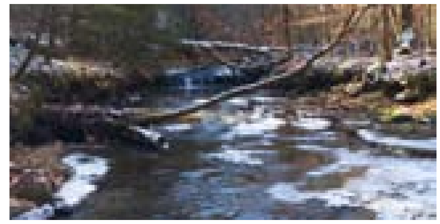
Matthew Thomas and Stephanie Brandt, Kentucky Department of Fish and Wildlife Resources

Patrick Rakes, J.R. Shute, Crystal Ruble, Missy Petty, and Meredith Hayes, Conservation Fisheries, Inc.

The Kentucky Arrow Darter (*Etheostoma spilotum*) has a limited distribution in the upper Kentucky River drainage, where it inhabits headwater (mostly 1st and 2nd order) streams. The Kentucky Department of Fish and Wildlife Resources (KDFWR) indentified the Kentucky Arrow Darter as a Species of Greatest Conservation Need in its State Wildlife Action Plan to address research and survey needs for the species. A variety of human activities, including coal mining, logging, agriculture, gas/oil exploration, and land development have contributed to the species' decline. Based on its decline and the magnitude and imminence of its threats, the U.S. Fish and Wildlife Service determined that the Kentucky Arrow Darter warrants listing under the Endangered Species Act. It is currently a Candidate for Federal Listing based on its inclusion in the USFWS Candidate Notice of Review published in the Federal Register (Nov. 10, 2010; Federal Register / Vol. 75, No. 217). In 2008, the KDFWR partnered with Conservation Fisheries, Inc. (CFI) to develop successful spawning protocols and produce the offspring needed to reestablish extirpated populations within the species' historic range. Long Fork (Red Bird River drainage) in Clay County was chosen as the reintroduction stream because: 1) it is within the historic range of the species; 2) habitat conditions are suitable; 3) there is some level of protection (i.e., within the Daniel Boone National Forest); and 4) it contained no pre-existing population of *E. spilotum* based on previous surveys.

Brood stock was collected in March 2015 from Big Double Creek, a tributary of the Red Bird River in the Daniel Boone National Forest, Clay County. At least five of the new wild-caught females and all of the males were used in this year's effort in addition to five captively conditioned (2014) wild females and one captively conditioned (2012) wild female. All males were separated from females due to aggression, held individually in 75 L tanks, and only introduced singly into the separate breeding tanks for a few days at a time. March spawning was observed in aquaria at CFI's hatchery facility when temperatures briefly exceeded 13°C. Spawning activity quickly declined in late April and on 10 May the chiller was removed and water temperatures were allowed to rise above 19°C.

On 28 July 2015, the young (n=376) were tagged with visible implant elastomer tags and released into Long Fork at multiple sites spanning the reach from midpoint of the stream to the Long Fork Road crossing. A total of 1,823 Kentucky Arrow Darters have been stocked in Long Fork since 2012. Periodic surveys were conducted in 2012-2015 in Long Fork by CFI biologists and KDFWR by performing a combination of visual surveys and seine hauls. A total of 448 tagged (propagated) and 54 untagged (wild-spawned) Kentucky Arrow Darters have been observed through 2015. Monitoring efforts so far have confirmed the survival of tagged *E. spilotum* released into Long Fork for periods exceeding two years. This result, combined with an increasing trend in numbers of untagged individuals in 2013-2015, suggests dispersal of stocked fish in the stream followed by successful reproduction and recruitment. Although natural reproduction in these propagated fish has been evident, it would be premature at this point to suggest that the project has been successful (Thomas and Brandt 2013). Previous non-game fish restoration attempts have shown it takes several years to document success when stocking relatively limited numbers of individuals, particularly small species that are short-lived and cryptic (Shute et al. 2005).



Long Fork, Clay County, Kentucky

Funding Source: *State Wildlife Grant Program (SWG) In-kind matching funds provided by Conservation Fisheries provided by Conservation Fisheries, Inc.*

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

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.

Left to right, clockwise: Cogur Fork, McCreary Co., KY.; CFI and KDFWR and staff hiking in brood stock; CFI and KDFWR staff conducting follow up monitoring surveys; CFI staff conducting visual surveys.

The Cumberland Darter (*Etheostoma susanae*) has a limited range in the upper Cumberland River drainage, most of which is in Kentucky. The U.S. Fish and Wildlife Service published a final rule (Sept. 8, 2011; Federal Register / Vol. 76, No. 153) listing the species as endangered throughout its range because of recent range curtailment and fragmentation resulting from habitat degradation. In 2008, the Kentucky Department of Fish and Wildlife Resources (KDFWR) partnered with Conservation Fisheries, Inc. (CFI) to develop successful spawning protocols for the Cumberland Darter and produce the offspring needed to re-establish extirpated populations within its historic range. Because of the apparent rarity of this species, captive propagation and reintroduction is considered an appropriate tool for its recovery and eventual delisting. To avoid mixing potentially unique evolutionary lineages artificially propagated individuals are being released within the watershed from which brood stock are taken. Cogur Fork (Indian Creek-upper Cumberland River drainage) in McCreary County was chosen as the reintroduction stream because: 1) it is within the historic range of the species; 2) habitat conditions are suitable; 3) there is some level of protection (i.e., within the Daniel Boone National Forest; and 4) it contained to pre-existing population of *E. susanae* based on previous surveys.

A total of seventeen Cumberland Darters were collected in March 2015 from Barren Fork, McCreary County. Following observations of darkly pigmented males (heads and fins) defending cavities under slabs, weekly checks for eggs were initiated on 8 April 2015, at which time the first nest was collected. By 1 May all eggs from the first clutch had hatched and the water temperature was ~17°C. The last nest (~10 nests total) was collected on 22 April, by which point temperatures were ~19°C. Approximately 789 larvae were reared successfully to juveniles yielding ~61% overall survivorship. In September 2015, a total of 786 propagated juveniles and 43 brood stock tagged with visible implant elastomer tags were released into three nearly adjacent reaches in lower Cogur Fork.

A total of 4,945 Cumberland Darters have been stocked in Cogur Fork since 2009. Periodic surveys were conducted in 2010-2015 in Cogur Fork by CFI biologists and KDFWR by performing a combination of visual surveys and seine hauls. Access to the Cogur Fork is extremely limited which, in turn, has limitedmonitoring and stockings to the lower reaches of the watershed. Continued monitoring in 2016 will include remote upper sections of Cogur Fork to help gauge the success of this project. Monitoring efforts have confirmed the survival of tagged *Etheostoma susanae* released into Cogur Fork for periods exceeding one year. The steadily increasing number of untagged individuals collected during 2013-2015 monitoring may indicate the beginning of a naturally reproducing population in Cogur Fork. However, it would be premature at this point to suggest that the project has been successful in restoring a wild population. A collection of much larger numbers of untagged individuals over several years, or untagged fish collected after stocking ceases are benchmarks needed to support any strong argument for successful establishment of a reproducing population. Non-game fish restoration attempts have shown it takes several years to document success when stocking relatively limited numbers of individuals, particularly small species that are short-lived and cryptic (Shute et al. 2005). Field monitoring will continue in 2016.

Funding Source: *State Wildlife Grant Program (SWG) In-kind matching funds provided by Conservation Fisheries, Inc.*

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

Alligator Gar Propagation and Restoration in Western Kentucky

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

The Alligator Gar (*Atractosteus spatula*) 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 specimen was 9 feet, 8 inches with an approximate weight of 302 lbs. Females 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.

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, lower Cumberland and lower Tennessee River systems.

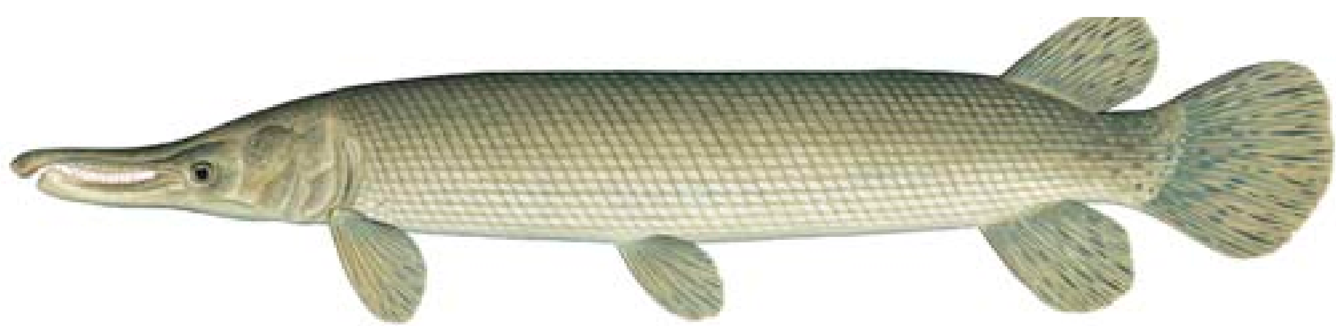
Little is known about the biology and habitat of this species in Kentucky.. In its southern range, the Alligator Gar typically inhibits big rivers, swamps, bayous, and brackish waters. The Alligator Gar is the most salt tolerant of all the gar species. In Kentucky, the Alligator Gar historically occupied sluggish pools, backwaters, and embayments of big rivers and larger reservoirs in the western portion of the state. Alligator Gar records have been confirmed from five locations in Kentucky: 1) Cumberland River, 3 miles below Dycusburg, Crittenden County (1925); 2) Ohio River at Shawnee Steam Plant, McCracken County (1975); 3) mouth of the Ohio River, Ballard/Carlisle County (1966); 4) mouth of Bayou du Chein, Fulton County (1974); and 5) Kentucky Lake at Cypress Creek embayment, Henry County, TN (1976). Alligator Gar have not been reported in Kentucky since 1977, despite numerous surveys. Currently, the Alligator Gar is listed as endangered by the Kentucky State Nature Preserves Commission and is listed as a Species of Greatest Conservation Need by the Kentucky Department of Fish and Wildlife Resources Wildlife Action Plan.

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 Wisconsin Department of Natural Resources. These fry will be reared at both the Pfeiffer Fish Hatchery and Minor Clark Fish Hatchery prior to being released into the wild. Stocking sites are areas that have historically contained Alligator Gar and which still provide suitable habitat for optimal survival.

From 2009-2015, a total of 33,462 Alligator Gar were stocked by the KDFWR. Size at stocking ranged from 7.3 to 14.5 inches. Alligator Gar were stocked in the following areas: (1) Clarks River; (2) Phelps Creek; (3) Bayou Creek; (4) Tradewater River; (5) Deer Creek; (6) Obion Creek; (7) Massac Creek; (8) Bayou de Chein; (9) Mayfield Creek; (10)Ballard WMA; (11) Barlow Bottoms WMA; and (12) Doug Travis WMA.

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

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



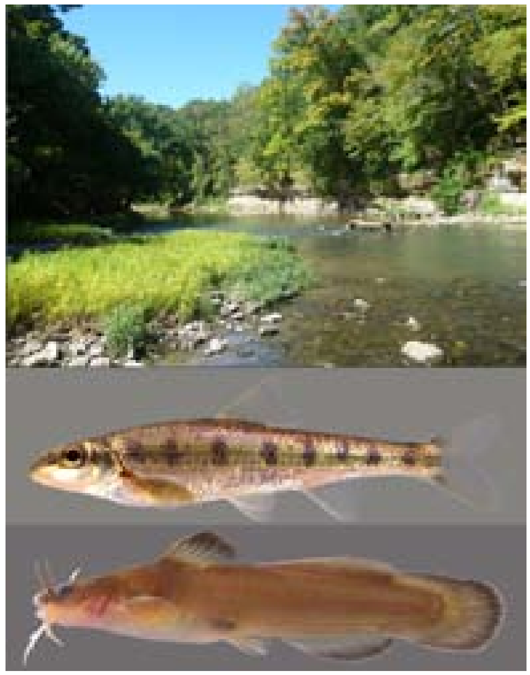
Alligator Gar illustration / Rick Hill

Status Assessment of Eight Fish Species of Greatest Conservation Need in the Red River, Lower Cumberland River Drainage, Kentucky

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

Species of Greatest Conservation Need (SGCN) are recognized in the Kentucky Wildlife Action Plan based on levels of endemism, lack of knowledge of current population status, distribution, life history characteristics, and potential importance as hosts to rare mussel species. Of the state's 244 native fish species, the Plan identifies 68 in need of conservation action.

The Cumberland River drainage supports one of the most diverse and unusual assemblage of fishes in Kentucky, including 28 (41%) of 68 fish SGCN. In 2011, we began an assessment of the fish fauna of the Kentucky portion of the Red River to obtain more complete and up-to-date information on the distributions and population status of rare or imperiled fishes. The Red River, a tributary of the lower Cumberland River located in south-central Kentucky and north-central Tennessee is known to support eight fish SGCN based on historical records: 1) *Ichthyomyzon castaneus* (Chestnut Lamprey; one site); 2) *Erimystax insignis* (Blotched Chub; 7 sites); 3) *Noturus exilis* (Slender Madtom; 5 sites); 4) *Forbesichthys agassizii* (Spring Cavefish; 5 sites); 5) *Etheostoma derivativum* (Stone Darter; 4 sites) ; 6) *E. maydeni* (Redlips Darter; 1 site); and 7) *E. microlepidum* (Smallscale Darter; 4 sites). Our sampling efforts to date have confirmed the presence of five of these species and new occurrence records for *Hemitremia*



Red River at KY/TN state line, Logan County (top), Blotched Chub (middle), and Slender Madtom (bottom)/ Matt Thomas

flammea (Flame Chub).

Fish community sampling in the Red River began in 2011 to assess the status of SGCN based on historic occurrences and obtain baseline data for species lacking complete distributional information. As of 31 December 2015, fish community data were obtained from a total of 68 sites, 5 of which were added last year. A total of 60 species have been recorded to date, including six of eight fish SGCN known from the drainage. In 2015, we collected Slender Madtom (*Noturus exilis*) at one site in the mainstem Red

River, Logan County, which is the first record of this species from the drainage since 1961. Two additional mainstem Red River sites produced large numbers of Blotched Chub (*Erimystax insignis*) and Smallscale Darter (*Etheostoma microlepidum*). The consistent presence of Blotched Chub and Smallscale Darter in collections made by Kentucky State Nature Preserves Commission, State Nature Preserves Commision?, KDFWR, and Kentucky Division Of Water personnel during the last 15 years suggests that populations are stable in this portion of the Red River in Logan County. The Red River appears to be the last stronghold for the Blotched Chub in Kentucky, as it has not been collected at other known localities in more than 25 years.

The only known populations of Smallscale Darter in the state are in the Little River (lower Tennessee River drainage),Trigg County, and Red River drainage, Logan County.

In 2016 we will continue fish community sampling needed to complete the basin-wide ichthyofaunal assessment for the Red River drainage in Kentucky. This project will provide information necessary to facilitate appropriate conservation actions that would benefit fish SGCN in the Red River and its tributary watersheds.

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

KDFWR Strategic Plan. Goal 1. Comprehensive Wildlife Conservation Strategy: Appendix 3.9; Class Actinopterygii and Cephalaspidomorphi.

Using Telemetry to Monitor the Movements and Distribution of Asian Carp in the Ohio River

Chris Hickey, Neal Jackson, Andrew Stump and Chris Bowers, Kentucky Department of Fish and Wildlife Resources; Jeff Stewart, United States Fish and Wildlife Service

In stark contrast to the current war being waged against invasive Asian carp populations all over the Mississippi River Basin, these fish were once eagerly imported into the US as part of an aquaculture program that was developed in the 1970's. Asian carp, like the Bighead (*Hypophthalmichthys nobilis*) and Silver carp (*H. molitrix),* were originally imported to control microscopic organisms that thrived in hypereutrophic conditions in intensive fish production ponds and wastewater treatment facilities. However, soon after their importation, the Asian carp were found to have escaped into the Mississippi River basin and subsequently became established. Since then Asian Carp populations have expanded exponentially and continue to increase their range as they continue to move up the Ohio River basin. The objective of this study is to identify the movement, distribution, and range expansion of Asian carp on the Ohio River. The data gathered will assist fisheries biologist with ongoing efforts to stop the Asian carp from their continued range expansion.

Surgery to implant tag in Silver carp / Taylor Nagle

Although the Asian Carp Telemetry study did not officially begin until 2015, the first tagging efforts were initiated as early as 2013. Biologists used a combination of gillnets and DC electrofishing to sample the Asian carp from the McAlpine, Markland and Meldahl pools of the Ohio River. The carp were surgically implanted with a transmitter that broadcasted an identifiable signal every 40 sec for up to 5 years. In 2015, 37 carp were implanted with transmitters which, in addition to the 155 tagged fish from 2013 and 2014, bring the 3-year total of tagged Asian Carp to 192. The transmitter locations are picked up by an extensive array of stationary ultrasonic receivers which are manually downloaded monthly. By the end of 2014, the project had a functioning 370 mile array created via the deployment of 55 receivers throughout 7 pools of the Ohio River. In 2015 additional receivers were deployed to fill in gaps between stations and with the cooperation of the US Army Corps of Engineers (USACE) deployed in a number of lock chambers at several Lock and Dam facilities. The efforts in 2015 were able to expand the array to 124 receivers that were spread out over 8 pools for a total length of 442 miles.

Preliminary analysis of the telemetry data from 2015 showed that there were 1.6 million detections coming from 98 of the possible 192 tagged fish (51.0%), all of which were found on only 54% of the study's receivers. Additionally, 70% (n = 69) of all fish represented in the 2015 data were detected by receivers in the McAlpine Pool in which the majority (72.3%) of the project's fish were originally collected. As in previous years, project biologists have plans in 2016 to increase the numbers of receivers and tagged carp found within this stretch of the Ohio River. Consideration is being given to extend efforts even further downriver to include the upper half of the Cannelton Pool and also to determine if multiple receivers can be deployed in tributaries to identify direction movement of tagged carp. However, the ultimate goal for this project continues to be the identification of aspects of their movements and distribution that will assist in the ongoing efforts to stop the range expansion of Asian carp.

Funding Sources: *Water Resources Reform and Development Act of 2014* and *United States Fish and Wildlife Service*

KDFWR Strategic Plan. Goal 1. Strategic Objective 2.

Asian Carp Demographics in Kentucky Lake

Commercial fishing for asian carp / Paul Rister

Allison DeRose and Tim Spier, Murray State University

Neal Jackson and Jessica Morris, Kentucky Department of Fish and Wildlife Resources

Adult Asian carp (Silver carp and Bighead carp) invaded Kentucky Lake and Lake Barkley as early as 2004. As populations increased, commercial markets developed leading to an increase in the harvest of Asian carp. To further encourage harvest of Asian carp, the Kentucky Department of Fish and Wildlife Resources (KDFWR) created an Asian Carp Harvest Program (ACHP) that allows commercial fishermen targeting Asian carp to fish in otherwise closed waters under close supervision. This program creates a platform for monitoring the population dynamics of Asian carp and provides a tool to assess the effectiveness of commercial removal efforts. The objective of this project is to identify and quantify biological factors that are important in managing Asian carp in Kentucky Lake including the source of fish in the population, growth rates, mortality rates, and the frequency and timing of spawning events.

Future projects aimed at reducing the negative impacts of Asian carp require information about the source of Asian carp within a river system. Asian carp in their early life stages have not been captured in Kentucky Lake in previous years, leading to uncertainty of the source of fish in this population. In order to compare gear types for capturing juvenile Asian carp in Kentucky Lake, Asian carp were targeted at early life stages. Light traps were first used in the spring when water temperatures reached 18°C. As temperatures warmed into the summer, juvenile Asian carp were targeted with electrofishing, cast nets, and fyke nets. These four gears yielded a combined total of 1,903 fish comprised of 34 species. Electrofishing produced the only juvenile Asian carp captured in Kentucky Lake through this project. Juvenile Asian carp were also captured in Kentucky Lake with cast nets outside of this project, suggesting that spawning is occurring above Kentucky Dam.

To assess additional population parameters, length, weight, sex, and gonad weights were recorded from 220 silver carp collected from commercial processors monthly from April 2015 – January 2016. Pectoral fin rays were also removed for aging. Additional samples were collected by MSU students and combined in this data set. Population parameters revealed that the silver carp in Kentucky Lake have shown little impact from current levels of harvest. Most silver carp captured within the commercial fishery in Kentucky Lake are large ($\bar{x}$ = 853mm: 750-1150mm: N=292). Length-weight relationships (N=271), showed fish that were relatively heavy at a given length when compared with silver carp from other populations. The number of males (117) to females (103) was approximately even suggesting little selectivity in harvest. Silver carp aged using cross sections of pectoral fin rays (N = 101) ranged from 3-9 years of age, and showed dominant year classes (3 and 4-year-olds: 88.1%), similar to silver carp populations in other basins. Annual mortality rates were in the low end of the range for silver carp populations (50.9%). Silver carp showed two peaks in spawning in April and October suggesting multiple spawning events in a given year. These data provide a baseline for future assessment of Asian carp harvest in Kentucky Lake.

Funding Source: *Sport fish Restoration (DJ) and United States Fish and Wildlife Service Aquatic Nuisance Species funding*

KDFWR Strategic Plan: Goal 1, Strategic Objective 2.

Control and Removal of Asian Carp in the Ohio River

Neal Jackson, Andrew Stump, Chris Hickey, and Chris Bowers, Kentucky Department of Fish and Wildlife Resources
Katherine Zipfel, West Virginia Division of Natural Resources
Jeff Stewart, United States Fish and Wildlife Service

Silver Carp in livewell / Jason Curry

In recent years Asian Carp have expanded their range from the Mississippi River into the Ohio River Basin. Eradication of invasive species after establishment is difficult and often limited by available resources. Prevention and rapid response are the best tools for limiting establishment of costly invasive species. With Asian Carp numbers already rapidly expanding physical removal in the Ohio River basin may be an effective tool to slow their upstream expansion. Recent studies on Asian carp harvest programs in the Illinois River show that the collapse of silver and bighead carp populations is possible if all fish sizes are targeted. Diverse and consistent removal efforts in the portion of the Ohio River where Asian carp are established may disrupt distribution of Asian carp, decrease pressure on defined barriers, and reduce numbers of Asian carp in sensitive areas to protect species of conservation need and important sport fisheries. The objectives of this project are to 1) remove Asian carp from Ohio River pools above McAlpine Dam; 2) compile information on Asian carp population dynamics as a tool for assessing success of removal efforts; and 3) encourage commercial removal of Asian carp in the Upper Ohio River by providing information to current and potential Asian carp processors.

Electrofishing and gill netting were conducted for 8 weeks from August- October 2015. Sampling sites focused on tributaries and embayments in each pool below Greenup Locks and Dam where densities of Asian carp are highest and fish are easiest to capture. A total of 47.19 hours were spent electrofishing and 2,566 yards of gill nets were used in the Ohio River and its tributaries between Cannelton and Greenup locks and dams to capture more than 4,054lbs of Asian carp. Of the three targeted Asian carps, Silver carp and grass carp were the most susceptible species to boat electrofishing while bighead carp were more effectively caught using gill nets. This removal project is a continuation and expansion of the removal efforts from 2013 and 2014. It is the first attempt to comprehensively track and total the numbers of carp removed from Ohio River pools in the upper ranges of Asian carp expansion.

In addition, state agencies in Kentucky are working with the commercial fishing industry in the western portion of the state to promote the harvest of Asian carp and identify ways to encourage the developing industry. The intent is to facilitate the commercial removal of Asian carp and provide a platform for data collection within the industry. In 2016 we plan to work directly with the commercial industry to experiment with fishing techniques that will increase fishing efficiencies and yield. While this market is currently small, partnering with industry may result in more cost-effective management of Asian carp numbers now and in the future.

Commercial fisherman of the Asian Carp Harvest Program / Neal Jackson

Funding Sources: *Water Resources Reform and Development Act of 2014* and *United States Fish and Wildlife Service*

KDFWR Strategic Plan. Goal 1, Strategic Objective 2.

Monitoring and Response to Asian Carp in the Ohio River

Neal Jackson, Andrew Stump, Chris Hickey, Chris Bowers, and Jason Curry, Kentucky Department of Fish and Wildlife Resources

Katherine Zipfel, West Virginia Division of Natural Resources

Jeff Stewart, Sam Finney, and Rob Simmonds, United States Fish and Wildlife Service

The bigheaded carps (Silver carp, *Hypophthalmicthys molitrix*, Bighead carp, *Hypophthalmichthys nobilis*, and Grass carp, *Ctenopharyngodon idella*), commonly referred to as Asian carp, have successfully expanded their range throughout the Mississippi River Basin, including the Ohio River Basin. Silver carp and Bighead carp are gregarious planktivores capable of producing many offspring. As such, they may affect aquatic food webs, competing with native fish. In 2015, the Kentucky Department of fish and Wildlife Resources (KDFWR) initiated a study on the distribution, abundance, and population dynamics of Asian carp in the Ohio River to provide an assessment tool that informs Asian carp prevention, removal, and response efforts.

KDFWR biologists monitored Asian carp over two periods (summer and fall) in each of four pools of the Ohio River along the leading edge of invasion (McAlpine pool thru Greenup pool) using gill nets and electrofishing. Spring electrofishing yielded 55 silver carp and a total catch of 10,648 fishes composed of 56 different species

Measuring a Silver Carp / Chris Hickey

(180.62 fish/hour). Fall electrofishing yielded 5 silver carp with a total catch of 6,290 fishes composed of 48 different species (296.65 fish/hour). All silver carp sampled came from the McAlpine pool.

Summer gill netting (10,733 yards of net) yielded 78 fishes comprised of 10 different species. One bighead carp was captured in the McAlpine pool while two bighead carp were caught in the Meldahl pool. Fall gill netting (3,475 yards) yielded 66 total fish comprised of 10 different species. Four silver carp were captured in McAlpine pool. Gill netting was not effective for capturing Asian carps in 2015, but recent information suggests that the specific type of gill nets used can have an impact on the resulting catch. In 2016 gill net specifications will be explored to improve catch rates. As expected, the lowermost pool, McAlpine pool, had a higher density of invasive carps than the three pools above it.

Sampling results from this project were combined with those from an adjacent project for analysis of population parameters such as age and growth, mortality, and length-weight relationships (N = 183). The dominant age classes of silver carp populations in the Cannelton and McAlpine pools were 4 and 5 years, respectively. The majority of silver carp captured in these areas are large (<30”). Length-Weight relationships, a measure of overall condition, showed silver carp in these pools to be of similar condition to those on the leading edge of invasion fronts in other river systems. Mortality rates for each pool were below 50% which is on the low end of the range shown in other river systems, suggestive of a population that has very little exploitation. Tracking population dynamics over time will allow assessment of removal efforts and barrier projects that aim to reduce the impacts of Asian carp .

Funding Sources: *United States Fish and Wildlife Service, Water Resources Reform and Development Act of 2014*

KDFWR Strategic Plan: Goal 1, Strategic Objective 2.

Impacts of Asian Carp Harvest Program on Sportfish in Kentucky

Livewell during Silver carp removal / Chris Hickey

Neal Jackson, Jessica Morris, Clint Cunningham, and Brad Richardson, Kentucky Department of Fish and Wildlife Resources

Kentucky is the home to fertile waters including the intersection of some of the nation's largest rivers which have long supported rich fisheries and a tradition of commercial fishing. These fertile waters are now being exploited by the highly invasive Asian carp and as carp numbers increase, commercial markets follow. The Asian Carp Harvest Program (ACHP) was created in 2013 to increase commercial harvest of Asian carp in Kentucky waters to assist in the control of their rapidly expanding population. In 2015, the Kentucky Department of Fish and Wildlife (KDFWR) initiated a 5 cent/lb subsidy to incentivize the harvest of Asian carp from Kentucky Lake and Lake Barkley. The ACHP allows commercial fishing access in areas that are popular sportfisheries such as below dams and in reservoirs, and sportfish anglers often hold the belief that commercial fishing with gillnets negatively impacts sportfisheries. The objective of this study is to obtain daily reports from and observe commercial fishers to assess direct impacts of commercial fishing on sportfish in Kentucky waters.

Since the implementation of the Asian Carp Harvest Program, commercial fishers in Kentucky have harvested a total of 1,590,188 lbs of Asian carp(1,555,473lbs silver carp, 34,715lbs bighead carp). The number of commercial fishers using the ACHP has doubled since 2013 resulting in an an expected increase in effort as well (7,666 yards fished in the 2013-2014 season over 74 trips, and 105,700 yards fished in 2015 over 239 trips). KDFWR conducted 32 ride alongs with commercial fishers fishing under the ACHP during May-December 2015. During ride alongs 38,483 yards of gill net were fished and 72,224 lbs of Asian carp were harvested. The most common gear types were 4-5" gill nets. Most fishing effort was in Lake Barkley and Kentucky Lake. Fifty-six percent of Asian carp harvested during ride alongs were from Lake Barkley and 24% came from Kentucky Lake.

There were 785 individual fish captured as bycatch, of which 15% were sportfishes. The survival rate of sportfish was greatest in the Ohio River at 100% and lowest in Lake Barkley at 86.3% with the overall survival rate being 89.52%. The most common species of sportfish in the bycatch was blue catfish (N=65) followed by channel catfish (N=25) and flathead catfish (N=20). Excluding catfish, the number of sportfish in the bycatch was very low (2%). No crappie and very few temperate or black bass species (N=14) were observed in commercial nets during ride alongs. Paddlefish were the most common bycatch species making up 46% of all bycatch. Survival rate of paddlefish during ride alongs was 56.79% but varied between water bodies and time of year. Other species of fish that were commonly observed as bycatch included skipjack herring (12%), smallmouth buffalo (8%), and freshwater drum (8%).

As concerns grow over the impacts of Asian carp to native ecosystems, management agencies scramble to find solutions. Commercial fishing is one of the only tools currently available to limit those impacts. Some fish and wildlife agencies are reluctant to allow commercial fishing with gillnets due to a negative public perception and lack of information on the potential impacts. This study shows that the common gear types used in Asian carp commercial fisheries in Kentucky pose no threat to sportfish in our waters.

Funding Sources: *Sport Fish Restoration (DJ) and United States Fish and Wildlife Service State/ Interstate Aquatic Nuisance Species Funding Program (SIANSMP)*

KDFWR Strategic Plan. : Goal 1, Strategic Objective 2.

Stalking bobcat / Dave Baker

Exploring Methods for Monitoring Bobcats in Kentucky

Laura Palmer, Danna Baxley, Brian Gray, Gary Sprandel, and John Hast, Kentucky Department of Fish and Wildlife Resources

John Yeiser, University of Georgia

As the bobcat has naturally recovered and increased significantly in abundance throughout its native range, this furbearer has become valued in fur and taxidermy markets and by recreational predator hunters. Conversely, others view bobcats as exploiters of small game and promote intensive control measures to reduce populations. With various groups pursuing harvest of bobcats and requesting increased bag limits, it is necessary for wildlife managers to identify methods to monitor bobcat populations that will provide harvest opportunity while sustaining population levels.

We are exploring various techniques for detecting and monitoring bobcats to aid in determining the status of bobcat populations in Kentucky. These methods include camera surveys, trapping and radio-collaring bobcats to determine home range characteristics and survival, and tooth sample collection to determine age structure.

A camera survey was conducted on the Green River Wildlife Management Area and surrounding private land in Taylor and Adair counties during June 2012 through April 2013. We are currently exploring the use of a spatial-mark resight model to estimate bobcat density. Marks were established via foothold and cage trapping efforts and bobcats were resighted (or sighted) using camera traps. These models rely on capture histories of both marked and unmarked animals at each camera trap to inform animal locations and movement capabilities, which in turn, informs abundance estimates within a given area. Because of the relatively low number of captures, we are using telemetry data on marked individuals to supplement the estimation of movement parameters.

Since 2012, a total of 59 (32M:27F) bobcats have been equipped with VHF or GPS-enabled radio collars. Twenty one mortalities (11M:10F) have been documented. Sources of mortality include hunting, trapping, road-kill, trauma, and potential poaching. Annual or seasonal home range locations have been collected for 23 (10M:13F) bobcats. Equipment failure has prevented data retrieval from several GPS collared bobcats.

Approximately 650 bobcat teeth have been collected from harvested bobcats through voluntary donations from hunters and trappers since 2012. Resulting age data, combined with harvester effort and survival data, will be used to determine the feasibility of statistical population reconstruction techniques.

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

KDFWR Strategic Plan. Goal 1.

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

John Hast, John J. Cox and Brittany Slabach, University of Kentucky

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The Kentucky bull elk project is in its fourth year and plans to answer a number of objectives concerning the ecology of bull elk. A key set of questions we intend to answer is how long do bulls live (survival), how many die each year (mortality), and what causes them to die (cause-specific mortality). The management of elk in the Eastern United States lacks the decades of research that western elk managers have to rely upon. As such, local research projects such as this must be used to tailor management actions, taking into consideration the dynamics of this growing herd and hunter goals that change over time. We had a unique chance to evaluate bull mortality and survival when the old system of elk hunting units (EHU) was changed to the current limited entry areas (LEA) and at-large areas for the 2013 hunting season. These LEAs became necessary because hunters were killing too many elk in a couple of specific areas, due to there being a lot of public land and a lot of hunter access on adjacent private lands. It is our goal to provide as much elk hunting opportunity as possible, while continuing to maintain high hunter satisfaction with the overall hunting experience.

Bull elk establishing dominance / John Hast

To examine the question of bull elk survival and cause specific mortality, we chemically immobilized 176 adult bull elk between 2011 and 2013 and equipped them with radio tracking collars. Additionally, we took a variety of other samples such as blood, tissue, fecal, and body measurements while the elk was immobilized. Elk were monitored once weekly via radio telemetry from the ground or air outside of the general hunting season and multiple times per week during the hunting season. Elk were immediately investigated upon the confirmation of a mortality signal and a necropsy was performed once the expired elk was located. Any hunter harvested elk were examined and an additional set of samples were taken post-harvest.

At this point in the study, 117 of the 176 (66.4%) captured elk have experienced a mortality event of which 76% were hunter related, 10% were attributed to *P. tenuis* (brain worm), 12% were random mortalities (ie. fence kill, road kill, etc.) and 2% were unknown mortalities. When specifically investigating mortality events in a time period overlapping the fall bull hunting season (August 1 to February 1) we noted that the middle age classes of bulls (4.5 to 5.5 years old) were taking the brunt of the harvest pressure. In the fall of 2012, bull elk 4.5 and 5.5 years old had a 41% and 35% chance of surviving the hunting season, respectively. Following the change in elk hunting regulations mentioned in the opening paragraph and a 1/3rd reduction in tags in the Hazard LEA, there was only a slight increase in 4.5 and 5.5 year old bull survival.

Given the lottery system of elk tag allocation that the state of Kentucky employs, most elk hunters each year are first time hunters. Our data suggests that most hunters choose to harvest a middle aged bull thus bottlenecking bull numbers as they grow out of the 5.5 year old age class. The recent installation of the three new LEAs occurred in response to the localized overharvest of bull elk in areas with large areas of public land and ease of hunter access. With a reduced number of tags in these areas, we should continue to see good numbers of harvestable bulls while allowing more to grow into the trophy age classes (9.5 years old and above).

Funding Source: *Wildlife Restoration Program (Pittman Robertson), University of Kentucky, and the Rocky Mountain Elk Foundation*

KDFWR Strategic Plan. Goal 1.

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

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Group dynamics - associations and relationships between individuals - are a key, yet often uninvestigated, parameter important to understanding population structure and persistence. Factors, such as selective take, have been shown to have differential effects on recruitment and fecundity, as well as connectedness and membership of groups. Yet short and long-term effects of these factors on group dynamics are not understood. Using standard very high frequency (VHF) radio collars and behavioral observations, we have been exploring group dynamics and the effects of human disturbance in cow elk.

A total of 94 cow elk have been outfitted with VHF collars and ear tags for individual identification (2013, N = 40; 2014, N = 54) since 2013. No additional animals were captured during the 2016 field season. Physiological parameters such as age, body condition, and morphological measurements were taken upon capture. Mortality is monitored weekly and behavioral observations occur during three biological time periods (winter herd, nursery herds, and rut harems).

Associations for 69 marked individuals have been quantified since 2013, including individuals marked in 2013 that survived the 2013-2014 hunting season (N = 6), and individuals captured in 2014 that survived the 2014-2015 hunting season (N = 27). Resident herds remained cohesive across the study area for both 2013 (E-I = -0.76, $p < 0.05$) and 2014 (E-I = -0.71, $p < 0.05$). A few individuals moved between resident herds after calving each year. A total of 26 overlapping subgroups (e.g., groups that compose the resident herd) were identified by hierarchical cluster analysis based on herd co-membership, where resident herds differed in the number of overlapping subgroups that occurred (level > 6.0; Site 1, N = 8; Site 2, N = 17). Subgroups were more significantly spatially cohesive across years (avg. = 3.14, med = 1, N = 253) compared to overall group spatial proximity (avg. = 7.80, med = 8.5, N = 390, $p < 0.005$); suggesting that socially mediated subgroups are the first social-tier in this population. Genetic relatedness, using 16 microsatellite loci, is currently being analyzed to test the hypothesis that family groups compose the subgroups of the resident herds (e.g., individuals within subgroups are more related to each other than the rest of the herd).

A total of 46 marked individuals were on the landscape at the start of the 2015 hunting season. A mortality rate of 28% was observed (N= 13; 2 archery; 10 modern gun; 1 wounding loss); which is comparable to the 2013 and 2014 hunting season. An analysis of probability of mortality and herd membership is currently being conducted. Preliminary survival analysis suggests that age effects position in the dominance hierarchy and dominance status effects probability of mortality due to human harvest. The effect of selective take of key individuals (e.g., dominants) on herd association patterns and persistence over time is currently being analyzed. Continued investigation into how these populations are structured and influenced by human factors will help aid management of this state resource.

Funding Sources: *Rocky Mountain Elk Foundation and the University of Kentucky*

KDFWR Strategic Plan: Goal 1.

Elk herd in summer / Brittany Slabach

Effects of the Conservation Reserve Enhancement Program on Grassland Birds in Kentucky


Preparing CREP fields

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Native grasslands are one of the rarest habitats in the eastern United States, and northern bobwhite (*Colinus virginianus*; hereafter bobwhite) have been declining for several decades. Habitat loss has been a major factor behind bobwhite declines and converting agricultural lands to native grasslands has been a central tool of bobwhite restoration. These grasslands benefit other avian species of concern as well.

The Conservation Reserve Enhancement Program (CREP) is a federally funded private-land conservation initiative that's established 100,000 acres of native grassland and riparian habitat in the Green River Basin. CREP practices have been shown to benefit grassland bird populations at the field scale; however, less is known about the benefits of the CREP at the landscape scale. Therefore, we have designed at study to investigate how the density of CREP across agricultural landscapes influences the number birds in local areas with little to no CREP.

This study focuses on agricultural areas within the Green River basin. Sampling points across the study area were chosen based on different combinations of CREP densities at both landscape (3000 m radius) and local (510 m radius) scales. The amount of CREP habitat was allowed to vary at the landscape scale but was kept relatively low (<6%) and constant at local scales. Kentucky Department of Fish and Wildlife Resources (KDFWR) biologists collected bird data from 2010—2015.

Often in similar studies, the statuses of fields are ignored, or in other words, it is assumed that all CREP areas are good bird habitat. We expect that this is not the case: fields can be managed differently (i.e., mowed vs sprayed), can have varying planting success, and are subject to variation in how quickly succession happens. Currently, we are using ground-truthed information and satellite images of CREP field statuses in 2016 to predict what fields looked like from 2010—2015. This way, we can more accurately depict the influence CREP has had on the landscape and bird populations.

Preliminary analysis indicates that increasing the amount of CREP at landscape scales increases the number of some species (e.g., bobwhite), but not others (e.g., eastern meadowlark, *Sturnella magna*). Further analysis will uncover the relative importance of the amount of CREP on the landscape, the management of CREP fields, and the pattern of land features in predicting how birds respond to broad-scale conservation. Our main goal is to produce a final 'landscape management plan' depicting best practices for producing high numbers of bobwhite and other grassland birds over a large area. We hope that this research guides habitat management for early successional species in the state of Kentucky and beyond, and that it serves to inform future conservation decisions.

Funding Source: *Wildlife Restoration Program (Pittman Robertson) and the University of Georgia*

KDFWR Strategic Plan: Goal 1.

Population Dynamics of Adult Female White-tailed Deer in Southeast Kentucky

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The white-tailed deer (*Odocoileus virginianus*) is a highly regarded game species throughout North America. Early in the 20th century, the deer population in the state of Kentucky was believed to number around 2,600 individuals. After almost 90 years, 50 of which contained active restoration efforts, the deer herd now exceeds 750,000 individuals, statewide. Although most of the state contains healthy numbers of deer, many counties in southeastern Kentucky are thought to have stable, yet low density populations.

Our research continues to focus on adult does in Clay County, KY, in efforts to identify survival, cause-specific mortality, fecundity, and natality of this important reproductive demographic group in an area of relatively low deer density. Adult does continue to be captured and immobilized using clover traps, drop-nets, and free-range darting, then fitted with a very high frequency (VHF) radio collar. Pregnancy status and number of fetuses are determined using ultrasonography. Vaginal implant transmitters (VIT) used in pregnant does have facilitated location of birth-site locations and fawns for an additional deer study. Adult does have been monitored twice weekly for mortality for 18-24 months. We are currently monitoring over 70 does to assess above-mentioned population parameters. These data should inform state wildlife managers about regional deer population dynamics that can be helpful for refinement of population models and the overall management of this important game species.

Funding Source: *Wildlife Restoration Program (Pittman Robertson) and the University of Kentucky*

KDFWR Strategic Plan. Goal 1.

Deer immobilized for research / John Cox

Survival of White-tailed Deer (*Odocoileus virginianus*) Neonates in a Southeastern Kentucky Population

Newborn fawn / Casey Maggard

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Gabriel Jenkins, Will Bowling, John Hast, and Kyle Sams, Kentucky Dept. of Fish and Wildlife Resources

Tina Johannsen - Georgia Department of Natural Resources

KDFWR and University of Kentucky researchers are entering the final field season of a three year research project examining deer fawn survival in a southeastern Kentucky population. Recent harvest trend data have suggested that deer populations in the southeastern portion of the state are not growing at a rate we would expect to observe under the Zone 4 designation (very conservative harvest regulations). To better understand these growth trends, it is critical to understand the factors that influence summer mortality and survival in fawns; when combined, the two rates will provide a measure of fall recruitment, or number of animals added to the huntable population each year.

66 fawns have been captured and collared over the previous two years of the study, primarily through the use of vaginal implant transmitters (VITs) inserted into radio collared females captured in a concomitant study. Fawns were also captured by utilizing thermal imaging (FLIR) cameras at night and by searching probable fawning habitats during the daylight hours. Once captured, fawns were fitted with an expandable neonate collar that allows us to monitor the animals until death or until the collar releases at around nine months of age.

20 adult does were inserted with VITs during the 2016 winter trapping season. With the use of these VITs, and through continued ground searches and thermal scans, we hope to end the 2016 fawning season with a three year sample size of ≥100 collared fawns. Upon completion of the upcoming field season, we will have a better understanding of what factors are influencing fawn mortality, as well as how many fawns are surviving into the fall hunting season. The results of this project will support future decisions regarding deer management in southeastern Kentucky.

Funding Source: *Wildlife Restoration Program (Pittman Robertson) and the University of Kentucky*

KDFWR Strategic Plan. Goal 1.

Researchers weigh a fawn / Kyle Sams

Incorporating disturbance ecology into native hardwood tree seedling restorations of the Kentucky Inner Bluegrass Savanna-Woodland

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KDFWR burn crew

Savanna systems are maintained by a particularly interesting balance of competition and disturbance. Historical evidence suggests the Inner Bluegrass Region of Central Kentucky was formerly typified by a Savanna-Woodland plant community, potentially maintained by periodic fires and herbivory impacts of mammals. Since the time of European pioneer settlement in the region (c.1750), fires have been suppressed and mammal populations have either been extirpated (American bison, *Bison bison*; Eastern elk, *Cervus canadensis canadensis*) or fluctuated drastically (White-tailed deer, *Odocoileus virginianus*; Eastern cottontail rabbit, *Sylvilagus floridanus*; multiple small rodent species). Land clearing and urbanization have eliminated over 99% of native Kentucky Bluegrass Savanna-Woodlands, emphasizing the need to conduct research and institute restoration efforts for this imperiled ecosystem.

In March 2011, fourteen species of native hardwood tree seedlings were planted into a long-term, large-scale restoration ecology experiment at Griffith Woods Wildlife Management Area (the best preserved Savanna-Woodland remnant in KY) to research the ecological factors that influence tree seedling regeneration. Experimental treatments of competition reduction, herbivore inhibition, and prescribed fire have been implemented to understand how these ecological filters influence seedling performance (i.e. growth and survival) and functional traits (i.e. leaf production, photosynthetic rates). This experiment is also revealing information about native herbivore browsing preferences and initial trends indicate species specific responses to herbivory, with preferences by deer for White Ash (*Fraxinus americana*) and Mulberry (*Morus* sp.), and preferences by rabbit for Hickory (*Carya* sp.), Kentucky Coffeetree (*Gymnocladus dioicus*) and Sugar Maple (*Acer saccharum*). Competitive effects of surrounding vegetation suppress many species' growth, while competition reductions through mowing favor increased above ground growth by Black Walnut (*Juglans nigra*) and White Ash.

Most recently, experimental work at Griffith Woods WMA has included the collaborative effort of UK researchers and KDFWR personnel to implement the initial five year prescribed fire treatment (conducted on March 7, 2016). To properly quantify seedling responses, we have measured temperatures experienced by seedlings during the fire, fire scarring on seedling trunks, top-killed and re-sprouting seedlings, soil nutrient inputs in burned versus control blocks, and overall seedling growth in burned versus control blocks. Additionally, remote sensing data using aerial drone flyovers and infrared thermal imaging will be used to construct a predictive fire behavior model. The ultimate goal of this research is to inform conservation and restoration efforts towards remnant Kentucky Bluegrass Savanna-Woodlands while also elucidating basic biological and ecological information on this guild of understudied tree species.

Funding Source: *University of Kentucky*

KDFWR Strategic Plan. Goal 1.

Least tern chick / John Brunjes

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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

PROJECT REFERENCES 2007-2015

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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