Kentucky Department of Fish and Wildlife Resources

Prescribed fire / John Brunjes

Annual Research Highlights 2013

Volume VII, Oct. 2014

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Our Mission:

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

Foreword

A biologist prepares stake buckets to be dropped into Cave Run Lake / Dave Baker

Research and monitoring are key steps towards conserving and enhancing fish, wildlife, and habitat resources of the Commonwealth. The 2013 KDFWR Research Highlights document represents targeted efforts by KDFWR and partners to fulfill statewide conservation goals. As stewards of fish and wildlife in Kentucky, it is our job to ensure seasons and bag limits are sustainable and to determine if management actions achieve desired goals. The following project summaries serve as a testament to KDFWR's vigilance in the conservation of the fish and wildlife resources that we hold in trust for the public.

Funding Sources and Guide to Federal Programs

KDFWR receives no general fund taxpayer dollars. As a result, the Department relies on hunting and fishing license fees, boat registration fees, and federal programs to fund the seven divisions within KDFWR. Nearly all of the projects included in this document are funded in part by federal programs such as 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/or habitat conservation. Brief descriptions of each of these programs are as follows:

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

Wood duck banding / John Brunjes

These federal programs provided approximately 17.3 million dollars to KDFWR in 2013, while the sale of hunting and fishing licenses provided 26.3 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.

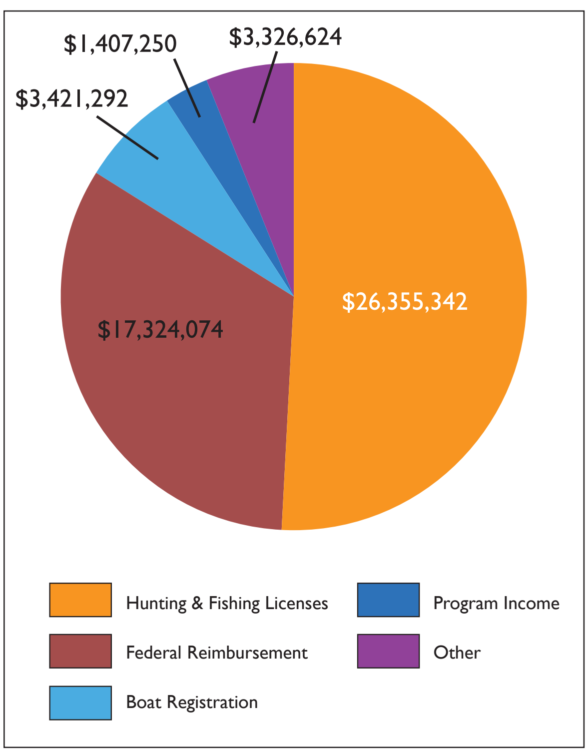


Figure 1. Kentucky Department of Fish and Wildlife Resources Funding Sources 2013. Total revenues for 2013 were $51,834,582.

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 2013, 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. In the table of contents, an expected date of completion, where applicable, is listed for each project. This will facilitate looking up detailed summaries of completed projects in later years. A comprehensive **project reference guide** lists all projects included in Research Highlights documents, beginning with publication year 2007.

Please use the following citation when referencing this document:

Kentucky Department of Fish and Wildlife Resources Annual Research Highlights, 2013. Volume VII. Publication of the Wildlife and Fisheries Divisions. October, 2014, 90 pp.

Table of Contents

Published Research

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

Johnson, J.S., and M.J. Lacki. 2013. Habitat associations of **Rafinesque's big-eared bats** (*Corynorhinus rafinesquii*) and their lepidopteran prey in bottomland hardwood forests. Canadian Journal of Zoology 91:94-101.

Johnson, J.S., and M.J. Lacki. 2013. Summer heterothermy in **Rafinesque's big-eared bats** (*Corynorhinus rafinesquii*) roosting in tree cavities in bottomland hardwood forests. Journal of Comparative Physiology 183:709-721.

Niemiller, M.L., G.O. Graening, D.B. Fenolio, J.C. Godwin, J.R. Cooley, W.D. Pearson, B.M. Fitzpatrick and T.J. Near. 2013. Doomed before they are described? The need for conservation assessments of cryptic species complexes using an **amblyopsid cavefish** (Amblyopsidae: *Typhlichthys*) as a case study. Biodiversity Conservation 22:1799-1820.

Sheehan, J., P.B. Wood, D.A. Buehler, P.D. Keyser and J.L. Larkin. 2013. Avian response to timber harvesting applied experimentally to manage **Cerulean Warbler** breeding populations. Forest Ecology and Management 321:5-18.

Steen, D.A., C.J.W. McClure, L.L. Smith, B.J. Halstead, C.K. Dodd, W.B. Sutton, J.R. Lee, D.L. Baxley, W.J. Humphries, and C. Guyer. 2013. The effect of coachwhip presence on body size of **North American racers** suggests competition between these sympatric snakes. Journal of Zoology 289:86-93.

Completed Projects and Monitoring Summaries

Wildlife

Fisheries

New Projects

These projects began in 2013

Wildlife

Fisheries

Habitat

Project Updates

This section includes brief updates for selected projects that began prior to 2013.

WILDLIFE

Big Game

Small Game

Songbirds and Raptors

Reptiles and Amphibians

FISHERIES

Warm Water Fisheries

Urban Fisheries

Lake Investigations/ Cold Water Fisheries

KDFWR employees look out over the recently procured Boone Tract of Kentucky River WMA / Lee McClellan

Wood ducks caught in net / John Brunjes

Completed Projects

Maximizing Wildlife Benefit of Surface Mine Reclamation in Kentucky: Are Wildlife-Friendly Mixes Adequate for Bond Release?

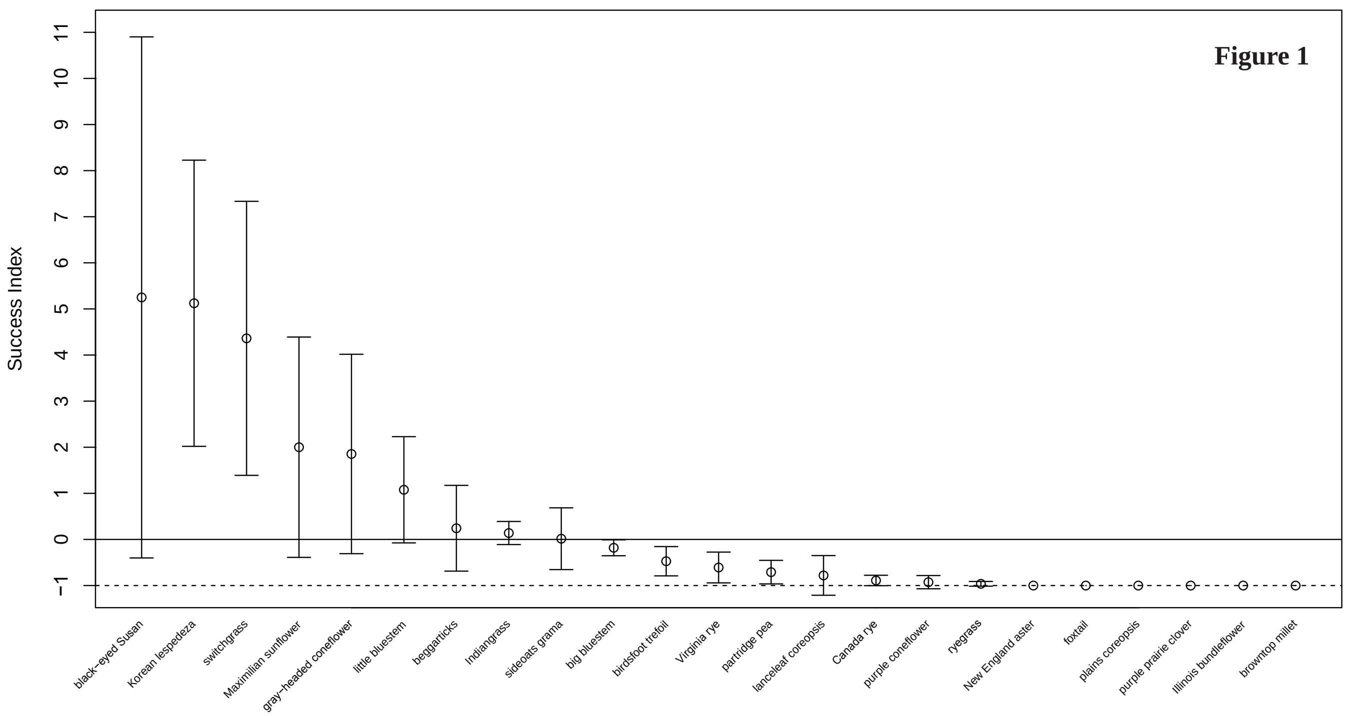
John Yeiser, Danna Baxley, Ben Robinson, John Morgan, Jacob Stewart, and Jim Barnard, Kentucky Department of Fish and Wildlife Resources.

Introduction

Appalachian states provide over 20% of total U.S. coal production, with West Virginia and Kentucky the second and third largest coal producing states overall, respectively (U.S. Energy Information Administration 2012). From 1976 to 2006, surface coal mining was the dominant driver of land use change in central Appalachia (Townsend et al. 2009). These land use changes consisted largely of the conversion of forested habitat to open lands (Loveland et al. 2003), and until 1977, companies were not required to adhere to either federal or state mineland reclamation standards.

As a result of intense public and political scrutiny (Randall et al 1978), mineland reclamation practices drastically changed in 1977 with the advent of the Surface Mining Control and Reclamation Act (SMCRA) (U.S. Public Law 95-87). The SMCRA is the primary federal law regulating coal mining in the United States and utilizes a cooperative approach where state agencies implement performance standards, permitting, inspection and enforcement, while the federal government maintains oversight of the program. Current SMCRA guidelines are designed to minimize erosion and negative impacts to water quality by rapidly establishing vegetation to stabilize soils. The SMCRA mineland reclamation standards vary depending on the target post-mineland reclamation

Field data collection / Ben Robinson



land use. Fish and wildlife habitat is a common post-mining land use in Appalachia.

Before surface mining begins, SMCRA requires mining companies to post monetary bonds to ensure proper reclamation. This bond money is returned to the company in three phases once specific reclamation practices have been completed (henceforth referred to as "bond release"). Bond release requirements are different among states, but in Kentucky bond release is attained when minelands are reclaimed to the appropriate success standard, or 80-90% vegetative cover depending on the post-reclamation land use (Kentucky Department of Surface Mining Reclamation and Enforcement, 1991). As an example of the value of these bonds, the Kentucky mining industry had 10,039 outstanding bonds valued at $839.9 million as of September 2010 (Kentucky Energy and Environment Cabinet 2012). The bond release format allows the state Office of Surface Mining to ensure compliance with reclamation standards. Most mining companies seek to attain bond release as soon as possible once mining has been completed. Wildlife habitat is one of the most common post-mining land uses because it requires establishment of grasslands that cover 80% ground area, and it is quicker and more cost effective than other post-mining uses (e.g. forest habitat, agricultural habitat, industrial development). Companies approach reclamation in terms of dollars and time; consequently, seed mixes composed of exotic plants (e.g. Sericea Lespedeza, *Lespedeza cuneata*) are most common, currently. These exotic plants successfully establish on minelands and are a quick and economical way for mining companies to meet bond release (Burger 2011). Although typical planting mixes meet erosion and vegetative requirements of SMCRA, these plants provide little value to wildlife as food and cover.

While an extensive literature base is available on mining-wildlife relationships (e.g. Brenner et al 2009, Ferreri et al. 2004, Gust and Schmidly 1986), few studies directly assess efficacy of grassland reclamation practices to benefit wildlife and pollinators in Appalachia. The studies quantitatively addressing optimal reclamation practices focus primarily on reclaiming forest, not grassland systems (e.g. Angel et al 2005, Burger et al. 2005, Burger et al. 2009). A 2012 literature review of coal mining and wildlife in the Eastern United States identified 300 articles, reports, dissertations, theses, and other documents of interest; only eight of these documents address native plant restoration on reclaimed mine land (Buehler and Percy unpublished manuscript). Developing reclamation practices that promote ecological restoration of native plant and animal communities is a top priority research need.

Multiple studies suggest ways to improve reclamation efforts to benefit wildlife. Holl (2002) recommended lengthening bond release periods, planting a wider variety of tree species, and advocated a need for research on native and naturalized ground species that may be used to diversify reclamation efforts. Brenner et al. (1975) suggested using native grass and forb mixes to optimize biodiversity and wildlife value. The value of native warm season grasses and native forbs as beneficial wildlife food and cover is well-known (e.g. Barnes et al. 1995, Harper et al. 2008, Holimon et al. 2012); however the efficacy of using wildlife-friendly seed mixes to reclaim minelands in Appalachia has not been directly addressed. In addition to questions of efficacy, costs of native seed mixes exceed costs of typical non-native seed mixes, and native plants often take longer to establish. Our primary study objective was to experimentally assess the efficacy of hydroseeding wildlife-friendly seed mixes to meet SMCRA bond requirements for fish and wildlife habitat (80% vegetative cover) on Kentucky mine sites. Additionally, we sought to determine if differences in slope affect success of wildlife-friendly plantings. To our knowledge, this is the first study aimed at bridging the scientific gap between subjective and quantitative management recommendations regarding grassland mineland reclamation efforts.

Methods

We studied mineland revegetation success at 9 replicates across three sampling sites (ICG n=2, PB n=4, SF n=3) located in Perry, Knot, and Breathitt Counties. We investigated revegetation success of three different seed mixes: typical, wildlife-friendly, and hybrid. Seed mixes and seeding rates for each treatment were the same at each sampling location. Between 21 May and 24 April 2009, mine site personnel hydro-seeded treatment plots using the same commercial hydro-seeding equipment used onsite for routine reclamation planting.

Vegetation sampling occurred between 21 August and 12 September, 2013, five growing seasons post-reclamation. We arranged treatment plots consecutively along a hillside and we stratified vegetation sampling by slope. We sampled vegetation within each treatment plot along a transect running vertically from the base of the incline to the peak. At the onset of this study, we permanently marked transect locations with rebar stakes. Every 15 ft, we arranged four 1 m2 sub-plots along a cross-transect running perpendicular to the vertical transect, with two sub-plots on either side. We adopted this sampling design to achieve 5% sampling coverage of each treatment plot. We randomly chose locations of sub-plots along the cross-transect using dice to determine distance and a coin flip to determine direction (right or left) from the vertical transect. Within each sub-plot, we estimated percent cover of native and exotic vegetation, grass, forbs, and bare ground. Percent cover of each species within the sub-plot was recorded as one of five cover classes: 0–20%, 20–40%, 40–60%, 60–80%, and 80–100%. Vegetative cover means of each seed mix treatment were pooled across all sites and slopes and were compared to Lowest Acceptable Values, as calculated in Kentucky Department of Surface Mining Reclamation and Enforcement (1991). We repeated sampling measures along the vertical transect until we reached the peak of the slope or had sampled 7 cross-transects.

We averaged the midpoints of cover estimates across all sub-plots within a cross-transect, and we averaged cross-transect means across treatment plots for comparison of vegetative parameters between treatments. All statistical analyses were performed in R version 3.0.1 (R Core Team 2013) using the package “vegan” (Oksanen et al. 2013). We ran a distance-based redundancy analysis (db-RDA) to investigate how our constraining variables (seed mix, sampling site, and slope) influenced plant community dissimilarity between treatments. Using percent cover estimates as measures of abundance we calculated a Bray-Curtis distance matrix using the “vegdist” command, and performed the db-RDA on the

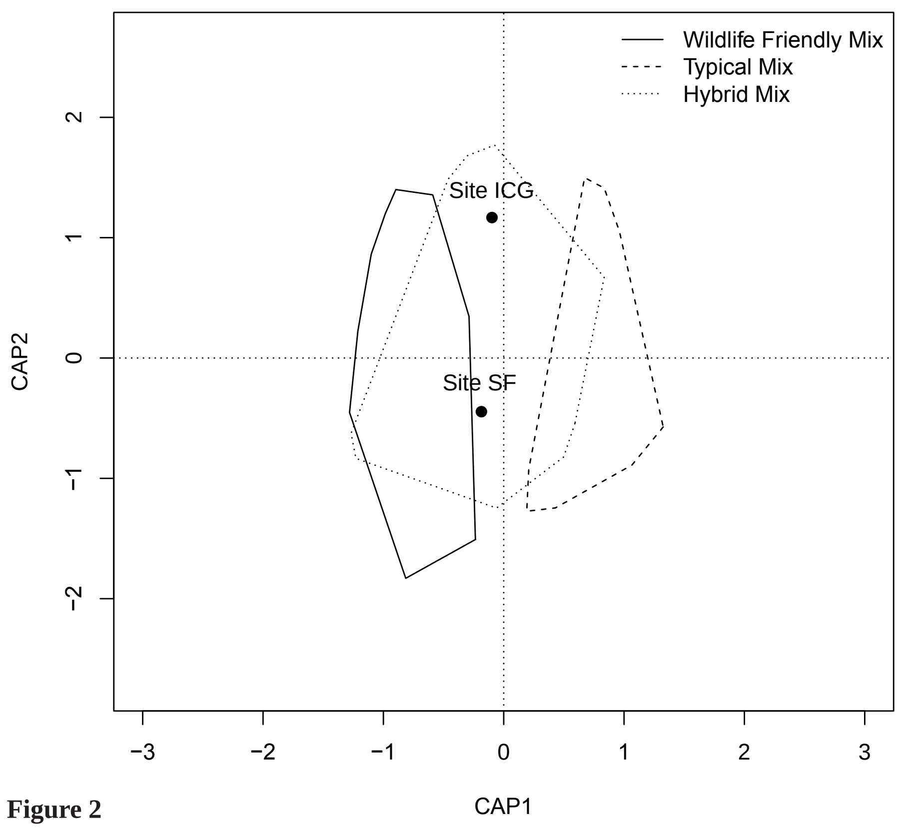
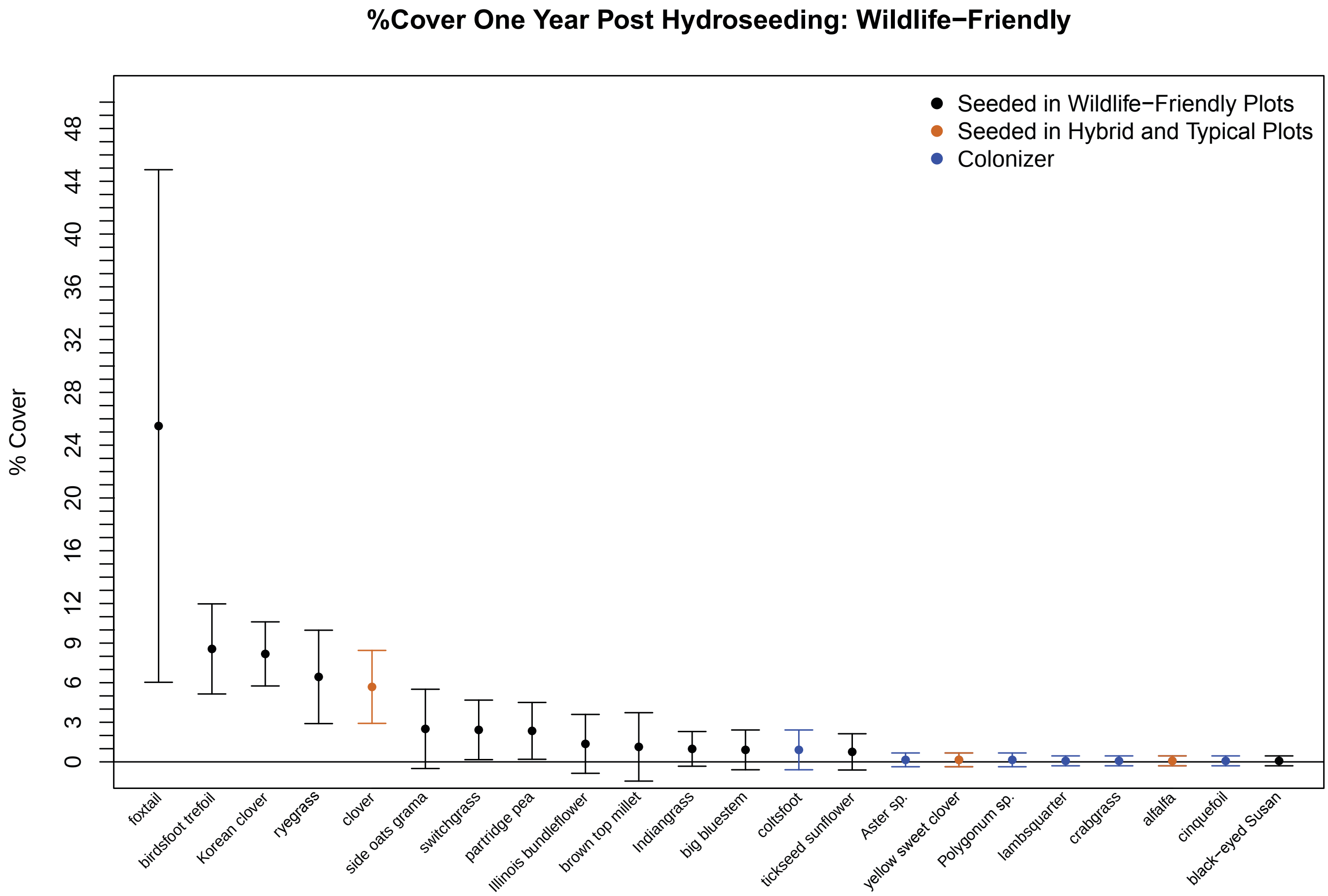


Figure 2



distance matrix using the "capscale" command. We ran a redundancy analysis (RDA) on a species cover/seeding rate ratio to understand how sampling site and slope influenced the establishment and persistence of species in wildlife-friendly mixes. We recognized species with higher cover/seeding rate ratios as more successful compared to species with lower cover/seeding rate ratios. To understand how habitat structure was influenced by our treatments, sampling site, and slope we ran a RDA with our constraining variables and percent grass, forbs, and bare ground.

Results

The wildlife-friendly seed mix met SMCRA requirements when averaged across all sampling areas and slopes (mean cover = 86.07%, 95% CI [75.94, 96.20], Lowest Acceptable Value = 72.85). Location of transects along the slope had little influence on vegetative cover. The majority of variation in vegetative cover within wildlife-friendly treatments was caused by a statistical outlier, which we identified using a Cochran test for outlying variance (C = 0.30, df = 19.89, k = 9.00, $p < 0.001$). Slope failure occurred at this site within the duration of our study causing much of its area to be uninhabitable for plant life, but because unstable slopes are common on minelands, we retained this outlier. Sampling site had relatively greater influence on establishment success of plants in wildlife-friendly mixes than did slope (total constrained inertia = 77.73, RDA1 Eigenvalue = 66.12, RDA2 Eigenvalue = 9.71; permutation test df = 8, F = 4.34, p = 0.005, n permutations = 199). Success indices of several species displayed positive associations to sampling site, including greyheaded coneflower and black-eyed Susan to site ICG, Korean clover to site PB, and switchgrass to site SF. Success index of switchgrass was also associated with locations highest along the slope.

In wildlife-friendly sampling sites that met SMCRA requirements black-eyed Susan, Korean lespedeza, switchgrass, Maximilian sunflower, gray-headed coneflower, little bluestem, beggarticks, Indiangrass, and sideoats grama were successful (i.e. success index scores equal to or greater than zero) (Figure 1). Several species in wildlife-friendly plots were initially successful one year post hydroseeding, including foxtail, birdsfoot trefoil, and Korean clover. The majority of successful plants in hybrid treatments were wildlife-friendly, with alfalfa, redtop, and birdsfoot trefoil being the only successful typical plants.

Clear distinctions between wildlife-friendly and typical seed mix plant communities five years post hydroseeding were indeed caused by treatment, with variation within seed mix treatments caused by sampling site (Figure 2) (total constrained inertia = 16.70, CAP1 Eigenvalue = 10.61, CAP2 Eigenvalue = 3.30; permutation test $df = 10$, $F = 8.23$, $p = 0.005$, n permutations = 199). Increased grass cover was associated with site ICG (total constrained inertia = 291.60, RDA1 Eigenvalue = 165.36, RDA2 Eigenvalue = 115.30, permutation test $df = 10$, $F = 3.28$, $p = 0.005$, n permutations = 199), but site scores in ordination space indicated habitat structure was similar between all sites, seed mixes, and slopes.

Discussion

Our study provided evidence of successful wildlife-friendly revegetation of minelands. Vegetative cover at wildlife-friendly plots was comparable to typical mix plots five years post hydro-seeding and met bond requirements. Slope had little influence on success of plantings, and high vegetative cover in wildlife-friendly plots was consistent across sampling points except in the case of slope failure; this indicates that wildlife-friendly seed mixes have potential to be established successfully across large geographic areas. On average across all sites, eight out of nine successful plants within wildlife-friendly mixes were native to the eastern US. While Korean lespedeza is a non-native plant, it is not overly invasive, and it covers bare ground created by clumps of native grasses and forbs. Ground cover is essential to meeting bond release, and plants similar to Korean lespedeza are needed to ensure sufficient vegetative cover. Several plants were failures by our standards as well, including ryegrass, foxtail, and brown-top millet; however, these plants are also necessary when revegetating minelands because they can potentially provide early vegetative cover that likely prevents large scale erosion. Despite several species within our wildlife-friendly seed mix failing, we recommend replicating our wildlife-friendly seed mix in future mineland reclamation efforts because variation across geographic areas was evident, and plants that did not succeed during our study may succeed in future studies in different regions.

There is vast potential for implementing native grassland habitat on abandoned and reclaimed minelands in Appalachia. Approximately 2.9 million acres had been permitted for coal mining in Appalachian states as of 2011, with permits in Kentucky alone accounting for over 1.9 million acres (Office of Surface Mining 2011). The vegetative communities of our wildlife-friendly and typical seed mix treatments were not similar after five years, indicating that planted communities will likely persist indefinitely. Variation within treatments was caused by sampling site, indicating that species composition will differ between wildlife-friendly plantings across landscapes, potentially creating large areas of heterogeneous grasslands. Increases in plant richness can increase pollinator richness (Ebeling et al. 2008) and reclaimed minelands can possess 300 times the nectar of surrounding forests (Holl 1995); even small areas of flowers can attract pollinators in agricultural areas (Lagerlöf et al. 1992). Pollinators are valuable to food production and human economies (reviewed in Kearns et al. 1998). In fact, a diverse group of crops comprising 35% of global food production rely on animal pollinators (Klein et al. 2007). Large areas of open grasslands are rare in the eastern US and many grassland bird populations are influenced by habitat patch size (Vickery et al. 1994), yet greater abundance of a species is not guaranteed by increasing grassland area (Murray et al. 2008). Habitat structure and heterogeneity are vital to maintaining healthy grassland bird populations (Gill et al. 2006, Ribic et al. 2009), and converting minelands to diverse, predominately native grasslands has potential to provide these populations with large areas of diverse habitat. Upland game birds, such as Northern bobwhite, also benefit from native grasses and forbs (Blank 2013, Washburn et al. 2000).

Management Implications

We recommend using our wildlife-friendly seed mix to revegetate minelands in Appalachia. Wildlife-friendly seed plantings resulted in greater than 80% vegetative cover, satisfying SMCRA requirements in Kentucky, and eight of nine successful plant species were native to the eastern US. Alterations to seed mix composition and planting rates may be necessary in future reclamation efforts because of differences in geographic regions, and land managers should tailor our recommended seed mix in response to long term goals. Successful plantings of native and wildlife-friendly grasses and forbs have potential to produce millions of acres of high quality habitat for grassland birds, upland game birds, and insect pollinators. Our wildlife-friendly seed mix was more expensive than the typical seed mix and will be a limiting factor in large scale reclamation. Cooperative efforts between resource management agencies, mining companies, surface mining reclamation enforcement entities, and entities overseeing abandoned minelands to facilitate wildlife-friendly plantings would be the most feasible way to conduct large scale wildlife-friendly reclamation on surface mines in Appalachia.

Literature Cited

Angel, P., V. Davis, J. Burger, D.

Graves, and C. Zipper. 2005. The Appalachian Regional Reforestation Initiative. The Appalachian Regional Reforestation Initiative Forest Reclamation Advisory No 1.

Barnes, T. G., L. A. Madison, J. D. Sole, and M. J. Lacki. 1995. An assessment of habitat quality for northern bobwhite in tall fescue-dominated fields. Wildlife Society Bulletin 23:231–237.

Blank, P. J. 2013. Northern bobwhite response to Conservation Reserve Program habitat and landscape attributes. Journal of Wildlife Management 77:68–74.

Brenner, F. J., R. H. Crowley, M. J. Musaus, and J. H. Goth. 1975. Evaluation and recommendations of strip mine reclamation procedures for maximum sediment-erosion control and wildlife potential. in: Third Symposium on Surface Mining and Reclamation.

Brenner, F. J., J. L. Stenglein, and M. R. Ridge. 2009. Evaluating the potential impacts of surface mining on water quality and macroinvertebrate communities in a native brook char fishery. in: Proceedings of the National Meeting of the American Society of Mining and Reclamation.

Burger, J., D. Graves, P. Angel, V. Davis, and C. Zipper. 2005. The Forestry Reclamation Approach. Appalachian Regional Reforestation Initiative. Forest Reclamation Advisory No. 2.

Burger, J. A., Dan Kelting, and C. E. Zipper. 2009. Restoring the value of forests on reclaimed mined land. VCE publication 460-138. http://pubs.ext.vt.edu/460-138.

Burger, J. A. 2011. Sustainable mined land reclamation in the eastern U.S. coalfields: a case for an ecosystem reclamation approach. in: Proceedings, 2011 National Meeting of the American Society of Mining and Reclamation.

Buehler, D. A., and Percy, K. 2012. Coal mining and wildlife in the eastern United States: a literature review. Unpublished report, University of Tennessee, Knoxville.

Ebeling, A., A. Klein, J. Schumacher, W. W. Weisser, and T. Tscharntke. 2008. How does plant richness affect pollinator richness and temporal stability of flower visits? Oikos 117:1808–1815.

Ferreri, C. P., J. R. Stauffer, and T. D. Stecko. 2004. Evaluating impacts of mountain top removal/valley fill on stream fish populations. in: Proceedings of the National Meeting of the American Society of Mining and Reclamation.

Gill, D. E, P. Blank, J. Parks, J. B. Guerard, B. Lohr, E. Schwartzman, J. G. Gruber, G. Dodge, C. A. Rewa, and H.F. Sears. 2006. Plants and breeding bird response on a managed Conservation Reserve Program grassland in Maryland. Wildlife Society Bulletin 34:944–956.

Gust, D. A. and D. J. Schmidly. 1986. Small mammal populations on reclaimed strip-mined areas in Freestone County, Texas. Journal of Mammalogy 67:214-217.

Harper, C. A., C. E. Moorman, and P. D. Keyser. 2008. Native warm-season grasses and early successional wildlife habitat: Past lessons and a new vision. Proceedings Eastern Native Grass Symposium 6:120–126.

Holimon, W. C., J. A. Akin, W. H. Baltosser, C. W. Rideout, and C. T. Witsell. 2012. Structure and composition of grassland habitats used by wintering Smith's Longspurs: the importance of native grasses. Journal of Field Ornithology 83:351–361.

Holl, K. D. 1995. Nectar resources and their influence on butterfly communities on reclaimed coal surface mines. Restoration Ecology 3:76–85.

Holl, K. D. 2002. Long-term vegetation recovery on reclaimed coal surface mines in eastern USA. Journal of Applied Ecology 39:960–970.

Kearns, C. A., D. W. Inouye, and N. M. Waser. 1998. Endangered mutualisms: the conservation of plant-pollinator interactions. Annual Review of Ecology and Systematics 29:83–112.

Kentucky Department of Surface Mining Reclamation and Enforcement. 1991. Field sampling techniques for determining ground cover, productivity, and stocking success of reclaimed surface mined lands. Technical Reclamation Memorandum 19.

Klein, A., B. E. Vaissière, J. H. Cane, I. Steffan-Dewenter, S. A. Cunningham, C. Kremen, and T. Tscharntke. 2007. Importance of pollinators in changing landscapes for world crops. Proceedings: Biological Sciences 274:303–313.

Lagerlöf, J., J. Stark, and B. Svensson. 1992. Margins of agricultural fields as habitats for pollinating insects. Agriculture, Ecosystems, and Environment 40:117–124.

Loveland, T., G. Gutman, M. Buford, K. Chatterjee, C. Justice, C. Rogers, B. Stokes, and J. Thomas. 2003.

Chapter 6: Land use/land-cover change *in* Strategic plan for the U.S. climate change science program. Subcommittee on Global Change Research, U.S. Climate Change Science Program, Washington, D.C. USA.

Murray, L. D., C. A. Ribic, and W. E. Thogmartin. 2008. Relationship of obligate grassland birds to landscape structure in Wisconsin. Journal of Wildlife Management 72:463–467.

Office of Surface Mining. 2010. Annual report 2010–2011. http://www.osmre.gov/resources/reports/2010-11.pdf. Accessed 12 May 2014.

Randall, A., O. Grunewald, S. Johnson, R. Ausness, and A. Pagoulatos. 1978. Reclaiming coal surface mines in central Appalachia: a case study of the benefits and costs. Land Economics 54:472–489.

Ribic, C. A., M. J. Guzy, and D. W. Sample. 2009. Grassland bird use of remnant prairie and Conservation Reserve Program fields in an agricultural landscape in Wisconsin. American Midland Naturalist 161:110–122.

Townsend, P. A., D. P. Helmers, C. C. Kingdon, B. E. McNeil, K. M. de Beurs, and K. N. Eshleman. Changes in the extent of surface mining and reclamation in the Central Appalachians detected using a 1976–2006 Landsat time series. Remote Sensing and Environment 113:62–72.

Vickery, P. D., M. L. Hunter Jr., and S. M. Melvin. 1994. Effects of habitat area on the distribution of grassland birds in Maine. Conservation Biology 8:1087–1097.

Washburn, B. E., T. G. Barnes, and J. D. Sole. 2000. Improving northern bobwhite habitat by converting tall fescue fields to native warm-season grasses. Wildlife Society Bulletin 28:97–104.

Funding Source: *Kentucky Department of Fish and Wildlife Resources*

KDFWR Strategic Plan. Goal 1.

Using Prescribed Fire and Herbicide to Manage Rank Native Warm Season Grass for Northern Bobwhite

Field data collection / Don Pelly

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

Introduction

An estimated 98% of native grasslands have been lost across the United States because of human activity (Noss et al. 1995) and population declines of northern bobwhite (*Colinus virginianus*, hereafter bobwhite) have been reported for several decades (Leopold 1931, Brennan 1991, Peterson et al. 2002). Habitat loss and fragmentation have been identified as main factors influencing bobwhite declines (Roseberry and Sudkamp 1998), and restoration of habitat at large scales has been recommended as the most effective way to promote healthy populations (Guthery 1997, Williams et al. 2004, Morgan and Robinson 2008). A major focus of habitat restoration for bobwhites is the conversion of fields of cool season grass to nwsg (Barnes 2004, Harper and Gruchy 2009). Warm season grasses native to the southeast, such as big blue stem, little blue stem, switchgrass, side-oats grama, and indiangrass provide greater quality habitat and food resources for wildlife compared to non-native grasses such as fescue (Barnes et al. 1995, Washburn et al. 2000). Native grasses are structurally different from fescue as well; they grow in clumps that create bare ground and foster shrub and forb growth. Open space at the lowest vertical strata within grassland is important for bobwhite nesting, feeding, and brooding (Doxon and Carroll 2010).

Application of herbicides is generally effective at removing fescue and promoting forbs (Beran et al. 1999), but vegetation can display varying responses to herbicides, and some treatments can lead to undesirable vegetative communities (Chamberlain et al. 2007). Burning alone, while an important and effective management practice for early successional habitats, may proliferate some exotic species (Gill et al. 2006), and is not always effective at reducing cool season grass cover (Volesky and Connot 2000). Combinations of treatments such as disking, burning, and herbicide application are effective at improving bobwhite habitat in fields of exotic grass (Washburn et al. 2000, Greenfield et al. 2003, Harper and Gruchy 2009).

The USDA Conservation Reserve Program (CRP) has fostered establishment of over 6.7 million ac of native grass in 2013 (U. S. Department of Agriculture 2013). Over $150 million of easements and contracts to establish grasslands were administered from 2003 to 2007 under the USDA Grassland Reserve Program (GRP) (Bowen et al. 2010), with projected upkeep costs over $31.6 million (Grey et al. 2012). After conversion to nwsg, a primary concern for wildlife management is preventing fields from becoming rank, or densely vegetated and lacking open habitat space at low vertical strata. Rank nwsg stands could potentially inhibit the long term success of CRP and GRP efforts because they are generally unsuitable for early successional wildlife species (Burger et al. 1990, McCoy et al. 2001). Mid-successional, rank nwsg stands have characteristics similar to fields of exotic cool season grass: low forb abundance and diversity, little habitat heterogeneity, and little bare ground. Management practices that focus on improving vegetative composition and habitat structure are critical to maintaining early successional habitat (Harper et al. 2008) and maintaining this habitat is essential to promoting grassland bird populations (Harper 2007, Harper and Gruchy 2009). Improving habitat structure and vegetative composition for northern bobwhite in rank nwsg stands facilitates conservation of a rare ecosystem and has potential to benefit other grassland birds as well (Brennan and Kuvlesky 2005).

Little empirical research has focused on how to manage rank nwsg fields. Gruchy (2007) suggested disking as a strategy to reduce nwsg cover, but noted that disturbances such as disking and burning could potentially promote exotic vegetation growth. Frequent applications of disking and prescribed burns have improved bobwhite habitat on public lands in Kentucky but access to disking machinery needed for large scale habitat management is limiting for private land owners with relatively small area farms. The mean farm size in the southeastern US is 216 ac and the mean farm size in Kentucky is 169 ac, compared to 434 ac nationally (U. S. Department of Agriculture 2012). Prescribed burning followed by herbicide application has been shown to reduce cover of unwanted cool season grasses and has potential to improve bobwhite habitat by reducing nwsg cover on private lands that are not disked regularly. We sought to 1) determine how the following treatments compared to prescribed burning alone with respect to producing nwsg stands beneficial to bobwhite after two growing seasons: prescribed burn followed by application of 27.7% isopropylamine salt of imazapyr (herafter ISI), prescribed burn followed by 41% glyphosate application, or prescribed burn followed by application of an 7.78% imazapyr 62.22% diuron mixture (hereafter imazapyr), and 2) determine how habitat structure and vegetative composition differed between treatments.

Methods

We conducted our study on 7 nwsg fields at 4 study sites: Higginson-Henry Wildlife Management Area (WMA), Taylorsville Lake WMA, Green River WMA, and Shaker Village of Pleasant Hill. Our study fields were planted with nwsg from 1999–2009. Each field was at least 4 ac, had not been recently managed, and was ≥85% nwsg.

We implemented a randomized block design at each study site, and each block contained a grid of four 1 ac treatment cells. Treatments were randomly selected for application to cells. Each treatment cell was surrounded by a 15 ft buffer of tilled ground. Each study site contained 2 replicates (grids) except for Higginson-Henry WMA, which contained one replicate. Dormant season burns were performed before April 15 during 2011 or 2012 (Shaker Village of Pleasant Hill), with herbicides applied late spring the year of burn after approximately 6–8 in of regrowth. Glyphosate was applied at a rate of 2 qt/ac, imazapyr at a rate of 13 lbs/ac, and ISI at a rate of 1 qt/ac. All herbicides were applied using a non-ionic surfactant. We sampled during summer and fall the year of treatment and the following year.

We collected vegetation data in five 1-m^2 sample plots within each treatment cell; one sample plot in the center and at 20 m in each cardinal direction from the cell center for a total sampling effort of 560 1-m2 plots within 112 treatment cells (*n* = 28). We collected the following data at each sample plot: percent bare ground not obstructed by canopy vegetation, vegetation height (cm), vegetation heterogeneity, soil compaction (kPa), and percent light penetration, and percent cover of nwsg, forbs, sericea (*Lespodeza cuneata*), trees, shrubs, and cool season grasses. We selected three variables to represent vegetation composition and habitat structure: percent cover of nwsg, forbs, and bare ground. We graphically compared treatment means to a hypothetical combination of percent cover of bare ground (20%), nwsg (40%), and forbs (40%) determined to be optimum to bobwhite. We also established thresholds for bare ground (20-40%), nwsg (30-50%), and forbs (30-50%) that, although not optimum, would be beneficial to bobwhite. If treatment means were within beneficial thresholds of bare ground, forbs, and nwsg, then we concluded that conditions were suitable for bobwhite.

We ran repeated measures analysis of variance (ANOVA), blocked by sampling area, on all vegetative characteristics to compare influence of our treatments on stands of nwsg. We designated a p value of 0.10 because of inherent variation in landscape scale habitat management research and then applied a Bonferroni correction to acknowledge statistical significance at $p \leq 0.009$.

Results

The ISI treatment was most effective at producing levels of nwsg and forbs beneficial to bobwhite throughout the study (Fig. 1). Glyphosate produced beneficial levels of forbs after the first summer and levels of nwsg near beneficial thresholds throughout the study, and imazapyr and burn-only treatments did not produce beneficial levels of forbs, nwsg, or bare ground over the majority of our study (Fig. 1). None of our treatments produced levels of bare ground beneficial to bobwhite, yet the herbicide treatments produced levels

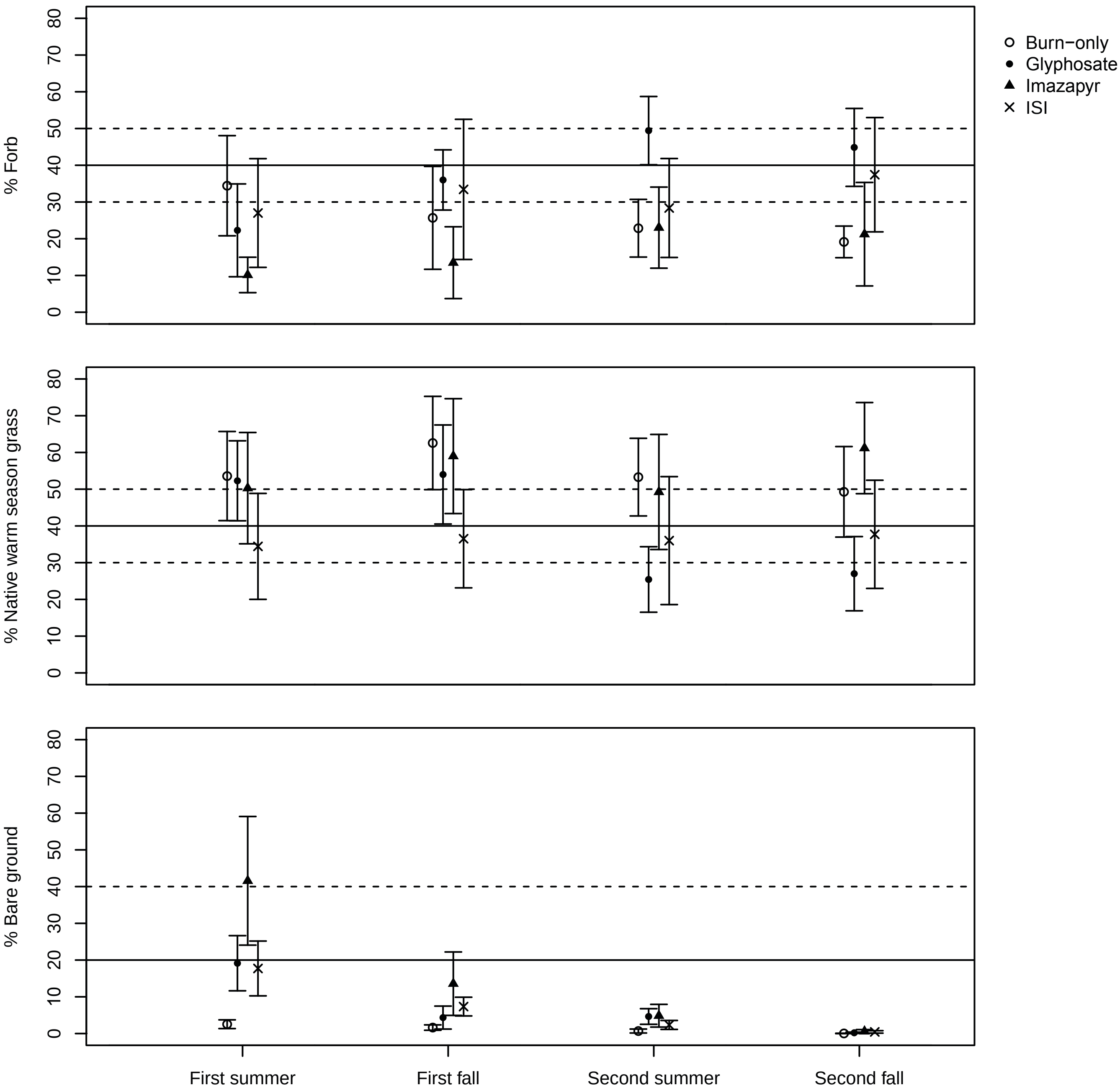


Figure 1

near beneficial thresholds initially.

Glyphosate produced nwsg stands with greater forb cover than other treatments ($df = 3$, $F = 8.52$, $P>F = 0.003$) and imazapyr produced stands with greater bare ground than other treatments ($df = 3$, $F = 7.27$, $P>F = 0.005$). Cover of nwsg did not differ between treatments. Burn-only treatments were characterized by less light penetration ($df = 3$, $F = 14.32$, $P>F < 0.001$) and greater mean vegetation height ($df = 3$, $F = 12.01$, $P>F < 0.001$) than other treatments. We observed differences between sites in light penetration ($df = 3$, $F = 8.75$, $P>F = 0.002$), soil compaction ($df = 3$, $F = 8.24$, $P>F = 0.003$), shrubs ($df = 3$, $F = 10.30$, $P>F = 0.001$), and forbs ($df = 3$, $F = 26.08$, $P>F < 0.001$), with Higginson Henry WMA having greater light penetration and less shrub cover than other sites, and Shaker Village of Pleasant Hill having greater forb cover and less soil compaction than other sites.

Initially herbicide treatments created habitat space within rank nwsg fields, but response of habitat structure variables to all treatments became similar over time. Glyphosate had the greatest influence on habitat structure compared to burn-only treatment in summer of the second growing season; with 22% lower vegetation height, 65% higher vegetation heterogeneity, and 10% greater light penetration, but trends suggest all treatments produced similar habitat structure in fall of the second growing season.

Trends in vegetative composition data indicated varying responses to treatments after 2 growing seasons: sericea was more successful at colonizing burn-only and glyphosate stands compared to imazapyr and ISI stands, ISI did not inhibit shrub growth as well as other treatments, and nwsg cover was less and forb cover greater in glyphosate stands compared to burn-only treatments.

Discussion

Landscapes dominated by homogeneous vegetation do not provide the habitat parameters required for bobwhite nesting and brooding. Forbs are beneficial to bobwhite when brooding (Collins et al. 2009), but have no influence on nest selection (Townsend et al. 2001). Tall grasses such as nwsg are associated with nest sites (Taylor et al. 1999); however, dense cover of nwsg results in less bare ground. Stands of nwsg with an equal ratio of forbs and nwsg and adequate bare ground are beneficial to bobwhite populations because they provide habitat for both nesting and brooding. ISI and glyphosate treatments produced grass stands with beneficial levels of forbs and nwsg during this study; therefore, we recommend their use when managing vegetative composition within rank nwsg stands. Results of burn-only treatments illustrate the need for herbicide application after burning to manage rank nwsg fields, as burning alone produced thick stands of nwsg with little bare ground throughout the study, produced decreasing forb cover over time, and had less influence on habitat structure than did herbicide treatments. Imazapyr treatments produced forb levels lower than, and nwsg levels similar to burn-only. We do not recommend use of imazapyr after prescribed burning as a management strategy for nwsg.

Complex vegetation structure is important to nesting bobwhites (Townsend et al. 2001); they prefer to nest in areas with herbaceous cover above approximately 40%, high visual obstruction from predators, less bare ground, greater vegetation height, and greater shrub cover compared to random areas (Lusk et al. 2006, Arredondo et al. 2007, Rader et al. 2007, Collins et al. 2009). After summer of the first growing season, each of our treatments produced vegetative heights greater than the minimum for nesting bobwhites (approximately 40 cm; Lusk et al. 2006). Lusk et al. (2006) determined that bobwhite nested in habitat with less than 30% bare ground and greater than 25% shrub cover, with more successful nests tending to be in areas with between 13–22% bare ground and 45–72% shrub cover. None of our treatments produced bare ground or shrub cover within the parameters of successful nests described above.

Openness at ground level is vital to bobwhite. It allows them space to loaf or travel between habitat patches. Increased bare ground improves bobwhite mobility, foraging rates on insects, and insect prey diversity (Doxon and Carroll 2010). This is especially important in summer when the majority of a bobwhite's diet consists of insects (Peoples et al. 1994), and in autumn when brooding young require high densities of insect prey (Stoddard 1931). Our results indicate that further management beyond prescribed burning followed by ISI or glyphosate application is required to produce stands with desired vegetative composition and habitat structure. Accumulated thatch was the main obstruction of bare ground where live vegetation was not present. Thatch is effectively removed with prescribed fire. Annual or biennial burning is likely the best option for increasing bare ground while using ISI or glyphosate to maintain the desired ratio of forbs and nwsg. Research on the response of nwsg stands to burning at several intervals after an original burn and herbicide application would add insight into the long term viability of this management practice, and would provide a time table for the management rotation required to achieve the desired ratio of nwsg, forbs, and bare ground. Herbicides could also be applied after each successive burn in future studies, but monitoring would be needed to ensure that desired species are not eradicated.

The management practices presented in our research have implications for wildlife other than bobwhite, such as grassland songbirds (Brennan and Kuvlesky 2005). Effects of habitat characteristics on grassland birds can vary between species (Winter et al. 2005), and heterogeneity in habitat structure and vegetative composition in grasslands is vital to increasing avian diversity and abundance in these ecosystems (Patterson and Best 1996, Fuhlendorf et al. 2006). Although all of our treatments produced similar habitat structure after two growing seasons, glyphosate has the greatest potential to improve habitat structure over time. Trends suggest that a management sequence of prescribed burning, glyphosate application, then annual or biennial prescribed burning has potential to create grasslands with high heterogeneity in vegetation, high forb cover, and beneficial levels of bare ground; however, there is potential for glyphosate to produce nwsg cover below what we considered beneficial to bobwhite.

Management Implications

We suggest the following management strategy as an alternative to disking for improving rank nwsg fields for bobwhite populations on private lands: dormant season burn followed by either glyphosate (2 qt/ac) or ISI (1 qt/ac) application paired with non-ionic surfactant in late spring after 6–8 in of regrowth. Our results indicate that herbicide application after prescribed burning initially creates open habitat, but also that management of habitat structure for bobwhite should occur at intervals less than two years. The removal of accumulated litter via annual or biennial burning would be the most efficient way to create bare ground after initial treatment. The ISI treatment was most effective at producing nwsg stands beneficial to bobwhite; however, the potential for management will vary based on funding, region, and goals for wildlife species. Generic glyphosate is readily available, less expensive, and less toxic than ISI herbicides, so glyphosate is a practical option for bobwhite management across large scales that include both public and private land. Glyphosate also had beneficial influence on habitat structure after initial application, and further application after a continued schedule of prescribed burns may produce desired habitat for many grassland birds. Imazapyr solutions are more expensive than ISI and glyphosate herbicides, and considering its high cost and low performance, its use in rank nwsg management should be avoided.

Literature Cited

Arredondo, J. A., F. Hernández, F. C. Bryant, R. L. Bingham, and R. Howard. 2007. Habitat-suitability bounds for nesting cover of northern bobwhites on semiarid rangelands. Journal of Wildlife Management 71:2592–2599.

Barnes, T. G. 2004. Strategies to convert exotic grass pastures to tall grass prairie communities. Weed Technology 18:1364–1370.

Beran, D. D., R. E. Gaussoin, and R. A. Masters. 1999. Native wildflower establishment with imidazoline herbicides. HortScience 34:283–286.

Bowen, T., H. Gordon, J. Rowe, and F. Spinelli. 2010. U.S. Department of Agriculture. Final benefit-cost analysis for the Grassland Reserve Program, Washington D.C., USA.

Brennan, L. A. 1991. How can we reverse the northern bobwhite population decline? Wildlife Society Bulletin 9:544–555.

Brennan, L. A., and W. P. Kuvlesky, Jr. 2005. North American grassland birds: an unfolding conservation crisis? Journal of Wildlife Management 69:1–13.

Chamberlain, M. C., L. W. Burger, Jr., D. Godwin, and B. Watkins. 2007. Efficacy of spring herbicide applications for fescue control: a comparison of three products. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 61:89–93.

Collins, B. M., C. K. Williams, and P. M. Castelli. 2009. Reproduction and microhabitat selection in a sharply declining northern bobwhite population. The Wilson Journal of Ornithology 121:688–695.

Doxon, E. D., and J. P. Carroll. 2010. Feeding ecology of ring-necked pheasant and northern bobwhite chicks in Conservation Reserve Program fields. The Journal of Wildlife Management 74:249–256.

Fuhlendorf, S. D., W. C. Harrel, D. M. Engle, R. G. Hamilton, C. A. Davis, and D. M. Leslie, Jr. 2006. Should heterogeneity be the basis for conservation? Grassland bird response to fire and grazing. Ecological Applications 16:1706–1716.

Gill, D. E., P. Blank, J. Parks, J. B. Guerard, B. Lohr, E. Schwartzman, J. G. Gruber, G. Dodge, C. A. Rewa, and H.F. Sears. 2006. Plants and breeding bird response on a managed Conservation Reserve Program grassland in Maryland. Wildlife Society Bulletin 34:944–956.

Greenfield, K. C., M. J. Chamberlain, L. W. Jr., Burger, and E. W. Kurzejeski. 2003. Effects of burning and discing Conservation Reserve Program fields to improve habitat quality for northern bobwhite (*Colinus virginianus*). American Midland Naturalist 149:344–353.

Harper, C. A. 2007. Strategies for managing early successional habitat for wildlife. Weed technology 21:935–937.

Harper, C. A., C. E. Moorman, and P. D. Keyser. 2008. Native warm-season grasses and early successional wildlife habitat: Past lessons and a new vision. Proceedings Eastern Native Grass Symposium 6:120–126.

Harper, C. A., and J. P. Gruchy. 2009. Conservation practices to promote quality early successional wildlife habitat. In, Burger Jr., L. W., and K. O. Evans, editors. Managing working lands for northern bobwhite: the USDA NRCS Bobwhite Restoration Project. Washington, D.C, USA.

Leopold, A. 1931. Report on a game survey of the north central states.

Sporting Arms and Ammunition Manufacturers' Institute, Madison, Wisconsin, USA.

Lusk, J. J., S. G. Smith, S. D. Fuhlendorf, and F. S. Guthery. 2006. Factors influencing northern bobwhite nest-site selection and fate. The Journal of Wildlife Management 70:564–571.

Morgan, J. J., and B. A. Robinson. 2008. Road to recovery: the blueprint for restoring the northern bobwhite in Kentucky. Kentucky Department of Fish and Wildlife Resources, Frankfort, USA.

Noss, R. F., E. T. LaRoe III, and J. M. Scott. 1995. Endangered ecosystems of the United States: A preliminary assessment of loss and degradation. U.S. Department of the Interior, National Biological Survey Report 28, Washington D.C., USA.

Patterson, M. P., and L. B. Best. 1996. Bird abundance and nest success in Iowa CRP fields: the importance of vegetation structure and composition. American Midland Naturalist 135:153–167.

Peoples, A. D., R. L. Lochmiller, J. C. Boren, D. M. Jr. Leslie, and D. M. Engle. 1994. Limitations of amino acids in diets of northern bobwhite (*Colinus virginianus*). American Midland Naturalist 132:104–116.

Peterson, M. J., X. B. Wu, and P. Rho. 2002. Rangewide trends in landuse and northern bobwhite abundance: an exploratory analysis. Pages 35–44 in S. J. DeMaso, W. P. Kuvlesky, Jr., F. Hernández, and M. E. Berger, editors. Quail V: Proceedings of the Fifth National Quail Symposium. Texas Parks and Wildlife Department, Austin, Texas, USA.

Rader, M. J. L. A. Brennan, F. Hernández, N. J. Silvy, and B. Wu. 2007. Nest-site selection and nest survival of northern bobwhite in southern Texas. The Wilson Journal of Ornithology 119:392–399.

Roseberry, J. L., and S. D. Sudkamp. 1998. Assessing the suitability of landscapes for northern bobwhite. Journal of Wildlife Management 62:895–902.

Stoddard, H. L. 1931. The bobwhite quail: Its habits, reservation, and increase. Charles Schriber's Sons, New York, New York, USA.

Taylor, J. S., K. E. Church, and D. H. Rusch. 1999. Microhabitat selection by nesting and brood-rearing northern bobwhite in Kansas. Journal of Wildlife Management 63:686–694.

Townsend, D. E. II., R. E. Masters, R. L. Lochmiller, D. M. Jr. Leslie, S. J. Demaso, and A. D. Peoples. 2001. Characteristics of nest sites of northern bobwhites in western Oklahoma. Journal of Range Management 54:260–264.

U. S. Department of Agriculture. 2013. Conservation Reserve Program: Monthly summary – October 2013. Accessed January 16, 2014. http://www.fsa.usda.gov/Internet/FSA_File/oct2013summary.pdf.

Volesky, J. D., and S. B. Connot. 2000. Vegetation response to late growing-season wildfire on Nebraska sandhills rangeland. Journal of Range Management 53:421–426.

Washburn, B. E., T. G. Barnes, and J. D. Sole. 2000. Improving northern bobwhite habitat by converting tall fescue fields to native warm-season grasses. Wildlife Society Bulletin 28:97–104.

Williams, C. K., F. S. Guthery, R. D. Applegate, and M. J. Peterson. 2004. The northern bobwhite decline: scaling our management for the twenty-first century. Wildlife Society Bulletin 32:861–869.

Winter, M., D. H. Johnson, and J. S. Shaffer. 2005. Variability in vegetation effects on density and nesting success of grassland birds. Journal of Wildlife Management 69:185–197.

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

KDFWR Strategic Plan. Goal 1.

Infected little brown bats / Brooke Hines

White-nose Syndrome (WNS) Summary for Kentucky

Brooke Hines, Kentucky Department of Fish and Wildlife Resources

Introduction

White-nose syndrome (WNS), named for the white fungus that appears on the muzzle and other parts of hibernating bats, is a disease associated with extensive mortality of bats in eastern North America. First documented in New York in the winter of 2006-2007, WNS has spread rapidly across the eastern United States and Canada, and has been detected as far west as Oklahoma. It was first identified in Kentucky in 2011.

Prior to finding WNS, Kentucky Department of Fish and Wildlife Resources (KDFWR), along with the U.S. Fish and Wildlife Service Kentucky Field Office (USFWS KFO), coordinated plans for surveillance and monitoring of WNS. Kentucky was the first state to complete a WNS Response Plan (Completed May 2009). This plan was used as a guiding document for development of the WNS National Plan and many other states' WNS response plans. Since 2009, Kentucky's WNS Response Plan has been updated yearly, with the most current version dated January 2014.

Methods

In 2010, KDFWR initiated an aggressive WNS surveillance and monitoring program in an attempt to collect as much pre-WNS data as possible (WNS National Plan Disease Surveillance Action Plan (https://www.

Dead tri-colored bat / Brooke Hines

whitenosesyndrome.org/national-plan/disease-surveillance). From 2009 to 2013, WNS surveillance and monitoring consisted of conducting Tier 1 (definition found in KY WNS Response Plan) surveys at scheduled hibernacula in addition to Tier 2 (definition found in KY WNS Response

Plan) WNS checks of hibernacula that were not scheduled for counts, but had 50 or more hibernating bats historically. In 2014, KDFWR discontinued Tier 2 WNS checks due to the state-wide spread of WNS.

Results

In 2010, Tier 1 and Tier 2 surveys were conducted at 92 sites. WNS was not found during these surveys. In 2011, Tier 1 and Tier 2 surveys were conducted at 101 sites. WNS was first documented on 4/1/2011 at a cave in Trigg County.

During the 2012 survey season (December 2011 through April 2012) KDFWR staff conducted Tier 1 and Tier 2 surveys at 96 sites. Of those sites surveyed, we found 10 to be WNS positive through lab confirmation of specimen submission.

In 2013, KDFWR staff conducted

Heavily infected little brown bat / Larisa Bishop

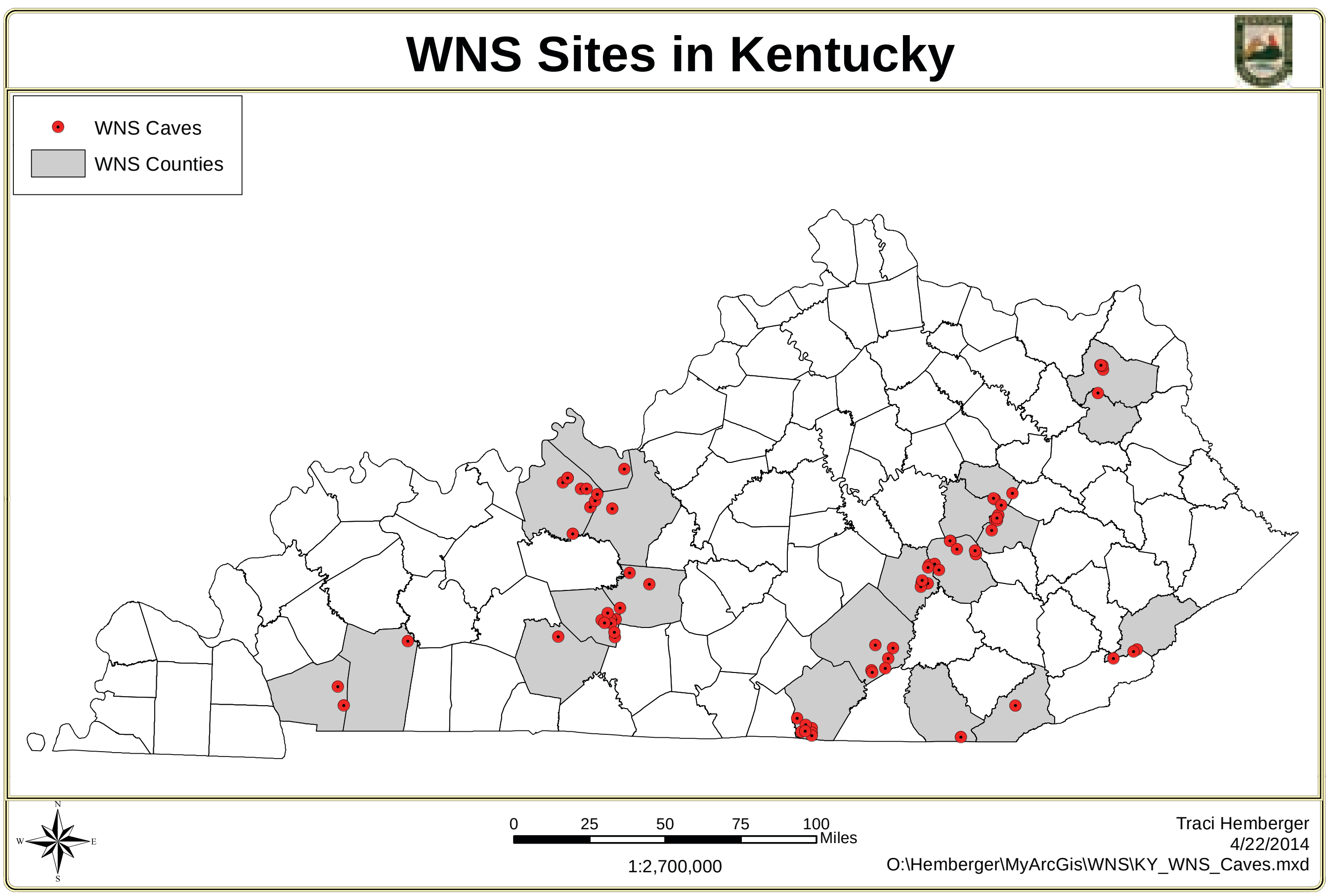
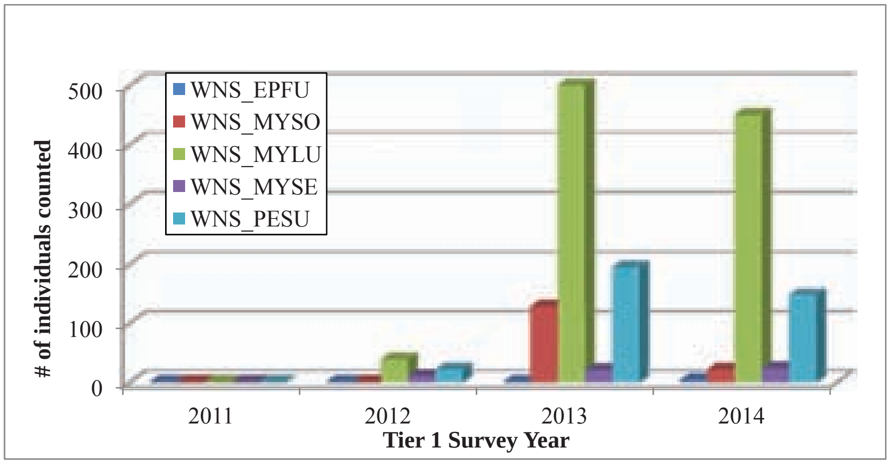


Figure 1. Bats Showing Visible Signs of WNS at All WNS Positive Sites



Mortality started to become apparent in 2013 and 2014 (Figure 2). Most species observed dead are PESU, however, MYLU numbers indicate mortality but very few carcasses are found.

Tier 1 and Tier 2 surveys at 81 sites from January to April. WNS was confirmed at 30 additional sites.

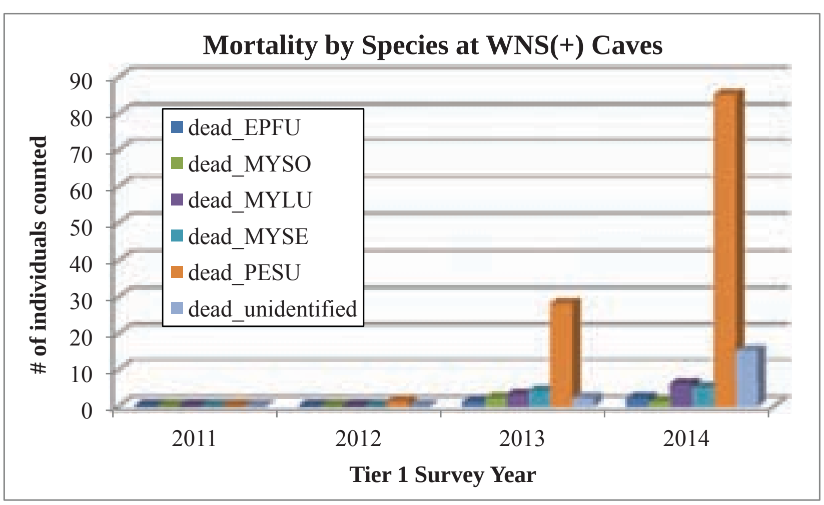
The 2014 survey season (December 2013-March 2014) not only showed an increase in the number of sites with signs of WNS, but also marked the first signs of mortality and species population declines. Tier 1 surveys were conducted at 65 sites with WNS confirmation at an additional 28 sites.

To date, WNS has been lab or visually confirmed at 72 sites in 20 counties (see map).

Discussion

Species declines from 2012 to 2014 from the 2011 WNS infected site are as follows: little brown bats (MYLU) - 97%, Indiana bats (MYSO) – 28%, and tri-colored bats (PESU) – 26%.

Figure 2. Bat Species Mortality at WNS Positive Sites



<u>**Species trends at sites found WNS (+) during the winter of 2012**</u>

The tri-colored bat population decline is misleading as this species exhibits “roost-shifting” behavior during the second or third year of WNS infection. Tri-colored bats will hibernate in varying temperatures and those that are in warmer sections of the cave will shift toward the entrance where temperatures are cooler due to airflow. This is believed to be an attempt to “force torpor” which allows bats to preserve fat reserves. Most PESU that roost shift are found dead or moribund.

Also, PESU numbers from most caves are misleading in that they roost singly and throughout the cave. They are commonly found in sections surveyors typically do not count due to lack of Myotis, which are the focal species of the population counts.

Species population surveys from 2012-2014 at sites where WNS was confirmed in 2012 show substantial declines. Six out of the 10 sites found WNS positive had trend data which could be further analyzed to assess species declines. Species declines are as follows: MYLU - 85%, PESU – 82%, northern long-eared bat (MYSE) – 78%, and MYSO 60%.

Species population trend data from sites found WNS positive in 2013 were analyzed at 11 of the 30 sites. Of these 11 sites, species data was too variable to make any assumptions at this point in time. Only data for MYLU showed any consistent trends and at nine of the 11 sites, MYLU had declined 38%.

Visibly Infected Bats and Mortality Trend Data

Species trend data for MYLU indicated a decline in the hibernating population 1-2 survey seasons after WNS is detected. MYSE and PESU, however, show an increase in hibernating population numbers prior to WNS detection. This is most likely due to roost shifting behavior which has been noted in several sites in KY and in several states.

Signs of WNS are typically found in MYLU, MYSE, and PESU (Figure 1). MYSO start to show signs of the fungus typically after it is detected on other species (see difference from 2012 to 2013). Big brown bats (EPFU) have not shown signs of WNS in Kentucky to date, however, they do not hibernate in large numbers so population declines may be difficult to assess.

The following graphs are Tier 1 survey results for even years at hibernacula with one year of post-WNS trend data.

- MYLU are decreasing at the six sites we have post WNS (+) data trends (Figure 3).
- PESU are decreasing at four sites and increasing at two (Figure 4). This increase is likely due to roost shifting behavior and inability to determine if hibernating PESU are alive or in torpor.
- MYSE populations are variable which has historically been shown at sites even prior to WNS arrival (Figure 5).
- Figure 6 shows MYSO populations at sites which have historically had over 1,000 individuals; some declines are evident. However, MYSO populations are holding somewhat steady at other sites.

Funding Sources: *State Wildlife Grant (SWG) and U.S. Fish and Wildlife Service (Section 6)*

KDFWR Strategic Plan. Goal 1. Kentucky's Comprehensive Wildlife Conservation Strategy. Appendix 3.4. Kentucky's prioritized taxa-specific conservation actions. Class Mammalia. Action #4.

Figure 3. MYLU Trends at Six WNS Positive Sites

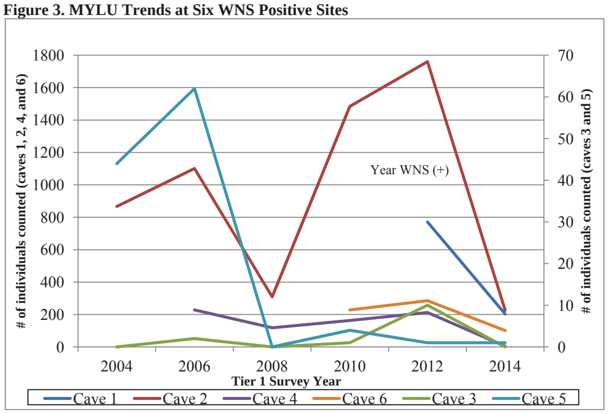


Figure 4. PESU Trends at Six WNS Positive Sites

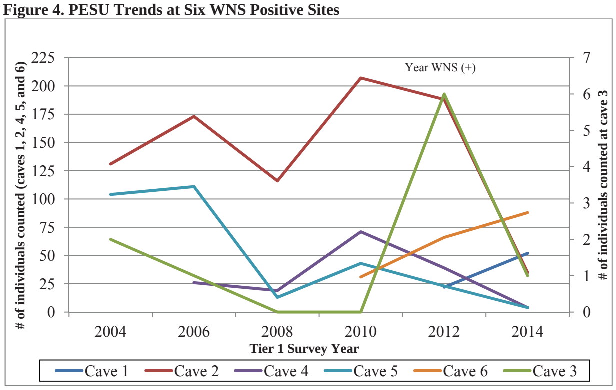


Figure 5. MYSE Ttrends at Six WNS Positive Sites

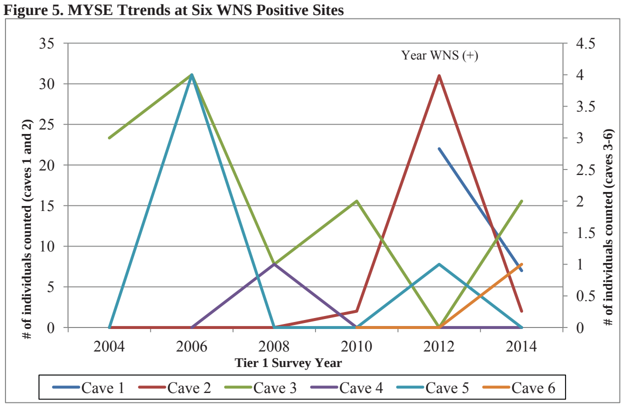
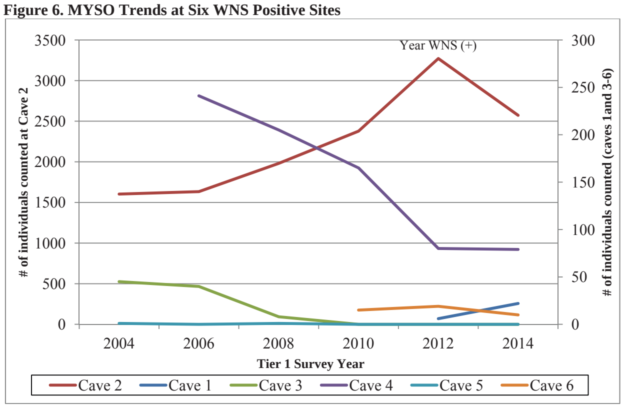


Figure 6. MYSO Trends at Six WNS Positive Sites



Evaluation of a Sauger Stocking Program on the Kentucky River

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

Introduction

Sauger *Sander Canadensis* are found in the Lower Mississippi and Ohio rivers and their major tributaries such as the Green, Salt, and Kentucky rivers in Kentucky (Burr and Warren 1986). These rivers provide large, turbid habitat with deep water and low gradients that sauger prefer (Becker 1983; Jaeger et al. 2005; Kuhn et al. 2008). During the winter and spring, sauger congregate below dams and near creek mouths in these systems to spawn and provide substantial fisheries. Older lock and dam employees interviewed by Williams (1974) indicated that sauger were abundant in the upper reaches of the Kentucky River in the past. Sauger are now most often observed in the tailwaters of the first four dams (Carrollton to Frankfort) with numbers declining upstream. Anglers have been concerned with declining fishing success as lock chambers were used less frequently since the 1950's (Carter 1954). Stockings of sauger and walleye (*S. vitreum*) have been used extensively to expand, maintain, or supplement populations (LaJeone et al. 1992), but results are extremely variable (Laarman 1978; Ellison and Franzin 1992). To combat declines in the sauger fishery in the Kentucky River, the Kentucky Department of Fish and Wildlife Resources (KDFWR) stocked 2,060,000 fry, 149,038 fingerlings, and 295 adult sauger in the Kentucky River upstream of Beattyville between 1981 and 1985. These stockings were never evaluated, so KDFWR implemented a percid study on the Kentucky River in winter 2002 and spring 2003. Results were positive and it was decided that sauger fingerling stockings would continue in Pools 4 through 14. Sauger stocking, and consequently this study, began in 2006 with the hopes of reestablishing a self-sustaining sauger fishery in the Kentucky River above Lock and Dam 4.

Sauger fishing continues to increase in popularity, and it will be increasingly important to evaluate not only if natural reproduction occurs from stocking efforts, but also if the population can support harvest to maintain a sustainable sport fishery (LaJeone et al. 1992; Baccante et al. 2011). The objectives of this study were to: 1) evaluate the potential of establishing a self-sustaining, recreational sauger fishery through time-limited stockings in pools 4–14 of the Kentucky River, and 2) estimate the use and importance of the sauger fishery on the Kentucky River.

Methods

Stocking— Sauger brood stock were collected each winter from various water bodies including the Ohio and Kentucky Rivers (outside of the study area). Brood stock sauger were brought back to Pfeiffer Fish Hatchery in Frankfort, KY to be spawned. Offspring were reared to 1.5–2.0 in fingerlings and stocked into pools 4–14 of the Kentucky River. Stocking occurred from 2006 – 2010; stocking was discontinued from 2011–2013 to determine if the population was self-sustaining.

Sampling— Nocturnal, pulsed DC electrofishing was used to monitor sauger populations in the spring and fall of each year from 2006–2013. During spring sampling, four, 15-minute transects were made in the tailwaters

Kentucky River sauger / Nick Keeton

of Lock and Dams 5, 10, 11, and 12 when water temperatures were near 50°F. Twelve, 15-minute transects per pool were sampled in the fall when water temperatures were 60– 70°F. Additional sampling was conducted in fall 2011 to investigate sauger abundance in other reaches of the river; the North, Middle, and South Forks and pools 7 and 8 of the Kentucky River were sampled in the fall. All sauger collected were measured (nearest 0.1 in) and weighed (nearest 0.01 lbs).

Age structure and stocked fish contribution—Fingerling sauger were marked with oxytetracylcine (OTC) at Pfeiffer Fish Hatchery prior to stocking. Otoliths were removed to estimate age structure, check for OTC marks to estimate the contribution of the stocked fish to the population, and to determine if any natural reproduction was occurring.

Data Analysis—All sampling data was analyzed using SAS v. 9.2 (SAS; Cary, NC). Population parameters such as CPUE, CPUE by size class, relative weight, and mean length were calculated using KDFWR's KFAS and KSLO software run in SAS. Spring and Fall CPUE was regressed (PROC REG) against mean March – May discharge and stocking numbers. All variables were checked for normality using a Shapiro-Wilk test. Significance for all normality and regression tests was assessed at a level of $\alpha = 0.05$.

Results

Stocking— A total of 460,047 sauger fingerlings were stocked in pools 4–14 of the Kentucky River during May from 2006 – 2010. All sauger stocked ranged from 1.5–2.0 in.

Spring sampling—No sauger were collected during spring sampling in 2006 (Total CPUE=0.0 fish/hr). Catch rates of sauger increased yearly in all tailwaters through 2009 (Total CPUE=54.3 fish/hr) after which catch rates in all tailwaters decreased. Following the final stockings of sauger in 2010, catch rates declined annually in all tailwaters sampled. By 2012, all tailwaters except Lock and Dam 12 had catch rates of sauger that were below historical averages. Lock and Dam 12 tailwater fell below its historical average (Total CPUE=8.7 fish/hr) in 2011 (CPUE=3.0 fish/hr), rose above historical average in 2012 (CPUE=10.7 fish/hr), and then fell once again in 2013 (CPUE=4.0 fish/hr). Overall mean CPUE of sauger for the length of the study was 16.9 fish/hr.

Length frequencies of sauger were recorded each year during spring sampling (range 6.6–18.8 in, mean length 11.6 in) throughout the study. Mean length and size structure increased each spring. Catch rates for specific size class of sauger were also monitored each spring. Catch rates of sauger <8.0 in were generally low (mean CPUE=0.6 fish/hr, range = 0.0 fish/hr-1.5 fish/hr), and indicated that this size sauger were likely not fully recruited to electrofishing gear. Sauger 8.0–11.9 in exhibited the highest mean catch rate for all size classes examined (mean CPUE=10.0 fish/hr); however, sauger in the 12.0–14.9 in and ≥15 in groups dominated the catch in the last 2 years of the study. Catch rates of 8.0–11.9 in sauger ranged from 0.0 fish/hr in 2006 to 29.0 fish hr in 2009. Catch rates of 12.0 – 14.9 in sauger (mean CPUE=6.0 fish/hr) ranged from 0.0 fish/hr in 2006 to 21.3 fish/hr in 2009. Sauger ≥15.0 in had fairly low catch rates throughout the study (mean CPUE=2.0 fish/hr) and range = 0.0 fish/hr to 4.5 fish/hr.

Fall sampling—Catch rates of sauger for each year were lower in the fall than in the spring, with the exception of 2006 where spring sampling occurred before the stocking program began. Fall mean CPUE of sauger throughout the study was 4.7 fish/hr and ranged from 1.6 fish/hr in 2012 to 10.2 fish/hr in 2011. Unlike spring catch rates, fall catch rates did not follow a declining pattern once stocking was stopped. Rather, CPUE of sauger in fall was sporadic but generally low. Exploratory sampling in 2011 provided varied results, as CPUE ranged from 1.3 fish/hr in the Middle Fork of the Kentucky River to 18.6 fish/hr in Pool 7. Mean CPUE of these additional efforts was 8.6 fish/hr. These numbers were slightly lower than CPUE of pools 4, 9, 10, and 11, but did fall within range.

As with spring sampling, length frequencies of sauger were recorded each year during fall sampling. Sauger ranged from 5.8–19.2 in throughout the study. Total mean length for the study was 11.5 in (range = 7.8 in-15.3 in); mean length and size structure increased each fall. Catch rates of sauger <8 in were generally low (mean CPUE=0.6 fish/hr, range = 0.0 fish/hr in 2012-1.5 fish/hr in 2006). Sauger 8.0 – 11.9 in in size exhibited the highest mean catch rate for all size classes examined (mean CPUE=2.1 fish/hr); however, sauger in the ≥15 in group dominated the catch in the last 2 years of the study. Catch rates of 8.0–11.9 in sauger ranged from 0.2 fish/hr in 2012 to 5.5 fish hr in 2011 (mean CPUE=2.1 fish/hr). Catch rates of 12.0–14.9 in sauger ranged from 0.0 fish/hr in 2006 to 2.9 fish/hr in 2009 (mean CPUE=1.4 fish/hr). Sauger ≥15 ranged from 0.0 fish/hr in 2006 and 2007 to 1.9 fish/hr in 2011 (mean CPUE=0.7 fish/hr).

Mean relative weight (Wr) of sauger for the study was 83, and ranged from 76 in 2009 and 2013 to 88 in 2006 and 2007. Wr tended to decrease as size of sauger increased. Sauger 8.0-11.9 in had a mean Wr of 85 and ranged from 77 in 2009 to 89 in 2007 and 2011. Sauger 12.0-14.9 in had a mean Wr of 79 and ranged from 74 in 2009 to 85 in 2008. Sauger ≥15 in had mean Wr of 77 and ranged from 74 in 2009 and 2013 to 81 in 2010 and 2012.

Age structure and stocked fish contribution—Otoliths indicated that CPUE by age class decreased as age increased. Mean CPUE of age-1 sauger was 13.2 fish/hr (range = 0.0 fish/hr-30,9 fish/hr). Mean CPUE of age-2 sauger was 4.3 fish/hr (range = 0.0-14.4 fish/hr). Age-3 sauger had a mean CPUE of 2.3 fish/hr (range = 0.0-7.0 fish/hr). Mean CPUE of age-4 sauger was 0.4 fish/hr. Age-4 sauger were only collected in 2011. No sauger older than age-4 were collected throughout the study. Otoliths were not taken in 2012 or 2013; however, large fish were collected during spring samples in 2012 and 2013 that may have been age-4 or older fish. Stocked fish dominated the catch each year. OTC marked fish accounted for 74.4–100.0% of sauger collected each year.

Catch rate analysis—A Shapiro-Wilk test was conducted on all independent variables to test for normality. Number of sauger stocked during the current year (P=0.24), number of sauger stocked the previous year (P=0.24), and average March–May discharge (P=0.25) were all normally distributed. Multiple linear regression models indicated that spring catch rates were significantly influenced by stockings the previous year (P=0.02), indicating that increased stocking rates in one year will lead to higher catch rates the following spring. Additionally, fall catch rates were significantly influenced by average March–May discharge (P=0.01); greater spring discharge resulted in greater fall catch rates.

Discussion

Little data exists on the

contribution and success of sauger stockings; however, stocking plays an integral role in the management of walleye in North America (Goeman 2002). Though it may have a large role, its success in terms of establishing self-sustaining fisheries is highly questionable. Many studies (Cleary and Mayhew 1961; Koppelman et al. 1992; Vandergoot and Betttoli 2003) have reported poor success rates of stocking walleye fry and the increased survival and year-class contribution of stocked fingerlings. Heidinger and Brooks (1998) found that stocking fingerling sauger in the Illinois River contributed substantially to year-classes, particularly when natural reproduction was low and stocking did not follow a strong natural year-class. Our study suggests that stocked fingerling can have significant contributions to year-classes in the Kentucky River, as stocked sauger accounted for 74.4–100.0% of sauger populations and spring catch rates were directly related to number of fished stocked.

Spring catch rates of sauger in the Kentucky River decreased immediately after stocking was discontinued, and contribution of wild sauger never exceeded 25.6%. Mean length of sauger in both the spring and fall increased, likely as a result of shifting size and age structure resulting from limited natural recruitment. These trends indicate that very little natural reproduction is occurring in the Kentucky River. Furthermore, the relatedness of spring catch rates to the previous year's catch rate, affirms the evidence that sauger are not self-sustaining in the Kentucky River.

Sauger populations fluctuate naturally due to biotic and abiotic factors, and year-class strength can vary as a result of environmental factors, especially discharge rates (MacCrimmon and Skobe 1970; Swain 1974; Nelson and Walburg 1977). Our study corroborates those findings; fall catch rates of sauger were directly influenced by increased March–May discharge. Increased March–May discharge may have allowed sauger to reach flooded backwater areas where forage was abundant.

Populations may also exhibit long-term declines due to high exploitation (Hesse et al. 1994; Pegg et al. 1996; Sullivan 2003). The angler attitude survey conducted in our study indicated that exploitation was not unexpectedly high, but low natural reproduction may prohibit sustainability of even minimal harvest. The sauger fishery and exploitation rates on the Kentucky River are likely an underestimate, however, because our angler attitude survey was not conducted throughout what many consider to be the sauger fishing season (December–April) and efforts to survey anglers were limited to weekdays.

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). The Kentucky River is extremely channelized, and a series of 14 lock and dams limit fish movement through the river. Only locks 3 and 4 are operational and use is limited to the recreational boating season, further hindering movement potential and access to off-channel rearing habitats. Pegg et al. (1997) found that sauger moved up to 125 mi from tagging locations in the Lower Tennessee River, and other studies have documented high movement rates of sauger through North America (Collete et al. 1977; Penkal 1992). The longest pool on the Kentucky River is Pool 1 (27 mi). Limited habitat availability within pools and inability to move freely between pools may be resulting in poor natural reproduction of sauger in the Kentucky River.

Management implications and recommendations

Catch rates of sauger have decreased nearly each year since stocking halted. It is apparent that natural reproduction is limited throughout the river and that a high quality, self-sustaining population of sauger may not be feasible; however, there is likely substantial use of the current sauger fishery. In the absence of extreme changes to alter habitat (dam removal), continued stockings are needed to support a put-grow-take fishery. Future studies should be aimed at determining if current regulations on sauger in the Kentucky River (no size limit and 6 fish daily creel limit) are the best management options for the fishery. It is recommended that supplemental stockings of fingerling sauger (≥75,000 fingerlings/year) continue in the Kentucky River to maintain a put-grow-take fishery. If hatchery production cannot reach this level, any excess sauger should be stocked when available. Additionally, any excess walleye could be stocked throughout the river to provide a second put-grow-take fishery.

Literature Cited

Baccante, D.A., B.A. Barton, M.A. Bozek, and J.C. Bruner. 2011. Future research needs of walleye and sauger. Fisheries 36(12):618-619.

Becker, G. C. 1983. Fishes of Wisconsin. The University of Wisconsin Press, Madison Wisconsin.

Burr BM and Warren, Jr. ML. 1986. A distributional atlas of Kentucky fishes. Kentucky Nature Preserves Commission. Scientific and Technical Series Number 4. 398p.

Carter, B. T. 1954. The movement of fishes through navigation lock chambers in the Kentucky River. The Kentucky Academy of Science 15(3):48-56.

Cleary, R., and J. Mayhew. 1961. An

analysis of alternate-year walleye fry stocking program in the Cedar River in Iowa. Proceedings of Iowa Academy of Science 68:254-259.

Collette, B.B., M.A. Ali, K.E.F. Hokanson, M. Nagiec, S.A. Cmirnov, J.E. Thorpe, A.H. Weatherly, and JWillemsen. 1977. Biology of the percids. Journal of the Fiseries Research Board of Canada 34:1890-1899.

Ellison, D.G., and W.G. Franzin. 1992. Overview of the symposium on walleye stocks and stocking. North American Journal of Fisheries Management 12:271-275.

Goeman, T.J. 2002. Walleye management in North America. North American Journal of Fisheries Management 22:973-974.

Graeb, B.S., D.W. Willis, and B.D. Spindler. 2009. Shifts in sauger spawning locations after 40 years of reservoir aging: influence of a novel delta ecosystem in the Missouri River, USA. River Research and Applications 25:152-159.

Heidinger, R.C., and R.C. Brooks. 1998. Relative survival and contribution of saugers stocked in the Peoria Pool of the Illinois River, 1990-1995. North American Journal of Fisheries Management 18:374-382.

Jaeger ME, Zale AV, McMahon TE, Schmitz BJ. 2005. Seasonal movements, habitat use, aggregation, exploitation, and entrainment of saugers in the lower Yellowstone River: an empirical assessment of factors affecting population recovery. North American Journal of Fisheries Management 25: 1550–1568.

Koppelman, J.B., K.P. Sullivan, and P.J. Jeffries, Jr. 1192. Survival of three sizes of genetically marked walleyes stocked into two Missouri impoundments. North American Journal of Fisheries Management 12:291-298.

Kuhn KM, Hubert WA, Johnson K, Oberlie D, Dufek D. 2008. Habitat Use and Movement Patterns by Adult Saugers from Fall to Summer in an Unimpounded Small-River System. North American Journal of Fisheries Management 28(2):360-367.

Laarman. P.W. 1978. Case histories of stocking walleyes in inland lakes, impoundments, and the Great Lakes—100 years with walleyes. Pages 254 – 260 in R.L. Kendall, editor. Selected coldwater fishes of North America. American Fisheries Society, Special Publications 11, Bethesda, Maryland.

LeJeone, L. J., T. W. Bowzer and D. L. Bergerhouse. 1992. Supplemental stocking of fingerling walleyes in the upper Mississippi River. North American Journal of Fisheries Management 12:307-312.

MacCrimmon, H.R., and E. Skobe. 19070. The fisheries of Lake Simcoe. Ontario Department of Lands and Forests, Fish and wildlife Branch, Peterborough.

Nelson, W.R., and C.H. Walburg. 1977. Population dynamics of yellow perch (*Perca flavescens*), sauger (*Stizostediaon canadense*) and walleye (*S. vitreum*) in four main stem Missouri River reservoirs. Journal of Fisheries Research Board of Canada 34:1748-1763.

Pegg, M.A., J.B. Layzer, and P.W. Bettoli. 1996. Angler exploitation of anchor-tagged saugers in the lower Tennessee River. North American Journal of Fisheries Management 16:218-222.

Penkal, R.F. 1992. Assessment and requirements of sauger and walleye populations in the Lower Yellowstone River and its tributaries. Montana Department of Fish, Wildlife and Parks, Helena, Montana.

Sullivan, M.G. 2003. Active management of walleye fisheries in Alberta: dilemmas of managingrecovering fisheries. North American Journal of Fisheries Management 23:1343-1358.

Swain, D.P. 1974. Fisheries resource impact assessment of the upper Churchill river and lower Hughes River, Manitoba. Appendix B: an analysis of commercial fish catches from two Churchill River lakes in Manitoba in relation to river discharges and air temperature. Manitoba Department of Mines, Resources and Environment Management, Research Branch, Winnipeg.

Vandergoot, C.S., and P.W. Bettoli. 2003. Relative contribution of stocked walleyes in Tennessee reservoirs. North American Journal of Fisheries Management 23:1036-1041.

Williams, J. C. 1974. Commercial fishery investigations of the Kentucky River. Part I of III. Fish population studies and mussel bed surveys. Department of Biological Sciences, Eastern Kentucky University, Richmond, Kentucky. 64p.

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KDFWR Strategic Plan. Goal 1.

Evaluation of Restrictive Regulations on Rainbow Trout and the Performance of Two Strains in the Lake Cumberland Tailwater

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Introduction

Reservoir tailwaters can be an important resource for developing quality trout fisheries, especially when managed with restrictive regulations. The Kentucky Department of Fish and Wildlife Resources (KDFWR) manages a popular brown (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) fishery in the Lake Cumberland tailwater. Rainbow trout were first stocked in 1956, and brown trout were first introduced in 1982. For years, both species were regulated together using no length limits and a combined eight trout daily creel limit of which three could be brown trout (Kosa 1999). Over the last decade, the KDFWR has attempted to optimize stocking practices in the Lake Cumberland tailwater to increase the quality of the put-and-take rainbow trout fishery. In 2004, KDFWR implemented a 15-20 inch protective slot limit with a creel limit of 5 trout per day (only one of which may be over 20 inches). This regulation was expected to protect enough rainbow trout to prevent overharvest and increase quality, yet still allow for a put-and-take fishery.

There is a paucity of peer-reviewed research on the effects of restrictive minimum size and creel limits on salmonid populations (Power and Power 1996). An evaluation of the restrictive brown trout regulations on the Lake Cumberland tailwater has been completed (Dreves et al. 2014). So, the first goal of the current study was to evaluate the effectiveness of the rainbow trout restrictive harvest regulations in increasing the total number of rainbow trout and the number of quality size fish in the slot (15.0–19.9 in). The objectives of this portion of the study were to (1) compare the relative abundance of several size groups of rainbow trout before and after the restrictive regulations were implemented and (2) determine if there were any changes in rainbow trout growth rates or condition. Additionally, a minimum of 5 strains of rainbow trout are stocked into the Lake Cumberland tailwater annually. Long-term post-stocking performance of these various strains in the Lake Cumberland tailwater is unknown. The second goal of the study was to evaluate the post-stocking performance of two different strains of rainbow trout in the tailwater, one a relatively "domesticated" strain and the other a relatively "wild" strain. The specific objectives of the strain evaluation were to determine: (1) if the two strains exhibited differential growth and survival, (2) if "wild" strain fish are less susceptible to angling, and (3) the contribution that each strain makes to both the population and angler's creel.

This project was originally slated to extend at least through 2008 to give ample time for the rainbow trout population to respond to the regulations, along with being able to conduct the strain evaluation over multiple years. However, the rainbow trout population in the tailwater was highly negatively affected by the Wolf Creek Dam rehabilitation project which began in early 2007. Therefore, the project was cut short and only rainbow trout data through 2006 will be included in the evaluation.

Study Site

The Lake Cumberland tailwater in Kentucky is a 75.2 mi section of the Cumberland River which extends from the Wolf Creek Dam to the Kentucky-Tennessee state line. It is located in the Highland Rim Province of southeastern Kentucky and is managed as a coldwater fishery. The study area for this project encompasses the upper 38.3mi section beginning immediately below Wolf Creek Dam. Average daily discharge from the dam, released from 101 ft below maximum power pool, is 8,475 ft^3/s, but can fluctuate from 20 to 15,000 ft3/s within 3 h. Daily discharge fluctuations and durations of minimum flows are variable and depend on hydropower demands. Daily water level fluctuations can range from 20 ft in the upper reaches of the tailwater to 6 ft at the lower end of the study area. River width varies from 200 to 400 ft. Shoals associated with islands and small tributary streams, along with large woody debris along the banks, make up the primary in-stream habitat (Coopwood et al. 1987; Kosa 1999).

Methods

Rainbow trout stocked in the Lake Cumberland tailwater were produced at the Wolf Creek National Fish Hatchery, which is located immediately below Wolf Creek dam. Catchable-size rainbow trout that averaged about 9.0 in total length (TL) were stocked monthly from April through December from 1995 to 2006. Rainbow trout stocking rates were lowest during 1995 and 1996, but increased to approximately 145,000 fish annually (3,786 per mi) thereafter. Approximately 30,000 (783 fish per mi) catchable-size brown trout averaging 8.0 in TL were stocked in

March or early April from 1995 to 2006.

Annual trout population sampling was conducted at night in November of each year from 1995-2006 using boat-mounted pulsed DC electrofishing gear at five sites. During sampling, the Army Corps of Engineers provided a constant single turbine release from Wolf Creek Dam to ensure that all crews experienced a stable flow, thereby reducing sampling variation (Dauwalter et al. 2009). Multiple timed samples (15-min) were collected at each site. Trout captured were measured to the nearest 0.1 in TL and any marks were identified. From 2000 through 2006, trout were weighed to the nearest 0.01 lb. The sampling data was used to calculate catch-per-unit-effort (CPUE, fish/h), and to collect growth and relative weight (Wr) information.

In 2006, two strains of rainbow trout were differentially marked to analyze differences in relative survival, growth, and susceptibility to angling. Arlee strain rainbow trout were the domesticated strain used and were marked with a right pelvic fin clip (9.9 in, SE=0.04 in, N=500). McConaughy strain rainbow trout were the wild strain used and were marked with a left pelvic fin clip (9.4 in, SE=0.05 in, N=450). On 1 June 2006, 42,000 Arlee strain rainbow trout were stocked, while 43,500 McConaughy strain were stocked on 31-July 2006. Feeding rates were adjusted in an attempt to have each cohort of fish the same mean length at the time of stocking. Mean length, weight, and fin clip efficacy were estimated from a random subsample of fish from each cohort prior to stocking the marked fish.

A five mile section of the tailwater was sampled monthly from May to December in 2004 and 2006 to monitor monthly changes in growth and condition of marked rainbow trout. All trout collected were measured, weighed, and checked for fin clips, and in each sampling event, successive 15-minute runs were made until a minimum of 30 marked rainbow trout of that year's cohort were collected.

Since the rainbow trout population

A healthy rainbow trout from the Cumberland River / Dave Dreves was severely negatively impacted by the Wolf Creek Dam rehabilitation beginning in 2007, there are only three years of post-regulation data (2004-2006). This is not enough time for the ≥15 in rainbow trout to fully respond to the regulation changes so rigorous statistical analyses of pre- and post-regulation electrofishing data was not conducted.

Several other population parameters were collected to determine if there were any density dependent effects due to possible rainbow trout population increases. First year average monthly growth rates in length and weight were calculated. Comparisons of monthly growth in length and weight were made between 2004 and 2006.

Roving creel surveys were conducted on the upper 38.3 mi section of the Cumberland River in 1995, 2002, and 2006. In the 2006 creel survey, clerks identified fin-clipped rainbow trout in the angler's creel to differentiate the relative harvest of the two rainbow trout strains. The creel surveys were conducted 18 days per month, from March through November, , including eight weekend days. The study area was divided into four reaches ranging in size from 4.5 to 12 miles and a single reach was covered on each survey day. Because of greatly different usage patterns, the area of study was stratified into two strata for data summary: the 4.5 mi. reach from the dam to Helm's Landing was the upper stratum and the remaining three reaches combined from Helm's Landing to Highway 61 bridge (33.8 mi.) were the lower stratum.

Results and Discussion

Regulation Evaluation

Rainbow trout electrofishing catch rates increased in the three years following the implementation of the restrictive regulations. Overall rainbow trout catch rates in 2005 and 2006 were the highest recorded since intensive sampling of the Lake Cumberland tailwater began in 1995. The 2006 electrofishing catch rate of 219.7 fish/h represents a 63.8% increase from the catch rate observed in 2002, which exceeded the 15.6% projected increase. In three years, the regulations had the desired effects of both protecting more fish below the slot and increasing abundance of larger fish in the slot. By fall 2006, the catch rate of 15.0–17.9 in rainbow trout was at a record high and the catch rate of 18.0–19.9 in trout increased after 2003 and approached the record high. Taken in aggregate, the catch rate of ≥15 in rainbow trout was also at an all-time high in 2006 at 33.9 fish/h. However, there was no change in the catch rate of ≥20 in rainbow trout, likely because the length of the evaluation study was limited to three years and there were negative effects due to dam rehabilitation.

There were high numbers of first-year stocked rainbow trout in the 2005 and 2006 fall samples as indicated by number of fish in the 6–12 in size classes. Since the size at stocking did not vary, the positive trend in peak realative abundance for the second consecutive year after restrictive regulations were implemented is evidence that the overall growth rate of rainbow trout the first year after stocking did not decline. The monthly growth rate of rainbow trout in their first year in the tailwater was 0.48 in/month in 2004 and 0.6 in/month in 2006.

The total catch of rainbow trout in the 2006 creel survey decreased slightly from 2002. However, the catch rate of rainbow trout increased 9.7% from 2002 to 2006 (0.65 fish/hour in 2002 and 0.71 fish/hour in 2006). Further analysis of unexpanded length frequency distributions demonstrated that changes in regulations resulted in improved size structure of the angler catch. Rainbow trout that were ≥15 in accounted for 2.7 % of the catch (42 of 1,572) in the 1995 creel survey, 8.7 % of the catch (550 of 6,292) in 2002 and 12.7 % of the catch (551 of 4,329) in 2006.

The observed increases in electrofishing and angler catch rates of rainbow trout between 1995 and 2002 can most likely be attributed to the 86% increase in the number of rainbow trout stocked in the Lake Cumberland tailwater. However, number of rainbow trout stocked over the 2002–2006 time period were stable, so this was not a factor in the observed catch rate increases after 2002.

Strain Evaluation

The estimated growth in length of the Arlee strain from 23 May– 6 December was 0.60 in per month, although sample sizes were generally low. The estimate growth in length of the McConaughy strain from 20 July– 6 December was 0.67 in per month. The estimated weight change over these same periods was 0.09 lbs per month for both strains. Because of the lower sample sizes later in 2006, the Arlee data emphasizes growth shortly after stocking. After examination of the average length and weight on each sampling date, trends indicated that water temperatures at the end of the growing season adversely affected the Arlee strain greater than the McConaughy strain, particularly in terms of weight. An analysis of trout relative weight in the growing season after stocking shows a distinct seasonality. Condition typically declines in the month after stocking and then increases rapidly through October before falling in November and December, with the degree of drop-off related to the severity of the increase in water temperature in that particular year. A comparison of relative weight between the two strains over the course of the year reveals that the condition of both strains followed the normal seasonality. The later stocking date may not have allowed the McConaughy strain a comparable amount of time during the prime growing season to reach a similar relative weight as the

Arlee strain. However, by December, the drop from the peak relative weight for the Arlee strain was much more severe than for McConaughy strain, which may indicate that the Arlee strain is less tolerant of the warmer water temperatures that may occur in the Lake Cumberland tailwater in some years.

Low sample sizes for the Arlee strain compared to the McConaughy strain in the section of river sampled for monthly growth and condition analysis was surprising. This disparity may be related to the distance of stocking sites from sampling sites: approximately 6 miles in either direction. It appears that the Arlee strain did not disperse as far as the McConaughy strain. This same pattern held true during the intensive fall sampling. At the Above Winfrey's site (Rainbow Run), the catch rate of Arlee strain was 3.2 f/h while the McConaughy strain catch rate was 52.8 f/h. There was a disparity in catch rate between the two strains at all five fall sampling areas and Arlee strain were more susceptible to angling, as shown in the creel survey analysis (see below). The Arlee strain was approximately an inch greater in mean length than the McConaughy strain at each of the five sites in the November sample. However, by the time the McConaughy strain were stocked the Arlee strain had been in the river for about two months and already averaged about 2 in longer. So, in just three months, the McConaughy strain was able to gain nearly an inch in mean length on the Arlee Strain.

Creel clerks observed 5 times more of the Arlee strain (901 fish) harvested compared to the McConaughy strain (156 fish). An analysis of data by month revealed that the higher harvest of the Arlee strain was not due to earlier stocking. For August–November when both strains were at-large and susceptible to harvest, anglers harvested approximately 26,000 of the Arlee strain rainbow trout compared to 5,400 of the McConaughy strain, even though the initial Arlee number had already been reduced after two months at-large. The Arlee strain rainbow trout were harvested at higher rates than McConaughy for both bank and boat anglers except in October and November when the strains were harvested at the same rate by bank anglers.

It is apparent that the restrictive creel limit and protective slot limit regulations implemented for rainbow trout in 2004 had begun to positively influence rainbow trout population in positive ways and it was unfortunate that the project had to be cut short before the population reached equilibrium under the new regulations. However, the success of fisheries regulations ultimately depends on angler acceptance (Fatora 1978; Anderson and Nehring 1984; Brousseau and Armstrong 1987; Pierce and Tomcko 1998). Some anglers place high value on harvesting fish, while others enjoy catching and releasing high numbers of fish or simply catching large fish. Fatora (1978) stated that the ultimate goal of trout management should be to provide quality fishing for the varied desires of the resource users, and suggested that the trout resources in a given area should be managed differently in an effort to accommodate all angler desires. The Lake Cumberland tailwater rainbow trout regulations accomplish this by allowing for limited harvest of mostly smaller fish to satisfy the put-and-take component of the fishery yet protect enough large fish for a put-grow-and-take strategy that leads to good numbers of trophy fish.

Management Implications

The different rainbow trout strain characteristics may also be used to further these differing management strategies. It may be desirable to stock the upper tailwater, nearer the dam, with the more angling susceptible Arlee strain since this section is where most of the harvest-oriented angling takes place. The McConaughy strain which seems to grow faster and is less susceptible to harvest may be better suited to the section of river from Helm's Landing and below because these areas have not traditionally had as much harvest. Alternatively, if the management strategy is to produce the highest quality fishery in terms of increasing average fish length then the preference may be to focus more effort on stocking just the McConaughy strain over all sections of the river. If the management strategy is to increase angler catch rates only then more Arlee strain should be stocked. With any of the above strategies, the rainbow trout population needs to be continually monitored and the stocking rates adjusted if there is any evidence of stockpiling of fish.

1. Results of this evaluation indicate that the restrictive size and creel limits regulation on rainbow trout will have the desired effects and should remain following completion of the dam rehabilitation and a return to normal flows.

2. It is recommended that the rainbow trout population in the Lake Cumberland tailwater continues to be monitored to track population response after a return to normal conditions and to determine when the rainbow trout population reaches equilibrium under the restrictive regulations and at what level.

3. Density dependent mechanisms negatively affecting the rainbow trout population would most likely first be observed in the area just below the dam because of the high stocking density. The rainbow trout stocking rate in this area should be reduced and these fish distributed to areas downstream if any evidence of stockpiling is observed.

4. Conduct a multi-year rainbow trout strain comparison study to determine if the results of the one year study are accurate. It is recommended that the comparison be designed such that the strains are stocked at the same time and at similar lengths.

5. Conduct creel and angler attitude surveys to determine if pressure, catch rates, and angler satisfaction have returned to pre-dam rehabilitation levels.

Literature Cited

Brennan, L. A. 1991. How can we
Anderson, R. M., and R. B. Nehring. 1984. Effects of a catch-and-release regulation on a wild trout population in Colorado and its acceptance by anglers. North American Journal of Fisheries Management 4:257–265.

Brousseau, C. S., and E. R. Armstrong. 1987. The role of size limits in walleye management. Fisheries 12(1):2-5.

Coopwood, T. R., S. W. McGregor, T. S. Talley, and D. B. Winford. 1987. An investigation of the tailwater fishery below Wolf Creek dam, Russell County, Kentucky to Celina, Tennessee. U.S. Fish and Wildlife Service, Ecological Services. Cookeville, Tennessee.

Dauwalter, D. C., F. J. Rahel, and K. G. Gerow. 2009. Temporal variation in trout populations: implications for monitoring and trend detection. Transactions of the American Fisheries Society 138:38–51.

Dreves, D. P., J. R. Ross, J. T. Kosa, 2014. Brown trout population response to trophy regulations and reservoir discharge in a large, Southeastern U.S. tailwater. Bulletin Number 111. Kentucky Department of Fish and Wildlife Resources.

Fatora, J. R. 1978. Stream trout fishery management in the southeastern United States. Proceedings of the Annual Conference Southeastern Association of Fish and Wildlife Agencies 30(1976):280–284.

Kosa, J. 1999. Evaluation of rainbow and brown trout stockings in the Lake Cumberland tailwater. Kentucky Department of Fish and Wildlife Resources Bulletin 102. Frankfort.

Pierce, R. B., and C. M. Tomcko. 1998. Angler noncompliance with slot length limits for northern pike in five small Minnesota lakes. North American Journal of Fisheries Management 18:720-724.

Power, M., and G. Power. 1996. Comparing minimum-size and slot limits for brook trout management. North American Journal of Fisheries Management 16:49–62.

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

KDFWR Strategic Plan. Goal 1, Strategic Objective 1.6.

Biologists processing blue catfish at Taylorsville Lake / Obie Williams

New Projects

Ability of Hunters to Encounter Northern Bobwhite on Peabody Wildlife Management Area

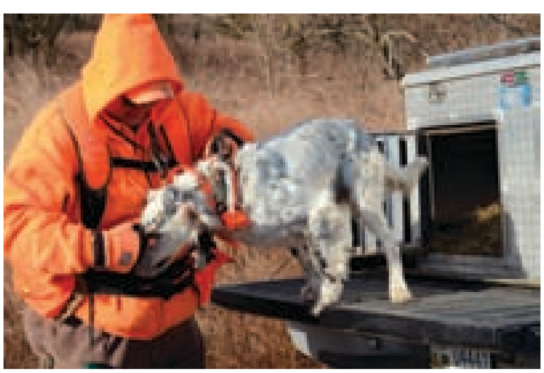
John Morgan, Ben Robinson, Danna Baxley, and John Yeiser, Kentucky Department of Fish and Wildlife Resources

GPS dog collar routes

The Kentucky Department of Fish and Wildlife Resources has invested a great deal of resources towards the management of Peabody Wildlife Management Area. The primary focus was the restoration of habitat for northern bobwhite. Since 2009, northern bobwhite populations have responded well to management actions by more than doubling the fall population (determined by fall covey counts). Despite the bobwhite response, hunter encounters (coveys flushed/hour) have not markedly improved.

The primary objective of management was to grow the bobwhite population, but it was also critically important for sportsmen and women to have improved hunting opportunities and higher levels of success (birds bagged and bird encounters) when afield. Therefore, it is imperative to understand the relationship between hunting effort and wild bird encounters on Peabody WMA.

There are two factors that we are investigating that could influence a hunter's ability to detect wild bobwhite. First, hunters may not be hunting the areas that bobwhite frequent. Through collaboration with the University of Tennessee, we are using radio-telemetry to classify bobwhite habitat use of Peabody WMA. In partnership with Garmin, we are deploying GPS dog collars to understand where hunters and bird dogs are hunting. We will be able to assess the relationship between habitat hunted and habitat used by bobwhite during the hunting season.



Hunter preparing dog / Ben Robinson

The second component of the project is assessing the effectiveness of bird dogs to locate bobwhite. The plight of KY's bobwhite population has minimized bird dog encounters with wild birds and elevated encounters with domestic birds. Through this project, we are investigating if a dog's exposure to wild or liberated birds affects their ability to find wild or liberated bobwhite. We are testing two groups of experienced bird dogs: dogs with little exposure to domestic bobwhite and dogs with high exposure to domestic bobwhite. In collaboration with the University of Tennessee, we are testing each group of dogs on radio-marked wild bobwhite coveys and domestic bobwhite coveys. We hope to learn about a bird dogs ability to find birds and learn about wild and domestic bird behaviors to avoid detection.

Although no formal analysis has taken place, we have noted some interesting observations. Wild bobwhites have shown a strong affinity for woody cover during the hunting season, but hunters may not be hunting woody cover to the extent the birds use it. The bird dog trials have highlighted how evasive wild bobwhites can be on Peabody WMA. Birds were quick to run and scatter, challenging both groups of bird dogs. On the other hand, we observed scattered wild birds holding extremely tight. These anecdotal observations do help explain the lack of hunter success on Peabody, but no conclusions can be drawn without further sampling and analysis.

Funding Source: *Wildlife Restoration Program (Pittman-Robertson), Kentucky Department of Fish and Wildlife Resources, and University of Tennessee*

KDFWR Strategic Plan. Goal 1. Strategic Objective 1.1.

Survival, Cause-Specific Mortality, and Recruitment of White-tailed Deer (*Odocoileus virginianus*) Neonates in Southeastern Kentucky

Joe McDermott and John Cox, University of Kentucky; Gabriel Jenkins, and Will Bowling, Kentucky Department of Fish and Wildlife Resources; Kristina Brunjes, Georgia Department of Natural Resources

Following an extensive trapping and relocation project that ended in 1999, it has been observed that the white-tailed deer (*Odocoileus virginianus*) population in southeastern Kentucky is in decline while populations in the rest of the state are stable or increasing. Because the factors influencing this decline in southeastern Kentucky are unknown, the goal of the research project is to determine the recruitment rate of white-tailed deer through a survival and cause-specific mortality study of neonates. Understanding cause-specific mortality and survival of fawns is important when preparing deer population models that can inform management decisions.

To address this regional deer issue, we will capture and collar fawns during the months of May and June in Clay and Leslie Counties using vaginal implant transmitters (VITs) inserted into does captured during a complimentary mortality survey occurring in the same region. Fawns will also be found by using thermal imaging cameras at night to detect the heat signature of deer. Once captured, fawns will be fitted with an expandable neonate collar that will allow us to monitor the animals until death or one year of age to assess survival, cause-specific mortality, and recruitment. To date, 14 adult does have been inserted with VITs with fawn capture season beginning spring 2014. Our findings should help inform wildlife managers about regional deer population dynamics and potential management responses.

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

KDFWR Strategic Plan. Goal 1.

Researchers with the University of Kentucky ultrasound a doe to check for pregnancy before inserting a VIT / Katie Haymes

KDFWR employees assist in work-up of captured deer / Caleb Haymes

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

Caleb Haymes, John Cox, University of Kentucky; Gabriel Jenkins, Will Bowling, Kentucky Department of Fish and Wildlife Resources; Kristina Brunjes, Georgia Department of Natural Resources

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 at 2600 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, low density populations.

Our research will 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. Does will be captured and immobilized using clover traps, drop-nets, and free-range darting, then fitted with a very high frequency (VHF) radio-transmitter collar. Pregnancy and number of fetuses will be determined using an ultrasound, and a vaginal implant transmitter (VIT) will be inserted in pregnant does to facilitate location of birth-site locations and fawns for a different study. Adult does will be monitored twice weekly for mortality for 18-24 months. We have thus far captured 17 adult female deer. These data should inform state wildlife managers about regional deer population dynamics that can be helpful for refinement of population models and overall management of this important game species.

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

KDFWR Strategic Plan. Goal 1.

Evaluation of a 15-inch Minimum Size Limit and Reduced Daily Creel Limit on Smallmouth and Largemouth Bass in the Floyds Fork

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

Floyds Fork smallie / Nick Keeton

Warm water stream fisheries are a valued resource in the southeastern United States, particularly smallmouth bass fisheries. With the popularity of this resource among anglers, management agencies are looking into strategies to improve and enhance stream fisheries. Information on fishing pressure, effort, catch, harvest, survival, mortality and exploitation is crucial for formulating management policies across large spatial scales.

The 21st Century Parks is developing Parklands of the Floyd's Fork along 20 miles of the Floyd's Fork in Jefferson County. All 20 miles of Floyd's Fork within the park boundaries will be open to recreational fishing. Carry down and canoe access sites will be situated at various locations along the stream in an effort to promote fishing and boating throughout the park. Both largemouth and smallmouth bass in the Floyds Fork are managed under statewide size (12 in minimum) and creel limit (6 fish daily limit). Now that it will be open to the public, the amount of fishing pressure on this system will increase based on the park's proximity to highly populated areas. With the expected increase in fishing pressure, it is probable that the quality of the largemouth and smallmouth fisheries would quickly decline.

The concern is that the densities of largemouth and smallmouth bass in the Floyds Fork are relatively low when compared to other black bass stream fisheries. Catch rates for largemouth bass range from 6.0 fish/hr to 6.3 fish/hr in 2012 and 2013 while catch rates for smallmouth were 15.5 fish/hr to 16.0 fish/hr on Floyds Fork during the same period. Catch rates of quality size (≥12.0 in) fish was also relatively low and ranged from 0.0- 1.4 fish/hr for largemouth bass and 2.8 fish/hr for smallmouth bass from 2012-2013. This data indicates that black bass in Floyds Fork cannot sustain high levels of angler harvest due to low densities and poor recruitment. Typically, streams with poor recruitment, like Floyds Fork, are managed with a minimum length limit. In 2013, the Kentucky Department of Fish and Wildlife Resources Fisheries Division recommended that a 15 in minimum size limit and a 1 fish ≥15 in daily creel limit on largemouth and smallmouth bass combined for the section of Floyds Fork that extends from US 60 (Shelbyville Rd) Bridge downstream to US 31E/150 (Bardstown Rd) Bridge in attempt to reduce the potential of overharvest and maintain or enhance the fishery for both species.

This project seeks to evaluate the most restrictive regulation that the department has employed on a stream; it becomes effective on March 1, 2014.

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

KDFWR Strategic Plan. Goal 1, Strategic Objective 4.

Surveys for the Diamond Darter, an Endangered Species Known Historically from the Green River, Kentucky

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

The Diamond Darter (*Crystallaria cincotta*) a small, slender perch (maximum size 3 in) that formerly occurred in the Ohio River basin in the Cumberland, Green, Muskingum, and Elk River drainages in Kentucky, Tennessee, Ohio, and West Virginia. Currently, it exists only within the lower 22 mi of the Elk River in west-central West Virginia. No population estimates are available and despite concerted sampling efforts, only 16 individuals have been collected from the Elk River between 1980 and 2008. Based on its decline and the magnitude and imminence of its threats, the U.S. Fish and Wildlife Service (USFWS) listed the Diamond Darter as an endangered species in July 2013.

Because of its rarity, little is known about the life history and ecology of the Diamond Darter. In the Elk River, the species has been captured in riffles and pools at depths of <5 ft in moderate current over sand, gravel, and cobble substrates. Observations of captive individuals suggest that the species is crepuscular (more active at dusk and dawn), which is consistent with results of sampling efforts in the Elk River that proved more effective at dusk or during the night.

In Kentucky, the Diamond Darter is known only from six old records: Cumberland River, Lyon County (one record); upper Green River, Green and Edmonson Counties (three records); and Ohio River, Boone and Greenup-Boyd counties (two records). It was last collected in the Green River near Cave Island (now within Mammoth Cave National Park), Edmonson County, in 1929. Despite extensive sampling for fishes in the middle and upper Green River during the past 25 years, no records of Diamond Darter occurrence have been reported. However, it is possible that the species could still exist and has been overlooked because of inadequate methodologies available to capture small-bodied benthic fishes in areas inaccessible to seining. Another possible reason that this species has not been detected in the Green River is because fish sampling is almost always conducted during daytime hours. In the Elk River, sampling at night has proven more effective in capturing individuals due to the species' apparently increased crepuscular and nocturnal activity.

The upper Green River contains

Diamond Darter from Elk River, WV/ J.R. Shute, Conservation Fisheries, Inc.

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 94.5 mi section of the Green River from the downstream end of Cave Island (River Mile 200.3) to Roachville Ford (River Mile 294.8) has been designated as a critical habitat unit for the Diamond Darter in accordance with section 4(b)(2)(A) of the Endangered Species Act. This unit is tentatively being treated as unoccupied, pending a systematic survey using gear appropriate for capturing the species.

In September 2012, we began surveys for the Diamond Darter within the Green River critical habitat unit using an 8' benthic trawl designed to capture small-bodied fishes in larger rivers. Although the Green River's aquatic fauna, particularly fishes and mussels, has been reasonably well-documented, most fish surveys have been conducted during daylight hours and limited to wadeable habitats using a seine and/or backpack electrofisher. Our approach using the benthic trawl will enable us to more effectively target habitats too deep to sample via standard collecting gear. In addition to daytime trawling, in 2014 we will also conduct nocturnal sampling using seines and visual inspection of shallow runs over gravel and sand using spotlights. Our sampling locations include flowing pools, runs, and deep (>3 ft) riffles, as well as known localities for Streamline Chub (*Erimystax dissimilis*), Shoal Chub (*Macrhybopsis hyostoma*), and Stargazing Minnow (*Phenacobius uranops*), which have habitat preferences similar to the Diamond Darter. We hypothesize that trawling combined with nocturnal surveys using seines and spotlights will increase the likelihood of detecting Diamond Darter presence in the Green River based on the effectiveness of these methods in the Elk River, WV.

The objectives of this project are: 1) determine presence and distribution of the Diamond Darter in the upper mainstem Green River; 2) estimate population densities and provide a catch-per-unit-effort; and 3) determine habitat usage. If the species is discovered through our sampling effort, each individual will be photographed, measured for total length, and a fin clip taken for genetic analysis before being released unharmed. Although no Diamond Darters have been encountered thus far, for each location sampled we have recorded fish community data (composition and abundance) and an array of physical habitat variables, including stream width, depth, substrate composition, current velocity, and riparian cover. This information will be valuable should reintroduction of the species in the Green River be considered as a recovery action in the future.

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

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

Distribution and Status of the Sheltowee Darter, a Species Endemic to the Dix River Drainage, Kentucky

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

Sheltowee Darter, breeding male / Matt Thomas

The Sheltowee Darter (*Etheostoma* sp. cf. *spectabile)* is recognized as a valid, but undescribed species in the Orangethroat Darter (*Etheostoma spectabile*) group. It is endemic to the Dix River drainage (Kentucky River basin) in Mercer, Casey, Boyle, Garrard, Lincoln, and Rockcastle counties of the south-central Bluegrass region of Kentucky. Land use within the Dix River drainage is predominantly agricultural, with high livestock densities and cattle having free access to streams. In addition, failing septic systems and various forms of development and construction activities result in excessive nutrient input and siltation, which have led to habitat and water quality degradation, harmful algal blooms, and subsequent fish kills.

Like other members of the Orangethroat Darter group, Sheltowee Darters concentrate in headwater and small streams over gravel and cobble substrates. Spawning success is dependent upon the presence of clean gravel necessary for females to burrow and lay eggs. Excessive siltation covers the substrate and reduces or eliminates the oxygen supply to the eggs. Although most species in the Orangethroat Darter group can be abundant in suitable habitat, most populations of the Sheltowee Darter may be adversely affected by increasing pressure on headwater streams by human activities.

We compiled and reviewed previous fish collection records from the Dix River drainage, which included published data, museum records, and unpublished data from Kentucky Department of Fish and Wildlife Resources, Kentucky Division of Water, Kentucky State Nature Preserves Commission, Kentucky Transportation Cabinet, and Third Rock Consultants, LLC. Sample localities were chosen throughout the Dix River drainage based on historic (1953-2008) records of Sheltowee Darter presence, as well as additional sites that could potentially result in new occurrences within the drainage.

We conducted backpack electrofishing surveys at 56 sites throughout the Dix River drainage during March-April of 2012 and March-June of 2013 to accomplish the following objectives: 1) assess the current distribution and status of the Sheltowee Darter to determine whether any level of conservation status designation is warranted; and 2) provide an updated assessment of the fish fauna of the Dix River drainage, with emphasis on fish species of greatest conservation need (SGCN).

Preliminary results indicate that the Sheltowee Darter is widely distributed in the Dix River drainage, but with variable abundances among sites. The species was present at 40 of 56 sites sampled and in 34 of 35 streams with historic records. Streams supporting Sheltowee Darters were generally small (1st and 2nd order with average watershed area of 28 km2) with perennial flow and shallow riffles and runs over bedrock with patches of gravel. Spawning in 2013 occurred from 13 March – 29 April based gravid females and brilliantly colored males in our samples. Although the species appears to be common within its range, additional sampling will be completed in 2014 to more accurately assess the complete distribution and how extensive habitat and water quality degradation in the watershed is impacting populations. This project will provide information necessary to facilitate appropriate conservation actions that could benefit this species and other fish SGCN within the Dix River drainage.

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: Taxa specific project.

Using Forest Stand Improvement Techniques to Enhance Oak Regeneration and Mast Yields on Yatesville Wildlife Management Area

Harley Weaver, John Yeiser, Danna Baxley and Jim Barnard, Kentucky Department of Fish and Wildlife Resources

Over the past several decades, Kentucky's forest lands have been subject to multiple emerging issues. A substantial loss in oak regeneration, and subsequently its continued contribution of hard mast yields, poses a threat to forest-dependent wildlife, including deer, turkey, and bear. Invasive species, including introduced pathogens, continue to negatively influence our native ecosystems. Additionally, a lack of disturbance regimes has impacted those wildlife species dependent on early-successional forest, including Ruffed Grouse and Golden-Winged Warblers. In response to these issues, KDFWR has a renewed interest in statewide management of forest resources.

In an effort to increase forest productivity on Yatesville Wildlife Management Area, we implemented a long-term forest monitoring project (case study) assessing differences between a treatment and reference site. The treatment site involves a"Hack-N-Spray" chemical application, eradicating all red maple over 1 meter in height and sequestering beech to lower-lying areas of the slope. No management occurred on the reference block. Beginning in 2013, we monitored the following parameters at long-term monitoring stations established within treatment and reference plots: basal area, canopy cover, number and species of all tree and shrub stems (< 1 ft tall), and number of fruits per stem for soft mast plants within our plots.

Preliminary data analysis (1-year after treatment) indicates higher percentages of canopy cover in the reference areas when compared to the treatment areas, and treatment areas comprised of greater numbers of soft mast stems and oak stems in the understory. A 5-year monitoring plan will assess the long-term impacts of chemically culling red maple and beech within forest plots on Yatesville WMA.

Serviceberry flowers in pre-bloom stage within the treatment block / Harley Weaver

Funding Source: *Wildlife Restoration Program (Pittman-Roberston)*

KDFWR Strategic Plan: Goal 1.

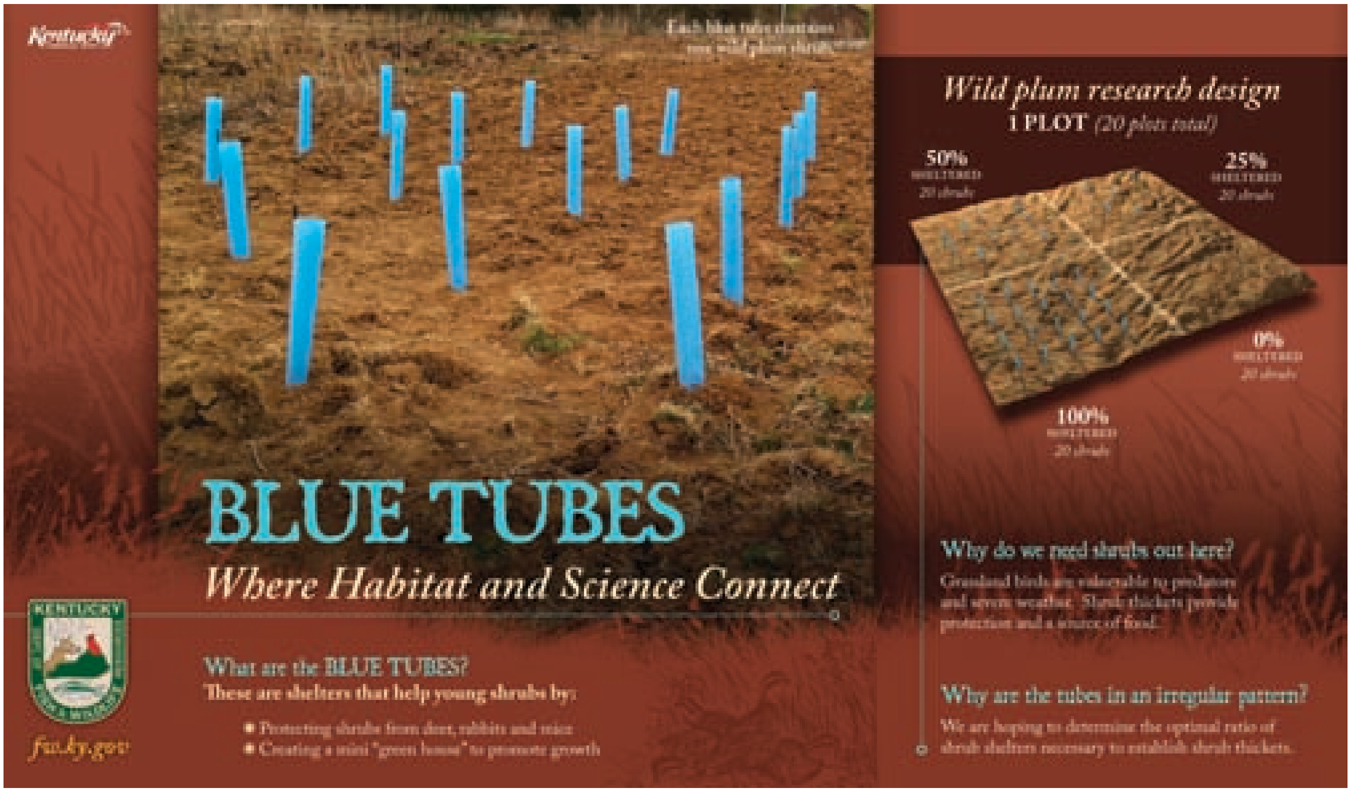


Figure 1: *Blue tubes kiosk signage at Shaker Village / Obie Williams*

Minimizing Cost and Maximizing Native Shrub Establishment using Tree Shelters on Shaker Village of Pleasant Hill

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

The Wildlife Division's Research and Small Game Programs teamed up to investigate the most effective way to establish native shrubs for wildlife habitat. When managing for small game such as bobwhite quail and rabbits, shrubby cover is often one of the most overlooked habitat components. However, this important habitat feature should be a top priority when managing for these species. Quail and rabbits experience multiple benefits from shrubs; one of the most important being escape cover from aerial predators like hawks. Animals also seek shelter from extreme weather conditions in these areas during the summer and winter months.

One of the biggest challenges encountered while establishing native shrubs is damage caused by deer, rabbits, and rodents. Deer regularly browse on the leaves and stems while rabbits and rodents such as mice and shrews girdle the base of the stems.

Damage can be prevented by using tree shelters. These shelters come in a variety of types and range in price from a few cents to several dollars per shelter. Studies have been conducted on the efficacy of tree shelters, and results indicate that tree shelters increase survival and growth of trees and shrubs.

Since we know that tree shelters greatly reduce herbivory damage, we are most interested in minimizing costs associated with installing protective tubes across large landscapes. Using the Shaker Village Quail Focus Area in Mercer County as our study site, we are attempting to determine how many tree shelters are required to successfully establish shrub blocks (American plum) for wildlife. We created 20 replicates across the property (Figure 1). Shrubs will be surveyed annually for 3-5 years to determine survival. Early observations on our study site indicate that unsheltered shrubs are highly susceptible to herbivory and stand little chance of survival.

Funding Sources: *Wildlife Restoration Program (Pittman-Robertson)*

KDFWR Strategic Plan. Goal 1. Strategic Objective 1.1.

Ecological Factors Influencing Native Hardwood Seedling Establishment in the Kentucky Inner Bluegrass Blue Ash-Oak Savanna-Woodland

Ohio buckeye / JD Shaffer

James D. Shaffer, Scott K. Gleeson, John J. Cox, and John M. Lhotka - University of Kentucky

KDFWR Contact: *Derek Beard*

The Kentucky Inner Bluegrass blue ash-oak savanna-woodland has been historically considered the dominant vegetation type of Central Kentucky. Anecdotal evidence in early floristic surveys documented an abundance of open-grown, shade intolerant tree species (e.g. bur oak [*Quercus macrocarpa*], honey locust [*Gleditsia triacanthos*]) and an abundance of native river cane (*Arundinaria gigantea*). Additionally, large herds of American bison (*Bison bison*) and elk (*Cervus canadensis*) were often observed grazing in a grassland/savanna type habitat.

After European pioneer settlement, rapid conversion of the landscape to agricultural uses eliminated over 99% of the original vegetation type, and the remaining 1% has been severely degraded with all of the native grassland vegetation lost. Small remnants of savanna-woodland exist, with the largest and best preserved stand occurring at Griffith Woods Wildlife Management Area in Harrison Co., KY. Multiple old-growth bur oak, chinquapin oak (*Q. muehlenbergii*), blue ash (*Fraxinus quadrangulata*) and shellbark hickory (*Carya lacinosa*) are preserved on the site, however, a lack of seedling recruitment is resulting in a savanna-woodland regeneration failure. Restoration of this vegetation community is difficult without an intact reference system, therefore experimental reconstruction is necessary to determine species assemblages.

Savanna systems are generally considered to be maintained through disturbance factors (e.g. drought, fire, or herbivory), but grass-seedling competition likely influences establishment as well. To test these factors, a large-scale, long-term seedling establishment experiment has been implemented at Griffith Woods WMA. Over 6,000 seedlings of fourteen species of native hardwoods have been experimentally planted to assess the factors of competition and disturbance and their influence on growth and survival. Manipulations of vegetation removal (through mowing and herbicide application) and herbivory removal (through individual seedling protectors/shelters) have been applied in a factorial block-plot design, and this particular experimental setup accommodates future experimental burn treatments as well. Prior to planting, a native grass and forb mix was established to mimic former native vegetation structure. Although previous herbivores have been extirpated (i.e. bison and elk), browsing by white-tailed deer (*Odocoileus virginianus*), eastern cottontail (*Sylvilagus floridanus*) and various small rodent species (*Microtus* spp., *Peromyscus* spp., and *Reithrodontomys* sp.) is currently occurring. Data collection on growth (height, ground line diameter, leaf number, and leaf length) and herbivory (browser type, browse severity) in addition to abiotic environmental parameters (i.e. light levels and soil nutrient availability) have been or are in the process of being collected. In addition to providing insights into the ecological factors that establish and maintain native Bluegrass savanna-woodland, this project will also re-introduce and restore a native tree assemblage that will simultaneously provide valuable food resources and habitat for native wildlife.

Funding Source: *University of Kentucky*

KDFWR Strategic Plan. Goal 1.

The Impacts of Imazapic on Garlic Mustard and Non-Target Forest Floor Vegetation in Central Kentucky's Hardwood Forests

Dr. Thomas Barnes and Pavan Podapati, University of Kentucky

KDFWR Contact: *Derek Beard*

Numerous flowering plants make their home in the hardwood forests of central Kentucky, some of which exhibit impressive displays of wildflowers during spring. Many of these species serve as valuable forage and cover for wildlife. Threats such as forest fragmentation and the establishment of exotic invasive species have taken a toll on both wildlife and plant communities in these ecosystems. One invasive plant proliferating through many of Central Kentucky's forests is garlic mustard (*Alliaria petiolata*), an upright biennial herb native to Europe and Asia.

Garlic mustard germinates in late winter/early spring, allowing it to establish earlier than other plants. By mid-late spring, first-year rosettes can form dense carpets on most available substrates (e.g. soil, fallen tree trunks, other debris), crowding out other native plants. Garlic mustard also exudes defensive chemicals into the soil that inhibit mycorrhizal fungi (fungi that form symbiotic relationships with plants) and some native plants. Garlic mustard has almost no natural enemies (herbivores, parasites) in North America, and individual second-year plants can produce hundreds of seeds. The most common garlic mustard removal methods are hand-pulling, mechanical removal and herbicide application. Using herbicide on large infestations is typically less labor- and cost-intensive than the other aforementioned methods, but poses risks to non-target wildlife and flora. Glyphosate is commonly wielded against garlic mustard, but indiscriminately harms many species. We have focused on exploring imazapic (Plateau®) as an alternative for garlic mustard removal. Many habitat managers in the central and western United States use imazapic to promote native grass and wildflower establishment, and the imazapic formulation in Plateau® is known to be effective in controlling garlic mustard.

Our research utilizes forested tracts at Canoe Creek (Garrard Co.), Curtis Gates Lloyd WMA (Grant Co.), and Raven Run Nature Sanctuary (Fayette Co.). We established small research blocks with individual plots at these sites in preparation for herbicide treatment comparison. These plots received separate applications of glyphosate (Mad Dog® Plus) and imazapic (Plateau®) during February-March 2014. We are now observing changes in the percent cover of garlic mustard and non-target forest understory plant species. These observations will continue over the next twelve months. By collecting this data, we hope to educate managers on the risks and benefits of imazapic application in Central Kentucky's forests. This information should help habitat managers decide on an effective garlic mustard control regimen that meshes with their habitat rehabilitation goals.

Garlic mustard rosettes / Pavan Podapati

Funding Source: *University of Kentucky*

KDFWR Strategic Plan. Goal 1.

Biologists process a black bear in the mountains of eastern Kentucky / Obie Williams

Project Updates

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

Biologists study elk in tree plot / John Hast

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

The Kentucky bull elk project is in its fourth year and plans to answer a number of objectives concerning the ecology of bull elk, such as: 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 such as this project 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.

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 tracts 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) and University of Kentucky*

KDFWR Strategic Plan. Goal 1.

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

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

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

A total of 94 cow elk have been outfitted with very high frequency (VHF) collars and ear tags for individual identification (2013, N = 40; 2014, N = 54). Physiological parameters such as age, body condition, and morphological measurements are taken upon capture. To monitor fecundity and calving sites, a subset of cows received vaginal implant transmitters (VITs)(2013, N = 5; 2014, N = 10). Behavioral observations occur during three biological time periods (winter herd, nursery herds, and rut harems). Mortality is monitored weekly.

Marked individuals represent a variety of age classes, with ages ranging from 1–20 years. Preliminary data shows the presence of a linear dominance hierarchy, minimal mixing between groups, and overall stable group dynamics. All cows that received VITs calved 20 May–10 June 2013. Calves were sampled between 2–24 hours post birth, yielding 3 bull and 2 cow calves. All calves were in excellent condition, with an average body weight of 29.2 lbs (SD = 5.4). A total of 55 marked individuals were on the landscape (includes marked cows, calves, and spikes) in 2013. Of these 38 were cows marked with VHF collars and 7 were calves that were marked via the VIT pilot (total N = 45); of these 19 mortalities occurred resulting in a mortality rate of 42%. It is evident that a majority of mortality results from the cow gun season; the highest percentage of individuals being taken are within prime reproductive age class (2-7 years). The effect of such a take on overall group dynamics has yet to be discerned. Behavioral data collection and mortality monitoring will occur throughout 2014.

Funding Source: *Rocky Mountain Elk Foundation*

KDFWR Strategic Plan. Goal 1.

Marked cow elk post capture. / Brittany Slabach

Releasing bobwhite quail / Kyle Servedio

Northern Bobwhite Ecology on a Reclaimed Surface Coal Mine

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

In 2008, the Kentucky Department of Fish and Wildlife Resources (KDFWR) established a plan to restore bobwhite and bobwhite habitat across the Bluegrass state. *The Road to Recovery: The Blueprint for Restoring the Northern Bobwhite in Kentucky* is a comprehensive plan with the goals of stabilizing bobwhite populations statewide, increasing populations in focal areas, increasing statewide recreation related to bobwhite, and generating funding to support bobwhite restoration. One of the key steps outlined in the management plan was establishing bobwhite research in Kentucky. In 2009 KDFWR and the University of Tennessee started a multi-year bobwhite research project on Peabody Wildlife Management Area (PWMA).

Reclaimed surface mines account for 600,000 acres of land within Kentucky and mines reclaimed after the passing of the Surface Mining Control and Reclamation Act (SMCRA) have persisted in early successional vegetative communities. Reclaimed mines provide large tracts of usable space available to bobwhite and a novel opportunity to manage bobwhite populations. However, two main problems exist on reclaimed surface mine lands: (1) reclamation is accomplished with invasive, non-native species, limiting the establishment of native vegetation and (2) research investigating bobwhite ecology on reclaimed surface mines is lacking.

Since 2009, we have trapped 2,003 bobwhite and collared 1,535 individuals, with a 2.48% trapping success rate. Overall crude mortality rate on PWMA was 81.6%, with a 14.8±1.5% summer survival rate and a 28.1±2.2% winter survival rate. Using covey-call surveys, we estimated the fall population size of bobwhite on PWMA of 2,481 (2009), 3,889 (2010), 3,838 (2011), 4,156 (2012), and 6,472 (2013). Bobwhite had an average summer home range of 40.4±2.4 hectares and an average winter home range of 29.6±1.3 hectares. Bobwhite moved an average of 133.9±2.2 meters per day throughout the year with increased movement in April (147.0±8.5 m), October (143.6±7.5 m), November (142.8±7.9 m), and December (130.9±7.2 m). We found 127 nests during the 4 breeding seasons of the project. The overall nest survival rate on Peabody was 35.2±3.7%. Of the 127 nests found 51% contained sericea lespedeza (*Lespedeza cuneata*) as a building material, 28% contained native warm-season grass, and 66% contained cool-season grass, predominantly field brome (*Bromus arvensis)*. Vegetation data has been collected at 620 summer telemetry locations and 450 winter telemetry locations, as well as an equal number of random locations. By comparing the vegetation at telemetry locations and random locations we will be able to determine the vegetative attributes influencing northern bobwhite microhabitat selection. Telemetry locations will also be used to determine northern bobwhite habitat selection at the landscape scale. Data collection for the first phase of the project was completed March 31st of this year. Data is currently being analyzed and results should be finalized by January of 2015. KDFWR will continue to expand the habitat management currently implemented on PWMA and further research will be conducted.

Funding Sources: *Wildlife Restoration Program (Pittman-Robertson) and the University of Tennessee*

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

Barn Owl Management Update and 2013 Inventory

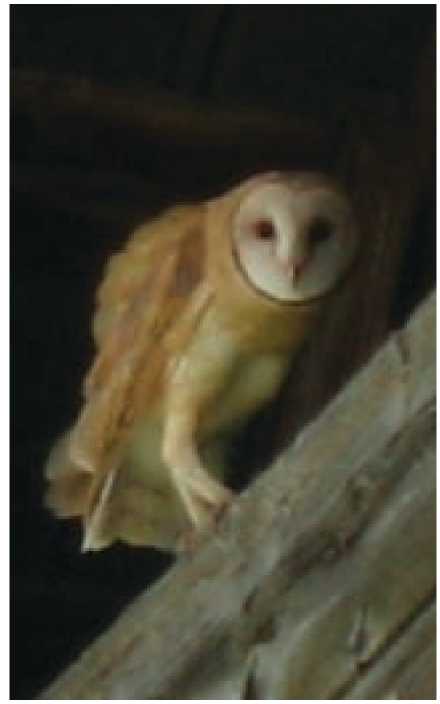
Kate Heyden, Kentucky Department of Fish and Wildlife Resources

Due to local conservation concern, the Barn Owl was included as a Species of Greatest Conservation Need in Kentucky's State Wildlife Action Plan in 2005. In order to learn more about Kentucky's nesting population of Barn Owls as a basis for conservation efforts, KDFWR conducted a statewide inventory in 2010. Twenty-six confirmed Barn Owl nest locations were documented during that effort.

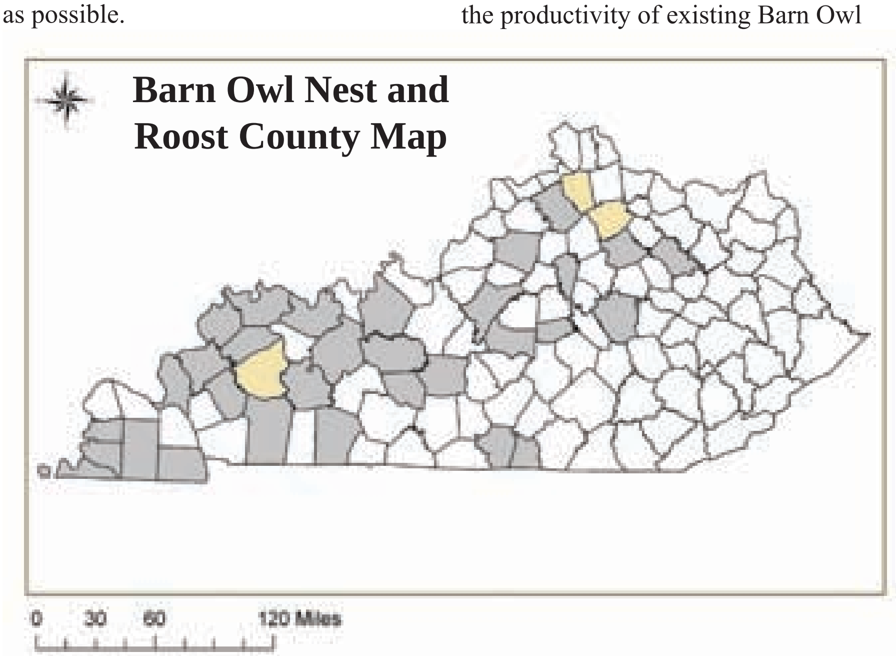
After the 2010 inventory, it was decided that Barn Owl nesting locations and productivity would be monitored by KDFWR annually, with an extensive survey and detailed report produced on a three-year interval. In 2013, another statewide inventory was completed for Barn Owls and again the goal was to document as many resident Barn Owls as possible.

Forty-eight confirmed Barn Owl nest locations were documented during the 2013 inventory. This was nearly twice the number recorded in 2010. Most nests were found on privately owned land, although seven (15%) were in nest boxes on WMAs. Nests were found in a variety of natural and man-made structures. Man-made structures used for nesting included nest boxes on various structures (15), building crevices- including attics (11), silos (5), grain bins (3), elevated hunting blinds (2), a bridge (1), a water tower (1) and a chimney (1).

Suitable nest site availability in the proximity of areas with a large prey base is assumed to be a major limiting factor for Barn Owl populations. KDFWR established a program to install nest boxes in suitable habitat on WMAs and other public lands in 2006. Since 2006, 54 nest boxes have been installed on public lands. Although several nest boxes on public lands have already become active, in 2010 our nest box efforts switched to maximizing the productivity of existing Barn Owl nests - whether they are on public or private land. Productivity may be hindered at unreliable nest sites, perhaps contributing to Barn Owl declines. For example, many nests are discovered when hollow trees are cut down, grain bins are drained, or old barns are demolished. Since 2010, KDFWR has worked to ensure that all known nesting Barn Owl pairs have a safe and permanent nest site by installing many nest boxes on private lands. Since 2006, KDFWR has installed 72 nest boxes on private lands, where there were Barn Owls in need of a safer nest site. It is hoped that these efforts will encourage a more stable Barn Owl nesting population statewide.



Barn Owl / Kate Heyden



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

KDFWR Strategic Plan. Goal 1. Comprehensive Wildlife Conservation Strategy. Appendix 3.2. Kentucky's Priority Research and Survey Needs by Taxonomic Class.

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

Will Bird and Phil Peak, Kentucky Herpetological Society

KDFWR Contact: *John MacGregor*

Kentucky's Wildlife Action Plan identifies reptile and amphibian species of greatest conservation need within the Commonwealth. Population dynamics and monitoring data is lacking for many reptiles and amphibians, particularly those that are rare and secretive. Beginning in 1982, the Kentucky Herpetological Society began efforts to target some of Kentucky's rare reptile and amphibian species to document distribution, and better understand population status.

Between 2003 and 2014, we submitted 7,725 records of 30 snake species into Kentucky's Fish and Wildlife Information System. Locating reptiles and amphibians can be difficult. We begin the process by identifying suitable locations for target species. These locations are on state, federal, and private lands. Once permission is granted to conduct surveys, we use different methods for locating specimens based on their biological requirements. Because they are ectotherms, we are able to utilize Artificial Cover (AC) to locate many of these animals. Heavy metal objects that absorb heat from the sun's rays and provide protection from the elements are set out at our study sites. We also deploy large wooden boards which retain moisture even during the drier months and provide refuge for many of the creatures that might otherwise stay far below the surface of the ground where they could remain undetected. There are species of reptiles and amphibians for which AC has proven less effective. When targeting these species we use box style funnel traps and also search natural forms of cover such as rocks and logs. Most importantly, we drive along old country roads when the conditions that induce snakes to move are present.

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

Crawfish frog / Will Bird

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

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

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

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

Largemouth bass (*Micropterus salemoides*) have been managed under the primary goal of giving anglers the best opportunity to catch big fish and these efforts have been successful in establishing high-quality fisheries throughout Kentucky. Despite ongoing efforts in the 1990's, resource managers with the Kentucky Department of Fish and Wildlife Resources (KDFWR) realized that the state was missing a legitimate "trophy" bass fishery. In 2002, many believed Cedar Creek Lake was the state's best chance to establish a trophy largemouth bass population. This newly filled 784 acre reservoir in central Kentucky was expected to have the productivity levels, habitat and forage fish that were required for thriving largemouth bass populations. In 2003, the KDFWR enforced a regulation limiting the angler's daily harvest to only 1 bass measuring 20 inches or more. This highly restrictive regulation was expected to facilitate the development of a trophy bass fishery. The objective of this study was to monitor all aspects of the largemouth bass population at Cedar Creek Lake, which included identifying how the fishery responded to this new regulation.

Since 2003, annual sampling efforts for largemouth bass at Cedar Creek Lake involved nocturnal electrofishing that was conducted every spring and fall. Bass were counted and measured to determine relative abundance, length frequency and reproductive success. The weight of each fish was also obtained to calculate their condition, but this was done only for bass sampled during the fall. Stomach contents were checked during the summer months to gather information on feeding habits of this largemouth bass population. Additional techniques were used periodically during the course of this project to provide further insight about the fishery, including information ranging from the age & growth rate of bass to opinions of the anglers that fished for them. Other sport fish populations were sampled as well to determine their status and how they were affected by management actions that increased the number of predators in the lake.

Cedar Creek Lake LMB / Chris Hickey

The first ≥ 20.0 in. largemouth bass was collected in 2006 and have since been sampled every spring. With the exception of 1 year, the catch rates of ≥ 20.0 in. bass have been increasing since that first capture. This includes the early May electrofishing efforts in 2013 when there were 36 ≥ 20.0 in bass sampled, which is currently the project's highest total. Furthermore, the overall spring catch rates of largemouth bass in 2013 (219.7 fish/hour) had declined from 2012 (254.3 fish/hour), but it was still higher than the project's average catch rate of 200.5 fish/hour. Oddly enough, this occurred even though the catch rates of <8.0 in. bass (6.3 fish/hour) was the project's lowest, which is evidence of poor spawning success for largemouth bass during the spring of 2012. The other notable results of the 2013 spring sampling was the 80.1 fish/hour catch rate for 12.0–19.9 in bass, indicating higher numbers of largemouth bass that surpass the 20 in mark are likelyduring the next couple of years.

By the end of 2013, most results obtained throughout the year were at or above normal for Cedar Creek Lake. This includes information on food habits obtained from the summer sampling efforts, and the overall condition of bass in the fall. The average relative weight in 2013 was 90.8, which was just above normal (Wr = 90.1). The 2013 catch rates of smaller bass were well below average. Age-1 fish were captured at a rate of 6.3 fish/hour (< 8.0 in.) in the spring, and the fall catch rates for age-0 bass were 11.14 fish/hour, which is substantially lower than the lake's average age-0 catch rate (33.8 fish/hour). This was less than the project's previous low from 2012 (18.3 fish/hour), and it is a trend that will need to be watched very carefully over the next couple years. However, it's likely that this could be the bass population's natural response to over-crowding that can accompany regulations that purposely reduce the anglers' harvest rates. Reproductive success and other major aspects of the fishery will continue to be monitored over the next couple years, which also coincide with end of this project. Ultimately, resource managers hope to use the results from 2014 and 2015 to determine if the population is finally beginning to level out or if Kentucky is on its way to obtaining its first true "trophy" bass fishery.

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

KDFWR Strategic Plan. Goal 1.

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

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

During most years, Kentucky's state fish hatcheries will produce nearly 150,000 channel catfish, and the bulk of these will be stocked in public fishing lakes throughout the state. Because these populations tend to encounter high harvest rates and low levels of natural reproduction, annual stocking of the nearly 8 in age-1 catfish is often the only way to maintain these put-grow-take fisheries. Although the data on angler usage is intermittent, creel survey results have estimated up to 60% of the channel catfish in these populations are harvested each year. More often than not, these fisheries will go unregulated and most channel catfish will be harvested before they reach their full potential. In 2004, the KDFWR made its first large scale attempt to regulate channel catfish fisheries by enforcing a 12.0 in minimum length limit at 11 state-owned lakes. This research project was initiated in 2006 to monitor the response of channel catfish to this new size limit and if it reduces the number of catfish the state hatcheries are asked to produce each year. After the first 5+ years, KDFWR ultimately decided to expand the 12 in minimum size limit to 3 more small state-owned lakes and this project has since shifted to monitoring those populations as well.

The most effective way to sample channel catfish in small impoundments was to leave 5 sets of baited, tandem hoop nets (3 hoop nets fastened together) in the lake for 3 days. Captured catfish were counted, measured and weighed to obtain data needed to estimate population abundance, size distribution and average condition. During the 1st 6 years of the project, tandem hoop nets were used to sample channel catfish at 6 small impoundments, which included 4 experimental lakes under the 12 in minimum length limit (Beaver, Elmer Davis, Guist Creek and Shanty Hollow lakes) and 2 control lakes with unregulated harvest of the channel catfish (McNeely and Reformatory lakes). Data from experimental lakes was used to determine if the new size limit could protect channel catfish without causing too much of a buildup just below the 12 in mark. Results obtained from the annual sampling efforts provided evidence that two of the 12 in lakes had highly abundant populations with growth rates that were considerably slower than others in the project. Biologists responded by dropping the stocking rates used at these lakes from 25 to 10 fish/acre, which is expected to reduce population densities and free up enough resources to allow the catfish growth rates to rebound. Even if the fishery did not improve substantially, the size limit was still effective as long as negative impacts were minimized and stocking rates were reduced enough to alleviate demand on the limited hatchery resources.

In March 2013, the 12 in limit was expanded to 3 more state-owned lakes with average catfish populations that are sustained by annual stocking efforts. Expansion of the size limit was implemented at McNeely and Reformatory Lakes because these catfish populations contain some large fish, but total abundance is below average despite annual stocking efforts. Anecdotal evidence suggests that these lakes have a lot of fishing pressure, and most catfish are harvested within a year of being stocked. Lake Reba (the 3rd water body) receives steady angling pressure, the channel catfish population is likely doing better because of more intensive stocking efforts. At Lake Reba, it was expected that the size limit would help the fishery maintain, or even improve on, its current status despite the future possibility of reduced stocking rates.


Channel catfish / Chris Hickey

Each new project lake was stocked with channel catfish at densities up to 25 fish/acre. Lakes were sampled October 2013, and most of those results followed what was expected from each lake. McNeely and Reformatory lakes had capture rates of 18.2 and 15.8 fish/hr, respectively. The results obtained at Lake Reba were slightly lower than expected, but a catch rate of 35.4 fish/hr was still an increase over the other 2 lakes despite very similar conditions and stocking history. Length/weight data collected from all 3 lakes was used to determine that the average fish in each population was in good to excellent condition. A unique aspect of the project in 2013 was the effort to obtain age & growth data from each population before the new size limit could alter that information. A subsample of catfish from each lake was collected, measured to the nearest 0.1 in, and then their otoliths were removed so that they can be carefully examined later in 2014 to provide valuable insight into the average growth of each fishery. The channel catfish populations at all 3 project lakes will continue to be closely monitored for several more years.

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

KDFWR Strategic Plan. Goal 1.

Evaluation of Kentucky's Largemouth Bass Stocking Initiative

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

The Kentucky Department of Fish and Wildlife Resources (KDFWR) has long used supplemental stocking as a tool to enhance largemouth bass populations, but the increasing demand on the state fish hatcheries has compelled biologists to reconsider how the stocking efforts are prioritized. As a result, KDFWR began prioritizing stocking efforts to provide the greatest benefit, which often means supplementing a poor year class of largemouth bass before it is too late to respond. For example, if this system predicts that a lake will have high abundance of age-1 bass during the next spring, it would allow stocking efforts to be diverted to a location that needs it more. During a different year, data might indicate this same lake has had a poor bass spawn, and if the predicted age-1 abundance is well below normal, fingerlings would then be stocked in an attempt to offset any negative impacts to the fishery. This project, also known as the Bass Stocking Initiative (BSI), has been trying to put this theoretical system to use by developing a protocol that uses the abundance of age-0 bass in the fall to predict if the number of age-1 fish during the next spring will be at least 10% below average.

As soon as 3 or more consecutive years of largemouth bass data are obtained for each of the 34 study lakes, the project's 2 key elements can be generated. These include the average spring abundance of age-1 bass and the 2 separate regression equations needed to make the year class predictions. The first equation uses the total age-0 catch rate in the fall (fish/hour) to predict the age-1 density for that year class in the upcoming spring. Although very similar to the first, the second equation only accounts for those age-0 bass that measured 5+ in. If a lake receives valid results from both equations, it is the regression with the lowest p-value that is used to make the age-1 predictions. Once the fall catch rates of age-0 bass are inserted into the chosen equation, the "prediction" can be checked against the lake's average spring density for age-1 bass. A predicted age-1 density that is well below the lake's average would put it on the BSI's potential stocking list, and this means that it has a good chance of being stocked that fall for this project, which over the years has utilized various stocking rates ranging from 2.5 fish/acre to 15 fish/acre. Ultimately, a lake's stocking density depended on the year and how far its predicted age-1 catch rate was below the average. With 2012 being the one exception, all bass fingerlings stocked from 2005 to 2013 were marked with a specific fin clip that allowed them to be easily distinguished from any naturally spawned fish.

During the earlier years of the project, larger lakes with perennial spawning problems (i.e. Laurel River Lake) received most of the fish, but the stocked bass had very little impact on these fisheries. Because the emphasis shifted to stocking the smaller lakes in 2009, the demand for the fingerlings declined substantially, which allowed the stocking rates to jump up as high as 15 fish/acre. These stocking rates were proven effective after there were more recaptures in the spring 2010 that any other previous year. This would be reinforced during the next couple of years when, in the fall of both 2010 and 2011, over 50% of the qualifying lakes were able to be stocked at the higher density of 15 fish/acre. After spring sampling efforts in 2011 and 2012 were completed, a comparison of the results showed that during both years there were recaptures of marked age-1 bass at 75% of the project lakes that had been stocked during the previous fall. The age-0 largemouth bass data obtained during the fall of 2012 indicated that only 6 project lakes were to be stocked because of poor year class strength. However, in 2012, the 88,000 bass fingerlings could not be marked prior to being stocked because there were scheduling conflicts with other hatchery activities. Hence, even though most project lakes were sampled the next spring, hatchery-reared age-1 bass could not be distinguished from natural fish so the 2013 bass data was only used to update each lake's predictive equation.

The bass sampling conducted for the project in fall 2013 indicated that only 7 lakes had densities of age-0 bass that were low enough to need stocking. After the data was inserted into the chosen regression equations, the predicted age-1 abundance for each lake was far enough below average to allow all of them to be stocked at higher densities that ranged from 10.0 to 15.3 fish/acre. Unlike the previous year, in 2013, biologists were able to stick to the original protocol that called for the 63,000+ fingerlings to be marked with a fin clip prior to being stocked. Hence, when resource managers return to these lakes in spring 2014 for their annual bass sampling, they will be able to differentiate the natural age-1 fish from those stocked for the BSI during the fall of 2013.

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

KDFWR Strategic Plan. Goal 1.

Black Bass Tournament Results in Kentucky

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

Every year, KDFWR's Fisheries Division uses electrofishing to sample the black bass populations at lake and rivers throughout the state, but this alone cannot provide all the necessary information about the fishery itself, including the fishing pressure and angler success rates. This data can be obtained from creel surveys, but reductions in funding and manpower have greatly limited how many of these can be conducted each year. This means it is virtually impossible for a water body to have multiple surveys during consecutive years, which are needed to identify how the status of the bass population relates to angler success. In an attempt to circumvent gaps in the angler data, a program was initiated in 1999 that asked black bass tournaments to submit their results and other important details of their event to the KDFWR. Resource managers then have the option of using this information with the annual electrofishing data to better explain any changes to a black bass fishery. The program also provides a yearly report that anyone can use as a reference when planning their next fishing event.

After the details of the program were developed, the next step was to send the necessary information to the different groups that organize bass tournaments in Kentucky. During 1999 and the next few years, information packets were mailed out containing a detailed explanation of the program and any materials that could be needed to record and submit the necessary tournament data. Over time, an online system was established for the program that allowed organizers to schedule their events and then ultimately report their data more efficiently. After this development, the news of this system spread quickly from one tournament organizer to the next and this led to a steady increase in the number fishing events that were submitting data. The annual report also helped boost the exposure of the program because it provided useful information about the different water bodies that hosted tournaments during the previous year. The section of the annual report that receives a lot of attention from anglers is the table that ranks the different lakes and rivers according to the year's tournament results.

For the first time since the program started, KDFWR made some major updates in 2010 that changed some of the data being requested from the tournaments. Aside from adjusting the size that identified a bass as a "big fish", the program now requested that the organizers report specific information on their tournament's format. This turned out to be critical because the team format had become very popular in the 10 years since the program was developed, and it was now being used by well over 75% of the scheduled tournaments. Without the updates, each participant would still be treated as an individual angler fishing for his/her own creel limit despite the format of their tournament. However, the new information allowed the 2 participants on a team to be considered as one unit, and this adjustment had the potential to greatly increase the accuracy of the results provided in the annual report.

In 2013, there were 33 different lakes and rivers in Kentucky that served as the location for the 295 tournaments reporting their catch data, which is an improvement over the 233 events in 2012. A combination of improved weather conditions during the 2013 tournament season and further efforts to raise awareness of the program is what more than likely helped it recover from back-to-back years of declining participation. With the KDFWR website being used to schedule 643 events in 2013, the 45.9% reporting rate was acceptable, but it was still substantially less than the program high of 61.0% in 2009. As expected, the 14,388 anglers, or 9,026 angling-units (individual anglers + teams), participating in the 2013 bass tournaments was also an improvement from the 13,636 anglers (8,050 angling-units) being reported in 2012. Interestingly, the total number of qualifying bass brought to the tournament scales in 2013 (n = 24,584) fell almost perfectly in-between the overall numbers reported in 2012 (n = 22,815) and 2011(n = 26,440). Unfortunately, each of these numbers are too heavily influenced by how many events actually reported their catch data, which means that they cannot be used properly to describe how well the anglers performed during a 2013 tournament. Luckily, the program does follow other statistics that do not rely on the overall number of tournaments that have participated. Hence, after considering the average size of a bass caught in 2013 (2.32 lb), the percentage of angling-units with a full limit of fish (37.6%), and the average weight to win a standard 8-hour event (14.65 lbs), the anglers appeared to enjoy an excellent tournament season in 2013, which is what resource managers would have expected considering that most of the results obtained during the sampling efforts in 2013 were very good. According to the results already obtained from this year's black bass sampling efforts, it's likely that anglers will once again experience a great tournament season in 2014.

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

KDFWR Strategic Plan. Goal 1.

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

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

The blue catfish (*Ictalurus furcatus*) stocking program is a relatively new tool used by the KDFWR to expand sport fishing opportunities at some lakes in Kentucky. These efforts have created catfish populations that are popular with anglers, but a small group of these have exceeded expectations. Not long after the stocking efforts began at Taylorsville Lake in 2002, it was apparent that blue catfish were well on their way to developing into a high-quality fishery. Since the population was not regularly monitored prior to 2007, a research was developed to identify its current status and to determine what management actions might foster the development of a trophy component to the fishery.

Information that was intermittently gathered between 2003 and 2006 indicated that blue catfish population at Taylorsville Lake was doing well with average growth rates of 3–5 inches a year. Since the project officially began in 2007, low-pulse DC electrofishing has been conducted on a regular basis each summer. Using multiple boats and crews, both ends of the lake were sampled concurrently, and any blue catfish caught during these efforts were counted, measured and sometimes weighed to determine the relative abundance, length frequency and average condition of fish in the population. All results were analyzed so that, if needed, these could be used to identify any changes to the fishery over the course of this project. In addition to the electrofishing, other techniques have been used during this project to evaluate different aspects of the blue catfish fishery, which included an angler exploitation study in 2008 and a creel survey conducted during the peak of the 2009 fishing season.

Sampling efforts in 2007 resulted in 590 blue catfish collected and a catch rate of 236 fish/hour. Unfortunately, during the next few years, the sampling results indicated that the blue catfish population was beginning to decline, and this culminated in overall catch rates of 119 and 116 fish/hour for 2009 and 2010, respectively. It's likely that this would have been more acceptable for an "average" fishery, but the 2009 creel survey results provided an explanation for the decline at Taylorsville Lake. After these results were compared to data from the 2006 survey, it was estimated that the number of blue catfish being harvested had a nearly 5-fold increase. This exponential increase, the >100 fish/hr decrease in the electrofishing results and the unanimous support of surveyed anglers was enough to warrant further action. Ultimately, by March 2011, the KDFWR was enforcing new fishing regulations at Taylorsville Lake that limited harvest to 15 catfish per day with only one allowed to be ≥25 in in length. These regulations were specifically developed to limit the total number of catfish taken each year and to protect the large fish in the population. The larger blue catfish were needed to help build up the fishery's trophy component and to protect the sexually mature fish that have the best chance to spawn in the lake.

At this point in the project, the primary objective began to shift towards evaluating how the blue catfish at Taylorsville Lake would respond to their new 15 fish daily creel and the "1-over 25 in." length limit. In order to accomplish this new goal, low-pulse DC electrofishing efforts had to be conducted each summer in the exact same manner as past years. The catch rates obtained during latest sampling efforts in 2013 (60.0 fish/hour) were not as high as those from 2012 (104.0 fish/hour), but both of those years were still an improvement over the extremely low catch rate of 2011 (27.1 fish/hour). Despite the decline in overall catch, the 2013 sample contained 22 blue catfish that were ≥ 25 inches in length, and this contributed to a catch rate of 7.3 fish/hour, which was the highest density obtained for the larger size class. In addition to this, blue catfish collected during the 2nd summer sampling effort of 2013 had an average relative weight (W_r) of 96.9, which indicates that they were in better condition than the catfish obtained in either 2012 (W_r = 94.5) or any other year of this project. And finally, there was subsample of catfish collected in 2013 that had otoliths removed and eventually mounted to glass slides, which will be closely examined during the 1st half of 2014 to determine the current growth rates of the population. The electrofishing efforts will continue during the summer of 2014 as well, and researchers expect the catch rates, especially those of larger fish, to be as good as or better than those obtained during the last couple years. They also hope to find strong evidence that blue catfish are successfully spawning in Taylorsville Lake, which would likely allow the population to reach levels that simply aren't possible under a standardized stocking rate of ~ 8 catfish per acre.

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

KDFWR Strategic Plan. Goal 1.

Stocking crappie at Kentucky Lake / Paul Rister

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

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

Despite the popularity of crappie fishing, it's frustrating for anglers when catch rates rely heavily on the success of a spawn from 2–3 years ago. In addition, the 2 species, black crappie and white crappie, exhibit different preferences at certain times of the year, and only white crappie are completely vulnerable to anglers that use traditional crappie fishing techniques, which includes vertical jigging over deepwater habitat. Unfortunately, the more popular locations in the state for crappie fishing, like Kentucky Lake, appear to be transitioning to a fishery where white crappie are no longer the dominant species, which can mean declining catch rates for the more traditional crappie anglers. When anglers report that catch rates are dropping too much, resource managers are motivated to begin picking apart both the annual sampling data and the creel survey results to find a potential solution. Most crappie populations in Kentucky are already regulated, but even the most stringent size/creel limits aren't always successful at maintaining the fisheries. In this situation, some managers would view the regulations as simply being ineffective, but others believe they could have a different impact altogether (i.e. playing a part in influencing the dominant species). Much effort has been placed on developing ways to improve crappie fisheries, and several nearby states have stocked crappie to counter poor spawns. Even though the success of these efforts have varied, KDFWR initiated a 5-year stocking program in 2009 that planned to distribute white crappie fingerlings to lakes throughout Kentucky. Ultimately, this project was developed to evaluate the results of these stocking efforts and identify any factors that might increase their effectiveness.

The project began in the fall of 2009 when 124,865 white crappie fingerlings were marked with oxytetracycline (OTC) and hauled to 4 lakes chosen for the stocking efforts. Most fingerlings received OTC marks each year to identify them as hatchery-reared fish if they're ever recaptured. Because fewer crappie were available in the fall of 2010 (n = 122,860), one of the original reservoirs was cut from the project so that the remaining lakes could be regularly stocked at higher rates. From 2010 to 2013, all crappie fingerlings were shared by 3 water bodies: Carr Creek Lake, Taylorsville Lake and the Blood River embayment of Kentucky Lake. Another major update occurred in 2010 when a Missouri fish hatchery started producing additional fingerlings for the project's last 3 years of stocking efforts (2011, 2012 and 2013). The Missouri hatchery's assistance guaranteed enough available fingerlings for the rest of the project, but there were concerns it would lead to stocking rates too high to be duplicated under normal circumstances. Regardless, the combined efforts of both hatcheries allowed the 3 project lakes to be stocked with increasing numbers of crappie in 2011 (n = 200,842), 2012 (n = 300,899) and 2013 (n = 387,313). Five years of stocking efforts ended in 2013 after more than 1 million crappie fingerlings had been distributed to Carr Creek, Taylorsville and Kentucky lakes, which exceeded initial predictions made in 2009.

The uniqueness of the study lakes prevented biologists from using the same sampling methods at each location, but regardless of these differences, they were able to collect data on the crappie populations in 2013. This project focused most on obtaining crappie from each lake and using them to estimate the overall contribution stocking efforts made to the fishery. The trap nets used at Taylorsville Lake during the fall of 2013 were able to catch 81 white crappie that ranged from ages 1 through 4. Further analysis confirmed the presence of OTC marks on the otoliths of 18 fish, which was used to conclude that stocked fish made up 22.2% of the white crappie in the sample. Trap nets were also used in fall 2013 at the Blood River Embayment of Kentucky Lake, but the most important sample was actually collected by anglers more than a month later. In early December 2013, anglers fishing the Blood River Embayment were able to contribute 111 white crappie with total lengths of 10 in. or better. Of these, 72 belonged to either the 2009, 2010 or 2012 year class, and because only 8 of those had OTC marks, it was determined that stocked crappie had made a 8.3% contribution to those 3 age groups. Fingerlings stocked into Kentucky Lake in 2011 were not marked so the 39 age-2 crappie in this sample cannot be classified as either hatchery-reared or natural fish until late 2014 when biologists expect the results of a more in-depth microchemistry analysis being completed on the otoliths of these fish. Finally, early spring electrofishing was used to sample almost 90 white crappie from Carr Creek Lake, and otoliths from these fish are currently in the process of being aged. Any crappie from the 2009 through 2012 year classes will then be checked for OTC marks to eventually determine how much, if any, of this sample consists of hatchery-reared fish. Although stocking efforts are not planned for 2014, each crappie population will continue to be sampled throughout the year. Ultimately, the results from this study will have an influence on the future of the white crappie stocking program in Kentucky.

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

KDFWR Strategic Plan. Goal 1.

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

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

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

These lakes are conveniently located near large populations of people. Anglers do not have to travel far from home to find good fishing. In 2013, 145,000 rainbow trout and 107,965 channel/blue catfish were stocked in the FINs lakes. The fish stockings provide fishing opportunities in lakes that in the past were overfished due to their size and fishing pressure exceeding the resources' capabilities. These lakes require routine stockings of catchable-size fish to sustain quality fishing opportunities to a diverse group of anglers. Lakes are stocked up to four times annually with catchable-size catfish (12–18 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 2013, hybrid sunfish were produced at Pfeiffer Fish Hatchery and 57,232 (5–8 inch) fish were stocked in June and October at lakes that had poor sunfish numbers or heavy fishing pressure. 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.

Introducing kids to fishing /Lee Jensen

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

A 2012 angler attitude survey at 27 FINs lakes indicated that the FINs program is attracting families with 29% of anglers fishing at FINs lakes ≤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 from the Kentucky general population according to 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". Fishing pressure continues to increase at these lakes and the feedback from local parks and anglers has been very positive.

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

KDFWR Strategic Plan. Goal 2.

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

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

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

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

Flathead catfish at A.J. Jolly Lake / Dane Balsman

A regulation was passed in 2009 that prohibited the harvest of flathead catfish from A.J. Jolly Lake. This regulation was critical to ensure that the stocked flathead catfish would remain in the lake to have the hypothetical desired effect. Sunfish and bass electrofishing are conducted each spring and fall to determine abundance, size structure, age, growth and condition. Bass sampling in 2013 was similar to the long term average with a slight increase in the number of larger fish. The bluegill size structure continues to remain poor with most fish in the 2–4 inch range. Very few bluegill reach 6 inches. Bluegill sacrificed for ageing revealed slow growth. Sampling for flathead catfish has yielded low numbers of fish. Sampling has been conducted at various times of the year with different DC pulse electrofishing settings with little luck. Little information exists on effective ways to sample for flathead catfish in small impoundments. In 2013, 32 flathead catfish were sampled. Seven of the 32 flatheads captured were fish from the Georgia stockings, while the other 25 were native fish. Sampled flathead catfish ranged in size from 6–27 in. Overall, sampling numbers remained low for flathead catfish for the year. The true population size of flathead catfish remains unclear. KDFWR will continue to sample flathead catfish, largemouth bass, sunfish, and channel catfish, to determine if flathead catfish can improve sportfish populations at A.J. Jolly Lake.

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

KDFWR Strategic Plan. Goal 1.

Rainbow trout being tagged and stocked into FINs lake / Dane Balsman

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

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

The Fishing in Neighborhoods (FINs) program provides fishing opportunities to cities of all sizes across the Commonwealth. These lakes require routine stockings of catchable-size fish to maintain quality fishing opportunities to a diverse group of anglers. An exploitation study was conducted at four FINs lakes from late 2010 to 2013. These exploitation studies in conjunction with creel and attitude surveys are necessary for assessing angler use of the fishery and fine tuning stocking rates.

An angler exploitation study of rainbow trout was conducted at Upper Sportsman's Lake in Franklin County (6.2 acres), Middleton Mills Shelterhouse Pond in Kenton County (1.2 acres), Alexandria Community Park Lake in Campbell County (7.0 acres) and Jacobson Park Lake (46.3 acres) in Fayette County. Tagged rainbow trout released for the study ranged in size from 8.0–11.9 in and averaged 0.36 lbs. Fish were tagged with yellow Floy FD-94 anchor t-bar tags below the dorsal fin. A total of 640–888 tagged trout were stocked in each of the four lakes in November, February and March. Exploitation rates were corrected for non-reporting, tag loss and tagging mortality with a 28%, 75%, 46% and 43% corrected harvest rates respectively at each aforementioned lake. The corrected catch rates were 88%, 86%, 82%, and 56% at the four lakes respectively. Harvest rates varied significantly between the four study lakes, while corrected catch rates were quite similar among the three smaller lakes. Jacobson Park Lake, the largest FINs lake had a lower catch rate for rainbow trout. The average number of days the trout were at large before being caught ranged from 23–46 days with a median of 16–34 days for the four lakes.

A channel catfish exploitation study was also conducted at the four aforementioned lakes from March–October. The dates of the study coincide with the date of the first stocking of the spring through the end of the anticipated fall fishing season. Tagged channel catfish ranged in size from 10.0–25.3 in and averaged 1.08 lbs. Fish were tagged with yellow carlin-dangler tags. The tags were attached to the fish using stainless steel wire threaded through the fish below and anterior to the dorsal spine. In total, 299–793 channel catfish were tagged in March, April and May at each of the four lakes. Exploitation rates were corrected for non-reporting, tag loss and tagging mortality. Corrected harvest rates were 32%, 49%, 32% and 39% respectively while corrected catch rates were 85%, 85%, 69% and 66% at the four aforementioned lakes respectively. The average number of days the tagged fish were at large before being caught was 12–22 days with a median of 3–9 days at the four lakes.

From this study, we conclude the catfish are caught quickly after stocking, but less than one half of catfish are initially harvested. Trout are not caught as quickly as catfish, however, they were highly utilized. Exploitation rates for trout were highly variable among lakes. The concurrent creel surveys at these study lakes indicate an estimated catch exceeding the number of stocked fish and harvest rates closely mirroring the number of stocked fish. Many of these fish may be caught multiple times before ultimately being harvested by anglers. The exploitation study fails to capture the estimated higher harvest rate due to the tag being removed the first time the fish is hooked, and likely being harvested on subsequent catches.

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

KDFWR Strategic Plan. Goal 2.

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

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

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

Although portions of the Levisa Fork are impounded by Fishtrap Lake, there is approximately 15 miles of unimpounded mainstem of the Levisa Fork between the lake and the Virginia state line and at least that many more miles beyond. The broad goal of this project is to re-establish a reproducing native "southern" strain walleye population to this section of the Levisa Fork. An established population of native walleye in the Levisa Fork will serve as a source of broodstock for potential native walleye restorations in other Kentucky river systems and will create a walleye sport fishery in the upper Levisa Fork. In order to accomplish these restoration goals, beginning in 2010, native strain walleye were collected from Wood Creek Lake and the Rockcastle River in the spring and transported to Minor Clark Hatchery to be used as broodfish. Walleye were spawned and the resulting fry were reared to fingerling size (1.5 in) in ponds, then stocked in the Levisa Fork in late May or early June. We are using a stocking rate of a minimum of 50 fingerlings/acre or 600 fingerlings/mile, and we plan to continue these efforts through at least 2015. In conjunction with stocking, we assessed 24-hour stocking mortality using mesh-lined barrels secured in the river. To monitor and assess stocking success, we sample walleye in the spring at multiple sites using boat-mounted pulsed DC electrofishing gear, and a sample of walleye are collected such that weight and length measurements and sex ratios can be recorded. All stocked fingerlings are marked with oxytetracycline (OTC) to determine recruitment of stocked fish. Limited sampling took place in 2011 through 2013 due to the inability to navigate the river due to inappropriate sampling conditions. Only a single walleye has been collected to date, however we have received multiple anecdotal reports of anglers catching walleye. Beginning in 2016, small walleye may be sacrificed and otoliths removed for examination for OTC marks. We also plan to implant PIT tags in captured walleye to follow movement and growth rates. Walleye sampling in the Levisa Fork is slated to continue through 2020 to allow for the reproductive potential of the stocked walleye population to reach a point where natural recruitment is possible and detectable.

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

KDFWR Strategic Plan. Goal 1.

Native walleye in the Upper Levisa Fork / Dave Dreves

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

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

Walleye being released back into the Rockcastle River / John Williams

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

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

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

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

KDFWR Strategic Plan. Goal 1.

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

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

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

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

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

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

KDFWR Strategic Plan. Goal 1.

Biologist hold muskellunge shocked from a Kentucky resevoir / Chad Nickell

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

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

Trout (*Oncorhyncus spp*. and *Salmo spp*.) sport fisheries in Kentucky's reservoir tailwaters are unique and important resources. These fisheries were created in reservoir tailwaters having coldwater discharges for either the entire year or a portion of the year. The Lake Cumberland tailwater trout fishery is the largest in Kentucky with more than 75 miles of suitable habitat available throughout the entire year. The Lake Cumberland tailwater receives the largest stocking in the state allocation of trout with approximately 161,000 rainbow (*O. mykiss*) and 38,000 brown (*S. trutta*) trout stocked per year. Growth and survival of stocked trout in the Cumberland River are sufficient to create a high quality trout fishery with opportunities to catch trophy-size fish. Since the brown trout fishery in the Lake Cumberland tailwater is managed as a trophy fishery, it is imperative that stocked brown trout grow rapidly and reach trophy size in as short a time period as possible. Over the last 15 years, the KDFWR used regulations and stocking practices to enhance the trout fishery in the Lake Cumberland tailwater. One further way to optimize stocking includes determining the most suitable strain of trout for the physical conditions and management goals of a particular fishery. Characteristics such as movement, mortality, growth and susceptibility to angling are of particular importance.

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

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

Large brown trout from the Cumberland River / John Williams

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

KDFWR Strategic Plan. Goal 1, Strategic Objective 1.6.

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

Native walleye shocked up from the Upper Barren River / Dave Dreves

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

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

Although portions of the Barren River are impounded, there are approximately 31 miles of unimpounded mainstem of the Barren River above Barren River Lake. The broad goal of this project is to re-establish a reproducing native "southern" strain walleye population to this section of the Barren River. An established population of native walleye in the Barren River will serve as a source of broodstock for potential native walleye restorations in other Kentucky river systems and will create a walleye sport fishery in the upper Barren River. In order to accomplish these restoration goals, beginning in 2007, native strain walleye were collected from Wood Creek Lake and the Rockcastle River in the spring and transported to Minor Clark Hatchery to be used as broodfish. Walleye were spawned and the resulting fry were reared to fingerling size (1.5 in) in ponds, and then stocked in the Barren River in late May or early June. We are using a stocking rate of a minimum of about 50 fingerlings/acre or about 600 fingerlings/mile, and we plan to continue these efforts through at least 2014. In conjunction with stocking, we assessed 24-hour stocking mortality using mesh-lined barrels secured in the river. To monitor and assess stocking success, we sampled walleye in the spring at multiple sites using pulsed DC electrofishing gear, and a sample of walleye are collected such that weight and length measurements and sex ratios can be recorded. We have been successfully sampling walleye in the Barren River for several years now and fish have been observed in excess of five pounds. In 2008, we began marking stocked fingerlings with oxytetracycline (OTC) to determine recruitment of stocked fish. Beginning in 2013, small walleye were sacrificed and otoliths removed for examination for OTC marks. Otoliths from both fish were marked indicating they were stocked fish. We also have implanted PIT tags in captured walleye to determine movement and growth rates. Walleye sampling in the Barren River is slated to continue through 2016 to allow for the reproductive potential of the stocked walleye population to reach a point where natural recruitment is possible and detectable.

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

KDFWR Strategic Plan. Goal 1.

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

A family fishing for trout / Gerard Buynak

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

There were an estimated 38,000 trout anglers in Kentucky who fished an estimated 336,000 days for trout in a 2006 U.S. Fish and Wildlife Service survey. The KDFWR manages roughly 300 miles (97 miles in tailwaters) of trout fisheries in 66 streams (include 15 tailwaters). The KDFWR has periodically surveyed constituents to gain insight into angler attitudes regarding fisheries resources, regulations, programs and needs. This information is used to assist in making decisions on where to focus management efforts and where resources can best be utilized. The KDFWR surveyed Kentucky anglers with a mail survey in 1982, a telephone survey in 1991, and another mail survey in 2003. Each of these surveys focused on general statewide attitudes and opinions. In 2003, a survey was conducted for the first time specifically targeting Kentucky trout anglers. The trout angler attitude mail survey was designed to gather information from the broad spectrum of trout anglers on their fishing habits and opinions.

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

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

The 2013 trout angler survey again followed the multiple contact model, which is the accepted standard in survey work. This methodology prescribes multiple contacts with each potential respondent to maximize response rate. Each person on the mailing list was contacted a minimum of three times and a subset who didn't return the survey initially was contacted a fourth time. The implementation of the survey was delayed until early July 2013 due to difficulties with printing and supplies delivery and the fourth quarter agency spending freeze. A total of 781 completed surveys were returned for a corrected response rate of just under 50%. In-house keypunching of the data took place in late 2013. Data analysis will be completed in the summer of 2014 and results should be available thereafter.

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

KDFWR Strategic Plan. Goal 1.

Evaluation of a Seasonal Rainbow Trout Fishery in Cedar Creek Lake

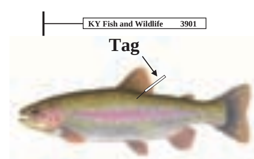
Dave Dreves and Paul Wilkes, Kentucky Department of Fish and Wildlife Resources

Rainbow trout (*Oncorhyncus mykiss*) are stocked in many small impoundments throughout Kentucky by KDFWR. This is in an effort to create an alternative fishery to traditional warmwater species and to provide a fishing opportunity during the cooler months of the year when other species do not bite as well. In a 2002 trout angler survey, of various waters stocked with trout, the category "lakes and reservoirs" was second in terms of the amount of effort expended fishing for trout. Most of these impoundments are small urban lakes that are part of KDFWR's Fishing in Neighborhoods (FINS) program. However the KDFWR does stock rainbow trout in a few larger reservoirs that are believed to have sufficient water quality to support trout year round. Cedar Creek Lake will be the largest reservoir (784 acres) that KDFWR has stocked with rainbow trout exclusively for a seasonal fishery. Cedar Creek Lake, impounded in 2002, is a KDFWR-owned lake in Lincoln County. From conception, the lake was designed and intended to be primarily a sport fishing lake. There is no swimming, no water skiing or jet skis allowed. The lake has a 300 ft buffer zone around the shoreline which is also owned and managed as a Wildlife Management Area by KDFWR. Since Cedar Creek Lake is promoted and managed by KDFWR as a "fishing lake" then it is reasonable to desire year round fishing opportunities for anglers. The lake already has tremendous fishing pressure during warmer months of the year. In a 2009 creel survey conducted at the lake, there were an estimated 49.2 trips per acre and about 245.8 man/hours per acre of fishing pressure. This represents more pressure than at any other lake of a similar size or larger. So, it is expected that the stocking of rainbow trout will provide another fishing opportunity that will extend the quality fishing at the lake throughout the winter months. It is hoped that this new fishing opportunity will spur increased fishing license and trout permit sales.

The primary objective of this study is to evaluate the angler utilization of rainbow trout and angler satisfaction with this new seasonal fishery in Cedar Creek Lake. Previous temperature and dissolved oxygen profiles at Cedar Creek Lake have shown that suitable water quality conditions exist to support trout from about the beginning of October to about early May. A total of 21,000 harvestable-size (9 in) rainbow trout were stocked during the cooler seasons at Cedar Creek Lake, with 12,000 fish being stocked in October 2012 and 9,000 fish in February 2013. Each stocking was allocated evenly among three stocking sites: 1) the lower ramp, 2) the middle ramp and 3) the bank fishing area near the Hwy 1770 bridge. An exploitation study and a creel survey was conducted in this first year of the project to evaluate rainbow trout angling pressure and harvest. The exploitation study involved tagging 600 fish in each of the two stockings and then tracking angler return of tags.

Number of anglers targeting rainbow trout was low and the exploitation study showed only 13.5% of the 21,000 stocked rainbow trout were caught and about 9% were harvested. The exploitation study and creel surveys will be repeated again in 2014–15 to determine if angler use of rainbow trout will increase. The results of this study will be used to determine whether stocking of rainbow trout will continue and whether this type of fishery could be successful in other warmwater reservoirs in the state.

CEDAR CREEK LAKE RAINBOW TROUT TAGGING STUDY



Rainbow Trout

REWARD

FOR ALL RETURNED TAGS

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

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

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

KDFWR Strategic Plan. Goal 1.

River Sport Fishery Survey – Ohio River Catfish

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

Commercial fishing for catfish in the Ohio River has recently switched from 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 lead to conflict between the two groups. The Kentucky Department of Fish and Wildlife began looking at some basic population parameters of catfish to address these issues.

Trotlines were used to sample catfish in Meldahl, Cannelton, JT Meyers, and Smithland pools. CPUE of blue catfish (BCF) and flathead catfish (FHC) were below average (2.9 and 0.1 fish/line, respectively), and CPUE of channel catfish (CCF) was below average (1.5 fish/line) in all pools. BCF lengths ranged from 10.1–43.5 in (mean length=22.2 in). Lengths of CCF ranged from 11.6–26.8 in with a mean length of 19.4 in. FHC lengths ranged from 18.3 – 22.2 in with a mean length of 19.7 in. Trophy catfish (BCF and FHC ≥35.0 in and CCF ≥28.0 in) accounted for 1.2% of the total catch.

Commercial ride alongs were used in Markland, McAlpine, and Smithland pools to gather data from hoop net catch. BCF CPUE was 0.7 fish/net/night and was at or above average (0.4 fish/net/night) in all pools. BCF lengths ranged from 10.0–45.1 in with a mean length of 28.0 in. FHC CPUE was 2.6 fish/net/night and was above average (1.7 fish/net/night). FHC lengths ranged from 12.4–47.1 in with a mean length of 26.1 in. Trophy catfish accounted for 10.4% of the total catch.

Electrofishing was conducted in Greenup, Meldahl, Markland, McAlpine, and Smithland pools. CPUE of BCF was 11.4 fish/hr, but was below average (6.9 fish/hr) in all pools except Smithland Pool (42.7 fish/hr). BCF lengths ranged from 3.4–22.8 in (mean length=9.6 in). CPUE of CCF was 27.2 fish/hr and was above or near average (13.7 fish/hr) in all pools except McAlpine Pool (4.7 fish/hr). CCF lengths ranged from 2.8–24.6 in (mean length=6.9 in). FHC CPUE was 38.9 fish/hr and was above average in all pools except Smithland Pool (14.7 fish/hr). FHC ranged from 3.4–38.8 in (mean length=14.7 in).

Eleven catfish tournaments were attended along the Ohio River. The 3-species total CPUE was 2.7 fish/boat/tournament. Roughly 9% of all weighed catfish were trophy catfish. BCF lengths ranged from 11.5–48.0 in (mean length=27.4 in) and mean CPUE was 1.4 fish/boat/tournament. CCF lengths ranged from 11.9–31.3 in (mean length=22.7 in) and mean CPUE was 1.1 fish/boat/tournament. FHC CPUE was 0.2 fish/boat/tournament, and ranged from 8.8–44.8 in (mean length=25.6 in).

A statewide catfish survey was conducted to gather information on the opinions and attitudes of catfish anglers. Roughly 92% of anglers had targeted catfish in the last three years. Most people catfished for fun or for a food source. Only 6% of anglers routinely targeted catfish for the opportunity to catch trophy fish. About 50% of anglers supported potential regulations on catfish while 25% were opposed. After multiple meetings and a great deal of public input, the commission passed the proposed regulations as stated: recreational fishermen on the Ohio River may harvest 1 BCF ≥35 in, 1 FHC ≥35 in, and 1 CCF ≥28 in. Harvest of fish below respective length limits will not be regulated. Commercial fishermen on the Ohio River and its tributaries may harvest 1 BCF ≥35 in, 1 FHC ≥35 in, and 1 CCF ≥28 in per day. However, 44 commercial fisherman that harvested >10,000 lbs of catfish in 2 of the last 3 years and an additional 6 commercial fishermen chosen by a lottery may harvest 4 (in aggregate) BCF and FHC ≥40 in and CCF ≥30 in in the Ohio River and its tributaries below Cannelton Lock and Dam. Harvest of fish below respective length limits will not be regulated.

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

KDFWR Strategic Plan. Goal 1.

Blue catfish from the Ohio River / Doug Henley

Ohio River Supplemental Stocking Survey-Markland Pool

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

Preparing fingerlings for the Ohio River / Doug Henley

Angler concerns over the decline in largemouth bass in the Ohio River became apparent to the KDFWR in 1997. Research was initiated to document the structure of largemouth bass populations throughout the Ohio River, verify if largemouth bass are declining in the river and if so, identify the causes for these declines. Recent research determined that largemouth bass year-class production in the Ohio River may be negatively impacted by an extended flood pulse and increased sedimentation. In turn, poor year-class production results in a less than optimal largemouth bass fishery in the river. Supplemental stocking has been shown to benefit largemouth bass population levels in some large riverine systems, and may be a viable technique used to increase year-class strength and ultimately improve the bass fishery in the Ohio River. As a pilot project, KDFWR began stocking largemouth bass fingerlings produced at Kentucky's fish hatcheries into embayments of the Markland Pool in June of 2007 and continued stocking through June of 2013.

The initial goal was a stocking rate of 100 fish/acre in each of the selected embayments. Fingerlings were marked with OTC, so that we could determine the contribution of stocked fish from age-0 to adulthood, compare growth between stocked and wild fish, and determine the contribution of stocked fish to year-class strength. Preliminary results from this study have shown through the four years of the study stocked fish composed 37–79% of the age-0 fish and that this contribution to year-class strength appears to be adding to the fishery. To further investigate the success of stocking the Ohio River embayments, in 2011 the stocking rates for study embayments were varied (0 fish/acre, 50 fish/acre, and 100 fish/acre). This should allow us to determine if a reduced stocking rate will result in similar contributions to year class strength and the fishery as well as the potential for movement out of stocked embayments. A total of 133,935 fingerling (mean length=1.9 in) were stocked into these 13 embayments in 2013.

Spring CPUE of largemouth bass ranged from 29.0 fish/hr in Woolper Creek to 88.8 fish/hr in Steeles Creek (mean CPUE=59.5), and 0.0 fish/hr in Gunpowder Creek to 12.0 fish/hr in Craigs Creek for spotted bass (mean CPUE=3.1). Smallmouth bass were only collected in Craigs Creek and Gunpowder Creek. Mean largemouth bass CPUE was much lower than in 2012 (CPUE=88.2); however, it was still the second highest since the study began. Mean length of largemouth bass ranged from 9.9 in in Woolper Creek to 12.1 in in Craigs Creek (total mean length=11.1 in). Spotted bass mean lengths ranged from 4.7 in in Woolper Creek to 14.5 in in Big Bone Creek (total mean length=8.9 in). Fall CPUE of largemouth bass ranged from 12.0 fish/hr in Woolper Creek to 60.0 fish/hr in Gunpowder Creek (mean CPUE=27.9 fish/hr) and 0.0 fish/hr in multiple embayments to 10.0 fish/hr in Gunpowder Creek for spotted bass (mean CPUE=2.8 fish/hr). Mean CPUE of largemouth bass was 27.9 fish/hr and was the lowest historical catch rate of the study. CPUE of spotted bass was also down considerably and was the second lowest since the study began. Mean length of largemouth bass ranged from 9.1 in in Woolper Creek to 12.0 in in Steeles Creek (total mean length=10.3 in). Mean length of spotted bass ranged from 6.8 in in Gunpowder Creek to 9.4 in in Big Bone Creek (total mean length=7.7 in).

Fall catch rates for stocked and natural largemouth bass fingerlings in 2013 were the lowest since the start of the study, with both CPUE being 0.9 fish/hr. Catch rates of age-0 largemouth bass were low in all embayments, and those embayments that were not stocked had no return of stocked age-0 largemouth bass.

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

KDFWR Strategic Plan. Goal 1.

Ohio River Supplemental Stocking Survey-Meldahl Pool

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

The Cumberland River above Lake Cumberland / Doug Henley

Meetings with Ohio River black bass fishermen in 1997 informed the KDFWR that problems existed with black bass population structure in the Meldahl Pool. Efforts were initiated to sample various sites in this pool and determine the factors influencing these populations. The KDFWR sampled Meldahl Pool since 1997. Sampling confirmed angler concerns and indicated that a relatively poor largemouth bass population existed in Meldahl Pool compared to other Ohio River Pools. Electrofishing surveys indicated that young-of-the-year production was low, potentially due to limited spawning habitat.

KDFWR implemented a spawning habitat manipulation study in 2003 through 2010 to determine if largemouth bass spawning could be enhanced through the introduction of supplemental spawning structures and cover. While black bass were observed utilizing both structures, the effort needed to significantly influence black bass reproduction on a pool wide basis through these means appeared immense. Based on the bass stocking study conducted in Markland Pool, it seems that stocking may be a more viable option to increase year-class strength and enhance the largemouth bass fishery. Six embayments in the Meldahl Pool were stocked with 33,841 fingerlings. Five embayments (Big Snag, Big Locust, Bracken, Lawrence, and Lee's Creek) were stocked at a rate of 100 fish per acre and Big Turtle Creek was stocked at a rate of 200 fish per acre.

Three to six transects were nocturnally electrofished in each embayment in spring 2013 for a total of 32 transects (5.3 hr total sample time). A total of 169 largemouth bass and 18 spotted bass were collected in the sample. CPUE of largemouth bass (CPUE=31.9 fish/hr) was up from 2012 (CPUE=23.7 fish/hr), and ranged from 12.9 fish/hr in Lawrence Creek to 55.0 fish/hr in Big Turtle Creek. No smallmouth bass were observed. Mean CPUE of spotted bass was 3.4 fish/hr and ranged from 0.0 fish/hr in Big Turtle Creek and Lees Creek to 10.0 fish/hr in Big Snag Creek. Overall mean length for largemouth bass was 10.7 in, and ranged from 9.4 in in Bracken Creek to 13.6 in in Lawrence Creek. Spotted bass overall mean length was 7.0 in and ranged from 4.2 in in Lawrence Creek to 8.0 in in Big Snag Creek.

Six transects were nocturnally electrofished in each embayment, except for Lee's Creek (only 3 transects could be completed) for a total of 33 transects (5.5 hr sample time). All black bass were weighed and measured in each study embayment with largemouth bass (n=159) CPUE ranging from 13.0 fish/hr in Big Locust Creek to 46.0 fish/hr in Bracken Creek, while the mean CPUE across all embayments for largemouth bass was 28.9 fish/hr. Spotted bass catch rates ranged from 1.0 fish/hr in Big Turtle Creek to 11.0 fish/hr in Big Snag Creek, with an overall mean of 6.2 fish/hr. One smallmouth bass was collected in Lawrence Creek. Catch rates were lower than 2012, and were the lowest since stocking began.

Catch rates for stocked largemouth bass fingerlings in fall 2013 ranged between 1.0 fish/hr in Big Locust Creek to 8.0 fish/hr in Big Snag Creek and Lees Creek. Mean CPUE of stocked age-0 largemouth bass decreased dramatically from 2012 (CPUE=23.1 fish/hr) to 2013 (CPUE=4.5 fish/hr). Of interest is Big Turtle Creek embayment. It was stocked with the highest rate (200 fish/acre), yet it had the lowest catch rate of stocked age-0 fish in 2011 and the second lowest in 2012. In 2013, it was slightly above average (CPUE=5.0 fish/hr) but still considerably low. Seventy-five percent of all age-0 fish examined were stocked fish, and all embayments had more stocked age-0 fish than natural age-0 fish.

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

KDFWR Strategic Plan. Goal 1.

Warm Water Stream Sport Fish Surveys

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

Quality size smallmouth bass can be found in many of Kentucky's rivers and streams. / Jeff Crosby

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 KDFWR has taken note that more information is needed to better inform the public of these opportunities while making sure these resources are being managed in a way that not only protects these fisheries but maximizes the fisheries potential.

During 2013, general sport fish surveys were completed on the Green, Barren and Gasper Rivers, Floyds Fork and Eagle Creek. Information was collected from these systems in an 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 to develop trend data. The purpose of collecting these data is to help the KDFWR make informed management decisions to further promote stream fishing in Kentucky, inventory current access sites, and identify new areas that could benefit from future access sites.

Data collected in 2013, showed trophy size smallmouth bass (≥20.0 in) and musky (≥40.0 in) are present in Barren River. Smallmouth bass populations in the Floyds Fork, Barren and Gasper Rivers all received "good" to "excellent" assessment rating in 2013. Green River recorded the best smallmouth bass catch rates at 32.0 f/h with fish sampled up to 18 in. The walleye fishery in Green River (222.0 f/h) was impressive not only for quantity but quality, with trophy fish (≥25.0 in.) present. Trophy size (≥10.0 in) rock bass were collected from the Gasper River while the largemouth bass fishery in Eagle Creek received the only "good" assessment rating this year, with fish collected up to 20 in. Furthermore, eleven new public access sites were identified and added to the boating and fishing guide during 2013.

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

KDFWR Strategic Plan. Goal 1.

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

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

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

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

In an effort to enhance the sauger fishery in the Kentucky River, the KDFWR implemented a sauger stocking program from 2006–2010 in the Kentucky River. Sauger stocking in the Kentucky River have been successful in establishing a put-grow-take type fishery; however, very little natural reproduction has been detected.

Sauger collected from the Barren River / David Baker

Similar stockings are being evaluated in the Green, Barren and Salt rivers. Fingerling sauger averaging 1.5 in in length will be stocked in each river system from 2012-2016 at an annual rate of 10 fish/acre. Sauger populations in these three river systems will be monitored through at least the spring of 2020 to determine if a self sustaining fishery will develop.

From 2012–2013, spring sauger catch rates have increased in both the Green and Barren Rivers. Green River catch rates increased from 4.7 fish/hr in 2012 to 12.0 fish/hr during 2013, with sauger ranging from 5–17 in. Meanwhile, 2013 spring catch rates on Barren River was 5.5 fish/hr, up from 1.7 fish/hr collected in 2012, with fish collected up to 15 in. size class. Thus far, very little to no natural reproduction has been detected in the Barren and Green Rivers.

Sauger catch rates in the Salt River during spring 2013 (11.0 fish/hr) were less than those collected in spring 2012 (29.0 fish/hr). A subsample of age-1sauger were collected in 2013 to check for oxytetracycline (OTC) marks. No OTC marks were observed on these fish indicating these were spawned naturally, but could be migrants from Ohio River sauger populations.

Fall electro-fishing surveys from 2012-2013 have indicate the overall condition of sauger in the Green, Barren and Salt Rivers remain poor across all size classes.

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

KDFWR Strategic Plan. Goal 1.

Juvenile lake sturgeon / Matt Thomas

Lake Sturgeon Telemetry in the Cumberland River

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

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

Thirty lake sturgeon were surgically implanted with ultrasonic transmitters at the Pfeiffer Fish Hatchery in Frankfort, KY. Twelve stationary receivers were deployed at sites upstream and downstream of the two stocking sites in the Big South Fork and Cumberland River to determine movement out of the stocking areas. All fish have been accounted for throughout the study and all stationary receivers have detected fish. Some of the lake sturgeon have been detected moving over 35 miles, while others appear to be staying in the areas where they were stocked. Fish that displayed movement moved downstream into Lake Cumberland during the summer and early fall, and current tracking data and stationary receiver logs indicate that the majority of fish are still in Lake Cumberland below the KY Route 90 Bridge. It is also apparent that some tagged fish have remained upriver of stocking sites (specifically in the Big South Fork). Half of the ultrasonic transmitters had short battery lives and have now expired; no additional data will be available from those fish. Six months of manual tracking has yielded four detections, all of which were recorded near the edges of the study site. Although not enough manual detections exist to quantify habitat use, all four detections occurred in inside bend habitats which provide sandy substrate and low velocity habitats often preferred by lake sturgeon.

Telemetry efforts will cease after March 2014. Trotlining Efforts will begin in December 2014 to gather CPUE, survival, and age/growth data and assess the success of KDFWR's stocking efforts. If reintroduction efforts are proved to be successful and a self-sustaining population is established, we can begin to manage for a unique sport fishing opportunity.

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

KDFWR Strategic Plan. Goal 1.

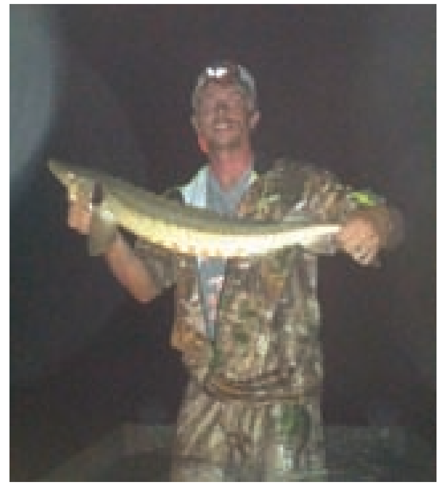
Lake Sturgeon Restoration in the Upper Cumberland River Drainage in Kentucky

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

Lake Sturgeon captured by young angler in Cumberland River above Mouth of Laurel/ Jeff Ginnan

The Lake Sturgeon (*Acipenser fulvescens*) is considered critically imperiled in Kentucky, where it is currently limited to the Ohio and Mississippi rivers. In 2007, the 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.

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 7.5–8.9 in total length. Since spring 2008, young Lake Sturgeon have been released annually at two locations in the upper Cumberland River drainage. The Cumberland River at the mouth of Laurel River received 959 fish (average 7.4–8.5 inches) in 2008, 2,004 fish (average 7.5 in) in 2009, 4,539 fish in 2010 (average 5.5–7.8 in), and 2,150 fish (average 8.2–8.9 in) in 2011. The Big South Fork Cumberland River at the Alum Creek access area received 716 fish (average 7.4 in) in 2008, 1,973 fish (average 7.5 in) in 2009, and 4,063 fish (average 5.5-7.8 in) in 2010. To date, a total of 16,404 fish have been stocked into the Cumberland River above Lake Cumberland. 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, and right anterior scutes 5-6 for 2011. Stocking did not occur in 2012 or 2013. During spring 2013, spawning was delayed in Wisconsin because of delayed ice melt and eggs could not be safely shipped due to extreme temperature differences in Wisconsin and KDFWR hatcheries. Stocking will continue at both locations in 2014. 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 effort for this rare species in the Cumberland River.



Lake Sturgeon caught by angler/ Jason Beavers

Twenty nine reports of Lake Sturgeon captured by anglers were received in 2009-2013. Most fish were captured from various locations in the impounded portion of the river (Lake Cumberland); however, during 2012-2013 we received additional reports from the Cumberland River below Wolf Creek Dam. These individuals either passed through the dam from the reservoir or migrated upstream from Tennessee. The size range of fish captured was 13–15 in weighing 1 lb or less (10 reports) and 20-30 in weighing 2-5 lbs (11 reports). A variety of sampling techniques are being evaluated to determine survival, habitat use, and movement patterns of stocked fish and will begin in 2014.

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 Propagation and Restoration in Western Kentucky

Ryan A. Oster, Steve Marple, Matthew Thomas, and Stephanie Brandt, 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 ft and weights of over 300 lbs. The largest reported size of an alligator gar is 9 ft, 8 in. This specimen weighed approximately 302 lbs. Its native range once occurred from the Florida panhandle west into the Gulf Coastal Plain to Veracruz, Mexico and throughout the Mississippi River Basin, including the lowermost Cumberland and Tennessee Rivers. In Kentucky, the Alligator Gar is native to the Ohio, Mississippi, and lower Cumberland and Tennessee River systems.

Little is known about the biology and habitat of this species in Kentucky and throughout the majority of its native range. In its southern range, the Alligator Gar typically inhibits big rivers, swamps, bayous, and brackish waters. The Alligator Gar is the most salt tolerant of all the gar species. In Kentucky, the Alligator Gar occupied sluggish pools, backwaters, and embayments of big rivers and larger reservoirs in western Kentucky. 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.

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

Stephanie Brandt with Alligator Gar captured in Lake Barkley during Carp Madness tournament / Matt Thomas

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 KDFWR Wildlife Action Plan.

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

During the 2013 Carp Madness tournament on Kentucky/Barkley Lakes, one commercial team collected an Alligator Gar while targeting Asian Carp. The fish measured roughly 54 inches in length and weighed 34 pounds. Upon examination, KDFWR biologists concluded this was a KDFWR stocked fish as determined by the presence of a coded microwire tag. The age class can't be determined with certainty, but we can say at its oldest, the fish was four years old. It appears Alligator Gar are locking through the dam below either lake in a similar fashion as other fish species.

From 2009–2013, a total of 24,739 Alligator Gar were stocked by the KDFWR. Size at stocking ranged from 7.3 to 14.5 in. 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.

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

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

The Cumberland Darter (*Etheostoma susanae*) has a limited range in the upper Cumberland River drainage, most of which is in Kentucky. The U.S. Fish and Wildlife Service recently published a final rule (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, 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. Artificially propagated individuals are being released within the watershed from which brood stock are taken, to avoid mixing potentially unique evolutionary lineages. Cogur Fork (Indian Creek-upper Cumberland River drainage) in McCreary County was chosen as the reintroduction stream because: 1) it is within the historic range of the species; 2) habitat conditions are suitable; and 3) there is some level of protection (i.e., within the Daniel Boone National Forest).

Brood stock was collected in January 2012 from Barren Fork, just above the Taylor Ridge Rd. crossing, McCreary County. These new wild-caught individuals were used in this year's propagation effort in addition to eight captively conditioned (2011) individuals. Following observations of darkly pigmented males (heads and fins) defending cavities under slabs, weekly checks for eggs were initiated on 12 April 2013, at which time the first nest was collected. By 23 April all eggs from the first clutch had hatched and the water temperature was ~17°C. Approximately 895 larvae were reared successfully to juveniles yielding ~76% overall survivorship. In July and August, a total of 893 propagated juveniles were tagged with visible implant elastomer (VIE) tags and released into three nearly adjacent reaches in lower Cogur Fork. Along with the juveniles produced in 2013, 14 individuals propagated in 2011 and 21 of the oldest adults were released in into Cogur Fork in August.

A total of 3,427 Cumberland Darters have been stocked in Cogur Fork since 2009. Periodic surveys were conducted in 2010–2013 in Cogur Fork by CFI biologists and KDFWR by performing a combination of visual surveys and seine hauls. Monitoring efforts so far have confirmed the survival of tagged fish released into Cogur Fork for periods exceeding one year and limited evidence of natural reproduction (8 untagged individuals since 2009, with 3 in 2013). However, it would be premature at this point to suggest that the project has been successful in restoring a wild population. The small number of untagged individuals could indicate the early establishment of a wild population in Cogur Fork, but collection of much larger numbers 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. Captive propagation, reintroduction, and field monitoring will continue in 2014.

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.

VIE-tagged Cumberland Darter/ CFI

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

Seining for VIE-tagged Kentucky Arrow Darters in Long Fork / CFI / Stephanie Brandt

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

The Kentucky Arrow Darter, *Etheostoma spilotum*, has a limited distribution in the upper Kentucky River drainage, where it inhabits headwater (mostly 1st and 2nd order) streams. The 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 warranted 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 re-establish 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; and 3) there is some level of protection (i.e., within the Daniel Boone National Forest).

Brood stock were collected in December 2012 from Big Double Creek, a tributary of the Red Bird River in the Daniel Boone National Forest, Clay County. The new wild-caught individuals were used in this year's effort in addition to one captively conditioned male taken from Big Double Creek in 2011. March spawning was observed in aquaria at CFI's hatchery facility when temperatures briefly exceeded 12°C. Although it appears that the use of a chiller contributed to spawning success in 2012, the opposite appears to have been the case in 2013 since it apparently held temperatures below those optimal for egg and/or larval survivorship (but extended the period of reproductive condition of the breeders). Production was also less in 2013 due to the reduced number of female breeders available (10 vs. 21 in 2012). These findings will guide efforts in 2014, both with respect to number of female breeders needed and the temperature "sweet spot" required for optimal reproduction.

On 15 July 2013, the young (n=218) were tagged with visible implant elastomer (VIE) tags and released into Long Fork at multiple sites spanning the reach from the mouth to ~1.5 km upstream at the Long Fork Road crossing. A total of 1,047 Kentucky Arrow Darters have been stocked in Long Fork since 2012. Periodic surveys were conducted in 2012–2013 in Long Fork by CFI biologists and KDFWR by performing a combination of visual surveys and seine hauls. A total of 255 tagged (propagated) and 20 untagged (wild-spawned) Kentucky Arrow Darters were observed in 2012-2013. While these results are encouraging, other 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. Captive propagation, reintroduction, and field monitoring will continue in 2014.

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.

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

Bennett Branch, Todd County (above); Flame Chub (lower left); Spring Cavefish (lower right) / Matt Thomas.

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

Species of Greatest Conservation Need (SGCN) are recognized in the KDFWR 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. Many fish species on this list are also included on the Kentucky State Nature Preserves Commission's current List of Rare and Extirpated Biota of Kentucky, as well as six species listed by the U.S. Fish and Wildlife Service as threatened or endangered. In 2010, the Kentucky Wildlife Action Plan was revised for the first time since its inception in 2005. Of the state's 244 native fish species, the Plan identifies 68 as in need of conservation action.

The Cumberland River drainage supports one of the most diverse and 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 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 four of these species and new occurrence records for *Hemitremia flammea* (Flame Chub).

Between 11 May 2011–16 May 2013, fish community data were obtained from a total of 63 sites throughout the Red River drainage in Simpson, Logan, Todd, and Christian Counties. Fishes were collected using a backpack electrofisher, dip nets, and a 6' X 15' (1/8" mesh) seine. At each site, all habitats within a 100–200 m reach were worked thoroughly to ensure a representative sample. Additional emphasis was placed on specific habitats known to support targeted fish SGCN. 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.

A total of 55 species have been recorded to date, including 5 of 8 fish SGCN known from the drainage. In 2013, the Flame Chub (*Hemitremia flammea*) was collected at three new localities, expanding the current distribution into two additional stream systems emanating from Robey Swamp, Simpson County. A total of 11 new occurrences of Spring Cavefish were documented, all of which were in streams that sink underground and receive cool, clear subterranean discharge. A new population of Stone Darter was discovered in Francis Branch in the upper Whippoorwill Creek drainage. New occurrences for these species reflect the sparse and unevenly distributed fish sampling effort in the Red River drainage in previous years. However, the absence of the Chestnut Lamprey, Slender Madtom, and Redlips Darter in our collections may indicate local extirpation of these species within the drainage due to habitat loss and degradation. In 2014 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: Taxa specific project.

Published Research

Barding, E.E., and M.J. Lacki. 2012. Winter diet of **river otters** in Kentucky. Northeastern Naturalist 19:157-164.

Barding, E.E., M.J. Lacki, and L.L. Patton. 2010. Recovery of the **river otter** to Kentucky. Proc. Annu. Conf. S.E. Assoc. Fish and Wildlife Agencies (*In press)*.

Baxley, D.L., J.O. Barnard, and H. Venter. 2012. *Chelydra serpentina* (**Common Snapping Turtle**) growth rates. Herpetological Review 43: 126-127.

Britzke, E.R., B.A. Slack, M.P. Armstrong, and S.C. Loeb. Effects of orientation and weatherproofing on the detection of bat echolocation calls. 2010. Journal of Fish and Wildlife Management 1(2):136-141.

Corn, J.L., M.E. Cartwright, K.J. Alexy, T.E. Cornish, E.J.B. Manning, A.N. Cartoceti, and J.R. Fischer. 2010. Surveys for disease agents in introduced **elk** in Arkansas and Kentucky. Journal of Wildlife Diseases 46(1):186-194.

Culp, J.J., A.C. Shepard, and M.A. McGregor. 2009. **Fish hosts** and conglutinates of the pyramid pigtoe (*Pleurobema rubrum*). Southeastern Naturalist 8(1):19-22.

Culp, J.J., W.R. Haag, D.A. Arrington, and T.B. Kennedy. 2011. Seasonal and species-specific patterns in abundance of **freshwater mussel** glochidia in stream drift. Journal of the North American Benthological Society 30:436-445.

Dzialak, M.R., K.M. Carter, M.J. Lacki, D.F. Westneat, and K. Anderson. 2009. Activity of post-fledging **peregrine falcons** in different rearing and habitat conditions. Southeastern Naturalist 8(1):93-106.

Edmonds, S. T., D. C. Evers, D. A. Cristol, C. Mettke-Hofmann, L. L. Powell, A. J. McGann, J. W. Armiger, O. P. Lane, D. F. Tessler, P. Newell, K. Heyden, and N. J. O'Driscoll. 2010. Geographic and seasonal variation in mercury exposure of the declining Rusty Blackbird. The Condor 112(4):789-799.

Eisenhour, D.J., A.M. Richter, and J.M. Schiering. 2011. Conservation status of the **longhead darter**, *Percina macrocephala*, in Kinniconick Creek, Kentucky. Southeastern Fishes Council Proceedings 53:13-20.

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

Frary, V.J., J. Duchamp, D.S. Maehr, and J.L. Larkin. 2011. Density and distribution of a colonizing front of the **American black bear** *Ursus americanus*. Wildlife Biology 17:404-416.

Griggs, A., M.K. Keel, K. Castle and D. Wong. 2012. Enhanced surveillance for white-nose syndrome in **bats**. Emerging Infectious Diseases 18:530-532.

Harris, D., C. Elliott, R. Frederick, and T. Edwards. 2009. Habitat characteristics associated with **American woodcock** (*Scolopax minor* Gmelin) nests in central Kentucky. The Journal of the Kentucky Academy of Sciences 70(2):114-144.

Hartman, P.J., D.S. Maehr, and J.L. Larkin. 2009. Habitat selection by **cerulean warblers** in Eastern Kentucky. The Wilson Journal of Ornithology 121(3):469-475.

Heyden, K.G. 2010. 2010 **Barn Owl** (*Tyto alba*) inventory and current management for the species in Kentucky. The Kentucky Warbler 86(4): 79-85.

Heyden, K. G. 2010. Current status of nesting Bald Eagles (*Haliaeetus leucocephalus*) in Kentucky. The Kentucky Warbler 86(4):85-89.

Hopkins, R.L. 2009. Use of landscape pattern metrics and multiscale data in aquatic species distribution models: a case study of a **freshwater mussel**. Landscape Ecology 29:943-955.

Hopkins, R.L., M.D. Burns, B. Burr, and L.J. Hopman. 2008. Building a centralized database for Kentucky **fishes**: Progress and future applications. Journal of the Kentucky Academy of Science 69 (2): 164-169.

Hopkins, R.L. and B.M. Burr. 2009. Modeling **freshwater fish** distributions using multiscale landscape data: A case study of six narrow range endemics. Ecological Modeling 220:2024-2034.

Johnson, J.S., J.N. Kropczynski, M.J. Lacki, and G.D. Langlois. 2012. Social networks of **Rafinesque's big-eared bats** (*Corynorhinus rafinesquii*) in bottomland hardwood forests. Journal of Mammalogy 93:1545-1558.

Johnson, J.S., and M.J. Lacki. 2013. Habitat associations of **Rafinesque's big-eared bats** (*Corynorhinus rafinesquii*) and their lepidopteran prey in bottomland hardwood forests. Canadian Journal of Zoology 91:94-101.

Johnson, J.S., and M.J. Lacki. 2013. Summer heterothermy in **Rafinesque's big-eared bats** (*Corynorhinus rafinesquii*) roosting in tree cavities in bottomland hardwood forests. Journal of Comparative Physiology 183:709-721.

Johnson, J.S., and M.J. Lacki. 2012 Summer heterothermy in **Rafinesque's big-eared bats** (*Corynorhinus rafinesquii*) roosting in tree cavities in bottomland hardwood forests. Journal of Comparative Physiology B: 1-13.

Larkin, J.L., D.S. Maehr, J.J. Krupa, J.J. Cox, K. Alexy, D.E. Unger, and C. Barton. 2008.
Small mammal response to vegetation and spoil conditions on a reclaimed surface mine in eastern Kentucky. Southeastern Naturalist 7(3):401-112.

Lynch, W.L., and C.N. Moreira. 2008. Nest arrival vocalizations of the **Turkey Vulture** *Cathartes aura* (Cathartidae: Falconiformes). Vulture News 59:3-6.

Morgan, J.J., G. Sprandel, B.A. Robinson and K. Wethington. 2012. A county-based **northern bobwhite** habitat prioritization model for Kentucky. Proceedings of the National Quail Symposium 7:281-287.

Niemiller, M.L., B.M. Fitzpatrick, P. Shah, L. Schmitz, and T.J. Near. 2012. Evidence for repeated loss of selective constraint in rhodopsin of **amblyopsid cavefishes** (teleostei: amblyopsidae). Evolution 67:732-748.

Niemiller, M.L., G.O. Graening, D.B. Fenolio, J.C. Godwin, J.R. Cooley, W.D. Pearson, B.M. Fitzpatrick and T.J. Near. 2013. Doomed before they are described? The need for conservation assessments of cryptic species complexes using an **amblyopsid cavefish** (Amblyopsidae: *Typhlichthys*) as a case study. Biodiversity Conservation 22:1799-1820.

Niemiller, M.L., J.R. McCandless, R.G. Reynolds, J. Caddle, T.J. Near, C.R. Tillquist W.D. Pearson, and B.M. Fitzpatrick. 2012. Effects of climatic and geological processes during the Pleistocene on the evolutionary history of the **northern cavefish**, *Ablyopsis spelaea*. Evolution 67: 1011-1025.

Owen C.T., J.E. Alexander, Jr., and M.A. McGregor. 2010. Control of microbial contamination during *in vitro* culture of larval **unionid mussels**. Invertebrate Reproduction and Development. 54 (4):187-193

Owen, C.T., M.A. McGregor, G.A. Cobbs, and J.E. Alexander Jr. 2010. Muskrat predation on a diverse **unionid mussel** community: Impacts of prey species composition, size and shape. Freshwater Biology 56(3): 554-564.

Patton, L.L, D.S. Maehr, J.E. Duchamp, S. Fei, J.W. Gassett and J.L. Larkin. 2010. Do the **golden-winged warbler** and **blue-winged warbler** exhibit species-specific differences in their breeding habitat use? Avian Conservation and Ecology 5(2).

Reidy, J.L., F.R. Thompson III, and J.W. Bailey. 2011. Comparison of methods for estimating density of **forest songbirds** from point counts. Journal of Wildlife Management 75:558-568.

Ruder, M.G., A.B. Allison, D.L. Miller, and M.K. Keel. 2010. **Pathology** in practice. Journal of the American Veterinary Medical Association 237(7):783-785.

Sheehan, J., P.B. Wood, D.A. Buehler, P.D. Keyser and J.L. Larkin. 2013. Avian response to timber harvesting applied experimentally to manage **Cerulean Warbler** breeding populations. Forest Ecology and Management 321:5-18.

Shock, B.C., S.M. Murphy, L.L. Patton, P.M. Shock, C.Olfenbuttel, J. Beringer, S. Prange, D.M. Grove, M. Peek, J.W. Butfiloski, D.W. Hughes, J.M. Lockhart, S.N. Bevins, S. VandeWoude, K.R. Crooks, V.F. Nettles, H.M. Brown, D.S. Peterson and M.J. Yabsley. 2011. Distribution and prevalence of *Cytauxzoon felis* in **bobcats** (*Lynx rufus*), the natural reservoir, and other wild felids in thirteen states. Veterinary Parasitology 175:325-330.

Steen, D.A., C.J.W. McClure, L.L. Smith, B.J. Halstead, C.K. Dodd, W.B. Sutton, J.R. Lee, D.L. Baxley, W.J. Humphries, and C. Guyer. 2013. The effect of coachwhip presence on body size of **North American racers** suggests competition between these sympatric snakes. Journal of Zoology 289:86-93.

Steen, D.A., L.L. Smith, J. Brock, J.B. Pierce, J.R. Lee, D. Baxley, J. Humphries, B. Sutton, D. Stevenson, C. Guyer, and B. Gregory. 2012. Multi-scale occupancy modeling of forest-associated **snakes** within the southeastern United States. Ecological Applications 22:1084-1097.

Tanner, E. P., A. M. Unger, P. D. Keyser, C. A. Harper, J. D. Clark, J. J. Morgan. 2012. Survival of radio-marked versus leg-banded **northern bobwhite** in Kentucky. Proceedings of the National Quail Symposium 7:212-216.

Thackston, R.E., D.C. Sisson, T.L. Crouch, D.L. Baxley, and B.A. Robinson. 2012. Hunter harvest of pen-reared **northern bobwhites** released from the surrogator. Proceedings of the National Quail Symposium 7:72-76.

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

Vukovich, M. and G. Ritchison. 2008. Foraging behavior of **Short-Eared Owls** and **Northern Harriers** on a reclaimed surface mine in Kentucky. Southeastern Naturalist 1(1):1-10.

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

Big Game
(Elk and Deer)

Small Game
(Quail, Squirrels, Rabbits)

Turkey

Furbearers

Bear

Birds

Songbirds and Raptors

Migratory Shorebirds and Colonial Nesting Waterbirds

Reptiles and Amphibians

Mollusks

Crayfish

Fishes

Habitat Restoration / Management

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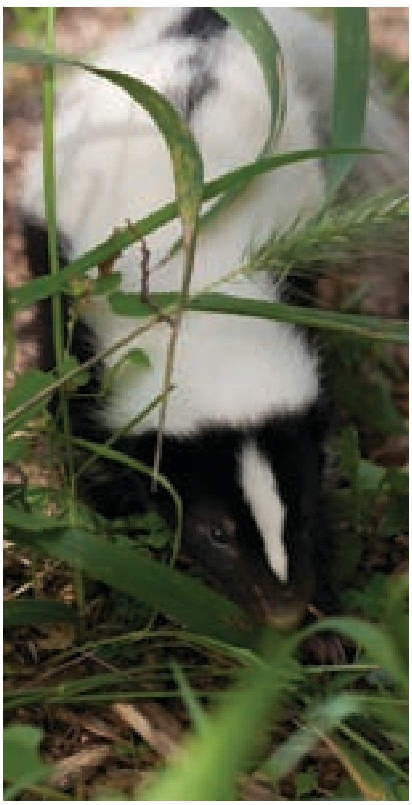

Skunk / Adrienne Yancy

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