Recovery Outline

for

Kentucky arrow darter (*Etheostoma spilotum*)
January 2017

Kentucky arrow darter
[Photo Courtesy of Dr. Matthew Thomas, KY Department of Fish and Wildlife Resources]

I. INTRODUCTION

This document outlines a preliminary course of action for the recovery of the Kentucky arrow darter (*Etheostoma spilotum*) until a comprehensive recovery plan for the species is approved. The Kentucky arrow darter is a small freshwater fish that occupies 48 streams in the upper Kentucky River basin in eastern Kentucky. We (U.S. Fish and Wildlife Service (Service)) listed this fish as a threatened species in the *Federal Register* on October 5, 2016 (81 FR 68963), with designation of 38 critical habitat units (81 FR 69312, see Appendix A). The primary threat to this darter species is habitat modification or destruction from surface coal mining, logging, oil/gas development, land development, agriculture, and inadequate sewage treatment, coupled with ongoing threats associated with inadequate regulatory mechanisms. The species' small, isolated populations also make it vulnerable to natural and catastrophic events related to human activity (e.g., drought, resource extraction, pollution spills, climate change, etc.).

<u>Listing and Contact Information</u>:

Listing Classification:	Threatened range wide (KY)
Effective Listing Date:	November 4, 2016
Lead Agency, Region:	U.S. Fish and Wildlife Service, Southeast Region
Lead Field Office:	Kentucky Ecological Services Field Office
Lead Biologist:	Michael A. Floyd, 502-695-0468, mike_floyd@fws.gov

II. RECOVERY STATUS ASSESSMENT

A. Biology

Taxonomy, Life History, Habitat, Distribution, and Trends
[*Note: For a more detailed description of the species' biology, please see the final listing rule, 81 FR 68963*]. The Kentucky arrow darter, *Etheostoma spilotum* Gilbert, is a small, compressed fish, with a background color of straw yellow to pale green and a body covered by a variety of stripes and blotches. Breeding males exhibit the most vibrant coloration, including scattered scarlet spots and scarlet to orange vertical bars. Kentucky arrow darters can reach 50 millimeters (mm) (2 inches (in)) in length by the end of the first year and reach a maximum length of 120 mm (4.7 in) (Lotrich 1973, Lowe 1979, Kuehne and Barbour 1983). The species' lifespan is approximately four years.

Kentucky arrow darters typically occupy small, headwater streams with watersheds ranging from 1 to 26 square kilometers (km^2) (10 square miles (mi^2)). Many of these habitats, especially in first-order reaches, can be intermittent in nature (Thomas 2008). Kentucky arrow darters are most often observed in pools or transitional areas between riffles and pools (glides and runs) with rocky substrates and ample cover (e.g., bedrock ledges, boulders, or woody debris piles) (Thomas 2008).

Spawning occurs in riffle habitats from late March to May, with peak activity occurring when water temperatures reach 13°C (55°F). Young Kentucky arrow darters can reach 50 mm (2 in) in length by the end of the first year (Lotrich 1973, Kuehne and Barbour 1983), when these individuals are generally sexually mature and participate in spawning with older age classes (Etnier and Starnes 1993). Juvenile Kentucky arrow darters can be found throughout the channel but are often observed in shallow water along stream margins near root mats, rock ledges, or some other cover. Kentucky arrow darters feed primarily on mayflies (Order Ephemeroptera) and other aquatic insects, but large individuals (longer than 70 mm (2.8 in) TL) often feed on small crayfishes (Lotrich 1973).

The Kentucky arrow darter occurred historically in at least 74 streams in the upper Kentucky River basin of eastern Kentucky (Gilbert 1887, Woolman 1892, Kuehne and Bailey 1961, Kuehne 1962, Branson and Batch 1972, Lotrich 1973, Branson and Batch 1974, Harker *et al.* 1979, Greenberg and Steigerwald 1981, Branson and Batch 1983, Branson and Batch 1984, Kornman 1985, Burr and Warren 1986, Measel 1997, Kornman 1999, Stephens 1999, Ray and Ceas 2003, Kentucky State Nature Preserves Commission (KSNPC) unpublished data). Its distribution spanned portions of 6 smaller sub-basins or watersheds (North Fork Kentucky River, Middle Fork Kentucky River, South Fork Kentucky River, Silver Creek, Sturgeon Creek, and Red River) in 10 Kentucky counties (Breathitt, Clay, Harlan, Jackson, Knott, Lee, Leslie, Owsley, Perry, and Wolfe) (Thomas 2008) (Figure 1).

Based on surveys completed since 2006, extant populations of the Kentucky arrow darter are known from 48 streams in the upper Kentucky River basin in eastern Kentucky (Figure 2; Table 1, Appendix B). These populations are scattered across 10 Kentucky counties: Breathitt, Clay, Harlan, Jackson, Knott, Lee, Leslie, Owsley, Perry, and Wolfe Counties (Thomas 2008, Service unpublished data). Populations in nine of these streams have been discovered since 2006, and one additional population (Long Fork, Clay County) was established through a reintroduction project led by the Kentucky Department of Fish and Wildlife Resources (KDFWR). Current populations occur in the following Kentucky River sub-basins (and smaller watersheds):

- North Fork Kentucky River (Troublesome, Quicksand, Frozen, Holly, Lower Devil, Walker, and Hell Creek watersheds);
- Middle Fork Kentucky River (Big Laurel, Rockhouse, Hell For Certain Creek, and Squabble Creek watersheds);
- South Fork Kentucky River (Red Bird River, Hector Branch, and Goose, Bullskin, Buffalo, and Lower Buffalo Creek watersheds);
- Silver Creek;
- Sturgeon Creek (Travis, Wild Dog, and Granny Dismal Creek watersheds); and
- Red River (Rock Bridge Fork of Swift Camp Creek).

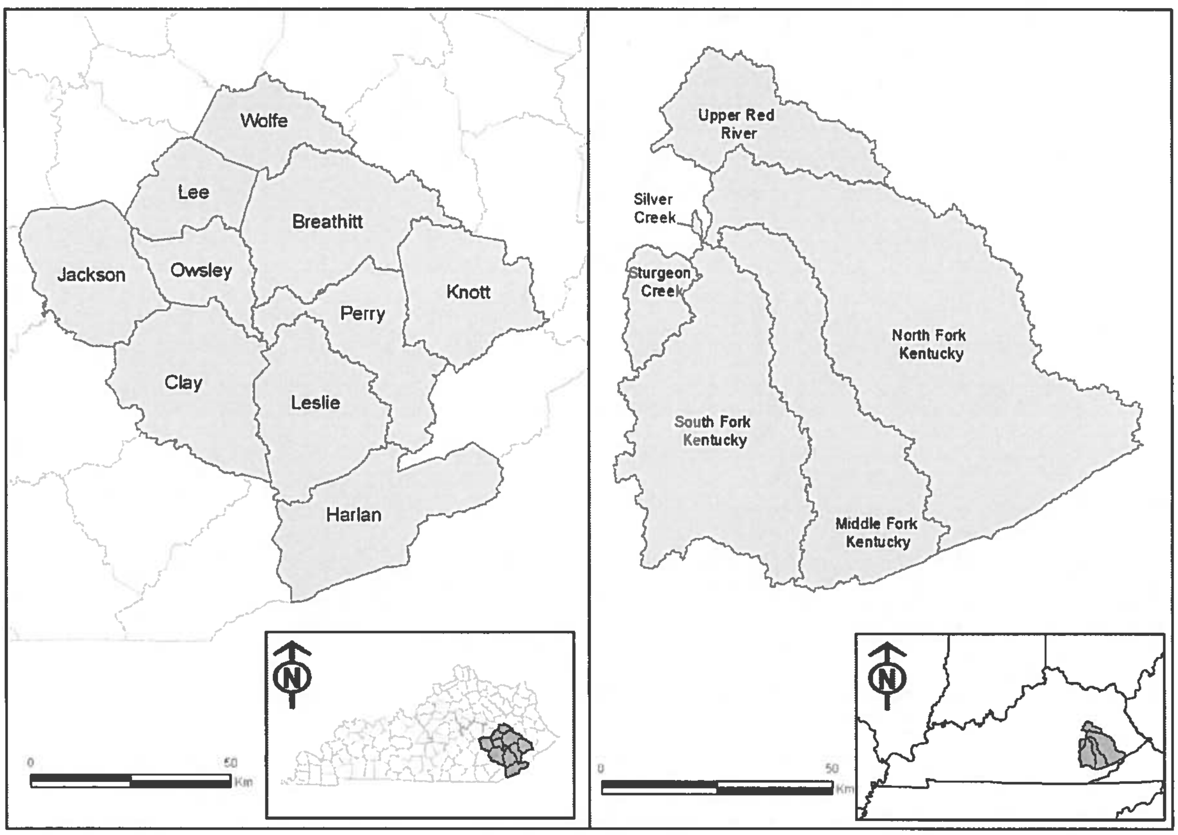

Figure 1. Kentucky counties within the Kentucky arrow darter's historical range (left) and upper Kentucky River sub-basins with historical records of the species (right).

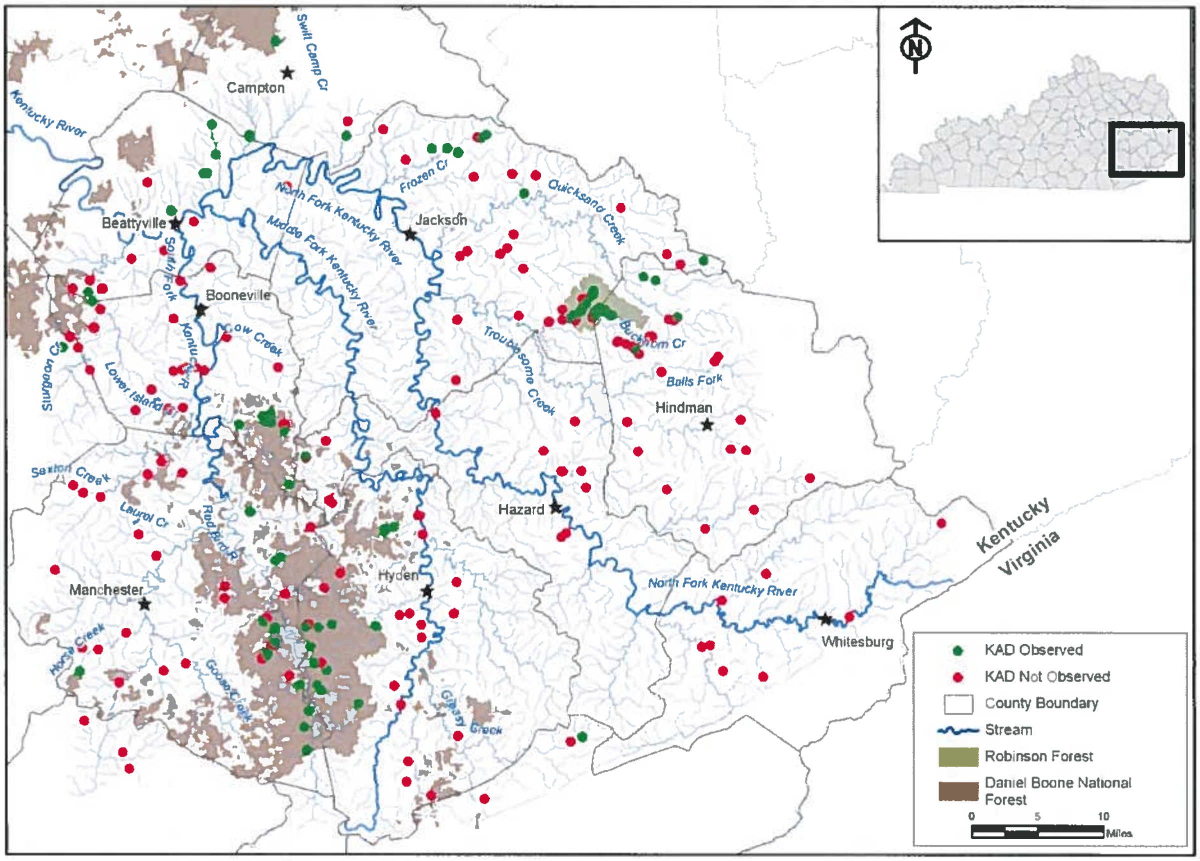

Figure 2. A summary of Kentucky arrow darter survey results at all (current and historical) sites visited between 2007 and 2014. Green circles indicate survey sites (reaches) where the species was observed. Red circles indicate survey sites (reaches) where the species was not observed.

Based on historical records and survey data collected at over 200 sites since 2006, the Kentucky arrow darter has declined significantly range-wide and has been eliminated from large portions of its former range, including 36 of 74 historical streams and large portions of the basin that would have been occupied historically by the species (Figure 2; Table 1, Appendix B). Forty-four percent of the species' extirpations (16 streams) have occurred since the mid-1990s, and the species has disappeared completely from several watersheds (e.g., Sexton Creek, South Fork Quicksand Creek, Troublesome Creek headwaters). Of the species' 48 extant streams, we consider just over half of these populations (25) to be "vulnerable", and most remaining populations are isolated and restricted to short stream reaches.

THREAT ASSESSMENT

In this outline, we present a summary of threats affecting the Kentucky arrow darter and the species' habitat. A detailed evaluation of factors affecting the species can be found in the listing determination (81 FR 68963) and critical habitat designation (81 FR 69312). The primary threat to the species is habitat modification or destruction from resource extraction (surface coal mining, logging, oil/gas development), land development, agriculture, and inadequate sewage treatment, coupled with ongoing threats associated with inadequate regulatory mechanisms. The species' small, isolated populations also make it vulnerable to natural and human induced catastrophic events (e.g., droughts, resource extraction, pollution spills, etc.).

Habitat: The Kentucky arrow darter's habitat and range have been destroyed, modified, and curtailed due to a variety of anthropogenic activities in the upper Kentucky River drainage. Resource extraction (e.g., coal mining, logging, oil/gas well development), land development, agricultural activities, and inadequate sewage treatment have all contributed to the degradation of streams within the range of the species (Branson and Batch 1972, Branson and Batch 1974, Thomas 2008, Kentucky Division of Water (KDOW) 2010, KDOW 2013a, KDOW 2013b). These land use activities have led to chemical and physical changes to stream habitats that have adversely affected the species. Specific stressors have included inputs of dissolved solids and elevation of conductivity, sedimentation/siltation of stream substrates (excess sediments deposited in a stream), turbidity, inputs of nutrients and organic enrichment, and elevation of stream temperatures (KDOW 2010, KDOW 2013a). The Kentucky Division of Water provided a summary of specific threats within the upper Kentucky River drainage, identifying impaired reaches in 21 streams within the Kentucky arrow darter's historical range (KDOW 2013a) (Table 2, Appendix B). Six of these streams continue to support populations of the species, but only one of these populations (Frozen Creek) is considered to be stable (see Table 1, Appendix B). Results of probabilistic surveys (i.e., surveys conducted at randomly selected sites with sites selected in a statistically valid way) by KDOW demonstrate the spatial degree of threats across the species' range. Out of 22 probabilistic sites (streams) visited within the upper Kentucky River basin in 2003, 18 were considered to be impaired (Payne 2016, pers. comm.), suggesting habitats across the species' range are impacted by the specific stressors identified above.

Water Quantity and Quality: Another threat to the Kentucky arrow darter is water quality degradation caused by a variety of nonpoint-source pollutants (contaminants from many diffuse and unquantifiable sources). Within the upper Kentucky River drainage, coal mining has been the most significant historical source of these pollutants, and this activity continues to occur throughout the drainage. Consequently, the potential remains for Kentucky arrow darters to continue to be adversely affected by water quality degradation associated with surface coal mining activities. Activities associated with coal mining have the potential to contribute high concentrations of dissolved salts, metals, and other solids that (1) elevate stream conductivity (a measure of electrical conductance in the water column that increases as the concentration of dissolved solids increases), (2) increase sulfates (a common dissolved ion with empirical formula of SO_4^{-2}), and (3) cause wide fluctuations in stream pH (a measure of the acidity or alkalinity of water) (Curtis 1973, Dyer and Curtis 1977, Dyer 1982, Hren *et al.* 1984, U.S. Environmental Protection Agency (USEPA) 2003, Hartman *et al.* 2005, Pond *et al.* 2008, Palmer *et al.* 2010, USEPA 2011). The coal mining process also results in leaching of metals and other dissolved solids that can result in elevated conductivity, sulfates, and hardness in the receiving stream. Stream conductivity in mined watersheds can be significantly higher compared to unmined watersheds, and conductivity values can remain high for decades (Merricks *et al.* 2007, Johnson *et al.* 2010).

Elevated levels of metals and other dissolved solids (i.e., elevated conductivity) in Appalachian streams have been shown to negatively impact biological communities, including losses of mayfly and caddisfly taxa (Chambers and Messinger 2001, Pond 2004, Hartman *et al.* 2005, Pond *et al.* 2008, Pond 2010, Pond 2012), reduced occupancy and conditional abundance of salamanders (Price *et al.* 2015), and decreases in fish diversity (Kuehne 1962, Branson and Batch 1972, Branson and Batch 1974, Stauffer and Ferreri 2002, Fulk *et al.* 2003, Mattingly *et al.* 2005, Thomas 2008, Service 2012, Black *et al.* 2013, Hitt 2014, Hitt and Chambers 2014, Daniel *et al.* 2015, Hitt *et al.* 2016). Kentucky arrow darters tend to be less abundant in streams with elevated conductivity levels (Service 2012), and are typically excluded from these streams as conductivity increases (Branson and Batch 1972, Branson and Batch 1974, Thomas 2008). Recent range-wide surveys of historical sites by Thomas (2008) and the Service (2012) demonstrated that Kentucky arrow darters are excluded from watersheds when conductivity levels exceed about 250 μS/cm. The species was observed at only two historical sites where conductivity values exceeded 250 μS/cm, and average conductivity values were much lower at sites where Kentucky arrow darters were observed (115 μS/cm) than at sites where the species was not observed (689 μS/cm). Hitt et al. (2016) reported that conductivity was a strong predictor of Kentucky arrow darter abundance in the upper Kentucky River drainage, and sharp declines in abundance were observed at 258 μS/cm (95 percent confidence intervals of 155–590 μS/cm).

Oil and gas exploration and drilling activities represent another significant source of harmful pollutants in the upper Kentucky River basin (KDOW 2013a). Once used, fluid wastes containing chemicals used in the drilling and fracking process (e.g., hydrochloric acid, surfactants, potassium chloride) are stored in open pits (retention basins) or trucked away to treatment plants or some other storage facility. If spills occur during transport or releases occur due to retention basin failure or overflow, there is a risk for surface and groundwater contamination. Any such release can cause significant adverse effects to water quality and aquatic organisms that inhabit these watersheds (Wiseman 2009, Kargbo *et al.* 2010, Osborn *et al.* 2011, Papoulias and Velasco 2013).

Other nonpoint-source pollutants common within the upper Kentucky River drainage with potential to affect the Kentucky arrow darter include domestic sewage (through septic tank leakage or straight pipe discharges) and agricultural pollutants such as animal waste, fertilizers, pesticides, and herbicides (KDOW 2013a). Nonpoint-source pollutants can cause increased levels of nitrogen and phosphorus, excessive algal growths, oxygen deficiencies, and other changes in water chemistry that can seriously impact aquatic species (KDOW 2010, KDOW 2013a, KDOW 2013b). Nonpoint-source pollution may be correlated with impervious surfaces and storm water runoff (Allan 2004) and include sediments, fertilizers, herbicides, pesticides, animal wastes, septic tank and gray water leakage, pharmaceuticals, and petroleum products.

Existing Regulatory Mechanisms: The Kentucky arrow darter and its habitats are afforded some protection from water quality and habitat degradation under the Federal Water Pollution Control Act of 1977, commonly referred to as the Clean Water Act (33 U.S.C. 1251 *et seq.*); the Federal Surface Mining Control and Reclamation Act (SMCRA) (30 U.S.C. 1201 *et seq.*) of 1977; Kentucky's Forest Conservation Act of 1998 (KRS secs. 149.330–355); Kentucky's Agriculture Water Quality Act of 1994 (KRS secs. 224.71–140); and additional Kentucky laws and regulations regarding natural resources and environmental protection (KRS secs. 146.200–360; KRS sec. 224; 401 KAR secs. 5:026, 5:031). While these laws have undoubtedly resulted in some improvements in water quality and stream habitat for aquatic life, including the Kentucky arrow darter, we must conclude that they alone have been inadequate in fully protecting this species; sedimentation and other nonpoint-source pollutants continue to pose a threat to the species.

Restricted Range and Population Size

The isolated nature of Kentucky arrow darter populations (Figure 2, above) restricts the natural exchange of genetic material between populations and makes natural repopulation following localized extirpations of the species unlikely without human intervention (Blanton-Johansen and Cashner (2016). Populations can be further isolated by anthropogenic barriers, such as dams, perched culverts, and fords, which can limit natural dispersal and restrict or eliminate connectivity among populations (Eisenhour and Floyd 2013). Such dispersal barriers can prevent reestablishment of Kentucky arrow populations in reaches where they suffer localized extinctions due to natural or human-caused events. The isolated nature and small size of many populations also likely makes them vulnerable to extirpation from intentional or accidental toxic chemical spills, habitat modification, progressive degradation from runoff (nonpoint-source pollutants), natural catastrophic changes to their habitat (e.g., flood scour, drought), and other stochastic disturbances (Soulé 1980, Hunter 2002, Allendorf and Luikart 2007). Inbreeding and loss of neutral genetic variation associated with small population size can further reduce the fitness of the population (Reed and Frankham 2003), subsequently accelerating population decline (Fagan and Holmes 2006). The long-term viability of a species is founded on the conservation of numerous local populations throughout its geographic range (Harris 1984). These separate populations are essential for the species to recover and adapt to environmental change (Noss and Cooperrider 1994, Harris 1984).

Species that are restricted in range and population size are also more likely to suffer loss of genetic diversity due to genetic drift, potentially increasing their susceptibility to inbreeding depression, decreasing their ability to adapt to environmental changes, and reducing the fitness of individuals (Soulé 1980, Hunter 2002, Allendorf and Luikart 2007). Blanton-Johansen and Cashner (2016) determined that the Kentucky arrow darter suffers from a high degree of contemporary genetic isolation, with restricted gene flow and low genetic diversity. It is likely that some Kentucky arrow darter populations are below the effective population size required to maintain long-term genetic and population viability (Soulé 1980, Hunter 2002, Blanton-Johansen and Cashner 2016).

Climate Change: There is uncertainty about the specific effects of climate change (and their magnitude) on the Kentucky arrow darter; however, climate change is almost certain to affect aquatic habitats in the upper Kentucky River drainage of Kentucky through increased water temperatures and more frequent droughts (Alder and Hostetler 2013), and species with limited ranges, fragmented distributions, and small population size are thought to be especially vulnerable to the effects of climate change (Byers and Norris 2011). Thus, we consider climate change to be a threat to the Kentucky arrow darter.

B. CONSERVATION ACTIONS

Conservation Strategy

Several conservation efforts have been completed or are ongoing for the Kentucky arrow darter. The Kentucky Ecological Services Field Office (KFO), in cooperation with KDFWR; KSNPC; U.S. Geological Survey (USGS); KDOW; U.S. Forest Service (USFS); Conservation Fisheries, Inc. (CFI); and The Appalachian Wildlife Foundation, Inc., completed a conservation strategy for the Kentucky arrow darter in 2014 (Service 2014). The strategy is divided into four major sections: (1) biology and status, (2) listing factors/current threats, (3) current conservation efforts, and (4) conservation objectives/actions. The strategy was developed as a guidance document that would assist the Service and its partners in their conservation efforts for the species. The strategy's first conservation objective addresses current informational needs on the species' biology, ecology, viability, and survey methods, while the remaining three conservation objectives address specific threats facing the species (Factors A, D, and E, respectively).

4(d) Rule

Along with the species' final listing rule, the Service issued a special 4(d) rule that excepted certain activities from section 9 prohibitions of the ESA. Therefore, any "take" of the darter during these activities (e.g., channel reconfiguration and restoration, bank stabilization, bridge and culvert replacement/removal, and stream crossing repairs) does not require an incidental take permit or authorization. These activities are expected to maintain or improve the connectivity of darter habitats, minimize in-stream disturbances, and maximize the amount of in-stream cover available for the darter, thus contributing to the conservation of the species. The KFO is currently working on a programmatic consultation process to streamline the section 7 consultation requirement for federal actions and to facilitate the completion of these activities.

Candidate Conservation Agreement with USFS

Prior to the species' final listing (2013-2015), the KFO and USFS cooperated on the development and completion of a candidate conservation agreement (CCA) for the Kentucky arrow darter within the Daniel Boone National Forest (DBNF). About half of the species' extant streams occur on lands owned and managed by the DBNF, so conservation of these populations is essential to the species' recovery, and a DBNF-specific conservation plan was needed to guide those efforts. The CCA is intended to conserve the Kentucky arrow darter on the DBNF by (a) protecting known populations and habitat, (b) reducing threats to its survival, (c) conserving the watersheds and ecosystems on which it depends, and (d) enhancing and/or restoring degraded habitat.

The CCA with the U.S. Forest Service (USFS) for DBNF provides an elevated level of focused management and conservation for portions of 20 streams that support populations of the Kentucky arrow darter. The CCA will benefit the species through the development of shared responsibilities and agency-specific commitments that will avoid and minimize potential adverse impacts to the species, obtain additional data and distributional information, and restore or enhance the species' habitats.

Propagation/Reintroduction

In 2005, KDFWR identified the Kentucky arrow darter as 1 of 251 Species of Greatest Conservation Need (SGCN) in its State Wildlife Action Plan (KDFWR 2005). The species remains a SGCN in the most recent version of the plan (2013), which identifies conservation issues (threats), conservation actions, and monitoring strategies for 301 animal species. In the original plan, KDFWR developed a priority list of research and survey needs for Kentucky's SGCN. From 2008 to present, KDFWR has partnered with CFI on a propagation and reintroduction study for the Kentucky arrow darter through the Service's State Wildlife Program (Thomas 2015, pers. comm.). Initial reintroduction efforts in Sugar Creek (2009–2011) were unsuccessful; however, recent efforts in Long Fork, another DBNF stream and tributary of Hector Branch in Clay County, have produced promising results. Since August 2012, a total of 1,447 captive-spawned Kentucky arrow darters have been tagged and reintroduced within a 1.5-km (0.9-mi) reach of Long Fork. Monitoring has been conducted on 14 occasions since the initial release using visual searches and seining methods. Tagged darters have been observed during each monitoring event, with numbers increasing from 18 (October 2012) to 86 (August 2013). Tagged darters have been observed throughout the Long Fork mainstem, both upstream and downstream of the release points. Surveys in July, August, and October 2016, indicate natural reproduction in Long Fork. Additional monitoring is planned for summer 2017.

Biological Research

Since 2013, the KESFO, KDFWR, and USFS (DBNF) have worked cooperatively with Eastern Kentucky University (EKU) on a study investigating Kentucky arrow darter movements, habitat characteristics, and population size in two DBNF streams, Gilberts Big Creek and Elisha Creek, in Clay and Leslie Counties. EKU used PIT-tags and placed antenna systems to monitor intra- and inter-tributary movement patterns in both streams, and they collected seasonal (spring, summer, and fall of 2013) biotic and abiotic data from 20 100-m (328-ft) reaches to determine habitat use and population density/size for both streams. Analysis and results of this study are ongoing.

In 2013, KSNPC and the Service initiated a study to investigate the distribution, status, population size, and habitat use of the Kentucky arrow darter within the upper Kentucky River system. One important aspect of the study was to account for imperfect detection (the inability to detect or find a species when it is actually present at a site) when surveying for the species. Studies that do not account for imperfect detection can often lead to an underestimation of the true proportion of sites occupied by a species and can bias assessments and sampling efforts. From June to September 2013, KSNPC and the Service visited 80 randomly-chosen sites (ranging from first- to third-order) across the upper Kentucky River basin in order to address these concerns and meet project objectives. As expected, Kentucky arrow darters were rare during the study and were observed at only 7 of the 80 sites, including two new localities (Granny Dismal Creek in Owsley County and Spring Fork Quicksand Creek in Breathitt County) and one historical stream (Hunting Creek, Breathitt County) where the species was not observed during previous status surveys. Presently, KSNPC and the Service are in the data analysis stage of this project.

In July 2013, EKU, the Service, and KSNPC initiated a population estimate and microhabitat characterization study on Clemons Fork, Breathitt County. The study was designed to estimate the Kentucky arrow darter's current population size and average density within Clemons Fork and to compare current densities with historical densities reported by Lotrich (1973). Additionally, population densities and habitat parameters will be compared to data from Gilberts Big Creek and Elisha Creek (both DBNF) to aid in delineation of essential habitat characteristics and development and implementation of conservation efforts. Field surveys were completed in August 2013. Data analyses are incomplete, but initial results include a mean density of 9.69 Kentucky arrow darters per sampling reach and a population estimate of 986 to 2,113 darters in Clemons Fork (95 percent confidence intervals).

From 2013-2016, Austin Peay State University worked with KDFWR and the Service on the first comprehensive assessment of genetic variation and gene flow patterns across the range of the Kentucky arrow darter (Blanton-Johansen and Cashner 2016). Funding for this project was provided through the Service's section 6 program. Approximately 25 individuals per population from 12 populations (streams) across the range of the species were genotyped (evaluated genetically to determine differences in their genetic make-up) using microsatellite markers (genetic marker used in determining genetic diversity; a section of DNA consisting of very short nucleotide sequences repeated many times, the number of repeats varying between members of the species). Resulting data were used to generate robust estimates of effective population sizes (the number of individuals in a population who contribute offspring to the next generation) and overall population and species variability. Blanton-Johansen and Cashner (2016) concluded the following:

1. The Kentucky arrow darter is a species with a high degree of historical connectivity based on analyses of mitochondrial DNA (genetic material obtained from the mitochondria of the cell), with a high degree of historical gene flow (genetic exchange) across the range.
2. Nuclear DNA evidence (genetic material obtained from the nucleus of the cell) suggests a high degree of contemporary genetic isolation and restricted gene flow within river systems.
3. Effective population sizes are relatively low and particularly low for populations that appear to have high census counts.
4. The loss of allelic diversity (the measure of genetic diversity based on the average number of alleles (alternative forms of the same gene) per locus present in a population) appears to be relatively recent and widespread and may signal the potential for extinction of some populations.
5. Loss of dispersal corridors has impacted gene flow in this species.
6. Conservation efforts should take into account the loss of connectivity among populations. Populations within each river system should be provided the opportunity for migration, and restoration efforts should focus on populations with greater allelic diversity, heterozygosity, and conformity to the Hardy-Weinberg Equilibrium (allele and genotype frequencies in a population will remain constant from generation to generation in the absence of other evolutionary influences).

Through Service-USGS Quick Response funding, the USGS Leetown Science Center evaluated the relationship between Kentucky arrow darter abundance and stream conductivity in the upper Kentucky River basin. Nonlinear regression techniques were used to evaluate significant thresholds and associated confidence intervals for Kentucky arrow darter abundance related to conductivity levels. As a contrast to Kentucky arrow darter, USGS also evaluated blackside dace occurrence in this regard. Data for the study were supplied by the Service's Kentucky and Tennessee Field Offices, KDFWR, and KSNPC. Boosted regression results indicated that stream conductivity was the strongest predictor in separate analyses of Kentucky arrow darter and blackside dace abundance. USGS concluded that the similar responses of these ecologically distinct taxa suggest the general importance of this water quality attribute for stream fish ecology in central Appalachia. Results of this study were published in *Southeastern Naturalist* in 2016 (Hitt et al. 2016). A follow-up FY17 Service-USGS proposal (Science Support Partnership) was submitted on June 1, 2016.

III. PRELIMINARY RECOVERY STRATEGY

A. RECOVERY PRIORITY NUMBER WITH RATIONALE

The Kentucky arrow darter is assigned a recovery priority of 11, which indicates the species faces a moderate degree of threat and demonstrates a low recovery potential. The recovery potential is considered low for the Kentucky arrow darter because habitats across the species' range have been degraded by a variety of stressors, many of these stressors continue to act on the species and its habitats, and most Kentucky arrow darter populations are isolated from one another, with low genetic diversity and no evidence of recent gene flow (Blanton-Johansen and Cashner 2016).

B. RECOVERY STRATEGY

The majority of streams within the Kentucky River basin have been modified from their historical condition due to a number of human-induced activities (e.g., surface coal mining, logging, agriculture, residential development, and road construction). The Kentucky arrow darter has suffered from these impacts. The species has been extirpated from at least 36 historical streams and is now restricted to 48 isolated stream reaches. Conservation and recovery of the species will require human intervention for decades to come. It is known that human activities, population numbers, and associated impacts change within drainage watersheds. Therefore, it is essential to characterize and monitor aquatic habitats on a watershed scale, and respond to changing conditions rapidly. As we work with partners to find out more about this species, we will continue addressing current threats to this threatened fish species. This approach will require monitoring extant populations of the Kentucky arrow darter, along with routine periodic monitoring of habitat conditions and investigations into the species' genetic diversity and gene flow within and between stream systems.

C. INITIAL ACTION PLAN

In an effort to protect and recover the Kentucky arrow darter in its historic range (to the extent possible), the Service anticipates the following recovery actions in relation to our recovery strategy (actions not in priority order):

1. Work cooperatively with regulatory and land management agencies to protect habitat integrity and quality of stream segments that currently support the species;

2. Seek voluntary, cooperative agreements with landowners as a practical and economical means of reducing non-point source pollution from private land use;
3. Encourage and support community based watershed stewardship planning and action, including working with partners to implement the conservation measures exempted by the 4(d) rule;
4. Develop and implement programs to educate the public and private industry on the need and benefits of ecosystem management, and to involve them in watershed stewardship and Kentucky arrow darter recovery efforts;
5. Identify and prioritize areas in the Kentucky River basin for protection, enhancement, and restoration;
6. Work cooperatively with the DBNF and other partners (e.g., KDFWR) to fully implement the CCA for Kentucky arrow darter and promote recovery of the species;
7. Continue research on Kentucky arrow darter genetic diversity and gene flow and work cooperatively with partners to determine the most effective conservation approach for the species;
8. Continue other basic research on the Kentucky arrow darter (e.g., life history) and apply the results toward management and conservation of the species;
9. Continue to develop and implement technology for maintaining and propagating the Kentucky arrow darter in captivity;
10. Continue augmentation and/or monitoring efforts in Long Fork (DBNF), Kentucky and consider the implementation of similar actions in other suitable habitats; and
11. Monitor existing Kentucky arrow darter populations and their habitats; initiate searches for unknown populations; and resurvey historical locations.

IV. PREPLANNING PROCESS

A. PLANNING APPROACH

We will develop a species status assessment (SSA) to inform future actions for the species and the recovery plan for the Kentucky arrow darter. The SSA will assess the species' biological condition and will provide a summary of the species' needs, the current species condition, and the future species condition. The recovery plan will include objective and measurable criteria which, when met, will ensure the conservation of the species. Recovery criteria will address all meaningful threats to the species, as well as estimate the time and the cost to achieve recovery. The SSA and the recovery planning effort will be led by the Kentucky Ecological Services Field Office, in cooperation with our partners. The draft recovery plan should be finalized and sent to the Regional Office for review in December 2018. The final recovery plan should be finalized and sent to the Regional Office for review by December 2019. These timelines may be affected by available resources and regional priorities.

B. STAKEHOLDER COMMENT

During the recovery planning process, input, comments, and review will be sought from multiple stakeholders within Kentucky. These will include State and Federal agencies, industrial and agricultural groups, research universities, conservation organizations, private citizens, and other groups. Many stakeholders are currently cooperating in ongoing aquatic conservation planning and action groups within the Kentucky River basin.

Approve: ______________________________ Date: 2·15·17

Assistant Regional Director, Region 4

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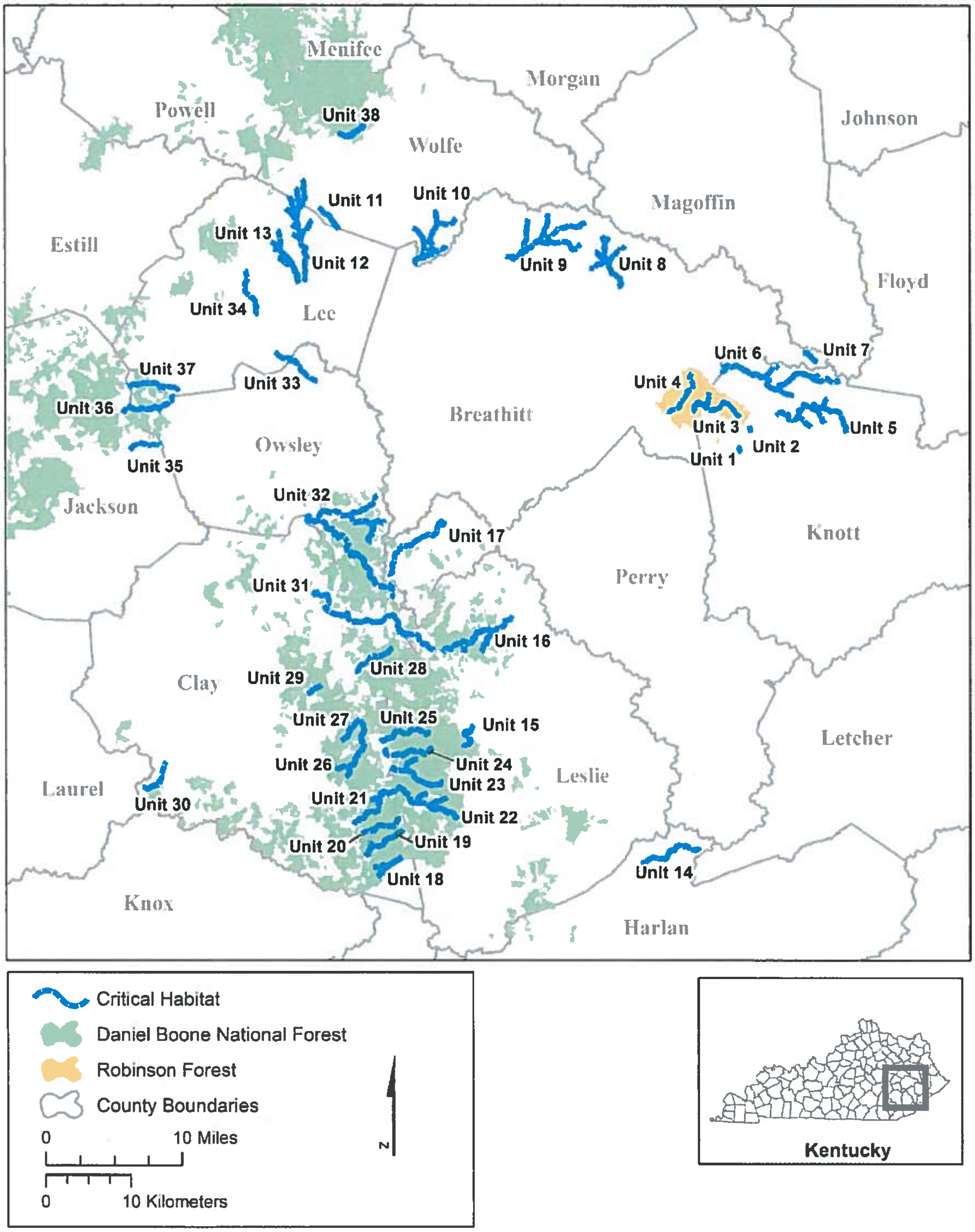
Appendix A
(81 FR 69312)

Index Map: Critical Habitat for Kentucky Arrow Darter (*Etheostoma spilotum*)



Appendix B

TABLE 1—KENTUCKY ARROW DARTER STATUS IN ALL STREAMS OF HISTORICAL (74) OR RECENT OCCURRENCE[1] (10; NOTED IN BOLD) IN THE UPPER KENTUCKY RIVER BASIN (81 FR 68963).

Sub-Basin	Sub-Basin Tributaries	Stream[1]	County	Current Status[2]	Date of Last Observation
North Fork	Lotts Creek	Lotts Creek	Perry	Extirpated	1890
	Troublesome Creek	Left Fork	Knott	Extirpated	1890
		Troublesome Creek	Perry	Extirpated	1890
		Mill Creek	Knott	Extirpated	1995
		Laurel Fork (of Balls Fork)	Knott	Extirpated	1995
		Buckhorn Creek (Prince Fork)	Knott	Vulnerable	2011
		Eli Fork[1]	Knott	Vulnerable	2011
		Boughcamp Branch	Knott	Extirpated	2011
		Coles Fork	Breathitt, Knott	Stable	2011
		Snag Ridge Fork	Knott	Stable	2008
		Clemons Fork	Breathitt	Stable	2013
		Millseat Branch	Breathitt	Extirpated	1976
		Lewis Fork	Breathitt	Extirpated	1959
		Long Fork	Breathitt	Extirpated	1959
		Bear Branch	Breathitt	Extirpated	2015
		Laurel Fork (of Buckhorn)	Breathitt	Extirpated	1976
		Lost Creek	Breathitt	Extirpated	1997
	Quicksand Creek	Laurel Fork	Knott	Stable	2014
		Baker Branch	Knott	Extirpated	1994
		Middle Fork	Knott	Stable	2015
		Spring Fork[1]	Breathitt	Vulnerable	2013
		Wolf Creek	Breathitt	Extirpated	1995
		Hunting Creek	Breathitt	Vulnerable	2013
		Leatherwood Creek	Breathitt	Extirpated	1982
		Bear Creek	Breathitt	Extirpated	1969
		Smith Branch	Breathitt	Extirpated	1995
	Frozen Creek	Frozen Creek	Breathitt	Stable	2013
		Clear Fork	Breathitt	Vulnerable	2008
		Negro Branch	Breathitt	Vulnerable	2008
		Davis Creek	Breathitt	Vulnerable	2008
		Lower Negro Branch[1]	Breathitt	Vulnerable	2016
		Cope Fork	Breathitt	Extirpated	1995
		Boone Fork	Breathitt	Extirpated	1998
	Holly Creek	Holly Creek	Wolfe	Vulnerable	2007
	Lower Devil Creek	Lower Devil Creek	Lee, Wolfe	Extirpated	1998
		Little Fork[1]	Lee, Wolfe	Vulnerable	2011
	Walker Creek	Walker Creek	Lee, Wolfe	Stable	2013
	Hell Creek	Hell Creek	Lee	Vulnerable	2013
Middle Fork	Greasy Creek	Big Laurel Creek	Harlan	Vulnerable	2009
		Greasy Creek	Leslie	Extirpated	1970
	Cutshin Creek	Cutshin Creek	Leslie	Extirpated	1890
	Middle Fork	Middle Fork	Leslie	Extirpated	1890
	Rockhouse Creek	**Laurel Creek[1]**	Leslie	Vulnerable	2013
	Hell For Certain Creek	Hell For Certain Creek	Leslie	Stable	2013
	Squabble Creek	Squabble Creek	Perry	Vulnerable	2015
South Fork	Red Bird River	Blue Hole Creek	Clay	Stable	2008
		Upper Bear Creek	Clay	Stable	2013
		Katies Creek	Clay	Stable	2007
		Spring Creek	Clay	Stable	2007
		Bowen Creek	Leslie	Stable	2009
		Elisha Creek	Leslie	Stable	2014
		Gilberts Big Creek	Clay, Leslie	Stable	2013

South Fork	Red Bird River	**Sugar Creek**[1]	Clay, Leslie	Stable	2008
		Big Double Creek	Clay	Stable	2014
		Little Double Creek	Clay	Stable	2008
		Big Creek	Clay	Extirpated	1890
		Jacks Creek	Clay	Vulnerable	2009
		Hector Branch	Clay	Extirpated	2015
		Long Fork (of Hector Br.)[1]	Clay	Stable	2014
	Goose Creek	Horse Creek	Clay	Vulnerable	2013
		Laurel Creek	Clay	Extirpated	1970
	Bullskin Creek	Bullskin Creek	Clay, Leslie	Vulnerable	2014
	Buffalo Creek	Laurel Fork	Owsley	Stable	2014
		Cortland Fork[1]	Owsley	Vulnerable	2014
		Lucky Fork	Owsley	Stable	2014
		Left Fork	Owsley	Stable	2014
		Right Fork	Owsley	Vulnerable	2009
		Buffalo Creek	Owsley	Vulnerable	1969
	Sexton Creek	Bray Creek	Clay	Extirpated	1997
		Robinsons Creek	Clay	Extirpated	1997
		Sexton Creek	Owsley	Extirpated	1978
	Lower Island Creek	Lower Island Creek	Owsley	Extirpated	1997
	Cow Creek	Right Fork Cow Creek	Owsley	Extirpated	1997
	Buck Creek	Buck Creek	Owsley	Extirpated	1978
	Lower Buffalo Creek	Lower Buffalo Creek	Lee, Owsley	Vulnerable	2007
Silver Creek			Lee	Vulnerable	2008
Sturgeon Creek		**Travis Creek**[1]	Jackson	Vulnerable	2008
		Brushy Creek	Jackson, Owsley	Extirpated	1996
		Little Sturgeon Creek	Owsley	Extirpated	1996
		Wild Dog Creek	Jackson, Owsley	Stable	2007
		Granny Dismal Creek[1]	Lee, Owsley	Vulnerable	2013
		Cooperas Cave Branch	Lee	Extirpated	1996
		Sturgeon Creek	Lee	Extirpated	1998
Red River	Swift Camp Creek	Rockbridge Fork	Wolfe	Vulnerable	2013

[1]Non-historical occurrence discovered or established since 2006.

[2]Current Status: Stable, = (1) there is little evidence of significant habitat loss or degradation, (2) darter abundance has remained relatively constant or increased during recent surveys, or (3) evidence of relatively recent recruitment has been documented since 2006; Vulnerable = (1) there is ample evidence of significant habitat loss or degradation since the species' original capture, (2) there is an obvious decreasing trend in abundance since the historical collection, or (3) no evidence of relatively recent recruitment (since 2006) has been documented; or Extirpated = (1) all known suitable habitat has been destroyed or severely degraded, (2) no live individuals have been observed since 2006, or (3) live individuals have been observed since 2006, but habitat conditions do not appear to be suitable for reproduction to occur (e.g., elevated conductivity, siltation) and there is supporting evidence that the observed individuals are transients (fishes originating from another stream that occupy a particular habitat for only a short time).

TABLE 2—SUMMARY OF 303(D) LISTED STREAM SEGMENTS WITHIN THE HISTORICAL RANGE OF THE KENTUCKY ARROW DARTER (KDOW 2013A).

Stream	County	Impacted Stream Segment(s) - stream km (stream mi)	Pollutant Source	Pollutant
Buckhorn Creek	Breathitt	0-10.0 (0-6.8)	Abandoned Mine Lands, Unknown Sources	Fecal Coliform (FC), Sediment/Siltation, Total Dissolved Solids (TDS)
Cope Fork (of Frozen Creek)	Breathitt	0-3.0 (0-1.9)	Channelization, Riparian Habitat Loss, Logging, Agriculture, Stream Bank Modification, Surface Coal Mining	Sediment/Siltation, TDS
Cutshin Creek	Leslie	15.6-17.2 (9.7-10.7)	Riparian Habitat Loss, Stream Bank Modification, Surface Coal Mining	Sediment/Siltation
Frozen Creek*	Breathitt	0-22.4 (0-13.9)	Riparian Habitat Loss, Post-Development Erosion and Sedimentation	Sediment/Siltation
Goose Creek	Clay	0-13.4 (0-8.3)	Septic Systems	FC
Hector Branch	Clay	0-8.8 (0-5.5)	Unknown	Unknown
Holly Creek*	Wolfe	0-9.8 (0-6.2)	Agriculture, Riparian Habitat Loss, Stream Bank Modification, Surface Coal Mining	Sediment/Siltation, Unknown
Horse Creek*	Clay	0-13.4 (0-8.3)	Riparian Habitat Loss, Managed Pasture Grazing, Surface Coal Mining	Sediment/Siltation
Laurel Creek	Clay	6.1-7.7 (3.8-4.8)	Managed Pasture Grazing, Crop Production	Nutrients/Eutrophication
Left Fork Island Creek	Owsley	0-8.0 (0-5.0)	Crop Production	Sediment/Siltation
Long Fork	Breathitt	0-7.4 (0-4.6)	Surface Coal Mining	Sediment/Siltation, TDS
Lost Creek	Breathitt	0-14.3 (0-8.9)	Coal Mining, Riparian Habitat Loss, Logging, Stream Bank Modification	Fecal Coliform, Sedimentation, Total Dissolved Solids, Turbidity

Lotts Creek	Perry	0.6-1.6, 1.9-9.6 (0.4-1.0, 1.2-6.0)	Riparian Habitat Loss, Land Development, Surface Coal Mining, Logging, Stream Bank Modification	Sediment/Siltation, TDS, Turbidity
Quicksand Creek	Breathitt	0-27.4, 34.9-49.6 (0-17.0, 21.7-30.8)	Surface Coal Mining, Riparian Habitat Loss, Logging, Stream Bank Modification	FC, Turbidity, Sediment/Siltation, TDS
Sexton Creek	Clay, Owsley	0-27.7 (0-17.2)	Crop Production, Highway/Road/Bridge Runoff	Sediment/Siltation, TDS
South Fork Quicksand Creek	Breathitt	0-27.2 (0-16.9)	Riparian Habitat Loss, Petroleum/Natural Gas Production Activities, Surface Coal Mining	Sediment/Siltation, TDS
Spring Fork (Quicksand Creek) *	Breathitt	5.0-11.1 (3.1-6.9)	Abandoned Mine Lands (Inactive), Riparian Habitat Loss, Logging, Stream Bank Modification	Sediment/Siltation, TDS, Turbidity
Squabble Creek*	Perry	0-7.6 (0-4.7)	Land Development, Surface Coal Mining	Sediment/Siltation, TDS
Sturgeon Creek	Lee	12.9-19.6 (8.0-12.2)	Riparian Habitat Loss, Crop Production, Surface Coal Mining	Sediment/Siltation
Swift Camp Creek	Wolfe	0-22.4 (0-13.9)	Unknown	Unknown
Troublesome Creek	Breathitt	0-72.6 (0-45.1)	Surface Coal Mining, Municipal Point Source Discharges, Petroleum/Natural Gas Activities	Sediment/Siltation, Specific Conductance, TDS, Turbidity

*Stream segment still occupied by Kentucky arrow darters.