U.S. FISH AND WILDLIFE SERVICE
SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

SCIENTIFIC NAME: *Etheostoma sagitta spilotum* Gilbert

COMMON NAME: Kentucky arrow darter

LEAD REGION: 4

INFORMATION CURRENT AS OF: March 26, 2010

STATUS/ACTION:
____ Species assessment - determined we do not have sufficient information on file to support a proposal to list the species and, therefore, it was not elevated to Candidate status
_X_ New candidate
____ Continuing candidate
___ Non-petitioned
___ Petitioned - Date petition received:
_ 90-day positive - FR date:
_ 12-month warranted but precluded - FR date:
_ Did the petition request a reclassification of a listed species?
FOR PETITIONED CANDIDATE SPECIES:
a. Is listing warranted (if yes, see summary of threats below)? N/A
b. To date, has publication of a proposal to list been precluded by other higher priority listing actions? N/A
c. If the answer to a. and b. is "yes", provide an explanation of why the action is precluded.
___ Listing priority change
Former LP: ___
New LP: ___
Date the species first became a Candidate (as currently defined):
___ Candidate removal: Former LP: ___
___ A - Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.
____U – Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.
___ F - Range is no longer a U.S. territory.
___ I - Insufficient information exists on biological vulnerability and threats to support listing.
___ M - Taxon mistakenly included in past notice of review.
___ N - Taxon may not meet the Act's definition of "species."
___ X - Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Fish, Percidae

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Kentucky

CURRENT STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Kentucky

LAND OWNERSHIP: Extant populations of the Kentucky arrow darter occur in watersheds that are privately owned and publicly owned (U.S. Forest Service, Daniel Boone National Forest [DBNF] and Robinson Forest, University of Kentucky [UK]). The DBNF's ownership is typically fragmented but is most concentrated within the South Fork Kentucky River basin in Clay, Leslie, and Owsley Counties. Robinson Forest is located in Breathitt and Knott Counties.

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BIOLOGICAL INFORMATION

Species Description

The Kentucky arrow darter, *Etheostoma sagitta spilotum*, is a rather large darter reaching 116 millimeters (mm) (4.6 inches [in]) total length (TL) (Kuehne and Barbour 1983, p. 71; Etnier and Starnes 1993, p. 523). It has a slender body, elongated snout, large mouth, and virtually scaleless head. The subspecies' ground color is straw yellow to pale greenish, and the back is crossed by 5 to 7 weak dorsal saddles, some of which may fuse with the 8 to 11 vertical lateral blotches (Kuehne and Barbour 1983, p. 71; Etnier and Starnes 1993, p. 523). Anterior blotches are generally oval with pale centers. Posteriorly, blotches extend ventrally almost to the midline and may resemble the letters N, W, U, or V. A dark vertical bar occurs at the base of the caudal fin, sometimes separated by two distinct spots. The belly is pale (Kuehne and Barbour 1983, p. 71).

During the spawning season, breeding males exhibit vibrant coloration. Most of the body is blue-green in color, with scattered scarlet spots and scarlet to orange vertical bars laterally; the vertical bars can be connected ventrally by an orange belly stripe (Etnier and Starnes 1993, p. 523). The spinous dorsal fin exhibits a blue-green central band and a scarlet marginal band. The soft dorsal and caudal fins are speckled with scarlet blotches or bands, and the anal and pelvic fins are blue-green to black. Females remain pale straw yellow with grayish markings (Etnier and Starnes 1993, p. 523).

Taxonomy

The Kentucky arrow darter was described from the Kentucky River basin (Little Sturgeon Creek, Owsley County) as *Etheostoma nianguae spilotum* (Gilbert 1887, pp. 53-54). Bailey (1948, p. 84) regarded *E. spilotum* Gilbert as a subspecies of *E. sagitta* (Jordan and Swain), and this relationship was later supported by Kuehne and Bailey (1961, p. 1), who recognized two subspecies of *E. sagitta*: *E. s. sagitta* (arrow darter - endemic to the upper Cumberland River basin) and *E. s. spilotum* (Kentucky arrow darter - endemic to the upper Kentucky River basin). The two subspecies and *E. nianguae* (Niangua darter) Gilbert and Meek, a Missouri endemic,

comprise the subgenus *Litocara* (Bailey 1948, pp. 79-84; Page 1983, p. 59; Etnier and Starnes 1993, p. 524).

The *E. sagitta* subspecies are indistinguishable based on general appearance, including pigment pattern and breeding color; however, the subspecies are separable based on various scale counts. Thomas (2008, p. 6) examined specimens of both subspecies and determined that the Kentucky arrow darter had lateral scale counts of 62 or fewer in 88% of individuals examined (vs. 63 or more in 94% of Cumberland arrow darters), pored lateral scale counts of 50 or fewer in 79% of individuals examined (vs. 51 or more in 91% of Cumberland arrow darters), and caudal peduncle scale counts of 22 or fewer in 72% of individuals examined (vs. 23 or more in 83% of Cumberland arrow darters). These differences reflect a trend toward larger scale size and a more weakly developed lateral line in the Kentucky arrow darter.

Thomas (2008, p. 2) questioned the validity of subspecific designations proposed by Gilbert (Gilbert 1887, pp. 53-54) and supported by Kuehne and Bailey (1961, p. 1) for the two arrow darter subspecies because (1) they can be distinguished morphologically (as described above), (2) they exist in allopatry (separate ranges with no overlap), and (3) they lack intergrades. In addition to these factors, preliminary evidence based on morphological characteristics and genetic variation (mitochondrial DNA) has indicated evolutionary independence for *E. s. sagitta* and *E. s. spilotum* (with no recent genetic exchange between populations) (Thomas 2008, p. 6). This supports Thomas' assertion that prior subspecific designations are invalid. Based on this evidence, Thomas (pers. comm., 2010) is preparing a manuscript that will present the rationale for elevating the two subspecies to species rank.

Habitat/Life History

During the most recent range-wide surveys (Thomas 2008, p. 6), Kentucky arrow darters were found in pools or transitional areas between riffles and pools (runs and glides) in moderate-to high-gradient streams. Individuals were usually associated with bedrock, boulder, and cobble substrates and occasionally observed around woody debris. Stream widths ranged from 1.5 to 20 meters (m) (5 to 66 feet [ft]) and depths at which individuals were captured ranged from 10 to 45 centimeters (cm) (4 to 18 in). During 2007 and 2008, Thomas (2008, p. 6) observed Kentucky arrow darters in streams ranging in size from first to third order, with 60 percent occurring in second order streams. The majority (72 percent) of these streams were in watersheds draining an area of 20 square kilometers (km^2) (7.7 square miles [mi^2]) or less. Many of these habitats, especially those in first order reaches, can be intermittent in nature. Lotrich (1973, p. 394) observed riffle habitats in Clemons Fork (Breathitt County) that were completely dry by late summer. These habitats continued to support arrow darters, but fishes were crowded into isolated pools once drying occurred.

Male darters establish territories over riffles from March to May, where they are quite conspicuous in water 5 to 15 cm (2 to 6 in) deep (Kuehne and Barbour 1983, p. 71). Males fan out a depression in the substrate and defend these sites vigorously. Initial courtship behavior involves rapid dashes, fin-flaring, nudging, and quivering motions by the male followed by similar quivering responses of the female, who then precedes the male to the nest. The female partially buries herself in the substrate, is mounted by the male, and spawning occurs (Etnier and Starnes 1993, p. 523). It is assumed that the male continues to defend the nest until the eggs

have hatched. Bailey (1948) described collected females as "bulging with eggs" in April, probably the peak spawning period. Lowe (1979) studied the biology of *E. s. sagitta* and determined that the peak spawning period was during April when water temperatures reached 13°C (55°F).

Young arrow darters can reach 50 mm TL by the end of the first year (Lotrich 1973, p. 384-385; Lowe 1979), and one-year olds are generally sexually mature and participate in spawning with older age classes (Etnier and Starnes 1993, p. 523). Lotrich (1973, p. 384) indicated mean length at age 2 of about 65 mm (2.6 in) and was unable to differentiate between older age classes (age 3+). Lowe (1979) reported four age classes, but growth was variable after age 1.

Lotrich (1973, p. 381) reported that Kentucky arrow darters captured in 1967 and 1968 from Clemons Fork fed primarily on mayflies, specifically the families Heptageniidae (genus *Stenonema*) and Baetidae. Mayflies comprised 77 percent of identifiable food items (420 of 542 items) in 57 arrow darter stomachs. Large arrow darters (individuals over 70 mm [2.8 in] TL) appeared to specialize on small crayfish, as 7 of 8 stomachs contained crayfish ranging in size from 11 to 24 mm (0.4 to 0.9 in). Lotrich (1973, p. 381) considered this to be noteworthy since stomachs of small arrow darters (<70 mm [2.8 in]) and stomachs of other darter species did not contain crayfish. He suggested that larger arrow darters were utilizing a different energy source, thus removing themselves from direct competition for food with other fishes in first and second order streams. This would allow these larger individuals to exploit an abundant food source and survive in extreme headwater habitats. Other arrow darter food items reported by Lotrich (1973, p. 381) and Etnier and Starnes (1993, p. 523) included larval blackflies (family Simuliidae) and midges (Chironomidae), with lesser amounts of caddisfly larvae, stonefly nymphs, and beetle larvae. Etnier and Starnes (1993, p. 523) reported that juvenile arrow darters feed on microcrustaceans and dipteran larvae.

Common associates of the Kentucky arrow darter include creek chub (*Semotilus atromaculatus*), central stoneroller (*Campostoma anomalum*), white sucker (*Catastomus commersonii*), emerald darter (*Etheostoma baileyi*), rainbow darter (*E. caeruleum*), fantail darter (*E. flabellare*), and Johnny darter (*E. nigrum*) (Kuehne 1962, p. 609; Lotrich 1973, p. 380; Thomas 2008, p. 7). Within first-order or headwater reaches of these stream systems, the species is most commonly associated with creek chub, fantail darter, rainbow darter, and Johnny darter.

Historic Range/Distribution

The Kentucky arrow darter's historical distribution was limited to the upper Kentucky River system in eastern Kentucky (Figure 1) (Kuehne and Bailey 1961, pp. 3-4; Kuehne 1962, pp. 608-609; Lotrich 1973, p. 380; Branson and Batch 1983, pp. 1-15; Burr and Warren 1986, p. 316; Ray and Ceas 2003, pp. 1-15). Its distribution spanned portions of five subbasins: Red River (Rockbridge Fork of Swift Camp Creek), Sturgeon Creek, South Fork Kentucky River, Middle Fork Kentucky River, and North Fork Kentucky River (Thomas 2008, p. 3).

Current Range/Distribution

The Kentucky arrow darter continues to occupy portions of the upper Kentucky River basin in eastern Kentucky, including the five subbasins listed above; however, recent range-wide surveys by Thomas (2009, pp. 3-6) and U.S. Fish and Wildlife Service (USFWS) (2009, pp. 1-4)

revealed that the species has disappeared from portions of its range (Figure 1). The species was

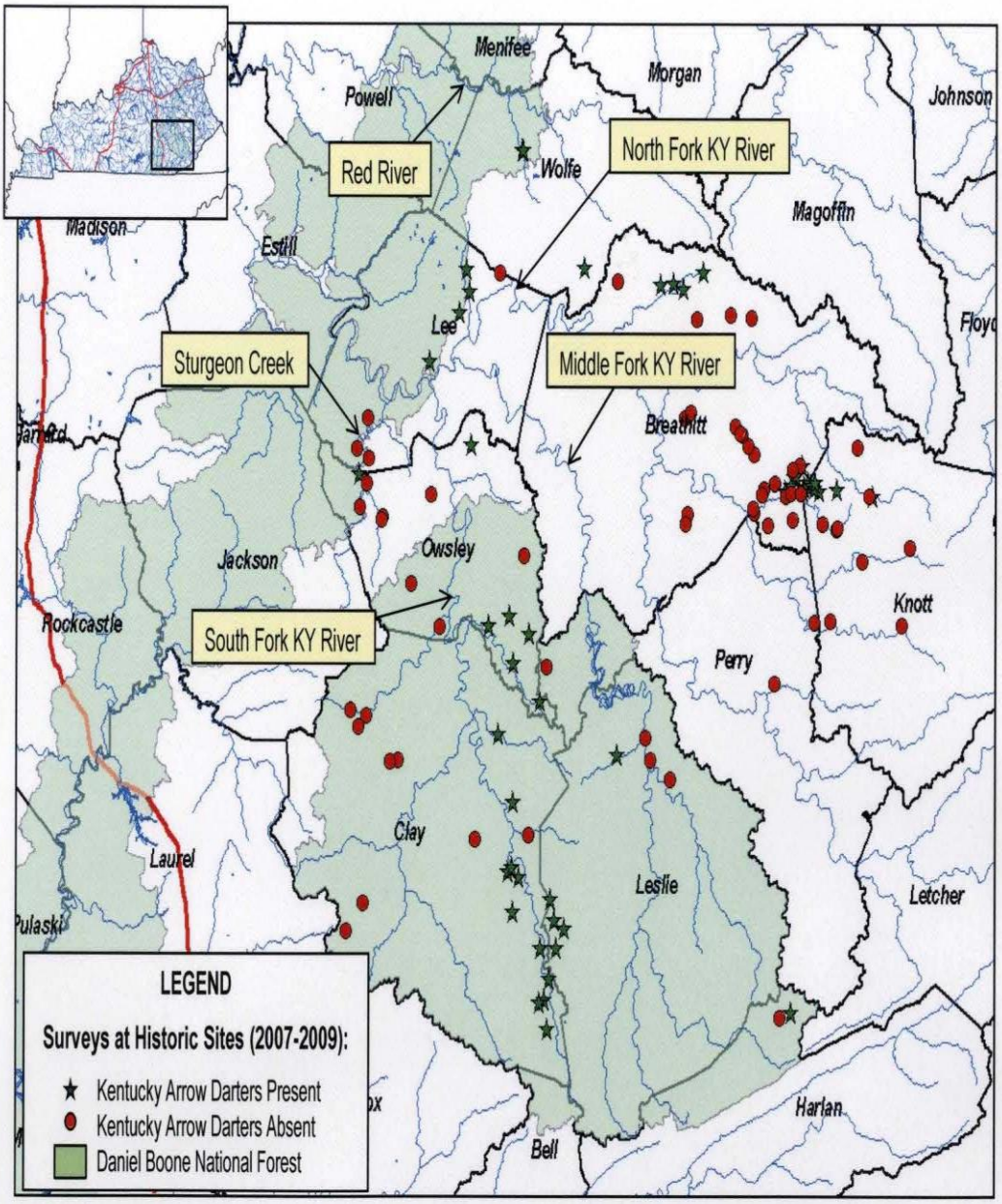

Figure 1. Current distribution of the Kentucky arrow darter, *E. sagitta spilotum*, in the upper Kentucky River drainage.

observed at only 33 of 68 historic streams (49 percent) and 45 of 100 historic sites (46 percent) during surveys completed from 2007 to 2009. A synopsis of survey results is provided below for each sub-basin. The current number of streams and sites known to support arrow darters in each basin is listed parenthetically after the basin name.

Red River (1/1). Greenberg and Steigerwald (1981, p. 37) discovered a previously unknown population of Kentucky arrow darters in Rockbridge Fork, a tributary of Swift Camp Creek, Red River basin in Wolfe County. Thomas (2008, p. 4) resurveyed this location in May 2007, collecting 10 individuals (representing at least 2 age classes) from a single sampling reach. Based on survey results and his observations of habitat conditions at the site, Thomas (2008, p. 4) concluded that the population was stable. The stream is located within the DBNF, Cumberland District (Red River Gorge area).

Sturgeon Creek (2/2). Gilbert (1887, pp. 53-54) described the Kentucky arrow darter based on specimens collected from Little Sturgeon Creek near Traveller's Rest, Owsley County. Based on those results and other collections since that time, the Kentucky arrow darter was known from eight historic sites and five streams within the Sturgeon Creek basin. Thomas (2008, pp. 3-4) surveyed seven of eight historic sites and three new sites (Duck Fork, Rowlette Branch, and Travis Creek) within the basin. Arrow darters were observed at only two sites in two streams - Wild Dog Creek (1 individual) and Travis Creek (2 individuals). Habitats within Cooperas Cave Branch appeared suitable for arrow darters, but none were observed. Thomas (2008, p. 4) reported that much of the basin had been cleared for agricultural and residential development, with denuded riparian zones, siltation, and eutrophication identified as potential stressors. Travis Creek represented a new stream and collection site for the subspecies.

South Fork Kentucky River (17/19). Some of the best remaining populations of Kentucky arrow darters are found within this basin. The majority of streams within the basin are located on the Daniel Boone National Forest (Redbird District) in Clay, Leslie, and Owsley Counties. These streams include the Buffalo Creek watershed in Owsley County, and several small, first- and second-order tributaries of the Red Bird River in Clay and Leslie Counties (Thomas 2008, p. 4). These streams are characterized by relatively intact riparian zones with little or no human development, high gradients with abundant riffles, cool temperatures, low conductivity (near baseline conditions, <100 µS), and stable channels with clean cobble/boulder substrates. Thomas (2008, p. 4) observed some oil and gas development and logging activity in these watersheds, but the activities did not appear to be adversely affecting these streams.

In contrast to streams within the DBNF (Redbird District), the remaining watersheds in the South Fork Kentucky River basin (Lower Buffalo Creek, Buck Creek, Cow Creek, Island Creek, Sexton Creek, and Goose Creek) have more residential and agricultural development, especially within their stream valleys (Thomas 2008, p. 4). Riparian zones tend to be narrower with less canopy cover, channel substrates are composed of smaller particles, siltation is more prevalent, and stream conductivity is higher (>160 µS). Four streams within these basins, Horse Creek (Clay County), Laurel Creek (Clay County), Lower Buffalo Creek (Lee and Owsley Counties), and Sexton Creek (Clay and Owsley

Counties), have been placed on Kentucky's 303d list of impaired waters (KDOW 2008, pp. 65-101) because they were not supportive of the Aquatic Life use designation. During surveys in 2008, Thomas (2008, p. 4) observed Kentucky arrow darters in only one of these streams, Lower Buffalo Creek.

Thomas (2008, p. 4) and USFWS (2009, pp. 1-4) surveyed 31 of 36 historic sites in the South Fork Kentucky River basin and observed Kentucky arrow darters at 19 of those sites. Only one stream, Lower Buffalo Creek, was located outside of the DBNF.

Middle Fork Kentucky River (2/2). This basin has fewer Kentucky arrow darter records than the North and South forks of the Kentucky River. Much of the basin has been severely impacted by surface and underground coal mining, and an approximate 31-mile (50 km) segment of the Middle Fork has been influenced by the construction and inundation of Buckhorn Lake. Arrow darters were observed at two streams, Hell for Certain Creek (Leslie County) and Big Laurel Creek (Harlan County). Hell for Certain Creek lies at the western edge of the basin where the majority of its watershed is situated within the DBNF (Redbird District). Big Laurel Creek is a tributary of Greasy Creek at the southeastern edge of the basin (Thomas 2008, pp. 4-5; USFWS 2009, pp. 1-4). Despite being surrounded by what appeared to be an intact forest, habitat quality in Big Laurel Creek was poor with heavy sedimentation (sand) and bank erosion (USFWS 2009, pp. 1-4). The source of the sediment was unknown, but upstream logging and associated road building were suspected as potential sources. Thomas (2008, p. 4) and USFWS (2009, pp. 1-4) surveyed 6 of 11 historic sites in the Middle Fork Kentucky River basin and observed Kentucky arrow darters at only 2 of those sites.

North Fork Kentucky River (11/21). The best habitat within this basin is located on UK's Robinson Forest in Breathitt and Knott Counties (Troublesome Creek basin). Two streams on Robinson Forest, Clemons Fork and Coles Fork, have stable populations of Kentucky arrow darters. The basins are intact and densely forested, with only minor interruption by logging roads. Both streams are high-gradient, cold, and dominated by cobble, boulder, and bedrock substrates. From 2007 to 2009, Thomas (2008, p. 5) and USFWS (2009, pp. 1-4) collected a total of 27 and 10 arrow darters, respectively, from Clemons Fork and Coles Fork. Thomas (2008, p. 5) and USFWS (2009, pp. 1-4) visited 12 additional Troublesome Creek basin sites located near Robinson Forest, but no arrow darters were collected. These sites were located on Bear Branch, Boughcamp Branch (of Buckhorn Creek), Buckhorn Creek, Balls Fork, Laurel Fork, Leatherwood Creek, Lewis Fork, Long Fork, Lost Creek, and Troublesome Creek. Kentucky arrow darters were first recorded from these basins during the 1960s, but these streams have been severely impacted by coal mining activities, and portions of at least three of these streams, Buckhorn Creek (mile 0-6.8), Long Fork (mile 0-8.95), and Troublesome Creek (mile 0-45.1), have been placed on Kentucky's 303d list of impaired waters (KDOW 2008, pp. 65-101).

Outside of the Troublesome Creek basin, Kentucky arrow darters were observed at two of eight sites in the Quicksand Creek basin (Breathitt and Knott Counties), four of six sites in the Frozen Creek basin, three of five sites in smaller tributaries of the lower North

Fork Kentucky River basin, and one direct tributary (Silver Creek) of the Kentucky River just downstream of its confluence with the South Fork Kentucky River. Only one of these streams, Frozen Creek (Breathitt County), appeared to have good, stable habitat conditions (Thomas 2008, p. 5). The remaining streams with arrow darters were moderately to severely impacted by sedimentation, bank erosion, and riparian disturbance. Portions of two streams, Cope Fork and Hell Creek, have been identified as impaired by the Kentucky Division of Water and are listed on Kentucky's 303d list of impaired waters (KDOW 2008, pp. 65-101).

Population Estimate/Status

Population estimates for the Kentucky arrow darter are not available; however, recent survey data (Thomas 2008, pp. 3-6; USFWS 2009, pp. 1-4) revealed that sites with arrow darters had an average of only three individuals per sampling reach and a median of two individuals per reach (range of 1 to 10 individuals). The low abundance values (compared to other darters) are not surprising since both arrow darter subspecies generally are not observed in large numbers, even in those streams where disturbance has been minimal (M. Thomas, pers. comm., 2010). The largest populations of Kentucky arrow darters were located in the following streams/basins:

- Several tributaries of South Fork Kentucky River, Redbird District of DBNF (Clay and Leslie Counties);
- Hell Creek, Walker Creek, and Frozen Creek - direct tributaries of North Fork Kentucky River – (Breathitt and Lee Counties);
- Clemons Fork and Coles Fork of Buckhorn Creek, North Fork Kentucky River basin (Breathitt County).

THREATS:

A. The present or threatened destruction, modification, or curtailment of its habitat or range.

The overall decline of the Kentucky arrow darter can be attributed to a variety of human-related activities in the upper Kentucky River basin. Activities such as coal mining, silviculture, agriculture, gas/oil well exploration, human development, and inadequate sewage treatment have all contributed to the degradation of streams within the range of the species (Branson and Batch 1972, pp. 513-516; Branson and Batch 1974, pp. 82-83; KDOW 2008, pp. 65-101; Thomas 2008, pp. 6-7). Adverse impacts result primarily from inputs of dissolved solids and elevation of instream conductivity, sedimentation, removal of riparian vegetation, bank erosion and channel instability, inputs of untreated sewage, and agricultural runoff.

Coal Mining

Coal mining activities represent the most imminent and substantial source of threats to the subspecies because these activities have the potential to significantly, and often permanently, alter instream water quality and cause physical habitat disturbance. Numerous studies have documented the fact that streams receiving discharge from mined areas exhibit characteristics not observed in unmined watersheds: (1) altered water quality conditions (Curtis 1973, pp. 153-155; Dyer and Curtis 1977, pp. 10-13; Dyer 1982, pp. 1-16; Hren *et al.* 1984, pp. 5-34; US EPA 2003, pp. 77-84; Pond *et al*. 2008, pp. 721-723); (2) increased sediment loads (Branson and Batch

1972, p. 513; Parker and Carey 1980, pp. 33-49 ; Osterkamp *et al.* 1984, pp. 59, 63; Pond 2004, pp. 19-20); (3) increased hydrologic response time to storm events (Bryan and Hewlett 1981, p. 298); (4) altered flow duration curves (USGS 2001, pp. 16-17); and (5) altered or changed channel morphology. As of March 2010, over 465 mining permits were active in the upper Kentucky River basin (LaSage, pers. comm., 2010). Some of these permits were active and coal removal was still occurring (about 360 permits), while others were inactive with reclamation activities underway (about 106 permits).

Impacts to instream water quality (chemistry) occur through inputs of dissolved metals and other solids that elevate stream conductivity, increase sulfate levels, and/or increase stream pH, (Curtis 1973, pp. 153-155; Pond 2004, pp. 6-7, 38-41; Hartman *et al.* 2005, p. 95; Mattingly *et al.* 2005, p. 59; Palmer *et al*. 2010, pp. 148-149). As rock strata and overburden (excess material) are exposed to the atmosphere, precipitation leaches metals and other solids (*e.g.*, Calcium, Magnesium, Sulfates, Iron, Manganese) from these materials and carries them in solution to receiving streams (Pond 2004, p 7). If valley fills are used as part of the mining activity, precipitation and groundwater percolate through the fill and dissolve minerals until they discharge at the toe of the fill as surface water (Pond *et al.* 2008, p. 718). Both of these scenarios result in elevated conductivity, sulfates, and hardness in the receiving stream. Increased levels of these metals and other dissolved solids have been shown to exclude fish species from streams in eastern Kentucky, including the federally threatened blackside dace (*Chrosomus cumberlandensis*) in the upper Cumberland River basin (Mattingly *et al.* 2005, pp. 59-62).

Based on earlier research by Branson and Batch (1974, pp. 81-83) and Dyer and Curtis (1977, pp. 1-13) and recent fish survey results by Thomas (2008, pp. 3-6) and USFWS (2009, pp. 1-4), it is clear that degraded water quality conditions in the upper Kentucky River basin have adversely affected Kentucky arrow darter populations. From late 1967 to 1975, Branson and Batch (1972, pp. 507-518; 1974, pp. 81-83), and Dyer and Curtis (1977, pp. 1-13) studied the effects of strip mining activities on water quality and stream fishes in the Quicksand Creek (Leatherwood Creek) and Buckhorn Creek (Bear Branch) basins, Breathitt County. Six first-order watersheds, three in the Leatherwood Creek basin and three in the Bear Branch basin, were investigated during the study, beginning in late summer 1967 prior to the onset of mining and continuing until 1975 (Figure 2). One of the six small watersheds, Jenny Fork, was not mined and served as a control watershed. Water quality data from mined watersheds showed increases in conductivity (Table 1), sulfate, magnesium, bicarbonate, and silt deposition (Dyer and Curtis 1977, pp. 3-7, 13). Water quality data from the reference site, Jenny Branch, showed little variation and remained at baseline levels.

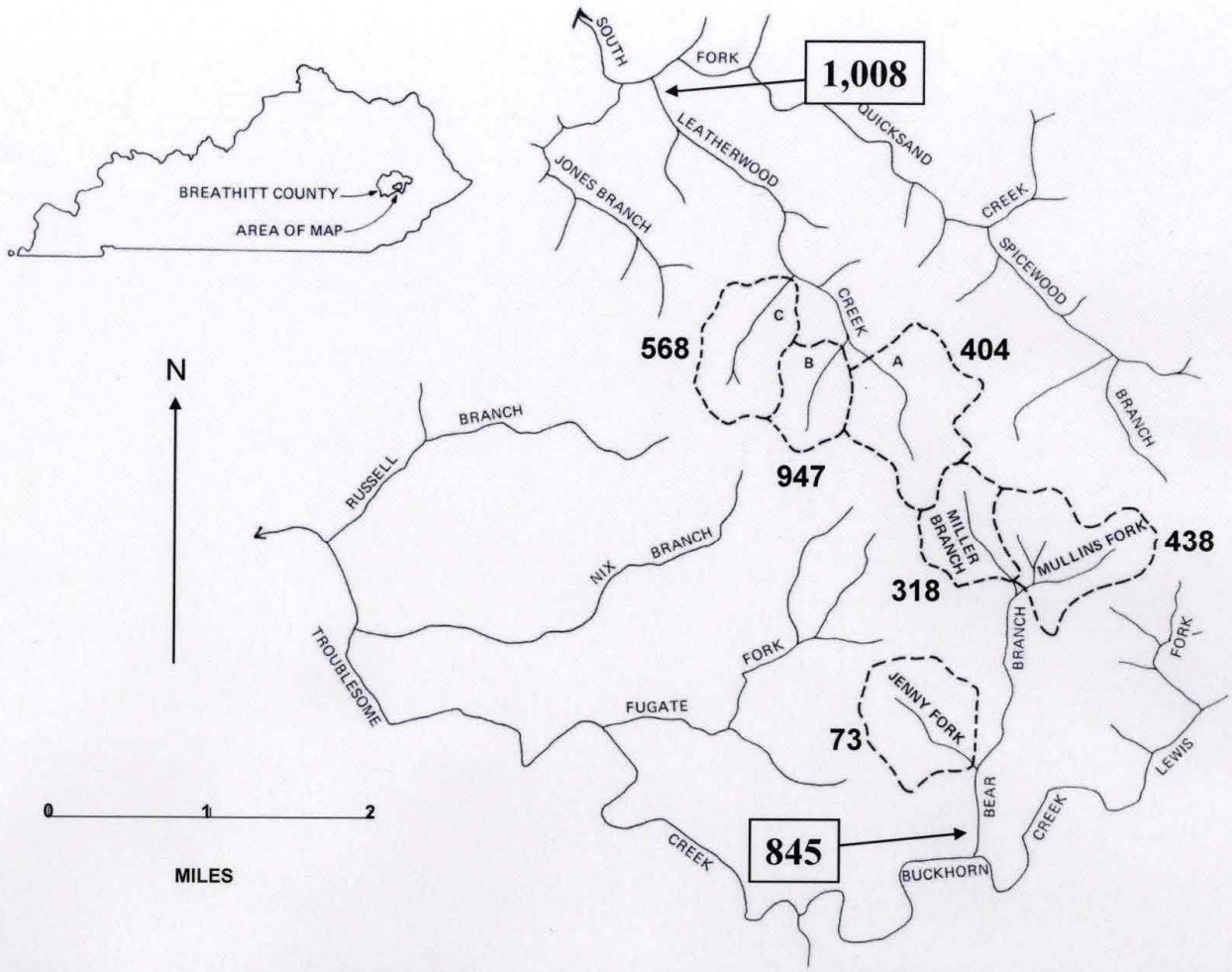

Figure 2. Map of Leatherwood Creek and Bear Branch watersheds, Breathitt County, Kentucky, showing study basins investigated by Dyer and Curtis (1977) from 1967-1975. Maximum conductivity values (µS) are listed next to each study basin; 2008 conductivity values (in boxes) are provided for Bear Branch and Leatherwood Creek.

Table 1. Summary of annual results for conductivity (µS) for individual watersheds, Bear Branch and Leatherwood Creek, Breathitt County, 1968-1975 (Dyer and Curtis 1977).

	Bear Branch			Leatherwood Creek		
Year	**Jenny (ref)**	**Miller**	**Mullins**	**A**	**B**	**C**
Mining began August 1967 (Leatherwood C) or May 1968						
1968	80	55	58	54	76	92
1969	80	65	79	100	177	138
1970	83	145	131	224	250	203
1971	62	245	102	298	294	385
1972	85	235	156	297	495	424
1973	78	317	319	381	664	525
1974	72	318	424	404	947	568
1975	72	298	438	388	759	550
2008	845			1,008		

Fish community data from the Bear Branch and Leatherwood Creek watersheds showed that fishes were pushed downstream or eliminated from the fauna altogether in mined watersheds (Branson and Batch 1972, pp. 514-515; Branson and Batch 1974, pp. 82-83). The only exception to this was the creek chub, which appeared to be tolerant of mining impacts. Several species, silver shiner (*Notropis photogenis*), Kentucky arrow darter, Johnny darter, variegate darter (*Etheostoma variatum*), greenside darter (*E. blenniodes*), and emerald darter (*E. baileyi*), were eliminated from Leatherwood Creek. Two species, northern hogsucker (*Hypentelium nigricans*) and blackside darter (*Percina maculata*), were eliminated from both streams. During the last fish sampling event in September 1972, Kentucky arrow darters were observed at the mouth of Bear Branch (Branson and Batch 1974, p. 82), but instream conductivity levels had not peaked. Branson and Batch (1972, p. 514) also did not observe young darters and minnows during later visits (early 1970s), suggesting that reproduction had been curtailed by the mining activity. Thomas (2008, p. 5) and USFWS (2009, pp. 1-4) resurveyed these streams in 2008 and found that conductivity levels had increased since the 1970s, reaching 845 µS in Bear Branch and 1008 µS in Leatherwood Creek (Figure 2). Kentucky arrow darters were not observed at these sites.

Recent range-wide surveys by Thomas (2008, pp. 3-6) and USFWS (2009, pp. 1-4) demonstrated that Kentucky arrow darters are excluded from watersheds when conductivity levels exceed about 250 µS. Mattingly *et al.* (2005, pp. 59-62) reported virtually identical results for the federally threatened blackside dace in the upper Cumberland River basin. Historic arrow darter sites that lacked darters had higher conductivity values (average = 680 µS) than historic sites that continued to support arrow darters (average = 105 µS). Arrow darters were observed at only one historic site (USFWS 2009, pp. 1-4), Walker Creek (Owsley County), with a conductivity value greater than 250 µS (400 µS).

There is a pattern of increasing conductivity and loss of arrow darter populations which is evident in the fish and water quality data from the Buckhorn Creek basin (1962 to present) in

Breathitt and Knott Counties. Kentucky arrow darters and other fish species were first reported from the basin in 1962 by Kuehne (1962, p. 608-609), who surveyed sites on the Buckhorn Creek mainstem and numerous tributaries - Bear Branch, Clemons Fork, Coles Fork, Laurel Fork, Lewis Fork, and Long Fork (Figure 3). Kuehne (1962, p. 608-609) documented Kentucky arrow darters at 16 of 22 sites within the basin. Since that time, the majority of these watersheds have been mined extensively and conductivities have increased, especially in areas to the south and east of the Buckhorn Creek mainstem. The only exceptions are two unmined watersheds, Clemons Fork and Coles Fork, both of which are located on UK's Robinson Forest. Thomas (2008, p. 5) and USFWS (2009, pp. 1-4) resurveyed sites on all historic streams (and most historic sites) in the Buckhorn Creek basin from 2007 to 2009, observing Kentucky arrow darters in only Clemons Fork and Coles Fork (Table 2). Conductivity levels of Clemons Fork and Coles Fork remained at or near background levels, (50 to 87 µS), but conductivity levels at other streams were elevated, with some of these being exceptionally high (Table 2). Portions of two of these streams, Buckhorn Creek (mile 0-6.8) and Long Fork (mile 0-8.95) have been placed on Kentucky's 303d list of impaired waters (KDOW 2008, pp. 65-101).

Table 2. Summary of conductivity values and arrow darter observations for the Buckhorn Creek basin, 2007-2009 (KAD = Kentucky arrow darter).

Stream	Conductivity (µS)	# KAD Observed	Last KAD Observation
Clemons Fork	71-87	27	2009
Coles Fork	50	10	2009
Bear Branch	845	0	1972
Buckhorn Creek	2,100	0	1995
Baughcamp Branch	1,995	0	1995
Laurel Fork	2,700	0	1976
Lewis Fork	592	0	1959
Long Fork	2,615	0	1959

Mine drainage also causes physical and chemical impacts to streams as a result of the precipitation of entrained metals and sulfate, which become unstable in solution (USEPA 2003, pp. 77-84; Pond 2004, p. 7). Hydroxide precipitants are formed from iron and aluminum, creating orange or white sludge ("yellow boy") that forms a thick coating on stream substrates (Pond 2004, p. 7). Most affected streams also have elevated levels of calcium in solution, and if pH is elevated, calcium sulfate ($CaSO_4$) or calcium carbonate ($CaCO_3$) will precipitate (USEPA 2003, pp. 77-84; Pond 2004, p. 7). These precipitants accumulate on substrates, encrusting and cementing stream sediments, making them unsuitable for colonization by invertebrates and rendering them unsuitable as foraging or spawning habitat for the Kentucky arrow darter. Acid mine drainage (AMD) tends to be more of a legacy problem, as enforcement, newer technology, and mining methods have mostly eliminated it in the coal fields of Kentucky and Tennessee (Pond 2004, p. 6). In the few streams where the problem persists, AMD can be highly detrimental to fish and aquatic insect populations (Henry *et al.* 1999, pp. 919-920; Pond 2004,

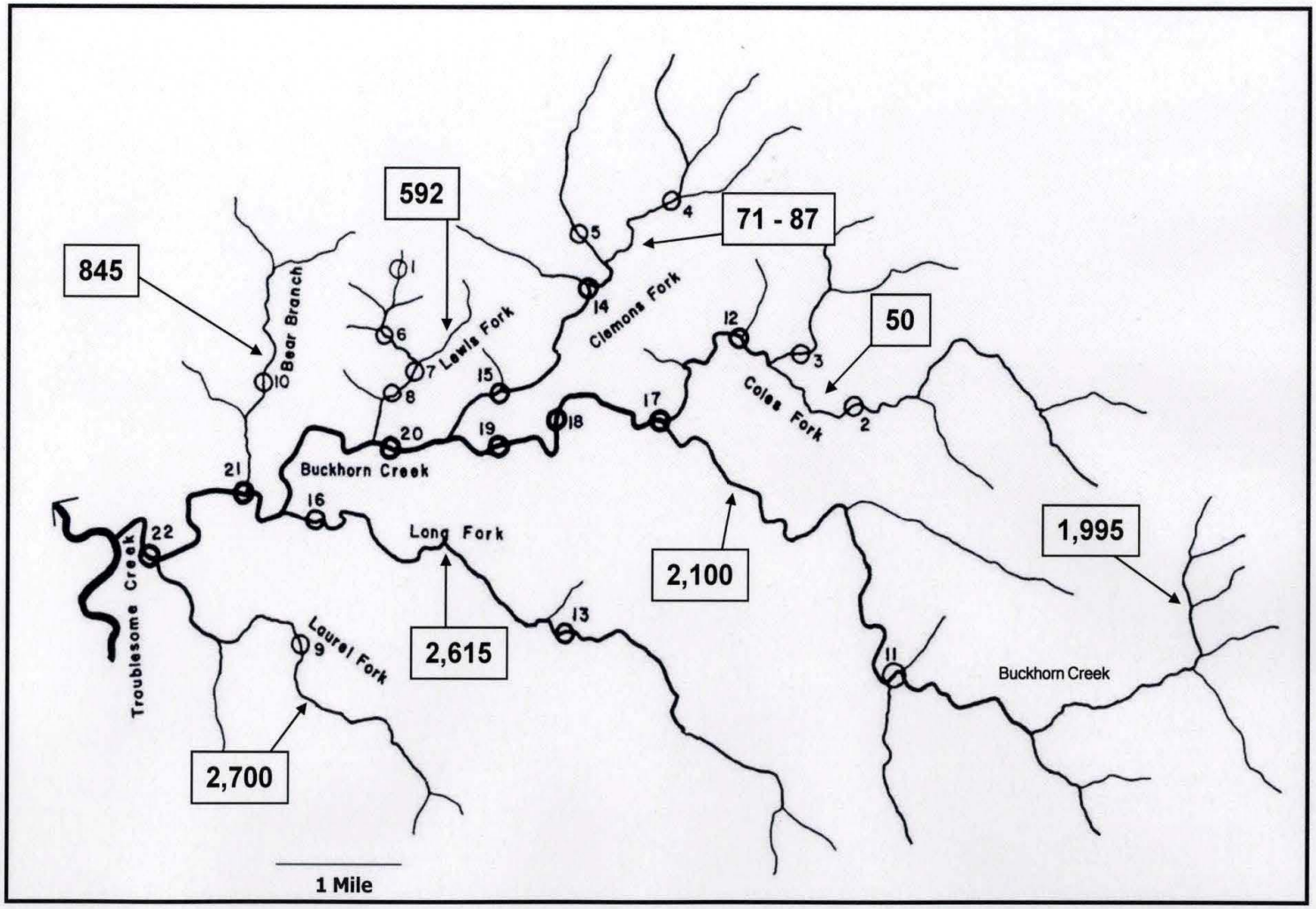

Figure 3. Map of Buckhorn Creek watershed, Breathitt and Knott counties, Kentucky, showing fish survey sites (open circles) of Kuehne (1962) and recent (2007-2009) conductivity values (boxes) taken by Thomas (2008) and USFWS (2009). Kuehne (1962) observed Kentucky arrow darters at 16 of 21 survey sites, including all named tributaries. The subspecies is now restricted to Clemons Fork and Coles Fork.

pp. 7-8). Streams affected by AMD tend to have low pH, high conductivity, and high metal and sulfate concentrations (Herlihy *et al.* 1990, pp. 101-105; Pond 2004, pp. 7-8).

Silviculture

Logging activities can adversely affect Kentucky arrow darters through sedimentation of instream habitats, removal of streamside (riparian) vegetation, and direct channel disturbance. Sedimentation occurs as soils are disturbed, the overlying leaf or litter layer is removed, and sediment is carried overland from logging roads, stream crossings, skid trails, and riparian zones during storm events. Excess sediment can bury instream habitats used by the species for foraging, reproduction, and sheltering, and it can disrupt the dynamic equilibrium of channel width, depth, flow velocity, discharge, channel slope, roughness, sediment load, and sediment size that maintains stable channel morphology. This can lead to channel instability and further degradation of instream habitats. Reductions in riparian vegetation can adversely affect the species through increased solar radiation, elevated stream temperatures, loss of allochthonous (organic material originating from outside the channel) food material, and bank instability / erosion. Direct channel disturbance occurs primarily at stream crossings during culvert, log, or rock placement. Severe impacts can occur when loggers use stream channels illegally as skid trails (M. Floyd, pers. obs. 2009).

Sediment (Nonpoint-Source)

Sediment (siltation) has been listed repeatedly by the Kentucky Natural Resources and Environmental Protection Cabinet (Division of Water) as the most common stressor of aquatic communities in the upper Kentucky River basin (KDOW 2008, pp. 65-101). Sedimentation comes from a variety of sources, but KDOW identified the primary sources of sediment as loss of riparian habitat, surface coal mining, and legacy coal extraction (KDOW 2008, pp. 65-101). All of these activities can result in canopy removal, channel disturbance, and increased siltation, thereby degrading habitats used by fishes for both feeding and reproduction. The reduction or loss of riparian vegetation results in the elevation of stream temperatures, destabilization of stream banks and siltation, and removal of submerged root systems that provide habitat for fish and macroinvertebrates (Mattingly *et al.* 2005, p. 5). Numerous streams within the Kentucky arrow darter's current range have been identified as impaired (primarily due to siltation from mining, logging, agricultural activities, and land development) and have been included on Kentucky's 303(d) list of impaired waters (KDOW 2008, pp. 65-101) (Table 3).

Sediment has been shown to damage and suffocate fish gills and eggs, larval fishes, bottom dwelling algae, and other organisms; reduce aquatic insect diversity and abundance; and, ultimately, negatively impact fish growth, survival, and reproduction (Waters 1995, pp. 5-7; Meyer and Sutherland (2005, pp. 2-3). Wood and Armitage (1997, pp. 211-212) identified at least five impacts of sedimentation on fish, including (1) reduction of growth rate, disease tolerance, and gill function; (2) reduction of spawning habitat and egg, larvae, and juvenile development; (3) modification of migration patterns; (4) reduction of food availability through the blockage of primary production; and (5) reduction of foraging efficiency. Kentucky arrow darter habitats are also affected when riparian corridors are disturbed or significantly altered during mine preparation, logging activities, or road construction.

Table 3. Summary of 303d listed streams in the upper Kentucky River basin (KDOW 2008, pp. 65-101) historically supporting the Kentucky arrow darter.

Stream	County	Impacted Stream Reach (mi)	Pollutant Source	Pollutant
Cope Fork (of Frozen Creek)	Breathitt	0-1.9	Channelization, loss of riparian habitat (RH), silviculture (silv), streambank modification (mod)	Sediment/siltation, total dissolved solids (TDS)
Buckhorn Creek	Breathitt	0-6.8	Coal mining, loss of RH, silv	Sediment/siltation, TDS
Cutshin Creek	Leslie	9.7-10.7	Loss of RH, streambank mod, surface coal mining	Sediment/siltation
Hell Creek	Lee	0-3.5	Abandoned mine lands impacts, surface mining, petroleum/gas production, silv	TDS, sediment/siltation
Holly Creek	Wolfe	0-6.2	Agriculture, loss of RH, streambank mod	
Horse Creek	Clay	0-8.3	Loss of RH, managed pasture grazing, surface mining	Sediment/siltation
Hunting Creek	Breathitt	0-2.6	Abandoned mine lands, loss of RH, silv, surface mining	Sediment/siltation, turbidity
Laurel Creek	Clay	3.8-4.8	Pasture grazing, crop production	Nutrients/eutrophication
Long Fork	Breathitt	0-4.6	Surface mining	Sediment/siltation, TDS
Lotts Creek	Perry	1.2-6	Coal mining, loss of RH, silv, streambank mod	Sediment/siltation, TDS, turbidity
Lower Buffalo Creek	Owsley	0-2.4	Loss of RH	Sediment/siltation
Quicksand Creek	Breathitt	0-17, 21.7-30.8	Coal mining, loss of RH, silv, streambank mod	Sediment/siltation, TDS
Right Fork Buffalo Creek	Owsley	0-2.1	Unknown	Unknown
Sexton Creek	Clay, Owsley	0-17.2	Crop production, highway road runoff	Sediment/siltation
South Fork Quicksand Creek	Breathitt	0-16.9	Loss of RH, petroleum/natural	Sediment/siltation, TDS

			gas development, surface mining	
Sturgeon Creek	Lee	8-12.2	Loss of RH, crop production, surface mining	Sediment/siltation
Swift Camp Creek	Menifee	0-13.8	Unknown	Unknown
Troublesome Creek	Breathitt	0-45.1	Coal mining, petroleum/natural gas development	Sediment/siltation, TDS

Oil and Gas

Oil and gas exploration activities represent a threat to the species. Exploration and drilling activities typically involve the construction of new roads and stream crossings, so the potential is high for sedimentation and other direct, physical disturbance to stream channels (*e.g.*, culvert placement, road building). Water quality degradation is a more significant threat associated with these activities because releases of chemicals can occur during the drilling process. Significant releases from gas well sites have been documented within the upper Cumberland River basin (M. Floyd, pers. obs., 2009) and likely occur in the Kentucky River basin as well.

Walker Creek, a direct tributary of the North Fork Kentucky River, is the only stream within the subspecies' range that continues to support arrow darters despite having a conductivity value (400 µS) greater than 250 µS. At the time of the field survey, the source of the elevated conductivity was unknown, but subsequent review of oil and gas mapping revealed that legacy oil and gas wells were abundant in the watershed, and along with legacy mining impacts, likely have contributed to the elevated conductivity. An adjacent stream, Hell Creek, has been placed on Kentucky's 303d list due to impacts from abandoned mines and petroleum/gas production activities.

Other

Other nonpoint-source pollutants that 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. Nonpoint-source pollutants can cause excess nutrification (increased levels of nitrogen and phosphorus) (Table 3, Laurel Creek), excessive algal growth, instream oxygen deficiencies, and other changes in water chemistry that can seriously impact aquatic species (KDOW 1996, pp. 48-50; KDOW 2006, pp. 70-73).

B. Overutilization for commercial, recreational, scientific, or educational purposes.

The Kentucky arrow darter is not believed to be utilized for commercial, recreational, scientific, or educational purposes. Individuals may be collected occasionally in minnow traps and used as live bait, but this activity does not pose a significant threat.

C. Disease or predation.

Although the Kentucky arrow darter is undoubtedly consumed by predators, predation by

naturally occurring predators is a normal aspect of the population dynamics and is not considered to currently pose a threat to the species.

D. The inadequacy of existing regulatory mechanisms.

The Commonwealth of Kentucky prohibits the collection of the Kentucky arrow darter and other fish species for scientific purposes without a valid state-issued collecting permit. However, this requirement does not provide any protection to the species' habitat. Within Kentucky, persons who hold a valid fishing license (obtained from Kentucky Department of Fish and Wildlife Resources (KDFWR)) are allowed to collect up to 500 minnows per day (a minnow is defined as any non-game fish less than 6 inches in length, with the exception of federally listed species). This regulation allows for the capture, holding, and potential use of the Kentucky arrow darter as a bait species. While we do not currently believe this is a significant threat (see Factor B), it is a potential threat.

The Kentucky arrow darter and its habitats are afforded some protection from water quality and habitat degradation under the Clean Water Act of 1977 (33 U.S.C. 1251 et seq.), Surface Mining Control and Reclamation Act of 1977 (30 U.S.C. 1234 – 1328), Kentucky's Forest Conservation Act of 1998 (KRS 149.330-355), Kentucky's Agriculture Water Quality Act of 1994 (KRS 224.71-140), and additional Kentucky laws and regulations regarding natural resources and environmental protection (KRS 146.200-360; KRS 224; 401 KAR 5:026, 5:031). However, as demonstrated under Factor A, population declines and degradation of habitat for this species are ongoing despite the protection afforded by these laws and corresponding regulations. While these laws have resulted in some improvements in water quality and stream habitat for aquatic life, including the Kentucky arrow darter, they alone have not been adequate to fully protect this species; elevated conductivity, sedimentation, and non-point source pollutants continue to be a problem.

States maintain water-use classifications through issuance of National Pollutant Discharge Elimination System (NPDES) permits to industries, municipalities, and others that set maximum limits on certain pollutants or pollutant parameters. For water bodies on the 303(d) list, States are required under the Clean Water Act to establish a total maximum daily load (TMDL) for the pollutants of concern that will bring water quality into the applicable standard. Eighteen (18) Kentucky arrow darter streams have been identified as impaired by the Kentucky Division of Water and placed on the State's 303(d) list (KDOW 2008) (Table 3). Causes of impairment were listed as increased sediment/siltation and total dissolved solids from coal mining, silviculture, loss of riparian habitat, and agriculture, and organic enrichment/eutrophication from agriculture. TMDLs have not yet been developed for these pollutants.

The Kentucky arrow darter has been designated as "Threatened" in Kentucky by the KSNPC (KSNPC 2005), but this designation conveys no legal protection under Kentucky state law.

E. Other natural or manmade factors affecting its continued existence.

The disjunct nature of some Kentucky arrow darter populations prohibits the natural interchange of genetic material between populations, and the small population size reduces the reservoir of genetic diversity within populations. This can lead to inbreeding depression and reduced fitness of individuals (Soule 1980, pp. 157-158; Hunter 2002, pp. 97-101). It is possible that some of the arrow darter populations are below the effective population size required to maintain long-term genetic and population viability (Soule 1980, p. 162-164; Hunter 2002, pp. 105-107).

Climate change has the potential to increase the vulnerability of the Kentucky arrow darter to random detrimental events (*e.g.*, McLaughlin *et al.* 2002; Thomas *et al.* 2004). Global warming is expected to result in increasing frequency and duration of droughts and the strength of storms (e.g., Cook *et al.* 2004). Severe droughts similar to those that affected eastern Kentucky in 2007 and 2008 could be intensified by rising mean air temperatures and reduced precipitation amounts as predicted by Mauer *et al.* (2007) and ClimateWizard (2009) over the next 40 years in eastern Kentucky. .

CONSERVATION MEASURES PLANNED OR IMPLEMENTED

KDFWR identified the Kentucky arrow darter as a Species of Greatest Conservation Need (SGCN) in its State Wildlife Action Plan (KDFWR 2005, p. 2.2.2). The plan identifies conservation issues (threats), conservation actions, and monitoring strategies for 251 animal species belonging to one of 20 terrestrial and aquatic habitat guilds (collection of species that occur in the same habitat). To fully understand these conservation issues, the KDFWR developed a priority list of research and survey needs for Kentucky's SGCN. The KDFWR attempted to address two of these needs in 2008 by initiating a propagation and reintroduction study for the Kentucky arrow darter through the Service's State Wildlife Grant program (Ruble et al. 2010, pp. 1-8). The study was designed to document details on the subspecies' reproductive biology and to begin conservation actions (*e.g.*, propagation and augmentation) that would preclude the need to list the Kentucky arrow darter as threatened or endangered under the ESA. The KDFWR partnered with Conservation Fisheries, Inc. (CFI) to develop successful spawning protocols and produce the offspring needed to augment populations within the subspecies' current range. During 2009, 110 juvenile arrow darters were produced by CFI from 4 adults (2 males and 2 females) captured in December 2008 from Big Double Creek, Clay County. The juveniles (30-35 mm total length) were released on July 15, 2009 to Sugar Creek, Leslie County, a tributary of the Red Bird River in the DBNF, Redbird District. Sugar Creek was chosen as a release site because it was located on public land, it was within the subspecies's known range, and it contained suitable habitat. Prior to release, all arrow darters were marked at CFI with a Northwest Marine Technologies elastomer tag. On August 25, 2009, CFI, KDFWR, and Kentucky Field Office (Service) personnel surveyed Sugar Creek (with seines) in an attempt to locate released individuals. No tagged fish were observed, but one arrow darter (70 mm total length) was observed that likely immigrated into Sugar Creek. The lack of tagged fish was not unexpected by CFI because in similar studies it has taken up to five years of stocking before tagged fish were observed (J. Shute, pers. comm., 2010). The scarcity of tagged fish was likely a result of predation, movement downstream due to high flows or normal dispersal, sampling inefficiency, or other factors. Additional releases into Sugar Creek are planned for 2010 Additional releases are planned for 2010.

A 0.55-km (1823-ft) stream restoration/enhancement project was completed in 2005 in the upper reaches of Bullskin Creek, Leslie County. Bullskin Creek represents suitable habitat for the Kentucky arrow darter and the subspecies was reported from the Bullskin Creek watershed as recently as 2007, when 2 individuals were collected approximately 12.1 stream km [7.5 mi] downstream of the restoration site (Thomas 2008, p. 4). The Bullskin project was funded through Kentucky's Wetland and Stream Mitigation Fund (managed by KDFWR's Stream and Wetland Restoration Program) and was intended to repair eroding banks and poor habitat conditions within Bullskin Creek. The project included a permanent, 9-m (30-foot) easement held by KDFWR. Habitat improvements in this reach of Bullskin Creek will benefit Kentucky arrow darters living in upstream and downstream reaches.

SUMMARY OF THREATS (including reasons for addition or removal from candidacy, if appropriate)

Three of the five listing factors considered by the Service pose threats to the Kentucky arrow darter: the present or threatened destruction, modification or curtailment of its habitat or range; the inadequacy of existing regulatory mechanisms; and other natural or manmade factors affecting its continued existence. The species' habitat and range have been severely degraded and limited by water pollution from surface coal mining and gas exploration activities; removal of riparian vegetation; stream channelization; increased siltation associated with poor mining, logging, and agricultural practices; and deforestation of watersheds. These threats are (1) widespread across the subspecies' range (the geographic scope is widespread and not localized); (2) imminent (the effects are manifested immediately and will continue); and (3) severe (stressors are of high intensity or high strength and can lead to mortality). The severity (or intensity) of these threats, especially impacts from mining and gas exploration activities, is high – these activities can permanently alter stream water quality (e.g., elevated conductivity) by contributing sediment, dissolved metals, and other solids to streams supporting Kentucky arrow darter populations. These water quality changes can be permanent and render these habitats unsuitable for the Kentucky arrow darter. Recent and past research has demonstrated that the subspecies is intolerant of these conditions, and it has been eliminated from a number of streams across its range. Current regulatory mechanisms have been inadequate to prevent these impacts. The small, remnant nature of many Kentucky arrow darter populations may prohibit the natural interchange of genetic material between these populations, and the small population size may reduce the reservoir of genetic diversity within populations. This can lead to inbreeding depression and reduced fitness of individuals. It is possible that some Kentucky arrow darter populations are below the effective population size required to maintain long-term genetic and population viability. We have no information indicating that the magnitude or imminence of these threats is likely to be appreciably reduced in the foreseeable future.

We evaluated the threats to the Kentucky arrow darter and considered factors that, individually and in combination, presently or potentially could pose a risk to the subspecies and its habitat. Based on our analysis of these threats, we find that this species is warranted for listing throughout all its range, and, therefore, find that it is unnecessary to analyze whether it is threatened or endangered in a significant portion of its range.

RECOMMENDED CONSERVATION MEASURES

Conservation measures for the Kentucky arrow darter should be concentrated in those watersheds where populations still occur and should be focused primarily on the protection and restoration of the existing water and habitat quality of these systems. Seven conservation actions were developed for the subspecies' habitat guild as part of KDFWR's State Wildlife Action Plan (KDFWR 2005, p. 2.2.2): (1) the creation of financial incentives to protect riparian corridors and watersheds, (2) acquisition and conservation easements of critical aquatic habitat, (3) encouragement and assistance in developing and implementing best management practices, (4) restoration of degraded habitats, (5) coordination and implementation of existing Farm Bill programs or other federal incentive programs, (6) education of user groups on significance and importance of riparian corridors and watersheds, and (7) development and initiation of local watershed improvement projects. Other appropriate conservation actions identified in KDFWR's plan include the development of protection and enhancement (mitigation) plans for mined watersheds and the development of strategies for reintroduction and enhancement of populations. In order to achieve conservation goals, the Service could pursue the development of candidate conservation agreements and candidate conservation agreements with assurances with potential partners. Conservation efforts could be augmented through additional research on the species' current distribution, life history, environmental requirements, and movement patterns.

LISTING PRIORITY (place * after number)

THREAT			
Magnitude	Immediacy	Taxonomy	Priority
High	**Imminent**	Monotypic genus	1
		Species	2
		Subspecies/population	**3***
	Non-imminent	Monotypic genus	4
		Species	5
		Subspecies/population	6
Moderate to Low	Imminent	Monotypic genus	7
		Species	8
		Subspecies/population	9
	Non-imminent	Monotypic genus	10
		Species	11
		Subspecies/population	12

Rationale for listing priority number:

Magnitude: The severity (or intensity) of these threats, especially impacts from mining, is high – these activities can permanently alter stream water quality (e.g., elevated conductivity) by contributing sediment, dissolved metals, and other solids to streams supporting Kentucky arrow

darter populations and these threats are widespread across the subspecies' range (the geographic scope is widespread and not localized). These water quality changes can be permanent and render these habitats unsuitable for the subspecies. Recent and past research has demonstrated that the subspecies is intolerant of these conditions and it has been eliminated from a number of streams across its range. Collectively, these factors are serious and significant impediments to the survival of the Kentucky arrow darter and are of "High" magnitude.

Imminence: Threats to the Kentucky arrow darter are imminent because the effects are ongoing and will continue. Demand for coal production is not expected to decline over the next 10 years and may increase; consequently, water quality degradation and physical habitat disturbance associated with coal mining activities are expected to continue. Other threats to the subspecies are not expected to diminish in the foreseeable future. Therefore, these factors are "Imminent."

Rationale for Change in Listing Priority Number (insert if appropriate): N/A

Yes Have you promptly reviewed all of the information received regarding the species for the purpose of determining whether emergency listing is needed?

Is Emergency Listing Warranted? No.

During the normal listing process, the subspecies will continue to be threatened by the listing factors described above, but these threats are not expected to jeopardize the subspecies' continued existence. The subspecies' continued existence is bolstered by the fact that populations occurring on public land (DBNF, Red Bird District and Robinson Forest) are protected from severe habitat degradation associated with coal mining and logging activities.

DESCRIPTION OF MONITORING: The KDFWR (Thomas 2008, pp. 3-6) and the Kentucky Field Office (USFWS 2009, pp. 1-4) initiated a basin-wide survey for the Kentucky arrow darter during the summers of 2007 to 2009. All streams known to support the subspecies were visited, as well as 85 percent of the subspecies' historic sites.

COORDINATION WITH STATES
Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment: Kentucky (Kentucky Department of Fish and Wildlife Resources and Kentucky State Nature Preserves Commission). The Kentucky arrow darter is included as a species of conservation concern in Kentucky's State Wildlife Action Plan (KDFWR 2005, p. 2.2.2).

Indicate which State(s) did not provide any information or comments: None

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APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve: _____ June 15, 2010
for Regional Director, Fish and Wildlife Service Date

Concur: _____ Date: October 22, 2010
ACTING
Director, Fish and Wildlife Service

Do not concur: _____ _____
Director, Fish and Wildlife Service Date

Director's Remarks:

Date of annual review: March 26, 2010

Conducted by: Dr. Michael A. Floyd
Kentucky Field Office