

DEPARTMENT OF THE INTERIOR**Fish and Wildlife Service****50 CFR Part 17**

[Docket No. FWS-R4-ES-2015-0132;
4500030113]

RIN 1018-AZ09

**Endangered and Threatened Wildlife
and Plants; Threatened Species Status
for Kentucky Arrow Darter With 4(d)
Rule**

AGENCY: Fish and Wildlife Service,
Interior.

ACTION: Proposed rule.

SUMMARY: We, the U.S. Fish and Wildlife Service (Service), propose to list the Kentucky arrow darter (*Etheostoma spilotum*), a fish species from the upper Kentucky River basin in Kentucky, as a threatened species under the Endangered Species Act (Act). If we finalize this rule as proposed, it would extend the Act's protections to this species.

DATES: We will accept comments received or postmarked on or before December 7, 2015. Comments submitted electronically using the Federal eRulemaking Portal (see **ADDRESSES**, below) must be received by 11:59 p.m. Eastern Time on the closing date. We must receive requests for public hearings, in writing, at the address shown in **FOR FURTHER INFORMATION CONTACT** by November 23, 2015.

ADDRESSES: You may submit comments by one of the following methods:

(1) *Electronically:* Go to the Federal eRulemaking Portal: <http://www.regulations.gov>. In the Search box, enter FWS-R4-ES-2015-0132, which is the docket number for this rulemaking. Then, in the Search panel on the left side of the screen, under the Document Type heading, click on the Proposed Rules link to locate this document. You may submit a comment by clicking on "Comment Now!"

(2) *By hard copy:* Submit by U.S. mail or hand-delivery to: Public Comments Processing, Attn: FWS-R4-ES-2015-0132; U.S. Fish and Wildlife Service, MS: BPHC, 5275 Leesburg Pike, Falls Church, VA 22041-3803.

We request that you send comments only by the methods described above. We will post all comments on <http://www.regulations.gov>. This generally means that we will post any personal information you provide us (see *Public Comments*, below, for more information).

FOR FURTHER INFORMATION CONTACT:
Virgil Lee Andrews, Jr., Field

Supervisor, U.S. Fish and Wildlife Service, Kentucky Ecological Services Field Office, 330 West Broadway, Suite 265, Frankfort, KY 40601; telephone 502-695-0468, x108; facsimile 502-695-1024. Persons who use a telecommunications device for the deaf (TDD) may call the Federal Information Relay Service (FIRS) at 800-877-8339.

SUPPLEMENTARY INFORMATION:

Executive Summary

Why we need to publish a rule. Under the Endangered Species Act (Act), if we find that a species may be an endangered or threatened species throughout all or a significant portion of its range, we are required to promptly publish a proposed rule to list the species in the **Federal Register** and make a final determination on our proposal within 1 year. Listing a species as an endangered or threatened species can only be completed by issuing a rule.

*This rule proposes the listing of the Kentucky arrow darter (*Etheostoma spilotum*) as a threatened species.* The Kentucky arrow darter is a candidate species for which we have on file sufficient information on biological vulnerability and threats to support preparation of a listing proposal, but for which development of a listing rule has until now been precluded by other higher priority listing activities. This rule assesses all available information regarding the status of and threats to the Kentucky arrow darter. Elsewhere in today's **Federal Register**, we propose to designate critical habitat for the Kentucky arrow darter under the Act.

The basis for our action. Under the Act, we may determine that a species is an endangered or threatened species based on any of five factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence. We have determined that the Kentucky arrow darter warrants listing based on three of the five factors (A, D, and E).

We will seek peer review. We will seek comments from independent specialists to ensure that our listing determination is based on scientifically sound data, assumptions, and analyses. We will invite these peer reviewers to comment on our listing proposal. Because we will consider all comments and information we receive during the comment period, our final determination may differ from this proposal.

Information Requested

Public Comments

We intend that any final action resulting from this proposed rule will be based on the best scientific and commercial data available and be as accurate and as effective as possible. Therefore, we request comments or information from other concerned governmental agencies, Native American tribes, the scientific community, industry, or any other interested parties concerning this proposed rule. We particularly seek comments concerning:

(1) The Kentucky arrow darter's biology, range, and population trends, including:

(a) Biological or ecological requirements of the species, including habitat requirements for feeding, breeding, and sheltering;

(b) Genetics and taxonomy;

(c) Historical and current range, including distribution patterns;

(d) Historical and current population levels, and current and projected trends; and

(e) Past and ongoing conservation measures for the species, its habitat, or both.

(2) Factors that may affect the continued existence of the species, which may include habitat modification or destruction, overutilization, disease, predation, the inadequacy of existing regulatory mechanisms, or other natural or manmade factors.

(3) Biological, commercial trade, or other relevant data concerning any threats (or lack thereof) to this species and existing regulations that may be addressing those threats.

(4) Additional information concerning the historical and current status, range, distribution, and population size of this species, including the locations of any additional populations of this species.

(4) Whether measures outlined in the proposed species-specific rule under section 4(d) of the Act are necessary and advisable for the conservation and management of the Kentucky arrow darter.

(5) Additional provisions that may be appropriate to except incidental take as a result of other categories of activities beyond those covered by this proposed species-specific rule and, if so, under what conditions and with what conservation measures, in order to conserve, recover, and manage the Kentucky arrow darter.

(6) Comments and suggestions, particularly from Federal agencies and other interested stakeholders that may be affected by the 4(d), regarding additional guidance and methods that

the Service could provide or utilize, respectively, to streamline the implementation of this 4(d) rule.

Please include sufficient information with your submission (such as scientific journal articles or other publications) to allow us to verify any scientific or commercial information you include.

Please note that submissions merely stating support for or opposition to the action under consideration without providing supporting information, although noted, will not be considered in making a determination, as section 4(b)(1)(A) of the Act (16 U.S.C. 1531 *et seq.*) directs that determinations as to whether any species is an endangered or threatened species must be made “solely on the basis of the best scientific and commercial data available.”

You may submit your comments and materials concerning this proposed rule by one of the methods listed in the **ADDRESSES** section. We request that you send comments only by the methods described in the **ADDRESSES** section.

If you submit information via <http://www.regulations.gov>, your entire submission—including any personal identifying information—will be posted on the Web site. If your submission is made via a hardcopy that includes personal identifying information, you may request at the top of your document that we withhold this information from public review. However, we cannot guarantee that we will be able to do so. We will post all hardcopy submissions on <http://www.regulations.gov>.

Comments and materials we receive, as well as supporting documentation we used in preparing this proposed rule, will be available for public inspection on <http://www.regulations.gov>, or by appointment, during normal business hours, at the U.S. Fish and Wildlife Service, Kentucky Ecological Services Field Office (see **FOR FURTHER INFORMATION CONTACT**).

Public Hearing

Section 4(b)(5) of the Act provides for one or more public hearings on this proposal, if requested. Requests for a public hearing must be received within 45 days after the date of publication of this proposed rule in the **Federal Register**. Such requests must be sent to the address shown in the **FOR FURTHER INFORMATION CONTACT** section. We will schedule public hearings on this proposal, if any are requested, and announce the dates, times, and places of those hearings, as well as how to obtain reasonable accommodations, in the **Federal Register** and local newspapers at least 15 days before the hearing.

Peer Review

In accordance with our joint policy on peer review published in the **Federal Register** on July 1, 1994 (59 FR 34270), we will seek the expert opinions of five appropriate and independent specialists regarding this proposed rule. The purpose of peer review is to ensure that our listing determination is based on scientifically sound data, assumptions, and analyses. The peer reviewers have expertise in the Kentucky arrow darter's biology, habitat, threats, etc., which will inform our determination. We will invite comment from the peer reviewers during this public comment period.

Previous Federal Action

The Kentucky arrow darter was first identified as a candidate for protection under the Act in the November 10, 2010, **Federal Register** (75 FR 69222). Candidate species are those fish, wildlife, and plants for which we have on file sufficient information on biological vulnerability and threats to support preparation of a listing proposal, but for which development of a listing regulation is precluded by other higher priority listing activities. Candidates are assigned listing priority numbers (LPNs) based on immediacy and the magnitude of threats, as well as the species' taxonomic status. A lower LPN corresponds to a higher conservation priority, and we consider the LPN when prioritizing and funding conservation actions. In our 2010 candidate notice of review (CNOR) (75 FR 69222), we identified the species as having an LPN of 3, in accordance with our priority guidance published on September 21, 1983 (48 FR 43098). An LPN of 3 reflects a subspecies with imminent, high magnitude threats. The Kentucky arrow darter was included in all of our subsequent annual CNORs (76 FR 66370, October 26, 2011; 77 FR 69994, November 21, 2012; 78 FR 70104, November 22, 2013; 79 FR 72450, December 5, 2014). On November 22, 2013 (78 FR 70104), we changed the LPN for the Kentucky arrow darter from 3 to 2 based on a change in the species' taxonomic status (change from subspecies to species rank). In our 2014 CNOR (79 FR 72450), we retained an LPN of 2 for this species.

Background

Species Information

Species Description and Taxonomy

The Kentucky arrow darter, *Etheostoma spilotum* Gilbert, is a small and compressed fish, which reaches a maximum length of about 120 millimeters (mm) (4.7 inches (in)). It has

a slender body, elongated snout, relatively large mouth, and virtually scaleless head (Kuehne and Barbour 1983, p. 71; Etnier and Starnes 1993, p. 523). The Kentucky arrow darter's background color is straw yellow to pale greenish, and the body is also covered by a variety of stripes and blotches. 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). The blotches are generally oval with pale centers at the front of the body but extend downward and may resemble the letters N, W, U, or V toward the back of the body. 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). Morphological differences between the Kentucky arrow darter and other darters make misidentifications unlikely. The species can be easily differentiated by its elongated snout, its oval or diamond-shaped lateral blotches, and its large size (for individuals greater than 100 mm (3.9 in) total length (TL)).

The Kentucky arrow darter belongs to the Class Actinopterygii (ray-finned fishes), Order Perciformes, and Family Percidae (perches) (Etnier and Starnes 1993, pp. 18–25; Page and Burr 2011, p. 569). The species was described from the Kentucky River basin (Sturgeon Creek, Owsley County) as *Etheostoma nianguae spilotum* (Gilbert 1887, pp. 53–54), but was later recognized and accepted as one of two subspecies of the arrow darter, *E. sagitta* (Jordan and Swain) (Bailey 1948, pp. 80–84; Kuehne and Bailey 1961, pp. 1–5; Kuehne and Barbour 1983, p. 71; Burr and Warren 1986, p. 316). Thomas and Johansen (2008, p. 46) questioned the subspecies status of *E. sagitta* by arguing that (1) the two subspecies, *E. sagitta sagitta* and *E. sagitta spilotum*, were distinguishable based on scale size and development of the lateral line (see note below); (2) the

two subspecies existed in allopatry (separate ranges with no overlap); (3) the two subspecies lacked intergrades (intermediate forms); and (4) unpublished genetic data (mitochondrial DNA) suggested evolutionary independence of Kentucky and Cumberland basin populations (with no recent genetic exchange). Based on these analyses, the two arrow darter subspecies have been elevated to species rank (Page and Burr 2011, p. 569; Eschmeyer 2014, p. 1). The Cumberland arrow darter, *E. sagitta* (Jordan and Swain), is restricted to the upper Cumberland River basin in Kentucky and Tennessee, and the Kentucky arrow darter, *E. spilotum* Gilbert, is restricted to the upper Kentucky River basin in Kentucky.

Habitat and Life History

Kentucky arrow darters typically inhabit pools or transitional areas between riffles and pools (glides and runs) in moderate- to high-gradient, first- to third-order streams with rocky substrates (Thomas 2008, p. 6). The species is most often observed near some type of cover—boulders, rock ledges, large cobble, or woody debris piles. During spawning (April to June), the species will utilize riffle habitats with moderate flow (Kuehne and Barbour 1983, p. 71). Thomas (2008, p. 6) observed Kentucky arrow darters at depths ranging from 10 to 45 centimeters (cm) (4 to 18 in) and in streams ranging from 1.5 to 20 meters (m) (4.9 to 65.6 feet (ft)) wide. Kentucky arrow darters typically occupy streams with watersheds of 25.9 square kilometers (km²) (10 square miles (mi²)) or less, and many of these habitats, especially those in first-order reaches, can be intermittent in nature (Thomas 2008, pp. 6–9). During drier periods (late summer or fall), some Kentucky arrow darter streams may cease flowing, but the species appears to survive these conditions by retreating into shaded, isolated pools or by dispersing into larger tributaries (Lotrich 1973, p. 394; Lowe 1979, p. 26; Etnier and Starnes 1993, p. 523; Service unpublished data). Lotrich (1973, p. 394) observed riffle habitats in Clemons Fork (Breathitt County) that were completely dry by late summer, but shaded isolated pools in these habitats continued to support Kentucky arrow darters.

Male Kentucky arrow darters establish territories over riffles from March to May, when 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. The spawning period extends from April to June, but peak activity occurs when water temperatures reach 13 degrees Celsius (°C) (55 degrees Fahrenheit (°F)), typically in mid-April (Bailey 1948, pp. 82–84; Lowe 1979, p. 44). Females produce between 200 and 600 eggs per season, with tremendous variation resulting from size, age, condition of females, and stream temperature (Rakes 2014, pers. comm.).

Young Kentucky arrow darters can exceed 25 mm (1 in) TL by mid-June and can reach 50 mm (2 in) in length by the end of the first year (Lotrich 1973, pp. 384–385; Lowe 1979, pp. 44–48; Kuehne and Barbour 1983, p. 71). 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) reported a mean length at age 2 of about 65 mm (2.6 in) but was unable to differentiate between older age classes (age 3+). Lowe (1979, p. 38) reported four age classes for the closely related Cumberland arrow darter, but growth was variable after age 1. 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. As stream flow lessens and riffles begin to shrink, most Kentucky arrow darters move into pools and tend to remain there even when summer and autumn rains restore stream flow (Kuehne and Barbour 1983, p. 71).

Limited information exists with regard to upstream or downstream movements of Kentucky arrow darters; however, preliminary findings from a movement study at Eastern Kentucky University (EKU) and a reintroduction project on the Daniel Boone National Forest (DBNF) suggest that Kentucky arrow darters can move considerable distances (Baxter 2014, pers. comm.; Thomas 2015a, pers. comm.).

The EKU study is using PIT-tags (electronic tags placed under the skin) and placed antenna systems (installed in the stream bottom) to monitor intra- and inter-tributary movement of Kentucky arrow darters in Gilberts Big Creek and Elisha Creek, two second-order tributaries of Red Bird River in Clay and Leslie Counties (Baxter 2014,

pers. comm.). PIT-tags have been placed in a total of 126 individuals, and Kentucky arrow darter movements have been tracked since December 2013. Recorded movements have ranged from 134 m (439 ft) (upstream movement) to 4,078 m (13,379 ft or 2.5 mi) (downstream movement by a female in Elisha Creek). Intermediate recorded movements have included 328 m (1,076 ft) (downstream), 351 m (1,151 ft) (upstream), 900 m (2,952 ft) (upstream/downstream), 950 m (3,116 ft) (downstream), 1,282 m (4,028 ft) (downstream), and 1,708 m (5,603 ft) (downstream).

Since 2012, the Kentucky Department of Fish and Wildlife Resources (KDFWR) has been releasing captive-bred Kentucky arrow darters into Long Fork, a DBNF stream and first-order tributary to Hector Branch in eastern Clay County, Kentucky, where the species had been extirpated. A total of 1,447 captive-spawned KADs (about 50–55 mm TL) have been tagged and reintroduced within a 1.5-km (0.9 mi) reach of Long Fork. Monitoring has been conducted on multiple occasions since the initial release using visual searches and seining methods. Tagged darters have been observed during each monitoring event, with numbers increasing since the reintroduction began in 2012. Untagged individuals began to appear in Long Fork in 2013, indicating natural reproduction in Long Fork. In 2015, KDFWR observed five untagged individuals (47–58 mm TL) and one tagged individual (90 mm TL) in Hector Branch, approximately 0.6 km (0.4 mi) upstream of its confluence with Long Fork, and they also observed four untagged individuals (44–52 mm TL) in Deerlick Branch, a first-order tributary of Hector Branch, approximately 1.0 km (0.6 mi) downstream of the confluence of Long Fork and Hector Branch (Thomas 2015a, pers. comm.). Based on these results, it is evident that at least some Kentucky arrow darters have moved out of Long Fork into other parts of the Hector Creek drainage. It is impossible to determine if the untagged fish were spawned in Long Fork or Hector Branch; however, the former scenario is most likely given the poor water quality and habitat conditions in Hector Branch and the lack of collection records in Hector Branch prior to reintroduction efforts. Considering the water quality and habitat conditions in Hector Branch, it is also plausible that the individuals captured in Hector Branch were in transit seeking higher quality habitat (e.g., small tributaries). Based on these results, it is clear that young Kentucky arrow darters can

disperse both upstream and downstream from their place of origin and can move considerable distances.

Additional insight into possibility of interstream dispersal can be gained from the closely related Cumberland arrow darter. Lowe (1979, pp. 26–27) observed potential movement behavior for the Cumberland arrow darter in Tennessee. During field observations in January and February 1975, no Cumberland arrow darters were observed near the mouth of No Business Creek, a tributary of Hickory Creek in Campbell County, Tennessee, and downstream of a perched culvert. During a subsequent survey at this location, Lowe observed a total of 34 Cumberland arrow darters, a dramatic increase compared to previous surveys. Lowe (1979, pp. 26–27) considered it unlikely that the Cumberland arrow darters originated from upstream reaches of No Business Creek because no individuals were observed upstream of the culvert during the length of the study and no individuals had been observed at the site during the previous week. The only plausible explanation for the sudden increase was that the Cumberland arrow darters had migrated from Hickory Creek or a nearby tributary of Hickory Creek (e.g., Laurel Fork).

Kentucky arrow darters feed primarily on mayflies (Order Ephemeroptera), which comprised 77 percent of identifiable food items (420 of 542 items) in 57 Kentucky arrow darter stomachs from Clemons Fork, Breathitt County (Lotrich 1973, p. 381). The families Heptageniidae (genera

Maccaffertium and *Stenonema*) and Baetidae were the dominant mayflies in examined stomachs of Cumberland arrow darters in Tennessee (Lowe 1979, pp. 35–36). Kentucky arrow darters greater than 70 mm (2.8 in) TL often feed on small crayfish, as 7 of 8 stomachs examined by Lotrich (1973, p. 381) from Clemons Fork contained crayfishes ranging in size from 11 to 24 mm (0.4 to 0.9 in). Lotrich (1973, p. 381) considered this to be noteworthy because stomachs of small Kentucky arrow darters (less than 70 mm (2.8 in) TL) and stomachs of other darter species did not contain crayfishes. He suggested that larger individuals were utilizing a different energy source, thus removing themselves from direct competition for food with other fishes in first- and second-order streams. Lotrich (1973, p. 381) speculated that this would allow these larger individuals to exploit an abundant food source and survive in extreme headwater habitats. Other 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 (*Camptostoma anomalum*), white sucker (*Catostomus 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 streams or headwater reaches, the species is most commonly associated with creek chub, central stoneroller, and fantail darter.

Historical Range and Distribution

The Kentucky arrow darter occurred historically in at least 74 streams in the upper Kentucky River basin of eastern Kentucky (Gilbert 1887, pp. 53–54; Woolman 1892, pp. 275–281; Kuehne and Bailey 1961, pp. 3–4; Kuehne 1962, pp. 608–609; Branson and Batch 1972, pp. 507–514; Lotrich 1973, p. 380; Branson and Batch 1974, pp. 81–83; Harker *et al.* 1979, pp. 523–761; Greenberg and Steigerwald 1981, p. 37; Branson and Batch 1983, pp. 2–13; Branson and Batch 1984, pp. 4–8; Kornman 1985, p. 28; Burr and Warren 1986, p. 316; Measel 1997, pp. 1–105; Kornman 1999, pp. 118–133; Stephens 1999, pp. 159–174; Ray and Ceas 2003, p. 8; 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, p. 3) (Figure 1).

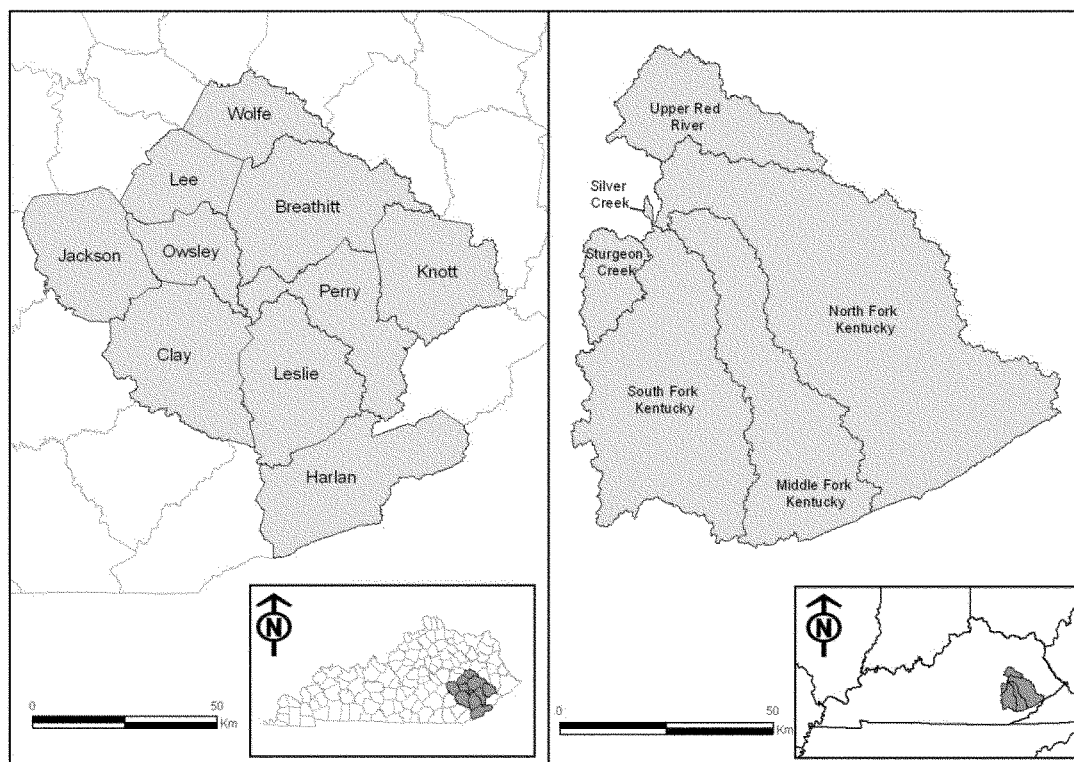


Figure 1. Kentucky counties within the Kentucky arrow darter's historical range (left) and upper Kentucky River sub-basins with historical records of the species (right).

The Kentucky arrow darter was first reported from the upper Kentucky River basin by Gilbert (1887, pp. 53–54), who collected 12 specimens from Sturgeon Creek near Travelers Rest, Owsley County. Woolman (1892, pp. 275–281) conducted more extensive surveys throughout the basin in the summer of 1890, reporting the species from seven additional streams: Big Creek, Cutshin Creek, Hector Branch, Lotts Creek, Middle Fork Kentucky River, Red Bird River, and Troublesome Creek. Kuehne and Bailey (1961, pp. 3–4) and Kuehne (1962, pp. 608–614) surveyed additional portions of the basin from 1954–1959, observing the species in Sexton Creek, Troublesome Creek (mainstem), and nine smaller streams in the Troublesome Creek watershed: Bear Branch, Buckhorn Creek, Clemons Fork, Coles Fork, Laurel Fork, Lewis Fork, Long Fork, Millseat Branch, and Snag Ridge Fork. From 1969–1978, biologists from EKU and KSNPC documented the species from an additional eight streams: Buck Creek, Buffalo Creek, Greasy Creek, Horse Creek, Jacks Creek, Laurel Creek, Leatherwood Creek, and Raccoon Creek (Branson and Batch 1972, pp. 507–514; Branson and Batch

1974, pp. 81–83; Harker *et al.* 1979, pp. 523–761; Branson and Batch 1983, pp. 2–13; Branson and Batch 1984, pp. 4–8; Burr and Warren 1986, p. 316). The number of known occurrences for the Kentucky arrow darter increased considerably during the 1990s (1990–1999), when EKU, KDFWR, the Kentucky Division of Water (KDOW), and KSNPC completed surveys throughout the basin, documenting the species' presence in a total of 46 streams (Kornman 1999, pp. 118–133; Stephens 1999, pp. 159–174; Ray and Ceas 2003, p. 8; KSNPC unpublished data).

Current Range and Distribution

Based on surveys completed since 2006, extant populations of the Kentucky arrow darter are known from 47 streams in the upper Kentucky River basin in eastern Kentucky. These populations are scattered across 6 sub-basins (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 Counties (Thomas 2008, pp. 3–6; Service unpublished data). Populations in nine

of these streams have been discovered or established since 2006. 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).

Population Estimates and Status

The species' status in all streams of historical or recent occurrence is summarized in Table 1, below, which is organized by sub-basin, beginning at the southeastern border (upstream end) of the basin (North Fork Kentucky River) and moving downstream. In this proposed rule, the term "population" is

used in a geographical context and not in a genetic context, and is defined as all individuals of the species living in one stream. Using the term in this way allows the status, trends, and threats to be discussed comparatively across streams where the species occurs. In using this term, we do not imply that the populations are currently reproducing and recruiting or that they are distinct genetic units. We considered populations of the Kentucky arrow darter as extant if live specimens have been observed or collected since 2006, and suitable habitat is present.

We are using the following generalized sets of criteria to categorize

the relative status of populations of 83 streams (74 historical and 9 non-historical discovered or established since 2006) included in Table 1. The status of a population is considered “stable” if: (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. The status of a population is considered “vulnerable” if: (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. The status of a population is considered “extirpated” if: (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 from another stream.

TABLE 1—KENTUCKY ARROW DARTER STATUS IN ALL STREAMS OF HISTORICAL (74) OR RECENT OCCURRENCE ¹ (9; NOTED IN BOLD) IN THE UPPER KENTUCKY RIVER BASIN

Sub-basin	Sub-basin tributaries	Stream ¹	County	Current status	Date of last observation	
North Fork	Lotts Creek	Lotts Creek	Perry	Extirpated	1890	
		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	2013
			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
		Clear Fork		Breathitt	Vulnerable	2008
	Negro Branch	Breathitt		Vulnerable	2008	
	Davis Creek	Breathitt		Vulnerable	2008	
	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
	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	

TABLE 1—KENTUCKY ARROW DARTER STATUS IN ALL STREAMS OF HISTORICAL (74) OR RECENT OCCURRENCE ¹ (9; NOTED IN BOLD) IN THE UPPER KENTUCKY RIVER BASIN—Continued

Sub-basin	Sub-basin tributaries	Stream ¹	County	Current status	Date of last observation		
Silver Creek	Goose Creek	Elisha Creek	Leslie	Stable	2014		
		Gilberts Big Creek	Clay, Leslie	Stable	2013		
		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		
		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.

From 2007–2012, the Service, KSNPC, and KDFWR conducted a status review for the Kentucky arrow darter (Thomas 2008, pp. 1–33; Service 2012, pp. 1–4). Surveys were conducted qualitatively using single-pass electrofishing techniques (Smith-Root backpack electrofishing unit) within an approximate 100-m (328-ft) reach. During these efforts, fish surveys were conducted at 69 of 74 historical streams, 103 of 119 historical sites, and 40 new (non-historical) sites (sites correspond to individual sampling reaches and more than one may be present on a given stream). Kentucky arrow darters were observed at 36 of 69 historical streams (52 percent), 53 of 103 historical sites (52 percent), and 4 of 40 new sites (10 percent). New sites were specifically selected based on habitat suitability and the availability of previous collection records (sites lacking previous collections were chosen).

From June to September 2013, KSNPC and the Service initiated a study that included quantitative surveys at 80

randomly chosen sites within the species' historical range (Service unpublished data). Kentucky arrow darters were observed at only seven 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 status surveys by Thomas (2008, pp. 1–33) and Service (2012, pp. 1–4).

During 2014–2015, additional qualitative surveys (single-pass electrofishing) were completed at over 20 sites within the basin. Kentucky arrow darters were observed in Bear Branch, Big Double Creek, Big Laurel Creek, Bullskin Creek, Clemons Fork, Coles Fork, Cortland Fork, Laurel Fork Buffalo Creek, and Squabble Creek. Based on the poor habitat conditions observed in Bear Branch (e.g., elevated conductivity, siltation, and embedded substrates) and its close proximity to Robinson Forest, we suspect that the

few individuals observed in Bear Branch were transients originating from Clemons Fork.

Based on historical records and survey data collected at over 200 sites since 2006, the Kentucky arrow darter has declined significantly rangewide and has been eliminated from large portions of its former range, including 36 of 74 historical streams (Figure 2) and large portions of the basin that would have been occupied historically by the species (Figure 3). 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' 47 extant streams, we consider half of these populations (23) to be "vulnerable" (Table 1), and most remaining populations are isolated and restricted to short stream reaches.

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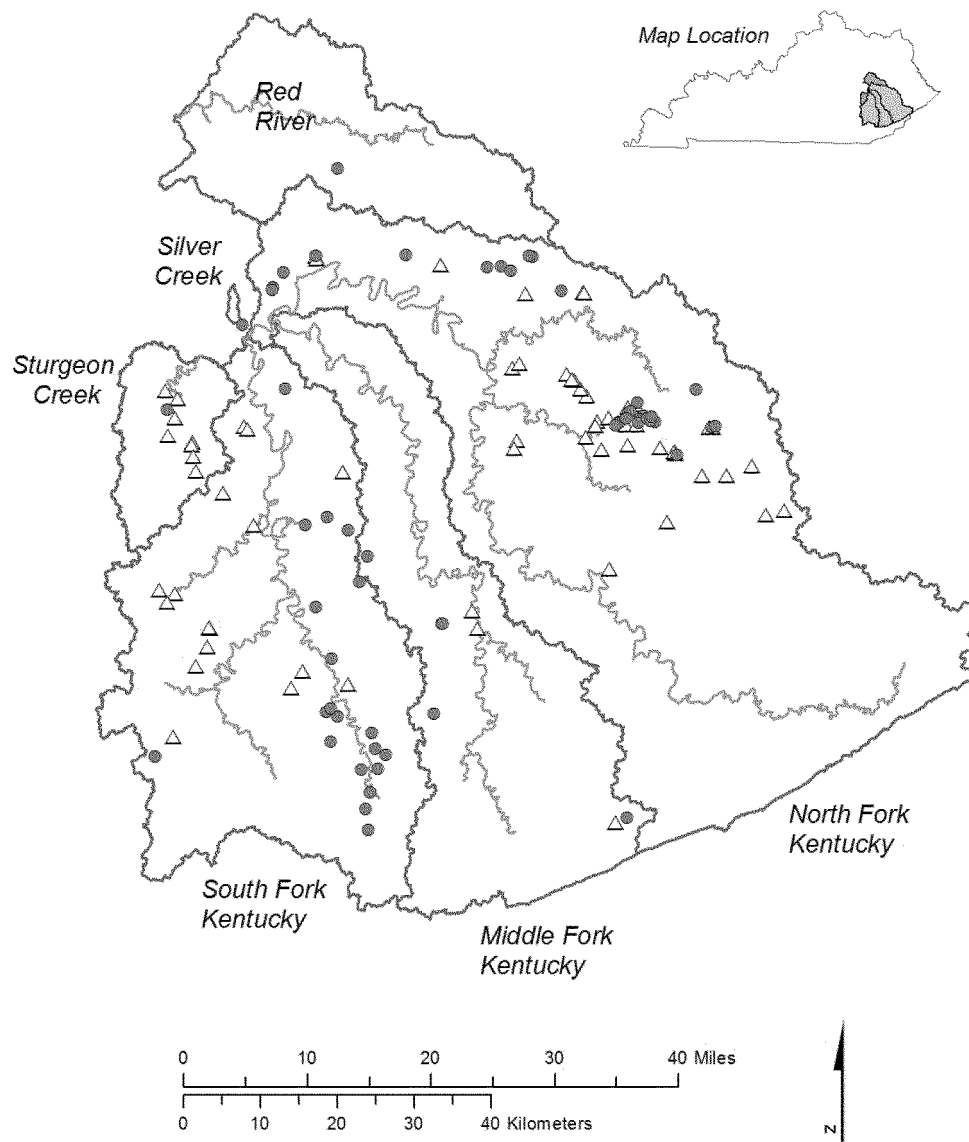


Figure 2. A summary of Kentucky arrow darter survey results at all historical sites visited between 2007 and 2015. Circles indicate survey sites (reaches) where the species was observed. Triangles indicate survey sites (reaches) where the species was not observed. Black lines indicate sub-basin boundaries; grey lines indicate 4th to 6th order streams.

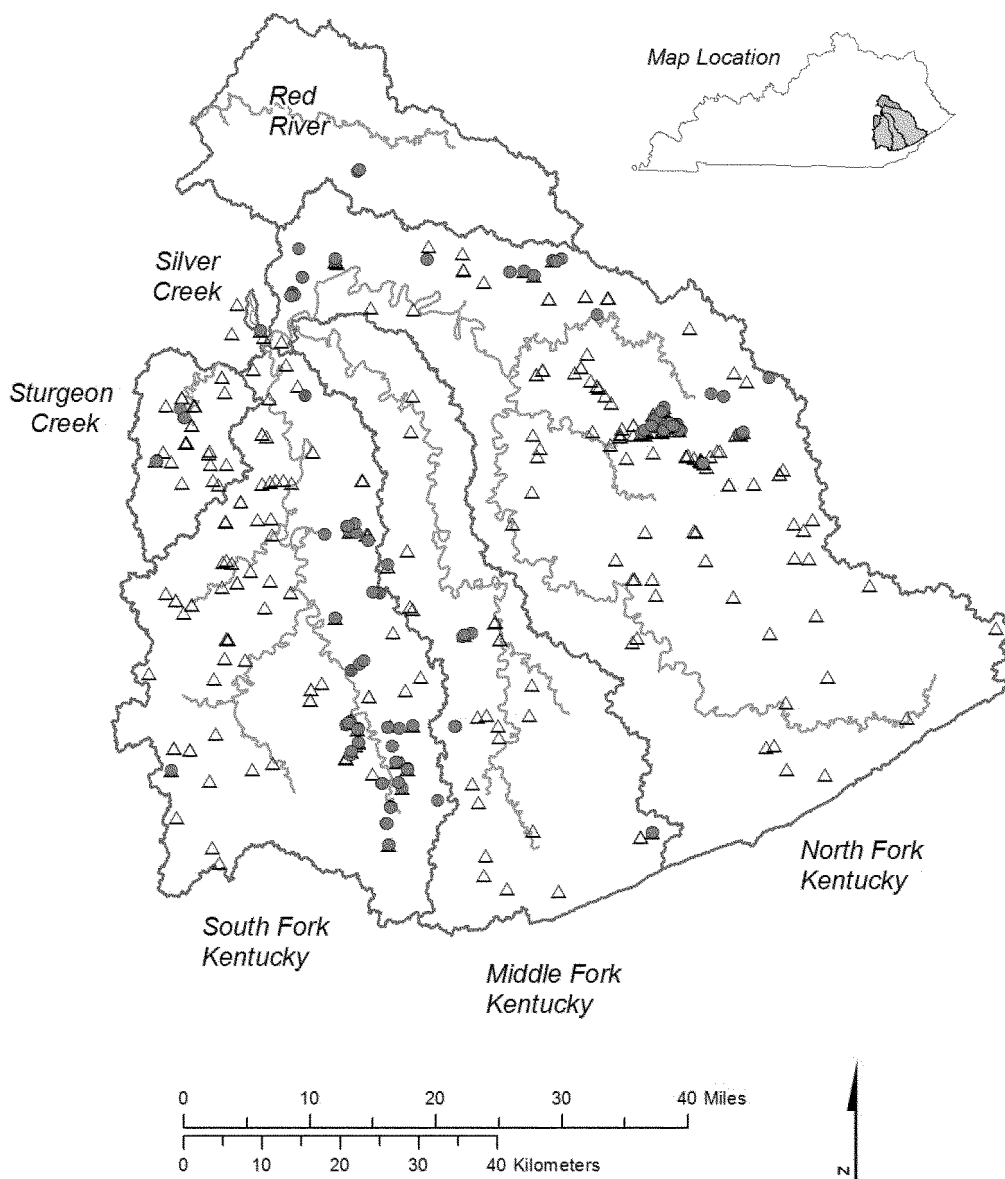


Figure 3. A summary of Kentucky arrow darter survey results at all sites visited between 2007 and 2014. Circles indicate survey sites (reaches) where the species was observed. Triangles indicate survey sites (reaches) where the species was not observed. Black lines indicate sub-basin boundaries; grey lines indicate 4th to 6th order streams.

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A synopsis of the Kentucky arrow darter's current range and status is provided below and is arranged by sub-basin, starting at the southeastern border (upstream end) of the basin and moving downstream. Within each sub-basin,

smaller watersheds and streams are addressed in a hierarchical fashion (follows the order used in Table 1).

North Fork Kentucky River Sub-Basin

The North Fork Kentucky River arises in eastern Letcher County, Kentucky,

near Pine Mountain and flows generally northwest for approximately 270 km (168 mi) to its confluence with the South Fork Kentucky River. Its watershed encompasses approximately 4,877 km² (1,883 mi²) in portions of Breathitt, Knott, Lee, Letcher, Perry, and

Wolfe counties. The Kentucky arrow darter was known historically from 33 streams in this sub-basin; we now consider the species to be extant in 17 streams (Thomas 2008, pp. 5–6; KSNPC unpublished data; Service unpublished data).

Lotts Creek—Lotts Creek is a tributary of the North Fork Kentucky River that flows westerly through east-central Perry County and southwestern Knott County. The Kentucky arrow darter was first reported from Lotts Creek by Woolman (1892, pp. 275–281), who described it as uncommon in the stream. No additional records are available from the Lotts Creek watershed, and our most recent survey (2009) was also unsuccessful (Service 2012, pp. 1–4). Based on the stream's poor habitat conditions (e.g., conductivity greater than 1,000 micro Siemens (μS)/cm, embedded substrates) and the lack of species records over the last 125 years (Service 2012, pp. 1–4), we do not consider the species to be extant within the Lotts Creek watershed.

Troublesome Creek—Troublesome Creek is a tributary of the North Fork Kentucky River draining portions of Breathitt, Knott, and Perry Counties. Historically, the Kentucky arrow darter was known from 16 streams in the Troublesome Creek watershed (Table 1) (Woolman 1892, pp. 275–281; Kuehne and Bailey 1961, pp. 3–4; Kuehne 1962, pp. 608–614; Harker *et al.* 1979, pp. 523–761; Measel 1997, pp. 8–11, 59; KSNPC unpublished data). The species has been eliminated from the upper reaches of Troublesome Creek, portions of the Buckhorn Creek watershed, and Lost Creek, but populations continue to occur in the upper Buckhorn Creek watershed, specifically Clemons Fork, Coles Fork, Snag Ridge Fork, Buckhorn Creek (headwaters, including Prince Fork), and Eli Fork (of Boughcamp Branch). The best remaining populations occur in Clemons Fork and Coles Fork, both tributaries of Buckhorn Creek that are located on Robinson Forest, a 59.9-km² (14,800-acre (ac)) experimental forest owned and managed by the University of Kentucky (UK). These watersheds are intact and densely forested, with only minor interruption by logging roads. Both streams are moderate- to high-gradient, cool, and dominated by cobble, boulder, and bedrock substrates. The species has been extirpated from most downstream tributaries of Buckhorn Creek (e.g., Long Fork) and most of the Buckhorn Creek mainstem; however, individuals are sometimes observed in these tributaries (e.g., Bear Branch, Boughcamp Branch) or the Buckhorn Creek mainstem where these habitats are located close to

occupied reaches. A small population continues to persist (and reproduce) within the Buckhorn Creek headwaters (Prince Fork and Eli Fork), but these watersheds are isolated from downstream populations due to severely degraded habitat and water quality conditions in the Buckhorn Creek mainstem and adjacent tributaries (Appalachian Technical Services (ATS) 2011, pp. 1–17). Surface coal mining has been practiced extensively within the Troublesome Creek watershed, and these activities continue to occur. A 10.9-km (6.8-mi) reach of Buckhorn Creek has been placed on Kentucky's 303(d) list of impaired waters due to siltation and elevated levels of total dissolved solids (KDOW 2013a, p. 341) and reported to the Environmental Protection Agency pursuant to section 303 of the 1972 Clean Water Act (33 U.S.C. 1251 *et seq.*)

Quicksand Creek—Quicksand Creek is a tributary of the North Fork Kentucky River that drains portions of Breathitt and Knott Counties. The Kentucky arrow darter was known from nine historical streams in the watershed (Table 1) (Harker *et al.* 1979, pp. 576–590; KSNPC unpublished data). The species has been extirpated from five of these streams (e.g., Leatherwood Creek), but extant populations remain in Laurel Fork, Middle Fork, Spring Fork, and Hunting Creek. Laurel Fork and Middle Fork support the best remaining populations. Both of these watersheds are sparsely populated and forested, with favorable water quality and habitat conditions for the species. The small Spring Fork population was discovered in 2013, and appears to be limited to an approximate 1.6-km (1-mi) headwater reach. Habitat conditions in Spring Fork are marginal for the species (e.g., heavy siltation, bank erosion), and instream conductivity is elevated (334 $\mu\text{S}/\text{cm}$). The species was first observed in Hunting Creek in July 1995 (six individuals observed), but the species was not observed during surveys by KDFWR in May 2007 (Thomas 2008, p. 5). Surveys by the Service in September 2013 produced four individuals, but habitat conditions continue to be marginal for the species. Based on these factors, we consider the Hunting Creek population to be vulnerable to extirpation.

Frozen Creek—Frozen Creek is a tributary of the North Fork Kentucky River in northern Breathitt County. The Kentucky arrow darter was known historically from six streams in the Frozen Creek watershed: Frozen Creek (headwaters), Clear Fork, Negro Branch, Davis Creek, Cope Fork, and Boone Fork (Kornman 1999, pp. 118–133; KSNPC

unpublished data). Thomas (2008, p. 5) revisited these sites in 2007 and 2008, and determined that the species was extant in four streams: Frozen Creek, Clear Fork, Negro Branch, and Davis Creek. The most individuals were observed in Frozen Creek, which also contained the most favorable habitat conditions for the species. The species was less abundant in Clear Fork, Negro Branch, and Davis Creek, and habitat conditions were marginal (e.g., extensive bedrock areas, substrates covered by thick layer of algae). Thomas (2008, pp. 5, 31–32) did not observe the species in Cope Fork or Boone Fork, both of which exhibited poor habitat and water quality conditions (e.g., siltation, elevated conductivity). Sedimentation continues to be a problem in the Frozen Creek watershed (KDOW 2013a, p. 329), and a 3.1-km (1.9-mi) reach of Cope Fork has been placed on Kentucky's 303(d) list of impaired waters due to elevated levels of total dissolved solids (e.g., elevated conductivity) (KDOW 2013a, p. 345).

Holly Creek—Holly Creek is a tributary of the North Fork Kentucky River in southern Wolfe County. Kentucky arrow darters were first observed in Holly Creek (one individual) in 1998 (Kornman 1999, pp. 118–133). Thomas (2008, p. 5) revisited the historical site in 2007, and observed two individuals. Despite the species' presence, habitat conditions in portions of the watershed continue to be poor, and a 10-km (6.2-mi) reach (RM 0–6.2) of Holly Creek has been placed on Kentucky's 303(d) list of impaired streams due to sedimentation from agriculture, stream bank modification, and riparian habitat loss (KDOW 2013a, p. 351). Based on these factors and the population's apparent small size, we consider the Holly Creek population to be vulnerable to extirpation.

Lower Devil Creek—Lower Devil Creek is a direct tributary of the North Fork Kentucky River in southern Wolfe County. The Kentucky arrow darter was first reported from Lower Devil Creek by Kornman (1999, pp. 118–133), who collected one individual in 1998. The species was not observed during subsequent surveys in 2007 and 2011 (Thomas 2008, pp. 5; Service unpublished data). Thomas (2008, p. 5) reported a new record for the watershed based on the collection of one specimen from Little Fork, a tributary to Lower Devil Creek. We observed an additional specimen during surveys in 2011. We consider the Little Fork population to be vulnerable to extirpation due to its apparent small population size and the stream's elevated conductivity (approximately 400 $\mu\text{S}/\text{cm}$).

Walker Creek—Walker Creek is a direct tributary of the North Fork Kentucky River in eastern Lee County. First discovered in 1996 (KSNPC unpublished data), this population continues to be relatively robust. The species was observed at all historical sites and one new site during surveys completed in 2008 and 2013 (KSNPC and Service unpublished data). Conductivity values continue to be high in downstream reaches (approximately 400 $\mu\text{S}/\text{cm}$), but these conditions do not appear to have reduced Kentucky arrow darter numbers. Historical land use within the Walker Creek watershed was dominated by oil and gas development/drilling, which may explain the elevated conductivity values observed during recent surveys.

Hell Creek—Hell Creek is a direct tributary of the North Fork Kentucky River in eastern Lee County. The species was first observed in Hell Creek (two individuals) in August 1995 (KSNPC unpublished data), followed by observations by Kornman (1999, pp. 118–133) in 1998 (two individuals) and Thomas (2008, p. 5) in 2007 (seven individuals). Surveys by KDFWR in July 2014 suggest a possible decline of the population in Hell Creek (Thomas 2014, pers. comm.). Kentucky arrow darters appeared to be less abundant (only two individuals observed despite exhaustive searches), and habitat conditions within Hell Creek had deteriorated (siltation was prominent) compared to previous surveys (Thomas 2014, pers. comm.).

Middle Fork Kentucky River Sub-Basin

The Middle Fork Kentucky River arises in southern Leslie County, Kentucky, near Pine Mountain and flows generally north for approximately 169 km (105 mi) to its confluence with the North Fork Kentucky River. Its watershed encompasses approximately 1,448 km² (559 mi²) in portions of Breathitt, Harlan, Lee, Leslie, and Perry counties. The Kentucky arrow darter was formerly known from seven widely scattered stream segments in the sub-basin. We now consider the species to be extant in four of these streams (Thomas 2008, pp. 4–5; Service unpublished data).

Greasy Creek—Greasy Creek is a tributary of the Middle Fork Kentucky River that drains southern Leslie county and a small portion of northern Harlan County. The Kentucky arrow darter is known from two historical streams within the watershed—Greasy Creek and Big Laurel Creek, a direct tributary of Greasy Creek (Branson and Batch 1984, pp. 4–8; KSNPC unpublished data). The species is presumed extirpated from the Greasy Creek

mainstem, but a small population remains in Big Laurel Creek based on collections completed in 2009 (Service 2012, pp. 1–4). We consider the Big Laurel Creek population to be vulnerable to extirpation due to sedimentation, channel instability, and elevated conductivity.

Cutshin Creek—Cutshin Creek is a tributary of the Middle Fork Kentucky River draining southeastern Leslie County. The species was first reported from Cutshin Creek by Woolman (1892, pp. 275–281), who observed the species 4.8 km (3 mi) upstream of the Cutshin Creek and Middle Fork confluence. Branson and Batch (1984, pp. 4–8) made the only other observation of the species in Cutshin Creek. They collected one specimen at the KY 80 crossing in June 1973. The species has not been observed in Cutshin Creek since that time.

Middle Fork—Woolman (1892, pp. 275–281) observed the species in the Middle Fork mainstem during surveys completed 6.4 km (4 mi) north of Hyden in August 1890. The species has not been observed in the Middle Fork since that time. Based on the size of the Middle Fork at this location (fourth- or fifth-order), it is likely that the specimen(s) observed by Woolman originated from a nearby tributary such as Hell For Certain Creek.

Rockhouse Creek—Rockhouse Creek is a tributary of Middle Fork Kentucky River in central Leslie County. In March 2013, biologists with KDFWR and DBNF discovered an unknown population of Kentucky arrow darter in Laurel Creek, a second-order tributary of Rockhouse Creek (Thomas 2013, pers. comm.). One individual was found in Laurel Creek after surveys in three separate reaches (over 4,000 shocking seconds). Laurel Fork is situated at the western edge of the Middle Fork sub-basin, and about 90 percent of its watershed is located within the DBNF (Redbird Ranger District).

Hell For Certain Creek—Hell For Certain Creek is a direct, second-order tributary to the Middle Fork Kentucky River in northern Leslie County (upstream of Buckhorn Lake). Kentucky arrow darters were first recorded from Hell For Certain Creek in 1994 (KSNPC unpublished data), and subsequent surveys in 2011 and 2013 produced additional specimens (Service unpublished data). The Hell For Certain Creek population appears to be at least moderately robust, and water quality and habitat conditions are favorable for the species. About 50 percent of the Hell For Certain Creek watershed is in public ownership (DBNF).

Squabble Creek—Squabble Creek is a tributary to Middle Fork Kentucky River

in northwestern Perry County. Squabble Creek enters the Middle Fork just downstream of Buckhorn Lake Dam in the community of Buckhorn. Kentucky arrow darters were first reported from Squabble Creek in 1996, when KSNPC biologists observed one individual from a small bedrock pool in the headwaters (KSNPC unpublished data). Thomas (2008, p. 25) resurveyed the historical collection site in 2008 but did not observe the species. Thomas (2008, p. 25) noted that sedimentation was “heavy” in the stream. We observed similar habitat conditions during recent surveys of Squabble Creek in February 2015, but two juvenile Kentucky arrow darters were observed near the historical collection site. Conductivity levels continue to be relatively low in the headwaters (130 $\mu\text{S}/\text{cm}$), but siltation/sedimentation remains a concern and residential land use continues to be extensive in the downstream half of the watershed. About 10 percent of the watershed is in Federal ownership (DBNF). Sedimentation and total dissolved solids have been identified as problems within Squabble Creek, as evidenced by the stream’s placement on Kentucky’s 303(d) list of impaired waters (KDOW 2013a, p. 368).

South Fork Kentucky River Sub-Basin

The South Fork Kentucky River is formed by the confluence of Goose Creek and the Red Bird River in northern Clay County, Kentucky, and flows north for approximately 72 km (45 mi) to its confluence with the North Fork Kentucky River. Its watershed encompasses approximately 1,937 km² (748 mi²) in portions of Bell, Clay, Jackson, Knox, Lee, Leslie, and Owsley counties. Historically, the Kentucky arrow darter was known from 28 streams in this sub-basin. The species has been extirpated from several watersheds (total of 9 streams) and is now considered to be extant in 20 streams (Thomas 2008, p. 4; KSNPC and Service unpublished data).

Red Bird River—The Red Bird River is a tributary of the South Fork Kentucky River that flows northerly through portions of Bell, Clay, and Leslie Counties. Historically, Kentucky arrow darters were known from 12 streams within the watershed (Woolman 1892, pp. 275–281; Branson and Batch 1983, pp. 2–13; KSNPC and Service unpublished data). The species has been extirpated from two streams, Big Creek and Hector Branch, but the Red Bird River watershed continues to support the largest concentration of occupied streams and some of the species’ best remaining populations. We have recent records from Blue Hole Creek, Upper

Bear Creek, Katies Creek, Spring Creek, Bowen Creek, Elisha Creek, Gilberts Big Creek, Sugar Creek, Big Double Creek, Little Double Creek, Jacks Creek, and Long Fork (of Hector Branch). Public ownership in these watersheds is extensive (Redbird Ranger District of DBNF), and the streams generally have intact riparian zones with little or no anthropogenic disturbance, cool temperatures, low conductivity (near baseline conditions of less than 100 $\mu\text{S}/\text{cm}$), and stable channels with clean cobble/boulder substrates. The presence of the species in Long Fork (of Hector Branch) is the result of a reintroduction effort by KDFWR and Conservation Fisheries, Inc. (CFI), of Knoxville, Tennessee (Thomas *et al.* 2014, p. 23).

Goose Creek—Goose Creek is a tributary of the South Fork Kentucky River that drains portions of southern and western Clay County and northeastern Knox County. Goose Creek flows northerly through these counties, joining with the Red Bird River at Oneida to create the South Fork Kentucky River. The Kentucky arrow darter was known historically from two Goose Creek tributaries: Horse Creek and Laurel Creek (Branson and Batch 1983, pp. 1–15). A small population continues to exist in Horse Creek, but the species has not been observed in Laurel Creek since 1970 (Service unpublished data). Habitat conditions in both streams are marginal to poor (Thomas 2008, p. 4), and both streams have been placed on Kentucky's 303(d) list of impaired waters (KDOW 2013a, pp. 352–353).

Bullskin Creek—Bullskin Creek is a tributary to the South Fork Kentucky River that drains eastern Clay County. The Kentucky arrow darter was first reported from Bullskin Creek in August 1998, when Stephens (1999, pp. 159–174) collected one individual. Additional specimens were observed by KDFWR and the Service in 2007 and 2014, respectively (Thomas 2008, p. 27; Service unpublished data).

Buffalo Creek—Buffalo Creek is a tributary to the South Fork Kentucky River that drains southeastern Owsley County. Since 1969, the Kentucky arrow darter has been reported from multiple stream reaches in both the Left and Right Forks (Branson and Batch 1983, pp. 1–15; KSNPC and Service unpublished data). The species continues to be extant in both forks, and the upstream reaches of the Left Fork (Laurel Fork, Cortland Fork, and Lucky Fork) appear to be the species' stronghold within the watershed. Public ownership (DBNF) is extensive within the drainage.

Sexton Creek—Sexton Creek is a tributary to the South Fork Kentucky River that drains portions of Clay, Jackson, and Owsley Counties. Historically, the Kentucky arrow darter was reported from Bray Creek, Robinsons Creek, and the Sexton Creek mainstem (Branson and Batch 1983, pp. 1–15; KSNPC unpublished data). The species has not been observed in the Sexton Creek watershed since 1997, and now appears to be extirpated.

Lower Island Creek—Lower Island Creek is a tributary to the South Fork Kentucky River that drains southwestern Owsley County. The Kentucky arrow darter was first reported from Lower Island Creek in 1997 (KSNPC unpublished data), but repeated surveys in the watershed have failed to produce additional specimens (Thomas 2008, p. 27; Service unpublished data). The species is now considered to be extirpated from the Lower Island Creek watershed.

Cow Creek—Cow Creek is a tributary to the South Fork Kentucky River that drains eastern Owsley County. The Kentucky arrow darter was first reported from the watershed in June 1993, when Burr and Cook (1993, pp. 55–56) observed two specimens in the headwaters of Right Fork Cow Creek near the community of Arnett. KSNPC surveyed the historical site again in 1997, and observed one individual (KSNPC unpublished data). Surveys by the Service in 2009 and 2011 did not produce additional specimens (Service 2012, pp. 1–4). The species is now considered to be extirpated from the Cow Creek watershed.

Buck Creek—Buck Creek is a tributary to the South Fork Kentucky River in northern Owsley County. The species was first reported from the Buck Creek watershed by Harker *et al.* (1979, pp. 656–671), who observed one individual in October 1978. Additional surveys were completed in May 2008 and June 2011, but the species was not observed (Service 2012, pp. 1–4). Based on our recent surveys, habitat conditions appear to be unfavorable for the species (e.g., conductivity greater than 400 $\mu\text{S}/\text{cm}$).

Lower Buffalo Creek—Lower Buffalo Creek is a tributary to the South Fork Kentucky River in Lee and Owsley Counties. The Kentucky arrow darter was first reported from Lower Buffalo Creek by Stephens (1999, pp. 159–174), who observed one individual in August 1998. Thomas (2008, p. 4) observed three individuals in May 2007, but described the habitat conditions as poor, with heavy siltation and eutrophication. Based on observations made by Thomas (2008, p. 4), we consider the Lower

Buffalo Creek population to be vulnerable to extirpation.

Silver Creek Sub-Basin

Silver Creek is a tributary to the Kentucky River that drains approximately 8.5 km² (3.3 mi²) in central Lee County, Kentucky. The Kentucky arrow darter was first recorded from Silver Creek in 1996, when KSNPC observed 10 individuals (2 age classes) near the city limits of Beattyville (KSNPC unpublished data). Thomas (2008, p. 31) surveyed the historical site again in May 2008, and observed one specimen. A small population appears to be extant in Silver Creek, but we consider this population to be vulnerable to extirpation.

Sturgeon Creek Sub-Basin

Sturgeon Creek is a tributary to the Kentucky River that flows northerly through Jackson, Lee, and Owsley Counties, draining approximately 287 km² (111 mi²). The Kentucky arrow darter was known historically from five streams within this sub-basin: Brushy Creek, Cooperas Cave Branch, Little Sturgeon Creek, Sturgeon Creek (mainstem), and Wild Dog Creek (Harker *et al.* 1979, pp. 607–623; Ray and Ceas 2003, pp. 12–13; KSNPC unpublished data). We now consider the species to be extant in one historical stream, Wild Dog Creek, and two recently documented streams, Granny Dismal Creek and Travis Creek (KSNPC and Service unpublished data). Wild Dog Creek appears to support the most robust population within this sub-basin.

Red River Sub-Basin

The Red River is a tributary of the Kentucky River that arises in eastern Wolfe County, Kentucky, and flows generally west for approximately 156 km (97 mi) through portions of Clark, Estill, Menifee, Powell, and Wolfe Counties. The Red River watershed encompasses approximately 1,261 km² (487 mi²). The Kentucky arrow darter was not observed within the sub-basin until 1980, when one individual was collected from the Swift Camp Creek watershed in Wolfe County (Greenberg and Steigerwald 1981, p. 37).

Swift Camp Creek—Swift Camp Creek is a tributary to the Red River that flows northerly through northwestern Wolfe County. The Kentucky arrow darter was known historically from only one Swift Camp Creek tributary: Rockbridge Fork (Greenberg and Steigerwald 1981, p. 37). Additional surveys by KDFWR and the Service in 1998, 2007, 2011, and 2013 demonstrate that the species continues to occur in Rockbridge Fork (Kornman

1985, p. 28; Thomas 2008, p. 4; Service unpublished data). Despite its location in the DBNF, bank erosion and siltation continue to be problematic in the watershed (Thomas 2008, p. 4).

Our recent survey data (Thomas 2008, pp. 25–27; Service 2012, pp. 1–4) indicate that Kentucky arrow darters occur in low densities. Sampling reaches where arrow darters were observed had an average of only 3 individuals per 100-m (328-ft) reach and a median of 2 individuals per reach (range of 1 to 10 individuals). Surveys in 2011 by the DBNF from Laurel Fork and Cortland Branch of Left Fork Buffalo Creek (South Fork Kentucky River sub-basin) produced slightly higher capture rates (an average of 5 darters per 100-m (328-ft) sampling reach) (Mulhall 2014, pers. comm.). The low abundance values (compared to other darters) are not surprising since Kentucky arrow darters generally occur in low densities, even in those streams where disturbance has been minimal (Thomas 2015b, pers. comm.).

Detailed information on population size is generally lacking for the species, but estimates have been completed for three streams: Clemons Fork (Breathitt County), Elisha Creek (Clay and Leslie Counties), and Gilberts Big Creek (Clay and Leslie Counties) (Service unpublished data). Based on field surveys completed in 2013 by EKU, KSNPC, and the Service, population estimates included 986–2,113 individuals (Clemons Fork), 592–1,429 individuals (Elisha Creek), and 175–358 individuals (Gilberts Big Creek) (ranges reflect 95 percent confidence intervals).

Based on observed catch rates and habitat conditions throughout the upper Kentucky River basin, the most stable and largest populations of the Kentucky

arrow darter appear to be located in the following streams:

- Hell For Certain Creek, Leslie County;
- Laurel and Middle Forks of Quicksand Creek, Knott County;
- Frozen and Walker Creeks, Breathitt and Lee Counties;
- Clemons Fork and Coles Fork, Breathitt and Knott Counties;
- Several direct tributaries (e.g., Bowen Creek, Elisha Creek, and Big Double Creek) of the Red Bird River, Clay and Leslie Counties; and
- Wild Dog Creek, Jackson and Owsley Counties.

The Kentucky arrow darter is considered “threatened” by the State of Kentucky and has been ranked by KSNPC as a G2G3/S2S3 species (imperiled or vulnerable globally and imperiled or vulnerable within the State) (KSNPC 2014, p. 40). Kentucky’s Comprehensive Wildlife Conservation Strategy (KDFWR 2013, pp. 9–11) identified the Kentucky arrow darter as a Species of Greatest Conservation Need (rare or declining species that requires conservation actions to improve its status).

Summary of Factors Affecting the Species

Section 4 of the Act (16 U.S.C. 1533), and its implementing regulations at 50 CFR part 424, set forth the procedures for adding species to the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the Act, we may list a species based on (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors

affecting its continued existence. Listing actions may be warranted based on any of the above threat factors, singly or in combination.

Factor A: The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range

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, pp. 513–516; Branson and Batch 1974, pp. 82–83; Thomas 2008, pp. 6–7; KDOW 2010, pp. 70–84; KDOW 2013a, pp. 189–214, 337–376; KDOW 2013b, pp. 88–94). 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 instream 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, p. 84; KDOW 2013a, pp. 189–214, 337–376). KDOW (2013a, pp. 337–376) 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 (Table 2). 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, above).

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

[KDOW 2013a, pp. 337–376]

Stream	County	Impacted stream segment (km (mi))	Pollutant source	Pollutant
Buckhorn Creek	Breathitt	0–6.8	Abandoned Mine Lands, Unknown Sources.	Fecal Coliform (FC), Sediment/Siltation, Total Dissolved Solids (TDS).
Cope Fork (of Frozen Creek)	Breathitt	0–1.9	Channelization, Riparian Habitat Loss, Logging, Agriculture, Stream Bank Modification, Surface Coal Mining.	Sediment/Siltation, TDS.
Cutshin Creek	Leslie	9.7–10.7	Riparian Habitat Loss, Stream Bank Modification, Surface Coal Mining.	Sediment/Siltation.
Frozen Creek *	Breathitt	0–13.9	Riparian Habitat Loss, Post-Development Erosion and Sedimentation.	Sediment/Siltation.
Goose Creek	Clay	0–8.3	Septic Systems	FC.

TABLE 2—SUMMARY OF 303(D) LISTED STREAM SEGMENTS WITHIN THE HISTORICAL RANGE OF THE KENTUCKY ARROW DARTER—Continued
[KDOW 2013a, pp. 337–376]

Stream	County	Impacted stream segment (km (mi))	Pollutant source	Pollutant
Hector Branch	Clay	0–5.5	Unknown	Unknown.
Holly Creek *	Wolfe	0–6.2	Agriculture, Riparian Habitat Loss, Stream Bank Modification, Surface Coal Mining.	Sediment/Siltation, Unknown.
Horse Creek *	Clay	0–8.3	Riparian Habitat Loss, Managed Pasture Grazing, Surface Coal Mining.	Sediment/Siltation.
Laurel Creek	Clay	3.8–4.8	Managed Pasture Grazing, Crop Production.	Nutrients/Eutrophication.
Left Fork Island Creek	Owsley	0–5.0	Crop Production	Sediment/Siltation.
Long Fork	Breathitt	0–4.6	Surface Coal Mining	Sediment/Siltation, TDS.
Lost Creek	Breathitt	0–8.9	Coal Mining, Riparian Habitat Loss, Logging, Stream Bank Modification.	Fecal Coliform, Sedimentation, Total Dissolved Solids, Turbidity.
Lotts Creek	Perry	0.4–1.0, 1.2–6	Riparian Habitat Loss, Land Development, Surface Coal Mining, Logging, Stream Bank Modification.	Sediment/Siltation, TDS, Turbidity.
Quicksand Creek	Breathitt	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	0–17.2	Crop Production, Highway/Road/Bridge Runoff.	Sediment/Siltation, TDS.
South Fork Quicksand Creek	Breathitt	0–16.9	Riparian Habitat Loss, Petroleum/Natural Gas Production Activities, Surface Coal Mining.	Sediment/Siltation, TDS.
Spring Fork (Quicksand Creek) *.	Breathitt	3.1–6.9	Abandoned Mine Lands (Inactive), Riparian Habitat Loss, Logging, Stream Bank Modification.	Sediment/Siltation, TDS, Turbidity.
Squabble Creek *	Perry	0–4.7	Land Development, Surface Coal Mining.	Sediment/Siltation, TDS.
Sturgeon Creek	Lee	8.0–12.2	Riparian Habitat Loss, Crop Production, Surface Coal Mining.	Sediment/Siltation.
Swift Camp Creek	Wolfe	0–13.9	Unknown	Unknown.
Troublesome Creek	Breathitt	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.

Water Quality Degradation

A 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 it continues to be practiced throughout the drainage. As of January 2015, 318 mining permits were associated with coal removal and production activities within the upper Kentucky River drainage (Laird 2015, pers. comm.). Of these, 136 permits were associated with active coal removal, encompassing a combined area of 777 km² (191,968 ac). The remaining 196 permits were classified as temporarily inactive or were associated with some type of reclamation activity. Permits associated with active coal removal consisted of six

primary types: access road, loadout (areas of coal storage, often located away from the mine site), prep plant (facility that washes coal prior to transport by rail or truck), refuse facility (stores non-coal rock, water, and slurry originating from an underground mine), surface, and underground. With respect to permit type, the greatest number of permits was associated with surface mines (64 permits), followed by underground (32), prep plant (20), access road (13), refuse facility (5), and loadout (2). With respect to county distribution, Perry County had the most permits (59), followed by Leslie (28), Breathitt (16), Knott (16), Clay (12), Harlan (2), Owsley (2), and Jackson (1). No activity was reported for Lee or Wolfe Counties. Six permits were located in Kentucky arrow darter watersheds: Buckhorn Creek (Breathitt and Knott Counties), Bullskin Creek

(Clay County), and Left Fork Buffalo Creek (Owsley County).

Annual coal production in eastern Kentucky (including counties in the upper Kentucky River drainage) has declined over the past 2 decades, but annual production in eastern Kentucky continues to be relatively high (over 37 million tons produced in 2014) (KEEC 2014, pp. 1–5), recoverable reserves for the eastern Kentucky portion of the Appalachian Basin are estimated at 5.8 billion tons (Milici and Dennen 2009, pp. 8–11), and the species' distribution continues to be fragmented and reduced as a result of previous (legacy) mining activities within 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.

With regard to specific pollutants, 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, pp. 153–155; Dyer and Curtis 1977, pp. 10–13; Dyer 1982, pp. 1–16; Hren *et al.* 1984, pp. 5–34; USEPA 2003, pp. 77–84; Hartman *et al.* 2005, p. 95; Pond *et al.* 2008, pp. 721–723; Palmer *et al.* 2010, pp. 148–149; USEPA 2011, pp. 27–44). As rock strata and excess rock material (overburden) are exposed to the atmosphere during the mining process, 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; KDOW 2010, p. 85). Dissolved ions can enter streams through surface runoff or as groundwater flowing through fractured geologic layers. If valley fills (hollow-fills) are used as part of the mining activity, precipitation and groundwater seep through the fill and dissolve minerals until they discharge at the toe of the fill as surface water (Pond *et al.* 2008, p. 718). All of these scenarios 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, pp. 365–373; Johnson *et al.* 2010, pp. 1–2).

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, pp. 34–51; Pond 2004, p. 7; Hartman *et al.* 2005, p. 95; Pond *et al.* 2008, pp. 721–723; Pond 2010, pp. 189–198) and decreases in fish diversity (Kuehne 1962, pp. 608–614; Branson and Batch 1972, pp. 507–512; Branson and Batch 1974, pp. 81–83; Stauffer and Ferreri 2002, pp. 11–21; Fulk *et al.* 2003, pp. 55–64; Mattingly *et al.* 2005, pp. 59–62; Thomas 2008, pp. 1–9; Service 2012, pp. 1–4; Black *et al.* 2013, pp. 34–45; Hitt 2014, pp. 5–7, 11–13; Hitt and Chambers 2014, pp. 919–924; Daniel *et al.* 2015, pp. 50–61). Stauffer and Ferreri (2002, pp. 11–21) investigated fish assemblages in eastern Kentucky and West Virginia streams

and determined that fish assemblages downstream of valley fills supported about half the number of species found at reference sites. Fulk *et al.* (2003, pp. 55–64) used the Stauffer and Ferreri (2002, pp. 11–21) data set to calculate bioassessment scores and reported decreased richness of cyprinids (minnows), decreased richness of invertivores (species that feed on invertebrates), and increased proportions of tolerant individuals in small watersheds (2–10 km^2 (0.77–3.86 mi^2)) below valley fills. Hitt and Chambers (2014, pp. 919–924) observed lower fish taxonomic and functional diversity in streams downstream of valley fills in West Virginia. Exposure assemblages (those downstream of valley fills) had fewer species, lower abundances, and less biomass than reference assemblages across years and seasons. Taxonomic differences between reference and exposure (mined) assemblages were associated with conductivity and aqueous selenium concentrations (Hitt and Chambers 2014, pp. 919–924). Daniel *et al.* (2015, pp. 50–61) examined the effects of mining (coal and mineral) at larger spatial scales and determined that mining can be a regional source of disturbance that negatively impacts fish communities far downstream. Even in watersheds with low mine densities (less than 0.01 mines/ km^2 (0.004 mines/ mi^2)), Daniel *et al.* (2015, pp. 56–57) detected significant negative responses in multiple fish metrics (*e.g.*, diversity, evenness, percent invertivores). Compared to other anthropogenic impacts assessed over large areas (agriculture, urban land use), mining had a more pronounced and consistent impact on fish assemblages (Daniel *et al.* 2015, p. 58).

Studies in the upper Kentucky River basin by Branson and Batch (1974, pp. 81–83), Dyer and Curtis (1977, pp. 1–13), Kuehne (1962, pp. 608–609), Thomas (2008, pp. 3–6), Pond (2010, pp. 189–198), and the Service (2012, pp. 1–4) have clearly demonstrated that surface coal mining activities have contributed to water quality degradation (*e.g.*, elevated conductivity) and the extirpation of Kentucky arrow darter populations from numerous tributaries in the Quicksand Creek and Buckhorn Creek drainages of Breathitt and Knott Counties. 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)

watersheds, Breathitt County. Six first-order watersheds, three in the Leatherwood Creek watershed and three in the Bear Branch watershed, were investigated during the study, beginning in late summer 1967, prior to the onset of mining, and continuing until 1975. 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, 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. 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, variegated darter (*Etheostoma variatum*), greenside darter (*E. blennioides*), and emerald darter—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 Service (2012, pp. 1–4) resurveyed these streams in 2008–2009, and found that conductivity levels had increased since the 1970s, reaching 845 $\mu\text{S}/\text{cm}$ in Bear Branch and 1008 $\mu\text{S}/\text{cm}$ in Leatherwood Creek. Kentucky arrow darters were not observed at these sites.

There is a pattern of increasing conductivity and loss of arrow darter populations that 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, pp. 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. Kuehne (1962, pp. 608–609) documented Kentucky arrow darters at 16 of 22 sites within the drainage. Since that time, the majority of these watersheds have been mined extensively and conductivity levels have increased. The only exceptions are two unmined watersheds on UK's Robinson Forest (Clemons Fork and Coles Fork) and two first-order tributaries in the Buckhorn Creek headwaters (Eli Branch and Prince Fork). Thomas (2008, p. 5) and the Service (2012, pp. 1–4) resurveyed sites on all historical streams (and most historical sites) in the Buckhorn Creek watershed from 2007 to 2010, observing Kentucky arrow darters in only Clemons Fork, Coles Fork, and Buckhorn Creek, upstream of Emory Branch.

Conductivity levels of Clemons Fork, Coles Fork, and Buckhorn Creek (upstream of Emory Branch) remained at or near background levels (50 to 110 $\mu\text{S}/\text{cm}$), but conductivity levels at other streams were elevated, with some of these being exceptionally high (greater than 2000 $\mu\text{S}/\text{cm}$).

ATS (2011, pp. 1–17) surveyed 27 sites in the Buckhorn Creek headwaters in 2008, observing similar patterns with respect to conductivity and Kentucky arrow darter distributions. ATS (2011, pp. 1–17) observed a few Kentucky arrow darters in high conductivity reaches (e.g., Buckhorn Creek mainstem); however, all of these fishes were adults and were observed near low conductivity reaches (e.g., Prince Fork). Due to increased levels of dissolved solids (and elevated conductivity), portions of two streams in the Buckhorn Creek watershed, Buckhorn Creek (mile 0–6.8) and Long Fork (mile 0–8.95), have been placed on Kentucky's 303(d) list of impaired waters (KDOW 2013a, pp. 337–376).

As demonstrated above, Kentucky arrow darters tend to be less abundant in streams with elevated conductivity levels (Service 2012, pp. 1–4; Service 2013, p. 9), and are typically excluded from these streams as conductivity increases (Branson and Batch 1972, pp. 507–512; Branson and Batch 1974, pp. 81–83; Thomas 2008, p. 3–6). Recent range-wide surveys of historical sites by Thomas (2008, pp. 3–6) and the Service (2012, pp. 1–4) demonstrated that Kentucky arrow darters are excluded from watersheds when conductivity levels exceed about 250 $\mu\text{S}/\text{cm}$. The species was observed at only two historical sites where conductivity values exceeded 250 $\mu\text{S}/\text{cm}$, and average conductivity values were much lower at sites where Kentucky arrow darters were observed (115 $\mu\text{S}/\text{cm}$) than at sites where the species was not observed (689

$\mu\text{S}/\text{cm}$). A similar phenomenon was reported by Black *et al.* (2013, pp. 34–35), who developed and validated a habitat model for the federally threatened blackside dace (*Chrosomus cumberlandensis*) in the upper Cumberland River drainage. Hitt (2014, pp. 5–7, 11–13) used a large presence-absence data set (511 sites) from the Service, KDFWR, KSNPC, and KDOW to evaluate the relationship between Kentucky arrow darter abundance and stream conductivity. Hitt (2014, pp. 5–7, 11–13) reported that conductivity was a strong predictor of Kentucky arrow darter abundance, and sharp declines in abundance were observed at 258 $\mu\text{S}/\text{cm}$ (95 percent confidence intervals of 155–590 $\mu\text{S}/\text{cm}$). Conductivity was the most important variable for the species and was more than twice as important as the two next-most important variables (upstream percent of forest and percent of agricultural land uses). Based on all the research discussed above, we believe it is clear that the overall conductivity level is important in determining the Kentucky arrow darter's presence and vulnerability, but the species' presence is more likely tied to what individual metals or dissolved solids (e.g., sulfate) are present. Determination of discrete conductivity thresholds or the mechanisms through which fishes are influenced will require additional study (KSNPC 2010, p. 3).

Mine drainage can also cause chemical (and some physical) impacts to streams as a result of the precipitation of entrained metals and sulfate, which become unstable in solution (USEPA 2003, pp. 24–65; 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 have elevated levels of calcium in solution, and if pH is elevated, calcium sulfate (CaSO_4) or calcium carbonate (CaCO_3) will precipitate (Pond 2004, p. 7; USEPA 2005, pp. 24–65). 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, 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).

Oil and gas exploration and drilling activities represent another significant source of harmful pollutants in the upper Kentucky River basin (KDOW 2013a, 189–214). Since January 2010, over 500 oil and gas wells have been permitted in counties where the species was known historically (KGS 2015, pp. 1–2), and demand for natural gas production in Kentucky is expected to increase in future years (KGS 2002, p. 4; KGS 2015, pp. 1–2; Weisenfluh 2014, pp. 1–2). Alternative methods (i.e., hydraulic fracturing (“fracking”) and horizontal drilling) have allowed for the expansion of oil and gas drilling into deposits that were previously inaccessible (KGS 2015, pp. 1–2; Papoulias and Velasco 2013, p. 92). This has led to increased activity within eastern Kentucky, including portions of the upper Kentucky River basin. Recent observations by the Service indicate that new well sites have been developed near several Kentucky arrow darter streams in Breathitt, Clay, Knott, Lee, and Wolfe Counties (e.g., Hell Creek, Laurel Fork Quicksand Creek, Little Fork Lower Devil Creek, Spring Creek, and Walker Creek).

A variety of chemicals (e.g., hydrochloric acid, surfactants, potassium chloride) are used during the drilling and fracking process (Colborn *et al.* 2011, pp. 1040–1042). Once used, fluid wastes containing these chemicals 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, pp. 127–142; Kargbo *et al.* 2010, pp. 5680–5681; Osborn *et al.* 2011, pp. 8172–8176; Papoulias and Velasco 2013, pp. 92–111). In 2007, this type of event occurred during the development of four wells along Acorn Fork in Knox County, Kentucky (Papoulias and Velasco 2013, pp. 92–111). Fracking effluent overflowed the retention pits directly into Acorn Fork, a known habitat for the federally threatened blackside dace. The release affected the entire length of Acorn Fork downstream of the release points (an approximate 3.2-km (2-mi) reach), decimating the fish and macroinvertebrate communities and resulting in instream conductivity

readings above 30,000 $\mu\text{S}/\text{cm}$ (Papoulias and Velasco 2013, pp. 92–111). Fishes exposed to the affected portions of Acorn fork showed general signs of stress and had a higher incidence of gill lesions than unexposed reference fishes. Gill lesions were consistent with exposure to low pH and toxic concentrations of heavy metals (Papoulias and Velasco 2013, pp. 104–105). It is unclear how many blackside dace were killed during the event because peak mortality was likely missed before researchers arrived to document the incident. However, one dead, one moribund, and several living but distressed blackside dace were observed. Because oil and gas exploration activities are increasing within eastern Kentucky, events similar to the Acorn Fork spill have the potential to occur within the upper Kentucky River drainage. It is also likely that these types of incidents would go unreported given the lack of Federal oversight and the number and distribution of oil and gas wells that are being developed within the range of the species.

Other nonpoint-source pollutants that are common within the upper Kentucky River drainage and have the 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, pp. 189–214). 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, pp. 70–84; KDOW 2013a, pp. 189–214; KDOW 2013b, pp. 88–94). Nonpoint-source pollution from land surface runoff can originate from virtually any land use activity and may be correlated with impervious surfaces and storm water runoff (Allan 2004, pp. 266–267). Pollutants may include sediments, fertilizers, herbicides, pesticides, animal wastes, septic tank and gray water leakage, pharmaceuticals, and petroleum products. These pollutants tend to increase concentrations of nutrients and toxins in the water and alter the chemistry of affected streams such that the habitat and food sources for species like the Kentucky arrow darter are negatively impacted.

Physical Habitat Disturbance

Sedimentation (siltation) has been listed repeatedly by KDOW as the most common stressor of aquatic communities in the upper Kentucky River basin (KDOW 2010, pp. 70–84;

KDOW 2013a, pp. 189–214; KDOW 2013b, pp. 88–94). Sedimentation comes from a variety of sources, but KDOW identified the primary sources of sediment as loss of riparian habitat, surface coal mining, legacy coal extraction, logging, and land development (KDOW 2010, pp. 70–84; KDOW 2013b, pp. 88–94). All of these activities can result in canopy removal, channel disturbance, and increased siltation, thereby degrading habitats used by Kentucky arrow darters 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 fishes and macroinvertebrates (the food source for Kentucky arrow darters) (Minshall and Rugenski 2006, pp. 721–723). Channelization of streams associated with residential development and agriculture has been widespread within the upper Kentucky River drainage. Generally, streams are relocated to one side of the stream valley to provide space for home sites, livestock, hay production, or row crops. Channelization dramatically alters channel dimensions, gradient, stream flow, and instream habitats, and these modified channels are often managed through vegetation removal and dredging to improve flood conveyance (Allan and Castillo 2007, p. 327) and through placement of quarried stone or gabion baskets to protect against bank erosion. All of these activities create unstable stream segments with shifting substrates, heavy sedimentation, eroding banks, and poor to marginal habitat conditions for the species. Twenty-one streams within the species' historical and 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 (Table 2). The species has been extirpated from most of these streams (or watersheds) and is considered to be stable in only one (Frozen Creek).

Resource extraction activities (e.g., surface coal mining, legacy coal extraction, logging, oil and gas exploration and drilling) are major sources of sedimentation in streams (Paybins *et al.* 2000, p. 1; Wiley *et al.* 2001, pp. 1–16; KDOW 2013a, pp. 189–214). Activities associated with surface coal mining (e.g., land clearing, road construction, excavation) produce large areas of bare soil that, if not protected or controlled through various erosion

control practices, can contribute large amounts of sediment during storm events. Mining companies are required to implement erosion control measures during mining activities, but sedimentation continues to be a significant stressor in some mined watersheds (KDOW 2013a, pp. 189–214). Land use practices such as the placement of valley fills can affect sediment and water discharges into downstream stream reaches, leading to increased erosion or sedimentation patterns, destruction or modification of in-stream habitat and riparian vegetation, stream bank collapse, and increased water turbidity and temperature (Wiley *et al.* 2001, pp. 1–16; Messinger 2003, pp. 17–20).

Similarly, logging activities can adversely affect Kentucky arrow darters and other fishes through removal of riparian vegetation, direct channel disturbance, and sedimentation of instream habitats (Allan and Castillo 2007, pp. 332–333). During logging activities, 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. Logging impacts on sediment production can be considerable, but access and haul roads often produce more sediment than the land harvested for timber (Brim Box and Mossa 1999, p. 102). 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 (Allan 2004, p. 262). The lack of stream-side vegetation also promotes bank erosion that alters stream courses and introduces large quantities of sediment into the channel. This can lead to channel instability and further degradation of in-stream 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 (Allan 2004, p. 262; Hauer and Lamberti 2006, pp. 721–723). 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).

Stormwater runoff from unpaved roads, all-terrain vehicle (ATV) trails,

and driveways represents a significant but difficult to quantify source of sediment that impacts streams in the upper Kentucky River basin.

Observations made by Service personnel during field collections suggest that this is a common and widespread problem during storm events across the species' range. 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 (Berkman and Rabeni 1987, pp. 285–294; Waters 1995, pp. 5–7; Wood and Armitage 1997, pp. 211–212; Meyer and Sutherland 2005, pp. 2–3).

Invasion of Hemlock Woolly Adelgid

The hemlock woolly adelgid (HWA) (*Adelges tsugae*), an aphid-like insect native to Asia, represents a potential threat to the Kentucky arrow darter because it has the potential to severely damage stands of eastern hemlocks (*Tsuga canadensis*) that occur within the species' range. The HWA was introduced in the Pacific Northwest during the 1920s, and has since spread throughout the eastern United States, reaching eastern Tennessee by 2002, and Kentucky by 2006. The species creates an extreme amount of damage to natural stands of hemlock, specifically eastern hemlock and Carolina hemlock (*Tsuga caroliniana*). Loss of hemlocks along Kentucky arrow darter streams has the potential to result in increased solar exposure and subsequent elevated stream temperatures, bank erosion, and excessive inputs of woody debris that will clog streams and cause channel instability and erosion (Townsend and Rieske-Kinney 2009, pp. 1–3). We expect these impacts to occur in some Kentucky arrow darter watersheds; however, we do not believe these impacts will be widespread or severe. Eastern hemlocks are not abundant in all portions of the Kentucky arrow darter's range, and we expect hemlocks to be replaced by other tree species in areas where hemlocks are more common. Our review of the available information indicates that the invasion of HWA and the subsequent loss of eastern hemlock in eastern Kentucky does not pose a threat to the Kentucky arrow darter, nor is it likely to become a threat in the future.

In summary, habitat loss and modification represent threats to the Kentucky arrow darter. Severe degradation from contaminants, sedimentation, and physical habitat disturbance have contributed to extirpations of Kentucky arrow darter

populations, and these threats continue to impact water quality and habitat conditions across the species' range. Contaminants associated with surface coal mining (metals, other dissolved solids), domestic sewage (bacteria, nutrients), and agriculture (fertilizers, pesticides, herbicides, and animal waste) cause degradation of water quality and habitats through increased conductivity and sulfates, instream oxygen deficiencies, excess nutrification, and excessive algal growths. Sedimentation from surface coal mining, logging, agriculture, and land development negatively affect the Kentucky arrow darter by burying or covering instream habitats used by the species for foraging, reproduction, and sheltering. These impacts can cause reductions in growth rates, disease tolerance, and gill function; reductions in spawning habitat, reproductive success, and egg, larval, and juvenile development; modifications of migration patterns; decreased food availability through reductions in prey; and reduction of foraging efficiency. Furthermore, these threats faced by the Kentucky arrow are the result of ongoing land uses that are expected to continue indefinitely.

Factor 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 by recreational anglers and used as live bait, but we believe these activities are practiced infrequently and do not represent a threat to the species. Our review of the available information does not indicate that overutilization is a threat to the Kentucky arrow darter now or likely to become so in the future.

Factor C: Disease or Predation

No information is available suggesting that disease is a threat to the Kentucky arrow darter; therefore, we do not consider disease to be a factor in the decline of the species. As to predation, although the Kentucky arrow darter is undoubtedly consumed by native predators (e.g., fishes, amphibians, and birds), the available information suggests that this predation is naturally occurring and a normal aspect of the species' population dynamics. Nonnative rainbow trout (*Oncorhynchus mykiss*) represent a potential predation threat (Etnier and Starnes 1993, p. 346) as they are introduced annually by KDFWR into portions of three Kentucky arrow darter

streams: Big Double Creek (Clay County), Sturgeon Creek (Lee County), and Swift Camp Creek (Wolfe County). Annual totals of 800 and 1,000 rainbow trout are introduced into Sturgeon Creek and Swift Camp Creek, respectively, but in these watersheds Kentucky arrow darter populations occupy portions of small tributaries located outside of actual stocking locations. Therefore, it is unlikely that rainbow trout and Kentucky arrow darters interact in these watersheds.

Up to 1,000 rainbow trout are stocked annually by KDFWR within Big Double Creek, with releases occurring in March, April, May, and October in habitats occupied by Kentucky arrow darters. KDFWR has no specific information on the feeding habits of rainbow trout in Big Double Creek, but KDFWR supported a research project (Brandt 2006, pp. 1–59) investigating the impact of stocked rainbow trout on native fishes in Rock Creek, McCreary County, Kentucky. Brandt (2006, pp. 1–59) examined the guts of 11 introduced rainbow trout obtained from 32 sampling sites within the Rock Creek watershed. The majority of stomachs were empty or contained remains of macroinvertebrates; however, gut contents from two individuals included remains of two native fishes, telescope shiner (*Notropis telescopus*) (n=2) and emerald darter (n=1). Brandt (2006, pp. 1–59) demonstrated that stocked rainbow trout can be piscivorous in Kentucky streams, but the magnitude of this threat was unclear.

Within Big Double Creek, stockings of rainbow trout have occurred for over 30 years (Williams 2014, pers. comm.), but the Kentucky arrow darter population in this stream continues to persist and appears to be stable (Table 1, above) based on recent surveys (Thomas 2008, p. 4; Thomas *et al.* 2014, p. 23). KDFWR also has no evidence suggesting that stocked rainbow trout can survive typical summer temperatures (greater than 19 °C (66 °F)) within Big Double Creek (Williams 2014, pers. comm.); stocked individuals are caught by anglers or perish once stream temperatures rise in warmer months. To assess the potential predation of rainbow trout on Kentucky arrow darters or other fishes, the Service and DBNF surveyed a 2.1-km (1.3-mile) reach of Big Double Creek on April 21, 2014, 17 days after KDFWR's April stocking event (250 trout). A total of seven rainbow trout were captured, and the gut contents of these individuals were examined. Food items were dominated by Ephemeroptera (mayflies), with lesser amounts of Plecoptera (stoneflies), Trichoptera

(caddisflies), Diptera (flies), Decapoda (crayfish), and terrestrial Coleoptera (beetles). No fish remains were observed. Based on all these factors and the absence of rainbow trout from the majority (98 percent) of Kentucky arrow darter streams, we do not believe that predation by nonnative rainbow trout poses a threat to the species. Our review of available information indicates that neither disease nor predation is currently a threat to the species or likely to become a threat to the Kentucky arrow darter in the future.

Factor D: The Inadequacy of Existing Regulatory Mechanisms

The Kentucky arrow darter has been identified as a threatened species within Kentucky (KSNPC 2014, p. 40), but this State designation conveys no legal protection for the species or its habitat. Kentucky law prohibits the collection of the Kentucky arrow darter (or other fishes) for scientific purposes without a valid State-issued collecting permit (Kentucky Revised Statutes (KRS) sec. 150.183). Enforcement of this permit requirement is difficult, but as discussed above under Factor B, we do not believe that these activities represent a threat to the species. Kentucky regulations (301 KAR 1:130, sec. 1(3)) also allow persons who hold a valid Kentucky fishing license (obtained from KDFWR) 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; however, again as discussed under Factor B, we believe these activities are practiced infrequently and do not represent a threat to the species. Because activities associated with these laws and regulations do not represent threats to the Kentucky arrow darter, we find that these existing regulatory mechanisms have been adequate in protecting the species.

Streams within UK's Robinson Forest (Coles Fork, Snag Ridge Fork, and Clemons Fork) are currently protected from the effects of surface coal mining due to a 1990 "lands unsuitable for mining" designation (405 KAR 24:040). The Secretary of the Kentucky Energy and Environment Cabinet (KEEC) has the authority to designate certain lands as unsuitable for mining if these activities will: (1) Be incompatible with existing State and local land use plans; (2) affect fragile or historic lands in which such operations could result in significant damage to important historic, cultural, scientific, and aesthetic values,

and natural systems; (3) affect renewable resource lands in which such operations could result in a substantial loss or reduction of long-range productivity of water supply or food or fiber products, and such lands to include aquifers and aquifer recharge areas; or (4) affect natural hazard lands in which such operations could substantially endanger life and property, such lands to include areas subject to frequent flooding and areas of unstable geology. The designation was made by the Secretary of the KEEC in response to a petition from the Sierra Club, Kentucky Resources Council, Inc., and Kentucky Conservation Foundation. The Secretary concluded that surface coal mining and reclamation operations were incompatible with UK's existing land use management plan and that these activities would significantly damage important scientific resources within the petition area.

Portions of 22 of the 47 streams with extant Kentucky arrow darter populations are located on the DBNF and receive management and protection through DBNF's land and resource management plan (LRMP) (USFS 2004, pp. 7–16). Public ownership in these watersheds ranges from about 50 to 100 percent. The LRMP is implemented through a series of project-level decisions based on appropriate site-specific analysis and disclosure. It does not contain a commitment to select any specific project; rather, it sets up a framework of desired future conditions with goals, objectives, and standards to guide project proposals. Projects are proposed to solve resource management problems, move the forest environment toward desired future conditions, and supply goods and services to the public (USFS 2004, pp. 7–16). The LRMP contains a number of protective standards that in general are designed to avoid and minimize potential adverse effects to the Kentucky arrow darter and other sensitive species; however, the DBNF will continue to consult with the Service when their activities may adversely affect streams supporting Kentucky arrow darters. In addition to conservation benefits provided by the LRMP, the Service and DBNF signed a candidate conservation agreement (CCA) for the Kentucky arrow darter in August 2015. 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 (USFWS and USFS 2015). The DBNF's ownership

and management under the LRMP contributes substantially to the conservation of the Kentucky arrow darter. A significant portion (about 38 percent) of the species' remaining populations occurs within the DBNF, and these populations have benefited from management goals, objectives, and protective standards included in the LRMP. Collectively, these streams contain some of the best remaining habitats for the species and support some of the species' most robust populations.

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 be a pose a threat to the species.

Although water quality has generally improved since the Clean Water Act and SMCRA were enacted or amended in 1977, there is continuing, ongoing degradation of water quality within the range of the Kentucky arrow darter. The species has been extirpated from 36 of its 74 historical streams (49 percent), and 16 of these extirpations (16 streams) have occurred since the mid-1990s. A total of 21 streams (335.8 stream km (208.7 stream mi)) within the species' historical range have been identified as impaired by the KDOW and placed on the State's 303(d) list of impaired waters. Of these 21 streams, only 5 continue to be occupied by Kentucky arrow darter (see Table 2), 4 of which are considered "vulnerable" (see Table 1). Resource extraction (e.g., coal mining, logging, oil/gas well development), land development, agricultural activities, stream bank modification, channelization, riparian habitat loss, and inadequate sewage treatment have been identified as sources of the impairment (Branson and Batch 1972, pp. 513–516; Branson and

Batch 1974, pp. 82–83; Thomas 2008, pp. 6–7; KDOW 2010, pp. 70–84; KDOW 2013a, pp. 189–214, 337–376; KDOW 2013b, pp. 88–94). Identified stressors (pollutants) include dissolved solids and elevation of instream conductivity, sediment/siltation, fecal coliform bacteria, nutrients/eutrophication, and turbidity (KDOW 2010, p. 84; KDOW 2013a, pp. 189–214, 337–376). 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 pollutant of concern that will improve water quality to meet the applicable standards. At present, the KDOW has not established TMDLs for identified pollutants within portions of the upper Kentucky River basin historically occupied by the Kentucky arrow darter. At present, TMDLs are not an adequate mechanism to address chemical pollutants or sedimentation of aquatic habitats. The Service is also not aware of any other current or future changes to State or Federal water quality or mining laws that will substantially affect the currently observed degradation of water quality.

Nonpoint-source pollution, originating from mine sites, unpaved roads, all-terrain vehicle (ATV) trails, driveways, logging skid trails, and other disturbed habitats is considered to be a continuing threat to Kentucky arrow darter habitats. Nonpoint-source pollution is caused by rainfall or snowmelt moving over and through the ground as runoff and transporting natural (sediment) and human-made pollutants to lakes, rivers, wetlands, coastal waters, and ground waters. Current laws do not adequately protect the Kentucky arrow darter and its habitats from nonpoint-source pollution because there is limited compliance with existing laws to prevent sediment and other pollutants from entering waterways. For example, forestry operations do not have permitting requirements under the Clean Water Act because there is a silvicultural exemption as long as best management practices (BMPs) are used to help control nonpoint-source pollution (Ryder and Edwards 2006, entire). The Kentucky Forest Conservation Act of 1998 (KRS 149.330–149.355) was developed to regulate timber harvesting operations in Kentucky. It requires that a Master Logger be on-site and in charge of commercial logging operations, and it also requires that all timber harvesting operators use appropriate best management practices (BMPs) for protection of water quality (Stringer and Thompson 2000, pp. 2–3). Without properly installed BMPs, 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.

Compliance monitoring from May 2014 to May 2015 within counties located in the upper Kentucky River basin indicated that approximately 19 percent of inspected sites (47 sites out of a total of 246 inspected sites) had some kind of compliance issue (e.g., poor BMP use), resulting in a written warning by the Kentucky Division of Forestry and at least a follow-up visit (Metzger 2015, pers. comm.). Because sediment BMPs are not always strictly applied and logging activities often result in water quality impairment, the Kentucky Forest Conservation Act is an inadequate regulatory mechanism for the protection of aquatic habitats supporting the Kentucky arrow darter.

Kentucky State laws and regulations regarding oil and gas drilling are generally designed to protect fresh water resources like the Kentucky arrow darter's habitat, but these regulatory mechanisms do not contain specific provisions requiring an analysis of project impacts to fish and wildlife resources (Kentucky Division of Oil and Gas *et al.* 2012, entire). Current regulations also do not contain or provide any formal mechanism requiring coordination with, or input from, the Service or the KDOW regarding the presence of federally endangered, threatened, or candidate species, or other rare and sensitive species.

In July of 2015, the Office of Surface Mining Reclamation and Enforcement (OSM) published in the **Federal Register** a Notice of Availability for a draft environmental impact statement regarding a proposed Stream Protection Rule (80 FR 42535; July 17, 2015) and the proposed Stream Protection Rule (80 FR 44436, July 27, 2015). The proposed rule states: "This proposed rule would better protect streams, fish, wildlife, and related environmental values from the adverse impacts of surface coal mining operations and provide mine operators with a regulatory framework to avoid water pollution and the long-term costs associated with water treatment" (80 FR 44436, see SUMMARY). While this proposed rule may provide benefits for the Kentucky arrow darter in the future, until the rule is finalized and implemented, we are unable to evaluate its potential effectiveness with regard to the Kentucky arrow darter and its habitat.

In summary, degradation of habitat for the Kentucky arrow darter is ongoing

despite existing regulatory mechanisms. These regulatory mechanisms have been inadequate to reduce or remove the threats to the Kentucky arrow darter.

Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence

Restricted Range and Population Size

The disjunct nature of some Kentucky arrow darter populations (Figures 2 and 3, above) restricts the natural exchange of genetic material between populations and makes natural repopulation following localized extirpations of the species arduous without human intervention. The localized nature and small size of many populations also 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, such as loss of genetic variation and inbreeding (Soulé 1980, pp. 157–158; Hunter 2002, pp. 97–101; Allendorf and Luikart 2007, pp. 117–146). Inbreeding and loss of neutral genetic variation associated with small population size can further reduce the fitness of the population (Reed and Frankham 2003, pp. 230–237), subsequently accelerating population decline (Fagan and Holmes 2006, pp. 51–60).

Species that are restricted in range and population size are 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, pp. 157–158; Hunter 2002, pp. 97–101; Allendorf and Luikart 2007, pp. 117–146). It is likely that some of the Kentucky arrow darter populations are below the effective population size required to maintain long-term genetic and population viability (Soulé 1980, pp. 162–164; Hunter 2002, pp. 105–107). The long-term viability of a species is founded on the conservation of numerous local populations throughout its geographic range (Harris 1984, pp. 93–104). These separate populations are essential for the species to recover and adapt to environmental change (Noss and Cooperrider 1994, pp. 264–297; Harris 1984, pp. 93–104). The level of isolation seen in this species makes natural repopulation following localized extirpations virtually impossible without human intervention.

Climate Change

The Intergovernmental Panel on Climate Change (IPCC) concluded that warming of the climate system is unequivocal (IPCC 2014, p. 3). Numerous long-term climate changes have been observed including changes in arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves, and the intensity of tropical cyclones (IPCC 2014, p. 4). Species that are dependent on specialized habitat types, limited in distribution, or at the extreme periphery of their range may be most susceptible to the impacts of climate change (see 75 FR 48911, August 12, 2010); however, while continued change is certain, the magnitude and rate of change is unknown in many cases.

Climate change has the potential to increase the vulnerability of the Kentucky arrow darter to random catastrophic events (McLaughlin *et al.* 2002, pp. 6060–6074; Thomas *et al.* 2004, pp. 145–148). An increase in both severity and variation in climate patterns is expected, with extreme floods, strong storms, and droughts becoming more common (Cook *et al.* 2004, pp. 1015–1018; Ford *et al.* 2011, p. 2065; IPCC 2014, pp. 58–83). Thomas *et al.* (2004, pp. 145–148) report that frequency, duration, and intensity of droughts are likely to increase in the Southeast as a result of global climate change. Predicted impacts of climate change on fishes include disruption to their physiology (such as temperature tolerance, dissolved oxygen needs, and metabolic rates), life history (such as timing of reproduction, growth rate), and distribution (range shifts, migration of new predators) (Jackson and Mandrak 2002, pp. 89–98; Heino *et al.* 2009, pp. 41–51; Strayer and Dudgeon 2010, pp. 350–351; Comte *et al.* 2013, pp. 627–636). According to Kaushal *et al.* (2010, p. 465), stream temperatures in the Southeast have increased roughly 0.2–0.4 °C per decade over the past 30 years, and as air temperature is a strong predictor of water temperature, stream temperatures are expected to continue to rise.

Estimates of the effects of climate change using available climate models typically lack the geographic precision needed to predict the magnitude of effects at a scale small enough to discretely apply to the range of a given species. However, data on recent trends and predicted changes for Kentucky (Girvetz *et al.* 2009, pp. 1–19), and, more specifically, the upper Kentucky

River drainage (Alder and Hostetler 2013, entire) provide some insight for evaluating the potential threat of climate change to the Kentucky arrow darter. These models provide estimates of average annual increases in maximum and minimum temperature, precipitation, snowfall, and other variables. Depending on the chosen model, average annual temperatures for Kentucky and the upper Kentucky River drainage are expected to increase by 2.5 to 5 °C (4.5 to 9 °F) by the 2080s (Girvetz *et al.* 2009, pp. 1–19; Alder and Hostetler 2013, pp. 1–9), while precipitation models predict that Kentucky will experience a slight increase in average annual precipitation (2 cm/day (0.8 in/day) (x 100)) through 2074 (Girvetz *et al.* 2009, pp. 1–19; Alder and Hostetler 2013, pp. 1–9).

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, entire), 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, p. 18). Thus, we consider climate change to be a threat to the Kentucky arrow darter.

In summary, we have determined that other natural and manmade factors, such as geographical isolation, small population size, and climate change, are threats to remaining populations of the Kentucky arrow darter across its range. The severity of these threats is high because of the species' reduced range and population size, which result in a reduced ability to adapt to environmental change. Further, our review of the best available scientific and commercial information indicates that these threats are likely to continue or increase in the future.

Proposed Determination

We have carefully assessed the best scientific and commercial information available regarding the past, present, and future threats to the Kentucky arrow darter. As described in detail above, the Kentucky arrow darter has been extirpated from about 49 percent of its historical range (36 of 74 historical streams), 16 of these extirpations have occurred since the mid-1990s, populations in nearly half of the species' occupied streams are ranked as vulnerable (see Table 1, above), remaining populations are fragmented

and isolated, and the species continues to be at risk throughout all of its range due to the immediacy, severity, and scope of threats from three of the five threat factors: habitat degradation and range curtailment (Factor A), inadequacy of existing regulatory mechanisms (Factor D), and other natural or manmade factors affecting its continued existence (Factor E).

Anthropogenic activities such as surface coal mining, logging, oil/gas development, land development, agriculture, and inadequate sewage treatment have all contributed to the degradation of stream habitats within the species' range (Factor A). These land use activities have led to chemical and physical changes to stream habitats that continue to affect the species. Specific stressors include inputs of dissolved solids and elevation of instream conductivity, sedimentation/siltation of stream substrates, turbidity, and inputs of nutrients and organic enrichment. These high magnitude stressors, especially the inputs of dissolved solids and sedimentation, have had profound negative effects on Kentucky arrow darter populations and have been the primary factor in the species' decline. Existing regulatory mechanisms (e.g., the Clean Water Act) have provided for some improvements in water quality and habitat conditions across the species' range, but these laws and regulations have been inadequate in protecting the species' habitat (Factor D), as evidenced by recent extirpations (16 streams since the 1990s) and the 21 303(d) listed streams within the species' historical range. The Kentucky arrow darter's vulnerability to these threats is even greater due to its reduced range, fragmented populations, and small or declining population sizes (Factor E) (Primack 2012, pp. 146–150). The effects of certain threats, particularly habitat degradation and loss, increase in magnitude when population size is small (Primack 2012, pp. 150–152).

The Act defines an endangered species as any species that is “in danger of extinction throughout all or a significant portion of its range” and a threatened species as any species “that is likely to become endangered throughout all or a significant portion of its range within the foreseeable future.” We find that the Kentucky arrow darter meets the definition of a threatened species based on the immediacy, severity, and scope of the threats identified above. The species' overall range has been reduced substantially, most of the species' historical habitat has been degraded, and much of the remaining habitat exists primarily in fragmented patches. Current Kentucky

arrow darter habitats continue to be lost or degraded due to surface coal mining, logging, oil/gas development, land development, agriculture, and inadequate sewage treatment, and it appears this trend will continue in the future. Regulatory mechanisms such as the Clean Water Act have been inadequate to reduce or remove these types of threats to the species. Extant populations are known from 47 streams, but these populations continue to be threatened by small population size, isolation, fragmentation, climate change, and the habitat degradation summarized above. All of these factors make the species particularly susceptible to extinction in the future.

We find that endangered status is not appropriate for the Kentucky arrow darter because we do not consider the species' threats to be so severe that extinction is imminent. Although threats to the species are ongoing, often severe, and occurring across the range, populations continue to occupy 47 scattered streams, 23 of which appear to support stable populations (see Table 1, above). Additionally, a significant number of extant Kentucky arrow darter populations (49 percent) occur primarily on public lands (*i.e.*, DBNF and Robinson Forest) that are at least partially managed to protect habitats used by the species. For example, the CCA with the U.S. Forest Service (USFS) for DBNF should provide an elevated level of focused management and conservation for portions of 20 streams that support populations of the Kentucky arrow darter. Based on all these factors, the Kentucky arrow darter does not meet the definition of an endangered species. Therefore, on the basis of the best available scientific and commercial information, we propose listing the Kentucky arrow darter as a threatened species in accordance with sections 3(20) and 4(a)(1) of the Act.

Under the Act and our implementing regulations, a species may warrant listing if it is an endangered or threatened species throughout all or a significant portion of its range. Because we have determined that the Kentucky arrow darter is a threatened species throughout all of its range, no portion of its range can be "significant" for purposes of the definitions of "endangered species" and "threatened species." See the Final Policy on Interpretation of the Phrase "Significant Portion of Its Range" in the Endangered Species Act's Definitions of "Endangered Species" and "Threatened Species" (79 FR 37577, July 1, 2014).

Available Conservation Measures

Conservation measures provided to species listed as endangered or threatened under the Act include recognition, recovery actions, requirements for Federal protection, and prohibitions against certain practices. Recognition through listing results in public awareness and conservation by Federal, State, Tribal, and local agencies; private organizations; and individuals. The Act encourages cooperation with the States and other countries and calls for recovery actions to be carried out for listed species. The protection required by Federal agencies and the prohibitions against certain activities are discussed, in part, below.

The primary purpose of the Act is the conservation of endangered and threatened species and the ecosystems upon which they depend. The ultimate goal of such conservation efforts is the recovery of these listed species, so that they no longer need the protective measures of the Act. Subsection 4(f) of the Act calls for the Service to develop and implement recovery plans for the conservation of endangered and threatened species. The recovery planning process involves the identification of actions that are necessary to halt or reverse the species' decline by addressing the threats to its survival and recovery. The goal of this process is to restore listed species to a point where they are secure, self-sustaining, and functioning components of their ecosystems.

Recovery planning includes the development of a recovery outline shortly after a species is listed and preparation of a draft and final recovery plan. The recovery outline guides the immediate implementation of urgent recovery actions and describes the process to be used to develop a recovery plan. The plan may be revised to address continuing or new threats to the species, as new substantive information becomes available. The recovery plan also identifies recovery criteria for review of when a species may be ready for reclassification from endangered to threatened or for delisting and methods for monitoring recovery progress. Recovery plans also establish a framework for agencies to coordinate their recovery efforts and provide estimates of the cost of implementing recovery tasks. Recovery teams (composed of species experts, Federal and State agencies, nongovernmental organizations, and stakeholders) are often established to develop recovery plans. If the species is listed, a recovery outline, draft recovery plan, and the final recovery plan will be available on

our Web site (<http://www.fws.gov/endangered>), or from our Kentucky Ecological Services Field Office (see **FOR FURTHER INFORMATION CONTACT**).

Implementation of recovery actions generally requires the participation of a broad range of partners, including other Federal agencies, States, Tribes, nongovernmental organizations, businesses, and private landowners. Examples of recovery actions include habitat restoration (*e.g.*, restoration of native vegetation), research, captive propagation and reintroduction, and outreach and education. The recovery of many listed species cannot be accomplished solely on Federal lands because their range may occur primarily or solely on non-Federal lands. To achieve recovery of these species requires cooperative conservation efforts on private, State, and Tribal lands. If this species is listed, funding for recovery actions will be available from a variety of sources, including Federal budgets, State programs, and cost share grants for non-Federal landowners, the academic community, and nongovernmental organizations. In addition, pursuant to section 6 of the Act, the State of Kentucky would be eligible for Federal funds to implement management actions that promote the protection or recovery of the Kentucky arrow darter. Information on our grant programs that are available to aid species recovery can be found at: <http://www.fws.gov/grants>.

Although the Kentucky arrow darter is only proposed for listing under the Act at this time, please let us know if you are interested in participating in conservation efforts for this species. Additionally, we invite you to submit any new information on this species whenever it becomes available and any information you may have for conservation planning purposes (see **FOR FURTHER INFORMATION CONTACT**).

Section 7(a) of the Act requires Federal agencies to evaluate their actions with respect to any species that is proposed or listed as an endangered or threatened species and with respect to its critical habitat, if any is designated. Regulations implementing this interagency cooperation provision of the Act are codified at 50 CFR part 402. Section 7(a)(4) of the Act requires Federal agencies to confer with the Service on any action that is likely to jeopardize the continued existence of a species proposed for listing or result in destruction or adverse modification of proposed critical habitat. If a species is listed subsequently, section 7(a)(2) of the Act requires Federal agencies to ensure that activities they authorize, fund, or carry out are not likely to

jeopardize the continued existence of the species or destroy or adversely modify its critical habitat. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into consultation with the Service.

Federal agency actions within the species' habitat that may require conference or consultation or both as described in the preceding paragraph include management and any other landscape-altering activities on Federal lands administered by the USFS; issuance of section 404 Clean Water Act permits by the U.S. Army Corps of Engineers; construction and maintenance of gas pipeline and power line rights-of-way by the Federal Energy Regulatory Commission; Environmental Protection Agency pesticide registration; construction and maintenance of roads or highways by the Federal Highway Administration; and projects funded through Federal loan programs which may include, but are not limited to, roads and bridges, utilities, recreation sites, and other forms of development.

Several conservation efforts are already being undertaken for the Kentucky arrow darter. The Service, in cooperation with KDFWR, KSNPC, U.S. Geological Survey (USGS), KDOW, DBNF, CFI, and The Appalachian Wildlife Foundation, Inc., completed a conservation strategy for the Kentucky arrow darter in 2014 (Service 2014, *entire*). 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 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'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).

With respect to the conservation strategy's first objective, several research projects have been initiated that will provide new information on the species' biology and threats (see descriptions in the following paragraphs). These projects include studies on the species' distribution, status, and population size; movement and microhabitat characteristics; genetics; and response to changes in water quality (*e.g.*, conductivity). Initial efforts to address objectives 2–4 have included the development of a CCA with the USFS, a propagation and reintroduction study

by KDFWR and CFI, field investigations to determine the predatory risk posed by nonnative trout, and continued informal discussions with our Federal, State, and private partners. If implemented, specific actions identified in the conservation strategy will help to reduce current threats to the Kentucky arrow darter.

As stated above, the Service and USFS recently signed a CCA for the Kentucky arrow darter on the 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 is 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.

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, *entire*). The species remains a SGCN in the most recent version of the plan (KDFWR 2013, pp. 61–62), which identifies conservation issues (threats), conservation actions, and monitoring strategies for 301 animal species belonging to 1 of 20 terrestrial and aquatic habitat guilds (collection of species that occur in the same habitat). In the original plan, KDFWR developed a priority list of research and survey needs for Kentucky's SGCN. In 2008, KDFWR attempted to address two of these needs by initiating a propagation and reintroduction study for the Kentucky arrow darter through the Service's State Wildlife Program (Ruble *et al.* 2010, *entire*). The study was designed to document details on the species' reproductive biology and to begin conservation actions (*e.g.*, propagation followed by reintroduction or augmentation) that would benefit the species. The KDFWR partnered with CFI to develop successful spawning protocols and produce the offspring needed to augment populations within the species' current range.

From 2009 to 2011, a total of 145 captive-spawned, juvenile Kentucky arrow darters (originating from brood stock taken from Big Double Creek) were produced by CFI, tagged (Northwest Marine Technologies elastomer tag), and introduced into Sugar Creek, Leslie County, a tributary of the Red Bird River in the DBNF, Redbird District (Thomas and Brandt 2012, pp. 57–64). Attempts to relocate tagged darters in August

2009, October 2009, March 2010, January 2012, and February 2012, were unsuccessful, so KDFWR and CFI made the decision to abandon efforts at Sugar Creek and begin another reintroduction effort at Long Fork, another DBNF stream and tributary of Hector Branch in Clay County.

Since August 2012, a total of 1,447 captive-spawned KADs (about 50–55 mm TL) 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) (Thomas *et al.* 2014, p. 23). Tagged darters have been observed throughout the Long Fork mainstem, both upstream and downstream of the release points, and two tagged individuals have been observed outside of Long Fork—one in Hector Branch, just downstream of its confluence with Long Fork, and one at the mouth of Deerlick Branch, a first-order tributary of Hector Branch located approximately 1 km (0.6 mi) downstream of the confluence of Long Fork and Hector Branch. The majority of individuals have been found in pools (depth of 20–61 cm (8–24 in)) with rock substrates, exposed bedrock, and some marginal cover (*e.g.*, tree roots). Surveys in July, August, and October 2013, produced a total of 20, untagged young-of-year arrow darters, while surveys in March, July, August, and October 2013, produced 25 untagged young-of-year. These results indicate natural reproduction in Long Fork. In 2015, KDFWR observed five untagged individuals in Hector Branch, approximately 0.6 km (0.4 mi) upstream of its confluence with Long Fork, and four untagged individuals in Deerlick Branch, approximately 1 km (0.6 mi) downstream of the confluence of Long Fork and Hector Branch. Additional monitoring and releases are planned for 2015.

The Service and KDFWR are working with ECU on a study that is 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 (Harrel and Baxter 2013, *entire*). ECU is using PIT-tags and placed antenna systems to monitor intra- and inter-tributary movement patterns in both streams, and they have 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. Preliminary findings include the following:

- 126 individuals pit-tagged;
- Population estimates for Elisha Creek: 592–1,429 individuals (summer) and 661–1,359 (fall) (range here and below reflects 95 percent confidence intervals);
- Population estimate for Gilberts Big Creek: 175–358 (summer);
- Maximum observed movement: 4,078 m (2.5 mi) (female, downstream in Gilberts Big Creek); and
- Other observed movements (7 individuals): 134 m (439 ft) (upstream), 328 m (1,076 ft) (downstream), 351 (1,151 ft) (upstream), 900 m (2,952 ft) (upstream/downstream), 950 m (3,116 ft) (downstream), 1,282 m (4,028 ft) (downstream) and 1,708 m (5,603 ft) (downstream).

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 basin. One important aspect of the study was to account for imperfect detection 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 (MacKenzie *et al.* 2002, entire; MacKenzie *et al.* 2005, entire). 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 status surveys by Thomas (2008, pp. 1–33) and Service (2012, pp. 1–4). Presently, KSNPC and the Service are in the data analysis stage of this project.

In July 2013, ECU, 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). Preliminary findings of this study were presented at the 2013 Southeastern Fishes Council Meeting, Lake Guntersville, Alabama (November 14–15, 2013).

Austin Peay State University is currently working 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 (Johansen *et al.* 2013, pp. 1–3). Approximately 25 individuals per population from up to 12 populations across the range of the species will be genotyped using microsatellite markers. Resulting data will be used to generate robust estimates of effective population sizes and overall population and species' variability. This information is essential to the development of effective conservation and recovery measures to ensure the long-term persistence of the species. Funding for this project is being provided through the Service's section 6 program.

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 (Hitt 2014, entire). 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, Dr. Hitt 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. Nonlinear regressions indicated a distinct decline in Kentucky arrow darter abundance at 258 $\mu\text{S}/\text{cm}$ (95 percent confidence intervals 155–590 $\mu\text{S}/\text{cm}$), above which abundances were negligible. Nonlinear threshold declines for blackside dace were observed at 343 $\mu\text{S}/\text{cm}$, and 95 percent confidence intervals bounded this relationship between 123–632 $\mu\text{S}/\text{cm}$. Boosted regression results indicated that stream conductivity was the strongest predictor in separate analyses of Kentucky arrow darter and blackside dace abundance. Hitt (2014, pp. 7–8) 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.

Proposed Special Rule

Under section 4(d) of the Act, the Service has discretion to issue regulations that we find necessary and advisable to provide for the conservation of threatened wildlife. We may also prohibit by regulation, with respect to threatened wildlife, any act that is prohibited by section 9(a)(1) of the Act for endangered wildlife. Exercising this discretion, the Service has developed general prohibitions that are appropriate for most threatened species at 50 CFR 17.31 and exceptions to those prohibitions at 50 CFR 17.32. While most of the prohibitions of 17.31 and 17.32 are appropriate for the Kentucky arrow darter, we find that some activities that would normally be prohibited under 17.31 and 17.32 are necessary for the conservation of this species because the species could benefit from habitat improvements in first- to third-order streams that are physically degraded (*e.g.*, unstable stream channels, eroding banks, no canopy cover). Therefore, for the Kentucky arrow darter, the Service has determined that a species-specific section 4(d) rule may be appropriate to promote the conservation of this species. As discussed in the Summary of Factors Affecting the Species section of this rule, the primary threat to the species is the continuing loss and degradation of habitat. Physical habitat degradation is widespread within the species' range, and sediment has been identified as the most common stressor (KDOW 2013a, pp. 189–214; KDOW 2013b, pp. 88–94). Sedimentation may originate from areas outside of the stream channel as a result of land use activities associated with surface coal mining, legacy coal extraction, logging, land development, channel relocations, and riparian clearing. All of these activities can cause sedimentation, but they may also lead to canopy removal clearing of riparian vegetation, and elevation of stream temperatures, thereby degrading habitats used by Kentucky arrow darters for feeding, sheltering, and reproduction. Sedimentation may also originate from areas within the stream channel as a result of channel instability and bank or stream bed erosion. Numerous streams within the species' current range have been identified as impaired (primarily due to siltation) and have been included on Kentucky's 303(d) list of impaired waters (see Table 2, above). Activities such as stream reconfiguration/riparian restoration, bridge and culvert

replacement or removal, bank stabilization, and stream crossing repair and maintenance, that follow the provisions of the species specific 4(d) rule below will improve or restore physical habitat quality for the Kentucky arrow darter and will provide an overall conservation benefit to the species.

The 4(d) rule, if approved, will not remove or alter in any way the consultation requirement under section 7 of the Act. However, we expect the 4(d) rule to provide greater certainty to Federal agencies and any third parties (e.g., permit applicants) in the consultation process for activities conducted in accordance with the provisions of the 4(d) rule. The consultation process may be further streamlined through programmatic consultations between Federal agencies and the Service for these activities. We ask the public, particularly Federal agencies and other interested stakeholders that may be affected by the 4(d) rule, to provide comments and suggestions regarding additional guidance and methods that the Service could provide or utilize, respectively, to streamline the implementation of this 4(d) rule (see Information Requested).

Provisions of the Proposed 4(d) Rule

This proposed 4(d) rule would except from the general prohibitions in 50 CFR 17.32 take incidental to the following activities when conducted within habitats currently occupied by the Kentucky arrow darter. All of the activities listed below must be conducted in a manner that (1) maintains connectivity of suitable Kentucky arrow darter habitats, allowing for dispersal between streams; (2) minimizes instream disturbance by conducting activities during low-flow periods when possible; and (3) maximizes the amount of instream cover that is available for the species:

(1) Channel reconfiguration or restoration projects that create natural, physically stable, ecologically functioning streams (or stream and wetland systems) that are reconnected with their groundwater aquifers (Parola and Biebighauser 2011, pp. 8–13; Parola and Hansen 2011, pp. 2–7; Floyd *et al.* 2013, pp. 129–135). These projects can be accomplished using a variety of methods, but the desired outcome is a natural, sinuous channel with low shear stress (force of water moving against the channel); low bank heights and reconnection to the floodplain; a reconnection of surface and groundwater systems, resulting in perennial flows in the channel; riffles and pools comprised of existing soil,

rock, and wood instead of large imported materials; low compaction of soils within adjacent riparian areas; and inclusion of riparian wetlands. First- to third-order, headwater streams reconstructed in this way would offer suitable habitats for the Kentucky arrow darter and contain stable channel features, such as pools, glides, runs, and riffles, which could be used by the species for spawning, rearing, growth, feeding, migration, and other normal behaviors.

(2) Bank stabilization projects that utilize bioengineering methods outlined in Kentucky Environmental and Public Protection Cabinet and Kentucky Transportation Cabinet (2005, pp. 116–128) to replace pre-existing, bare, eroding stream banks with vegetated, stable stream banks, thereby reducing bank erosion and instream sedimentation and improving habitat conditions for the species. Following these methods, stream banks may be stabilized using live stakes (live, vegetative cuttings inserted or tamped into the ground in a manner that allows the stake to take root and grow), live fascines (live branch cuttings, usually willows, bound together into long, cigar shaped bundles), or brush layering (cuttings or branches of easily rooted tree species layered between successive lifts of soil fill). These methods would not include the sole use of quarried rock (rip-rap) or the use of rock baskets or gabion structures.

(3) Bridge and culvert replacement/removal projects that remove migration barriers (e.g., collapsing, blocked, or perched culverts) or generally allow for improved upstream and downstream movements of Kentucky arrow darters while maintaining normal stream flows, preventing bed and bank erosion, and improving habitat conditions for the species.

(4) Repair and maintenance of USFS concrete plank stream crossings on the DBNF that allow for safe vehicle passage while maintaining instream habitats, reducing bank and stream bed erosion and instream sedimentation, and improving habitat conditions for the species. These concrete plank crossings have been an effective stream crossing structure on the DBNF and have been used for decades. Over time, the planks can be buried by sediment, undercut during storm events, or simply break down and decay. If these situations occur, the DBNF must make repairs or replace the affected plank.

We believe these actions and activities, while they may have some minimal level of mortality, harm, or disturbance to the Kentucky arrow darter, are not expected to adversely

affect the species' conservation and recovery efforts. In fact, we expect they would have a net beneficial effect on the species. Across the species' range, instream habitats have been degraded physically by sedimentation and by direct channel disturbance. The activities proposed in this rule will correct some of these problems, creating more favorable habitat conditions for the species. Like the proposed listing rule, this proposed 4(d) rule will not be finalized until we have reviewed comments from the public and peer reviewers.

Based on the rationale above, the provisions included in this proposed 4(d) rule are necessary and advisable to provide for the conservation of the Kentucky arrow darter. Nothing in this proposed 4(d) rule would change in any way the recovery planning provisions of section 4(f) of the Act, the consultation requirements under section 7 of the Act, or the ability of the Service to enter into partnerships for the management and protection of the Kentucky arrow darter.

We may issue permits to carry out otherwise prohibited activities involving threatened wildlife under certain circumstances. Regulations governing permits are codified at 50 CFR 17.32. With regard to threatened wildlife, a permit may be issued for scientific purposes, to enhance the propagation or survival of the species, economic hardship, zoological exhibition, educational purposes, and for incidental take in connection with otherwise lawful activities. There are also certain statutory exemptions from the prohibited activities, which are found in sections 9 and 10 of the Act.

It is our policy, as published in the **Federal Register** on July 1, 1994 (59 FR 34272), to identify to the maximum extent practicable at the time a species is listed, those activities that would or would not constitute a violation of section 9 of the Act (for this species, those section 9 prohibitions adopted through the proposed 4(d) rule). The intent of this policy is to increase public awareness of the effect of a proposed listing on proposed and ongoing activities within the range of species proposed for listing. Based on the best available information, the following actions are unlikely to result in a violation of section 9, if these activities are carried out in accordance with existing regulations and permit requirements, although this list is not comprehensive:

(1) Normal agricultural and silvicultural practices, including herbicide and pesticide use, which are carried out in accordance with any existing regulations, permit and label

requirements, and best management practices; and

(2) Surface coal mining and reclamation activities conducted in accordance with the 1996 Biological Opinion between the Service and OSM.

However, we believe the following activities may potentially result in a violation of section 9 of the Act, although this list is not comprehensive:

(1) Unauthorized collecting or handling of the species.

(2) Destruction or alteration of the habitat of the Kentucky arrow darter (e.g., unpermitted instream dredging, impoundment, water diversion or withdrawal, channelization, discharge of fill material) that impairs essential behaviors such as breeding, feeding, or sheltering, or results in killing or injuring a Kentucky arrow darter.

(3) Discharges or dumping of toxic chemicals, contaminants, or other pollutants into waters supporting the Kentucky arrow darter that kills or injures individuals, or otherwise impairs essential life-sustaining behaviors such as breeding, feeding, or sheltering.

Questions regarding whether specific activities would constitute a violation of section 9 of the Act should be directed to the Kentucky Ecological Services Field Office (see **FOR FURTHER INFORMATION CONTACT**).

Required Determinations

Clarity of the Rule

We are required by Executive Orders 12866 and 12988 and by the Presidential Memorandum of June 1,

1998, to write all rules in plain language. This means that each rule we publish must:

- (1) Be logically organized;
- (2) Use the active voice to address readers directly;
- (3) Use clear language rather than jargon;
- (4) Be divided into short sections and sentences; and
- (5) Use lists and tables wherever possible.

If you feel that we have not met these requirements, send us comments by one of the methods listed in the **ADDRESSES** section. To better help us revise the rule, your comments should be as specific as possible. For example, you should tell us the numbers of the sections or paragraphs that are unclearly written, which sections or sentences are too long, the sections where you feel lists or tables would be useful, etc.

National Environmental Policy Act (42 U.S.C. 4321 et seq.)

We have determined that environmental assessments and environmental impact statements, as defined under the authority of the National Environmental Policy Act, need not be prepared in connection with listing a species as an endangered or threatened species under the Endangered Species Act. We published a notice outlining our reasons for this determination in the **Federal Register** on October 25, 1983 (48 FR 49244).

References Cited

A complete list of references cited in this rulemaking is available on the

Internet at <http://www.regulations.gov> and upon request from the Kentucky Ecological Services Field Office (see **FOR FURTHER INFORMATION CONTACT**).

Authors

The primary authors of this proposed rule are the staff members of the Kentucky Ecological Services Field Office.

List of Subjects in 50 CFR Part 17

Endangered and threatened species, Exports, Imports, Reporting and recordkeeping requirements, Transportation.

Proposed Regulation Promulgation

Accordingly, we propose to amend part 17, subchapter B of chapter I, title 50 of the Code of Federal Regulations, as set forth below:

PART 17—[AMENDED]

- 1. The authority citation for part 17 continues to read as follows:

Authority: 16 U.S.C. 1361–1407; 1531–1544; and 4201–4245, unless otherwise noted.

- 2. Amend § 17.11(h) by adding an entry for “Darter, Kentucky arrow” to the List of Endangered and Threatened Wildlife in alphabetical order under FISHES to read as follows:

§ 17.11 Endangered and threatened wildlife.

* * * * *

(h) * * *

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
* FISHES	*	*	*	*		*	*
Darter, Kentucky arrow.	<i>Etheostoma spilotum</i> .	U.S.A. (KY)	Entire	T	NA	17.44(p)
*	*	*	*	*		*	*

- 3. Amend § 17.44 by adding paragraph (p) to read as follows:

§ 17.44 Special rules—fishes.

* * * * *

(p) Kentucky arrow darter (*Etheostoma spilotum*).

(1) *Prohibitions.* Except as noted in paragraph (p)(2) of this section, all prohibitions and provisions of 50 CFR 17.31 and 17.32 apply to the Kentucky arrow darter.

(2) *Exceptions from prohibitions.* (i) All of the activities listed in paragraph (p)(2)(ii) must be conducted in a manner that maintains connectivity of suitable Kentucky arrow darter habitats, allowing for dispersal between streams; that minimizes instream disturbance by conducting activities during low-flow periods when possible; and that maximizes the amount of instream cover that is available for the species.

(ii) Incidental take of the Kentucky arrow darter will not be considered a violation of section 9 of the Act if the take results from any of the following when conducted within habitats currently occupied by the Kentucky arrow darter:

(A) Channel reconfiguration or restoration projects that create natural, physically stable, ecologically functioning streams (or stream and

wetland systems) that are reconnected with their groundwater aquifers (Parola and Biebighauser 2011, pp. 8–13; Parola and Hansen 2011, pp. 2–7; Floyd *et al.* 2013, pp. 129–135). These projects can be accomplished using a variety of methods, but the desired outcome is a natural, sinuous channel with low shear stress (force of water moving against the channel); low bank heights and reconnection to the floodplain; a reconnection of surface and groundwater systems, resulting in perennial flows in the channel; riffles and pools comprised of existing soil, rock, and wood instead of large imported materials; low compaction of soils within adjacent riparian areas; and inclusion of riparian wetlands. First- to third-order, headwater streams reconstructed in this way would offer suitable habitats for the Kentucky arrow darter and contain stable channel features, such as pools, glides, runs, and riffles, which could be used by the species for spawning, rearing, growth, feeding, migration, and other normal behaviors.

(B) Bank stabilization projects that utilize bioengineering methods outlined

in Kentucky Environmental and Public Protection Cabinet and Kentucky Transportation Cabinet (2005, pp. 116–128) to replace pre-existing, bare, eroding stream banks with vegetated, stable stream banks, thereby reducing bank erosion and instream sedimentation and improving habitat conditions for the species. Following these methods, stream banks may be stabilized using live stakes (live, vegetative cuttings inserted or tamped into the ground in a manner that allows the stake to take root and grow), live fascines (live branch cuttings, usually willows, bound together into long, cigar shaped bundles), or brush layering (cuttings or branches of easily rooted tree species layered between successive lifts of soil fill). These methods would not include the sole use of quarried rock (rip-rap) or the use of rock baskets or gabion structures.

(C) Bridge and culvert replacement/removal projects that remove migration barriers (*e.g.*, collapsing, blocked, or perched culverts) or generally allow for improved upstream and downstream movements of Kentucky arrow darters while maintaining normal stream flows,

preventing bed and bank erosion, and improving habitat conditions for the species.

(D) Repair and maintenance of USFS concrete plank stream crossings on the DBNF that allow for safe vehicle passage while maintaining instream habitats, reducing bank and stream bed erosion and instream sedimentation, and improving habitat conditions for the species. These concrete plank crossings have been an effective stream crossing structure on the DBNF and have been used for decades. Over time, the planks can be buried by sediment, undercut during storm events, or simply break down and decay. If these situations occur, the DBNF must make repairs or replace the affected plank.

* * * * *

Dated: September 22, 2015.

Cynthia T. Martinez,
Acting Director, U.S. Fish and Wildlife Service.

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