Cumberland Elktoe
(*Alasmidonta atropurpurea*)

5-Year Review:
Summary and Evaluation

Cumberland elktoe in hand. Photo courtesy of Rebecca Schapansky, NPS.

July 2022

U.S. Fish and Wildlife Service
Southeast Region
Tennessee Ecological Services Field Office
Cookeville, Tennessee

5-YEAR REVIEW
Cumberland Elktoe (*Alasmidonta atropurpurea*)

I. GENERAL INFORMATION

A. Methodology used to complete the review:

This 5-year status review was completed by the species' lead recovery biologist in the U.S. Fish and Wildlife Service's (Service) Tennessee Ecological Services Field Office. Our sources of information for this 5-year status review include the final rule listing this species under the Endangered Species Act (Act); the Recovery Plan (Service 2004); and peer reviewed scientific publications, unpublished reports, and personal communications with qualified biologists or experts. All literature and documents used for this review are on file at the Tennessee Ecological Services Field Office in Cookeville, Tennessee.

The Federal Register notice announcing the initiation of this 5-year status review and a 60-day public comment period was published on June 23, 2021 (86 FR 32965). During the comment period, we received a public comment from the National Council for Air and Stream Improvement, Inc. and Niki Nicholas, Superintendent of the Big South Fork National River and Recreation Area, see Appendix A for details on the specific comments and how the Service addressed them.

The Service did not consider this 5-year status review to be "influential" under the Service's policy for Information Quality Guidelines and Peer Review; therefore, no external peer review was conducted. Per the guidelines, the Service will seek peer review when we can reasonably determine that dissemination of influential information "…will have or does have a clear and substantial impact on important public policy or private sector decisions, and thus, a decision or action to be taken by the Director", such as a change in listing status (i.e., delisting, downlisting, or uplisting of a species). Anthony Ford and Michael Floyd with the Tennessee and Kentucky Ecological Services Field Offices, respectively, provided comments during an internal review.

B. Reviewers

Lead Regional or Headquarters Office – Contact name and phone number:
Southeast Region – Carrie Straight, (404) 679-7226

Lead Field Office – Contact name and phone number:
Tennessee Ecological Services Field Office – Santiago Martín, (931) 525-4987

Cooperating Field Office – Contact name and phone number:
Kentucky Ecological Services Field Office – Michael Floyd, (502) 229-5433

C. Background

1. **Federal Register Notice citation announcing initiation of this review:**
   June 23, 2021, 86 FR 32965.

2. **Listing history**
   Original Listing
   Federal Register Notice: 62 FR 1647
   Federal Register Notice date: January 10, 1997
   Effective listing date: February 10, 1997
   Entity listed: Species
   Classification: Endangered

3. **Associated rulemakings:**
   Designation of critical habitat for five endangered mussels (including the Cumberland elktoe) in the Tennessee and Cumberland River basins, 69 FR 53136, August 31, 2004.

4. **Review History:**
   Each year, the Service reviews and updates listed species information for inclusion in the required Recovery Report to Congress. Through 2013, we did a recovery data call that included status recommendations such as "Stable, Decreasing or Increasing" for this animal. We continue to show that species status recommendation as part of our 5-year status reviews. The most recent evaluation for this animal was completed in 2015.

   Previous 5-Year Reviews:
   5-Year Review noticed on September 20, 2005 (70 FR 55157) and completed on January 24, 2007. The Service did not recommend a change to the species' endangered status.

   5-Year Review noticed on March 25, 2014 (79 FR 16366) and completed on July 16, 2015. The Service did not recommend a change to the species' endangered status.

5. **Species' Recovery Priority Number at start of review:**
   The Cumberland elktoe's recovery priority number is 5. The "5" indicates a species with a high degree of threat and a low potential for recovery.

6. **Recovery Plan:**
   Name of plan: Recovery Plan for Cumberland Elktoe, Oyster Mussel, Cumberlandian Combshell, Purple Bean and Rough Rabbitsfoot.
   Date issued: May 4, 2004

II. REVIEW ANALYSIS

A. Application of the 1996 Distinct Population Segment (DPS) policy

The Endangered Species Act (ESA) defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate wildlife. This definition limits listing DPSs only to vertebrate species of fish and wildlife. Because the species under review is an invertebrate, the DPS policy is not applicable.

B. Recovery Criteria

1. Does the species have a final, approved recovery plan containing objective, measurable criteria?

_X_ ***Yes***
____ ***No***

2. Adequacy of recovery criteria.

a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?
_X_ ***Yes***
____ ***No***

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?
_X_ ***Yes***
____ ***No***

3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been achieved.
Downlisting Criteria
The recovery plan has six recovery criteria for downlisting Cumberland elktoe to a threatened status. Achieving the following criteria would indicate to the Service that a downlisting should be considered:

Criterion 1. Through the protection of extant stream populations (e.g., continuing to use existing regulatory mechanism, establishing partnerships with various stakeholders, using BMPs, minimizing or eliminating threats), discovery of currently unknown streams, and/or reestablishment of historical stream populations, there exists:

a. At least five distinct viable stream populations of the Cumberland elktoe in the Cumberland River system. This will be accomplished by:

(1) Protecting all extant stream populations (i.e., Laurel Fork, Marsh Creek, Sinking Creek, Big South Fork system, Rock Creek) and ensuring that all of these streams have viable population status.

Criterion 2. One distinct naturally reproduced year class exists within each of the viable populations. The year class must have been produced within 5 years prior to the time the species are reclassified from endangered to threatened. Within 1 year before the downlisting date, gravid females of the mussels and their host fish must

be present in each viable population.

Criterion 3. Research studies of the mussels' biological and ecological requirements have been completed and any required recovery measures developed and implemented from these studies are beginning to be successful, as evidenced by an increase in population density of approximately 20 percent and/or an increase in the length of the river reach of approximately 10 percent inhabited by the species as determined through biennial monitoring.

Criterion 4. No foreseeable threats exist that would likely impact the survival of the species over a significant portion of its range.

Criterion 5. Within larger streams (e.g., Big South Fork), the species is distributed over a long enough reach that a single catastrophic event is not likely to eliminate or significantly reduce the entire population in that stream to a status of nonviable.

Criterion 6. Biennial monitoring for the species yields the results outlined in Criterion 1 and 2 over a 10-year period.

The recovery criteria for delisting the Cumberland elktoe are the same as those for downlisting with some modifications to Criterion 1 and 2. Achieving the following criteria, in addition to criterion 3, 4, 5, and 6 above, would indicate that the Service should consider delisting the species:

Criterion 1. Through the protection of extant stream populations (e.g., continuing to use existing regulatory mechanisms, establishing partnerships with various stakeholders, using BMPs, minimizing or eliminating threats), discovery of currently unknown stream populations, and/or reestablishment of historical stream populations, there exists:

a. At least seven distinct viable stream populations of the Cumberland elktoe in the upper Cumberland River system. This will be accomplished by:

(1) Protecting all extant stream populations (i.e., Laurel Fork, Marsh Creek, Sinking Creek, Big South Fork system, Rock Creek) and ensuring that all of these streams have viable population status.

(2) Establishing a distinct viable stream population in one additional stream in the upper Cumberland River system.

Criterion 2. Two distinct naturally reproduced year classes exist within each of the viable populations. Both year classes must have been produced within 10 years, and one year class must have been produced within 5 years of the recovery date. Within 1 year before the recovery date, gravid females of the mussels and their host fish must be present in each viable population.

To date, none of the recovery criteria have been achieved for the Cumberland elktoe.

C. Updated Information and Current Species Status

1. Biology and Habitat

a. Summary of New Information of Species Biology and Life History:

No new information is available relative to the species' genetics, taxonomy, distribution, and reproductive biology; however, some new abundance information is available for the Rock Creek and Big South Fork system populations. The best available information continues to indicate that the Cumberland elktoe has low resilience with many extant populations exhibiting low abundance and densities. Recruitment information is lacking (*i.e.*, Laurel Fork, Jellico Creek, Sinking Creek, and Rock Creek). Species redundancy is low, as most populations are limited to single streams. The most resilient and robust population is found in the Big South Fork system, much of which is protected within the Big South Fork National River and Recreation Area.

b. Abundance, population trends, demography:

To evaluate the recovery criteria, the Service (2004) recognized five extant populations: Laurel Fork, Marsh Creek, Sinking Creek, Big South Fork, and Rock Creek. The Big South Fork population consists of the upper Big South Fork mainstem and its tributaries (*i.e.*, North White Oak Creek, Clear Fork, North Prong Clear Fork, Crooked Creek, Bone Camp Creek, White Oak Creek, and New River) because there are no barriers to genetic interchange (Figure 1). An additional population not identified in the recovery plan has been detected in Jellico Creek (Haag and Cicerello 2016), although little is known about its status (Figure 1).

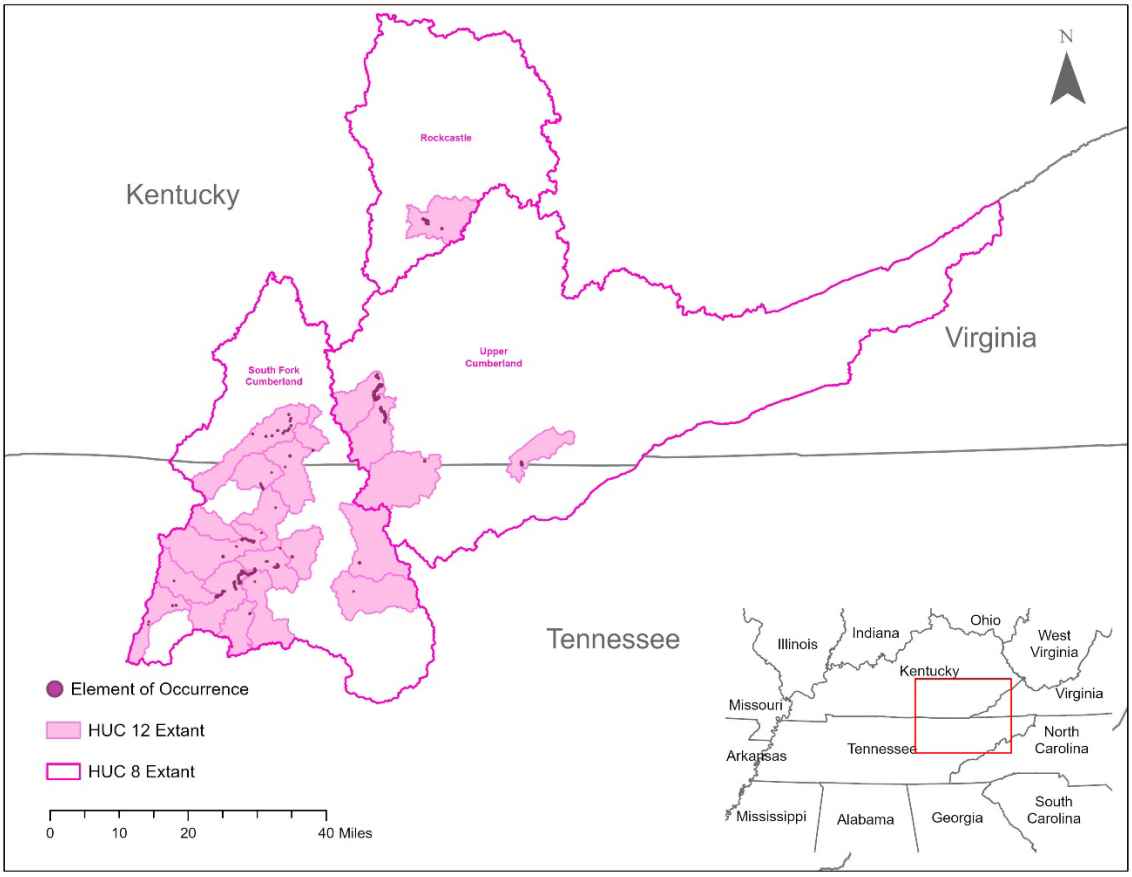

Figure 1: Current distribution of the Cumberland elktoe in Kentucky and Tennessee based occurrence records from stream where the species is still considered extant.

Specific information for each Cumberland elktoe population is discussed below.

Laurel Fork
No additional surveys have been completed in Laurel Fork (of Clear Fork) since the last 5-year status review. The status of this population is unknown, but it likely has low resiliency. Recent surveys prior to this review have produced few or no Cumberland elktoe individuals (Cicerello and Laudermilk 2001; Haag and Cicerello 2016).

Jellico Creek
No additional surveys have been completed in Jellico Creek since the last 5-year status review. The status of this population is unknown. The only observation of the species in this stream is a fresh dead individual collected in 2005 by James Kiser (Haag and Cicerello 2016). The Jellico Creek population is likely small and is isolated from other populations (Haag and Cicerello 2016).

Marsh Creek
No additional surveys have been completed in Marsh Creek since the last 5-year status review. Prior to the early 2000s, the March Creek population was

considered to be one of the species' largest (Dolloff *et al.* 2001), but this population has declined drastically over time, most likely due to coal and oil drilling in the drainage (Haag and Cicerello 2016). The current population status is unknown.

Sinking Creek
No additional surveys have been completed in Sinking Creek since the last 5-year status review. The status of this population is unknown. Haag and Cicerello (2016) considered the Sinking Creek population to be small and isolated.

Rock Creek
Since the last 5-year status review, there have been two survey efforts in Rock Creek: 1) a comprehensive mussel survey in 2017 (Ahlsteadt 2018) and 2) a 2020 qualitative search at two sites (McGregor and Jacobs 2020). Ahlstedt (2018) replicated a previous survey by Cicerello (1996), adding three additional survey sites. Ahlstedt (2018) documented the same species and similar mussel totals (231 vs 200) previously reported by Cicerello (1996), but the relative abundance of the Cumberland elktoe decreased from 20 percent to 5 percent. Mussel specimens reported by Ahlstedt (2018) were often larger, older individuals, with shell measurement data suggesting that mussel species may not have recruited within the last three-to-five years. The 2020 survey found nine live Cumberland elktoe mussels at two locations (McGregor and Jacobs 2020).

Big South Fork System
The Big South Fork population encompasses the upper Big South Fork mainstem and multiple tributaries:

- North White Oak Creek;
- Clear Fork and its tributaries - North Prong Clear Fork, Crooked Creek, Bone Camp Creek, and White Oak Creek; and
- New River - including one tributary, Buffalo Creek.

Previous surveys in the Big South Fork system have shown that the Cumberland elktoe is more abundant in tributaries of this system. For example, Ahlstedt *et al.* (2005) reported that the Cumberland elktoe had a relative abundance of 40 percent and a high catch-per-unit-effort (CPUE of 4.3 individuals/search hour) for survey sites in tributaries, while relative abundance and CPUE in the Big South Fork mainstem were less than 1 percent and 0.5 individuals/search hour, respectively.

Bakaletz (1991) was the first to report occurrence records of Cumberland elktoe in the Big South Fork mainstem in 1985 and 1986. Although found in low numbers, Bakaletz (1991) reported individuals from several different age classes. Since the last 5-year status review, McGregor (2012, 2020) continued standardized surveys in the Big South Fork mainstem at some of the same survey sites sampled by Ahlstedt *et al.* (2005). Additionally, the National Park Service

conducted annual mussel surveys at high traffic equestrian crossings (N. Nicholas 2021, pers. comm.). Quantitative sampling of the Big South Fork mainstem in 2011, 2013, 2017, and 2020 (McGregor 2012, 2020) yielded no individuals of Cumberland elktoe, and surveys at equestrian crossing between 2016 and 2020 a yielded no individuals (N. Nicholas 2021, pers. comm.). However, the presence of other federally listed mussels and juvenile mussels indicate suitable habitat conditions and suggest that the Cumberland elktoe could still be present in low densities (McGregor 2020).

New River and Tributaries

While the Cumberland elktoe was historically known from the New River drainage (Shoup and Peyton 1940), it was only rediscovered in this system in 2002 (Ahlstedt *et al.* 2005). Survey efforts in the upper New River in 2005 documented the species at a site downstream of the Bull Creek confluence (Ahlstedt *et. al*. 2017b). Cumberland elktoe was documented in Buffalo Creek in 2007. Ahlstedt (2017b) sampled 12 sites in Bull Creek and reported the species as uncommon or rare in this stream, even though one survey site yielded five live individuals. Shell measurements of all live and fresh dead Cumberland elktoe ranged from 54 to 94 millimeters (mm), which may indicate a lack of recent recruitment or a bias toward finding large individuals during qualitative surveys.

Since the last 5-year status review, Ahlstedt et al (2017a) surveyed additional sites in the downstream reaches of New River, including some tributaries. Of the 202 live mussels found during this effort, Cumberland elktoe comprised 4 percent of total abundance (tied for 3rd most). Shell measurements of all live Cumberland elktoe individuals ranged from 53.1 to 78.4 mm, indicating a lack of recent recruitment or a bias toward finding large individuals during qualitative surveys. Other species have shown successful recruitment in this system.

No additional surveys have been completed in Buffalo Creek since the last 5-year status review. The current population status is unknown but is likely small.

Clear Fork and Tributaries

Bakaletz (1991) reported the Cumberland elktoe at 17 of 20 sites surveyed in Clear Fork in 1985 and 1986. Additional survey efforts by Ahlstedt *et al.* (2005) found the Cumberland elktoe at all survey sites surveyed in this stream (five total). Both Bakaletz (1991) and Ahlstedt *et al.* (2005) found the species to be abundant in this tributary of the Big South Fork.

Surveys completed since the species' recovery plan indicate that it continues to have moderate to high resiliency in the Clear Fork. In surveys completed in 2011, McGregor (2012) reported relative abundance of 60 to 70 percent during quantitative and qualitative surveys, respectively. McGregor (2012) also observed evidence of successful recruitment based on the observation of multiple age classes with individuals measuring 34 to 124 mm (likely ranging from 2 to 15 years of age). Unfortunately, surveys in 2018 at this site only yielded five non-

listed mussel species compared to the 35 that were collected during the 2011 sampling event (N. Nicholas 2021, pers. comm.). McGregor (2019) speculated that the combination of drought, record low water levels, and extended temperatures above 30°C may have contributed to the loss of Cumberland elktoe individuals at this site. It is likely the resiliency of this population has decreased in recent years due to drought conditions in the watershed.

North Prong Clear Fork: The Cumberland elktoe was first reported from this Clear Fork tributary in 1988 (Gordon and Layzer 1993; Layzer and Moles 2009). Layzer and Moles (2009) estimated that the density of the Cumberland elktoe in North Prong Clear Fork declined from 2.33 individuals per square meter to 0.05 individuals per square meter between 1988 and 2008. No additional surveys have been completed in North Prong Clear Fork since the last 5-year status review.

Crooked Creek: Bakaletz (1991) did not find mussels in this Clear Fork tributary during mussel surveys in 1985 and 1986, but additional survey effort by Ahlstedt *et al.* (2005) resulted in the discovery of the Cumberland elktoe with 32 individuals observed at single survey site. No additional surveys have been completed since the last 5-year status review and current condition is unknown.

White Oak Creek: Ahlstedt *et al.* (2005) reported relatively high abundance for the Cumberland elktoe in this tributary of the Clear Fork (61 individuals observed at single site). No additional surveys have been in completed in White Oak Creek since the last 5-year status review.

Bone Camp Creek: The Cumberland elktoe was first reported from this White Oak Creek tributary in 1988 (Gordon and Layzer 1993; Layzer and Moles 2009). From 1988 and 2008, Layzer and Moles (2009) estimated that the density of the Cumberland elktoe in Bone Camp Creek declined from 0.52 individuals per square meter to below detection levels. However, the Cumberland elktoe continues to persist in Bone Camp Creek as evidenced by continued observation of live individuals during qualitative surveys, including a gravid female in 2014 (Ahlstedt 2014, pers. comm.; McGregor and Jacobs 2020; N. Nicholas 2021, pers. comm.).

North White Oak Creek

Bakaletz (1991) observed no mussels in this tributary of the Big South Fork during mussel surveys in 1985 and 1986, but additional efforts by Ahlstedt *et al.* (2005) yielded large numbers of Cumberland elktoe at five of six sites surveyed.

Since the last 5-year status review, the National Park Service established a permanent monitoring station in 2018 in North White Oak Creek. Quantitative sampling at this site yielded Cumberland elktoe densities of 0.033 individuals per square meter. Quantitative searches in the fall of 2021 also produced low densities (R. Schapansky 2022, pers. comm.). Recent qualitative searches at this site in 2021 (n=35) and 2022 during the Cumberland elktoe brooding period

(early spring-March) yielded multiple gravid females that were used as broodstock for propagation efforts, suggesting that the fall quantitative sampling (in the fall of the year) was less effective due to the burying behavior of Cumberland elktoe and reduced detection by surveyors (R. Schapansky 2022, pers. comm.).

Many of the extant Cumberland elktoe populations summarized above (i.e., Laurel Fork, Jellico Creek, Sinking Creek, and Rock Creek) have low resiliency, as evidenced by low abundance and a lack of age-class structure (low recruitment). In addition, all populations, except for the Big South Fork system, are limited to single streams in a straight-line distribution. Currently, the most resilient population is found in the Big South Fork system, where Cumberland elktoe abundance has remained relatively high, gravid females and successful recruitment has been observed, and host fishes are known to be present.

The lack of observations and unknown status of some of the Cumberland elktoe populations listed above are in part due to low detection probabilities (a rare species with low densities) and could be compounded by mussel reproductive phenology. Depending on the timing at which surveys occur relative to their breeding phenology and the river conditions, mussels can be difficult to find (Watters and O'Dee 2001). Negative surveys, therefore, do not necessarily indicate that a species is absent from a site, especially rare species (Villella *et al.* 2004). Additional surveys would further inform the status of these population. Long-term brooder species spawn in late summer or fall and brood their glochidia until the following spring or summer (Ortmann, 1909). The best time to survey for long-term brooders, such as the Cumberland elktoe, would be early spring or late summer-fall because they tend to be exposed at the bottom of the stream or river to interact with host fishes, and therefore are more easily detected (Villella *et al.* 2004).

c. Genetics:

The Service is not aware of new genetic information since completion of the recovery plan (USFWS 2004). The best available information suggests that some extremely small and geographically isolated Cumberland elktoe populations may already be below their effective population size or level required to maintain long-term genetic viability (Soulé 1980).

d. Taxonomic classification or changes in nomenclature:

No changes to taxonomic classification or nomenclature have occurred since this species was listed. Nomenclature is consistent and follows that listed in the Freshwater Mollusk Conservation Society checklist of freshwater mussels (Mollusca: Bivalvia: Unionida) of the United States and Canada (FMCS 2021).

e. Distribution and trends in spatial distribution:

There is no indication that the distribution of the Cumberland elktoe has changed substantially since the Service completed the last 5-year status review. The

Cumberland elktoe is limited in distribution to the upper Cumberland River system in southeastern Kentucky and north-central Tennessee, occupying streams above the hypothesized original location of Cumberland Falls near Burnside, Kentucky (McGrain 1955; Haag and Cicerello 2016)(see section II.C.1.b for a list of extant populations).

f. Habitat or ecosystem conditions:

The Cumberland elktoe inhabits shallow areas (depth of 0.3 to 0.5 meter) of small and medium-sized streams of moderate gradient, often in areas with slow current velocities (1 to 3 centimeter per second) (Call and Parmalee 1981; Layzer and Moles 2009). The species has been observed in areas with sand, gravel, and cobble substrates; however, the Cumberland elktoe seems to prefer sand substrates, with particle sizes less than 4 mm in diameter (Layzer and Moles 2009).

Habitat conditions seem to be improving in downstream reaches of the Rock Creek watershed. Downstream reaches of the Rock Creek watershed and one of its tributaries, White Oak Creek, were degraded due to activities associated with pre-law coal mining. Acid mine drainage (AMD) reported from over 40 coal mine portals and eight pyrite-rich (i.e., acid bearing material) refuse dumps decimated aquatic life in portions of the system (Barger and Robinson. 2008; Figure 1). Restoration efforts of abandoned mine lands in Rock Creek began in 1999 with the analysis of water quality data from 41 portals and seeps in the project area to calculate acid and metal loading for each portal (Figure 1). These efforts informed decisions on passive and active treatment options (Barger and Robinson 2008). For example, most of the refuse dumps have been stabilized and vegetated to minimize erosion and sedimentation, while drainage from the portals is being treated with passive AMD systems, primarily open limestone channels. Reclamation efforts to date have reduced sediment load and acid load entering the downstream reaches of the Rock Creek watershed, and acid loading from Rock Creek into the Big South Fork of the Cumberland River has been reduced from 1,452 tons annually to near zero (Barger and Robinson 2008). Fish populations are rebounding with increases in numbers, species diversity, and intolerant species richness. Ahlstedt (2018) reported seeing aquatic snails, darters, minnows, and smallmouth bass in some sections of lower Rock Creek, although no mussels were found.

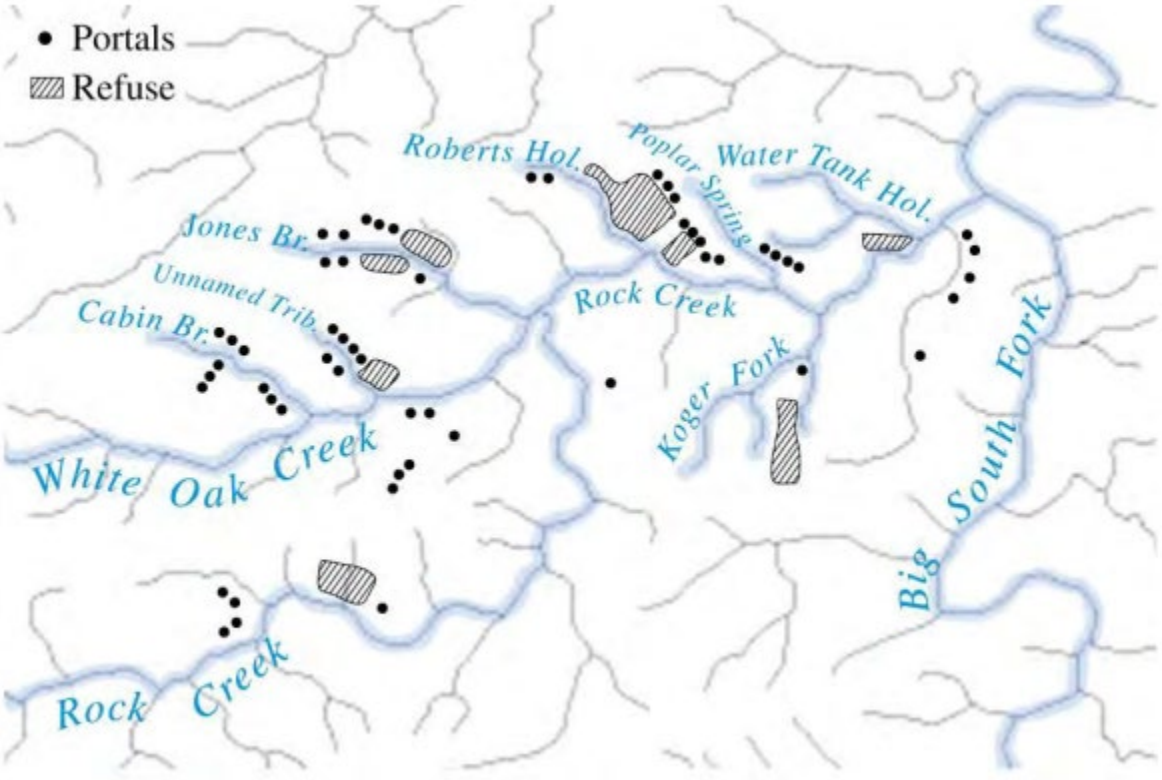

Figure 2: Map of 40 known mine portals and pyrite-rich refuse dumps in the lower Rock Creek watershed.

g. Other:

Period of Gravidity
The Cumberland elktoe appears to be a long-term brooder where females retain glochidia in their gills over the winter. Gravid females have been observed in March, April, October, and November (Gordon and Layzer 1993; Guyot 2005; R. Schapansky 2022, pers. comm.).

Fish Hosts
No new information about host fish has emerged since the last 5-year status review. The best available information continues to indicate that banded sculpin and northern hogsucker are the best fish hosts for propagation of Cumberland elktoe juveniles (Gordon and Layzer 1993; Guyot 2005; and McGregor 2013).

2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms):

a. Present or threatened destruction, modification or curtailment of its habitat or range:
The Service listed oil and gas development as well as coal mining as threats to the Cumberland elktoe in both the recovery plan and the last 5-year status review.

Activities associated with current and legacy coal mining can have lasting impacts on water quality (Zipper *et al.* 2016; Rogers *et al.* 2018; Cope *et al.* 2021). In particular, specific conductance, pH, dissolved solids, alkalinity, hardness, and sulfate have been correlated temporally with the progression of mining (Zipper *et al.* 2016). New research is beginning to shed light on the specific chemical constituents primarily responsible for declines in freshwater mussels, such as the Cumberland elktoe. In sites impacted by coal mining or natural gas extraction, total recoverable metals, polycyclic aromatic hydrocarbons (PAHs), major ions, or a combination of the three likely have contributed to sediment toxicity and mussel declines in the Upper Tennessee and Cumberland River systems (Wang *et al.* 2013; Price *et al.* 2014; Zipper *et al.* 2016; Rogers *et al.* 2018; Phipps 2019; Cope *et al.* 2021). Oil and gas wastewater from both conventional and unconventional wells have been shown to be a risk to aquatic organisms due to halide and ammonium levels in waters, even after brine treatment (Harkness *et al.* 2015).

b. Overutilization for commercial, recreational, scientific, or educational purposes:
The Cumberland elktoe is not known to have any commercial value and overutilization has not been identified as a problem.

c. Disease or predation:
At the time of listing, neither disease nor predation were considered threats to the species, but between 1988 and 1989 Layzer and Moles (2009) documented significant muskrat (*Ondatra zibethicus*) predation on Cumberland elktoe at North Prong Clear Fork. They estimated that muskrats had eaten 17.7 percent of the estimated adult population 216 of 2,866 at the study site (Layzer and Moles 2009). Layzer and Moles (2009) also noted significant predation (n=77) by muskrat at Bone Camp Creek in 2008. The Service does not have new information indicating that predation is a limiting factor to the recovery of the species at this time.

d. Inadequacy of existing regulatory mechanisms:
Protections afforded the Cumberland elktoe through regulatory mechanisms have not changed since the last 5-year status review. Existing regulatory mechanisms (*e.g.*, Clean Water Act and Surface Mining Control and Reclamation Act) have provided some improvements in water quality and habitat conditions but they have been inadequate in fully protecting the species and its habitats. Sedimentation and non-point source pollutants continue to be a chronic problem across the species' range. The information available to us at this time does not indicate that the magnitude or imminence of this threat is likely to be appreciably reduced in the foreseeable future.

e. Other natural or manmade factors affecting its continued existence:
Climate Change

Small and isolated Cumberland elktoe populations are less resilient to natural stochastic events (e.g., floods, drought, etc.) (Hastie *et al.* 2001; Haag and Warren 2008). Haag and Warren (2008) documented mussel declines of 65-83 percent in small streams in the Bankhead National Forest in Alabama following extreme drought in 2000. McGregor (2019) suggested the drought in 2016 may have similarly contributed to the loss of Cumberland elktoe in North White Oak and many other smaller tributary sites. During the 2016 drought, water levels were at record lows (< 3 cubic feet per second), and temperatures exceeded 30°C for an extended period (McGregor 2019). Several studies have been conducted in recent years on thermal tolerances of freshwater mussels and their hosts. Pandolfo *et al.* (2012) examined 10 species of mussels and found both glochidia and juvenile mussels had LT50s (lethal temperature for 50 percent of test subjects) ranging between 21.1°C -38.1°C with a mean of 33.1°C. Fish hosts also had similar thermal tolerance values in that study, ranging between 23.5°C -38.1°C with a mean of 33.1°C. Recruitment can also be impacted by drought conditions, Layzer and Moles (2009) indicated that low recruitment of Cumberland elktoe occurred during the three drought years preceding 1988 and two drought years preceding 2008 in North Prong Clear Fork and Bone Camp Creek, but recruitment was relatively strong in the years before and after drought.

In its Fifth Assessment Report, the Intergovernmental Panel on Climate Change (IPCC) concluded that warming of the climate system is unequivocal (IPCC 2014). Droughts in the Southeast are likely to increase in frequency, duration, and intensity (NCILT 2012). Stream temperatures in the Southeast have increased roughly 0.2°C –0.4°C per decade and are expected to continue increasing based on projected increases in air temperature (Kaushal *et al.* 2010). Thermal thresholds for mussels could be exceeded within the next 50 years based on models designed to simulate daily mean stream temperatures associated with climate change and land use change projections (Daraio *et al.* 2014). These changes will likely have adverse effects on recruitment in freshwater mussels like the Cumberland elktoe.

There is uncertainty about the specific effects of climate change (and their magnitude) on the Cumberland elktoe and its host fishes; however, species with limited ranges, fragmented distributions, and small population sizes are thought to be especially vulnerable to the effects of climate change (Byers and Norris 2011). Thus, we consider climate change to be a potential threat to the persistence and long-term viability of remaining Cumberland elktoe populations.

Undefined Threats

We are still evaluating threats to the Cumberland elktoe and other freshwater mussels. A number of streams have experienced "enigmatic declines" in their mussel faunas since the 1960s, including several within the range of the Cumberland elktoe (*e.g.*, Rockcaste River, Little South Fork Cumberland River) (Haag 2019). These declines have been similar in that they were relatively rapid (often with faunal collapse within 10 years), affected all species of mussels but no

other aquatic taxa, and appear to have specifically affected recruitment (Haag 2019). The cause of these enigmatic declines has not been identified, though many factors have been hypothesized (*e.g.*, agricultural effects, disease, introduction of the Asian clam), but these declines are concerning and remain a priority of ongoing research.

D. Synthesis:

The range of the Cumberland elktoe is limited to the upper Cumberland River drainage in southeastern Kentucky and north-central Tennessee, including streams above the hypothetical original location of Cumberland Falls near Burnside, Kentucky. All verified sites of occurrence are in the Cumberland Plateau Physiographic Province, giving it one of the most restricted ranges of any Cumberlandian mussel species. The species is represented currently by only six extant populations: Laurel Fork, Jellico Creek, Marsh Creek, Sinking Creek, Big South Fork system, and Rock Creek.

Most Cumberland elktoe populations have low resiliency, as indicated by low abundance, low density, and a lack of information on recruitment (i.e., Laurel Fork, Jellico Creek, Sinking Creek, and Rock Creek). Except for the Big South Fork system, most populations are limited to single stream reaches. The most resilient and robust population is found in the Big South Fork system, much of which is protected within the Big South Fork National River and Recreation Area.

Numerous threats persist for the Cumberland elktoe, including excessive sedimentation and current and legacy effects of resource extraction (oil and gas exploration and coal mining). Due to the restricted range of the remaining six extant populations, toxic spills are also a threat and could lead to extirpations. Climate change is an emerging threat that may be especially detrimental to the Cumberland elktoe, as species with limited ranges, fragmented distributions, and small population sizes are thought to be more vulnerable to the effects of climate change. The enigmatic declines that have occurred in mussel communities in the Rockcastle River and Little South Fork Cumberland River demonstrate the precarious status of these populations and reveal our poor understanding of the threats to the species.

Due to its fragmented distribution in small, isolated populations, its continued vulnerability to multiple threats, our poor understanding of these threats, and the low resiliency of extant populations, we believe that the Cumberland elktoe continues to meet the definition of endangered (in danger of extinction throughout all or a significant portion of its range). The recovery priority number for the Cumberland elktoe should remain at 5, as the species has a high degree of threat and a low recovery potential.

III. RESULTS

A. Recommended Classification:

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist** (*Indicate reasons for delisting per 50 CFR 424.11):*
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
__X__ **No change is needed**

B. New Recovery Priority Number: 5

The Service does not recommend a change to the Recovery Priority Number.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

- Implement conservation actions recommended in the Cumberland elktoe Recovery Plan (Service 2004), the Tennessee Wildlife Action Plan (https://www.tn.gov/content/tn/twra/wildlife/action-plan.html), or the National Strategy for the Conservation of Native Freshwater Mollusks (FMCS 2016).

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U.S. FISH AND WILDLIFE SERVICE
5-Year Review of Cumberland Elktoe (*Alasmidonta atropurpurea*)

Current Classification: Endangered.

Recommendation resulting from the 5-Year Review:

___ Downlist to Threatened
___ Uplist to Endangered
___ Delist
_X_ No change needed

Review Conducted By: Santiago Martín, Tennessee Ecological Services Field Office.

FIELD OFFICE APPROVAL:

Daniel Elbert, Tennessee Ecological Services Field Office, Fish and Wildlife Service

DANIEL ELBERT Digitally signed by DANIEL ELBERT
Date: 2022.07.12 17:15:41 -05'00'

Approve _____ Date _____

*Since 2014, Field Supervisors in the Region have been delegated authority to approve 5-year reviews that do not recommend a status change.

APPENDIX A: Summary of peer review for the 5-Year Review of *Alasmidonta atropurpurea*

Peer Review Method:
This 5-year status review was not considered to be "influential" under the Service's policy for Information Quality Guidelines and Peer Review. Therefore, no external peer review was conducted.

Public Comments:
We received the following comments from the National Council for Air and Stream Improvement, Inc. (NCASI) on August 23, 2021: 1) forestry best management practices (BMPs) are implemented at high rates nationally and in the ranges of the Cumberland elktoe, 2) forestry BMPs are effective for protecting water quality and habitat for at-risk species, 3) forestry BMPs are effective for protecting aquatic biota, and 4) contributions of forestry BMPs to conservation of aquatic organisms has previously been recognized by the Service.

The comments submitted by NCASI are the same as other public comments the organization has made for other aquatic species (e.g. Bluemask Darter, Slender Chub, Duskytail Darter, and Snail Darter). In this 5-year status review, we discuss threats from stream inflows of sediment due to resource extraction (see in Section II.C.2.a.). However, we did not identify forestry as a threat for this species because we have not observed instances where forestry practices have threatened the species.

We also received comments from Niki Nicholas, Superintendent of the Big South Fork National River and Recreation Area (BSFNRRA). Her comments provided updated information on monitoring efforts performed by her staff in partnership with Dr. Monte McGregor, State Malacologist for the Kentucky Department of Fish and Wildlife Resources, as well as results from surveys at equestrian stream crossing. The Service incorporated her comments as appropriate in section II.C.1.b.