

Cumberland Pigtoe
(*Pleurobema gibberum* = *Pleurobema gibberum*)

5-Year Review:
Summary and Evaluation



Photo by Richard Biggins, USFWS

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

5-YEAR REVIEW
Cumberland pigtoe (*Pleurobema gibberum*)

I. GENERAL INFORMATION

A. Methodology used to complete the review: No part of this review was contracted to an outside party. This review was completed by the U.S. Fish and Wildlife Service's (Service) Tennessee Ecological Services Field Office in Cookeville, Tennessee. In conducting this 5-year review, we relied on the best available scientific information pertaining to historic and current distribution, life history and habitat of this species. Our sources include the final rule (56 FR 21084) listing this species under the Endangered Species Act (Act), the species' recovery plan (Service 1992), peer reviewed scientific publications and survey reports. A *Federal Register* (FR) notice announcing the review and requesting information was published on September 21, 2007 (72 FR 54057). No comments were received during the 60-day public comment period.

We provided drafts of this 5-year review to individuals who have knowledge of this freshwater mussel and might have additional information about the species. Reviewers were asked to provide comments and any relevant information about the threats to the species and the current status of the species (See Appendix A).

B. Reviewers

Lead Region – Southeast Region: Kelly Bibb, 404/679-7132

Lead Field Office – Cookeville, TN, Ecological Services: Todd Shaw,
931/525-4985

C. Background

1. **Federal Register Notice citation announcing initiation of this review:**
September 21, 2007, 72 FR 54057
2. **Species status:** Uncertain
3. **Recovery achieved:** 1 (0-25%) recovery objectives achieved
4. **Listing history:**
Original Listing
FR notice: May 7, 1991; 56 FR 21084
Date listed: June 6, 1991
Entity listed: species
Classification: endangered
5. **Associated rulemakings:**
Not applicable

6. Review History:
Recovery Data Call: 2008-2014

The Recovery Plan for Cumberland Pigtoe Mussel (*Pleurobema gibberum*) (Service 1992) indicated that the species was once widely distributed in the upper Caney Fork River system upstream of Great Falls (a Cumberland River tributary) in Grundy, Van Buren, Warren, and White counties, Tennessee, but the species is presently known from short river reaches in only five Caney Fork River tributaries. The recovery plan further indicated that the species has been and continues to be impacted by water quality deterioration resulting from siltation contributed by coal mining and poor land use practices, other water pollutants and impoundments.

7. Species' Recovery Priority Number at start of review (48 FR 43098):
The Cumberland pigtoe is assigned a recovery priority number of 5 (high degree of threat and a low recovery potential); threats persist (agricultural runoff from plant nurseries and small farms, road maintenance, gravel dredging, etc.), reducing the likelihood of recovery.

8. Recovery Plan:
Name of plan: Recovery Plan for Cumberland Pigtoe Mussel (*Pleurobema gibberum*)
Date issued: August 13, 1992

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 DPS to only 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? Yes.

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? No. We have gained additional information on the species and discovered new populations since listing.

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria? Yes

3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information.

The Cumberland pigtoe mussel will be considered for reclassification to threatened status when the likelihood of the species becoming extinct in the foreseeable future has been eliminated by achievement of the following criteria:

1. Through protection of existing populations and through successful establishment of reintroduced populations or the discovery of additional populations, a total of four distinct viable populations exist. The populations shall be distributed within the upper Caney Fork River system and can include the present populations or newly discovered or created populations.

At the time the recovery plan was written, isolated populations of the Cumberland pigtoe were known to occur in short reaches of five tributaries in the upper Caney Fork watershed, including Cane Creek and (tributary to the Caney Fork River, Van Buren County, Tennessee), Calfkiller River (tributary to the Caney Fork River, White County, Tennessee), Hickory Creek (tributary to the Collins River, Warren County, Tennessee) the Barren Fork (tributary to the Collins River, Warren County, Tennessee), and Collins River (tributary to the Caney Fork River, Warren and Grundy counties, Tennessee) (Anderson 1990; Service 1992). Widlak (1992) later reported a population from Big Hickory Creek (tributary to Hickory Creek, Warren County, Tennessee), but that population is believed to be extirpated (Widlak 1992). Since completion of the recovery plan, additional populations of the Cumberland pigtoe have been discovered in Hills Creek (tributary to Collins River, Warren County, Tennessee), West Fork Hickory Creek (tributary to Hickory Creek, Coffee County, Tennessee) Liberty Creek (tributary to South Prong Barren Fork, Coffee County, Tennessee), Witty Creek (tributary to Barren Fork River, Warren County, Tennessee), and North Prong Barren Fork (tributary to Barren Fork River, Warren County, Tennessee), (Ahlstedt et al. 2004).

This criterion has not been met because a population structure and genetic diversity study has not yet been conducted to determine if four

genetically distinct viable Cumberland pigtoe populations exist among the remaining populations in the upper Caney Fork River system.

- 2. One distinct naturally reproduced year class exists within each of the four populations. The year class must have been produced within 5 years prior to the time the species is reclassified from endangered to threatened. Within 1 year of the downlisting date, gravid females and the mussel's host fish must be present in each populated river reach.**

The most comprehensive mussel survey of the upper Caney Fork River drainage was conducted from 2001 through 2004 and included 82 sampling sites (Ahlstedt et al. 2004). That effort determined recruitment of Cumberland pigtoe was occurring in the Collins River and North Prong Barren Fork, with a number of the sampled individuals measuring less than 40 millimeters (mm) (1.6 inches [in]). Following the 2004 survey, it was noted that additional sampling was needed to be carried out in the upper Caney Fork River drainage to include the Falling Water River and determine mussel species presence in that system (Ahlstedt et al. 2004).

Layzer et al. (2003) exposed 18 species of native freshwater fish to Cumberland pigtoe glochidia in a laboratory setting and found that metamorphosis of glochidia occurred on the telescope shiner (*Notropis telescopus*) and the striped shiner (*Luxilus chrysocephalus*). Based on the high incidence of glochidia encysted on telescope shiners, collected from the Collins River, and the observed successful metamorphosis of glochidia from naturally infested telescope shiners from the Collins River under laboratory conditions, the telescope shiner is believed to be the primary host for the Cumberland pigtoe, and Layzer et al. (2003) commented that striped shiner may be a marginal host, based on metamorphosis of a single glochium from 19 exposed striped shiners.

This criterion has not been met because individual Cumberland pigtoe populations have not yet been distinguished via a population structure and genetic diversity study, no mussel surveys have been conducted in recent years (since 2004) to assess year-class strengths or fecundity of the species, and no fish surveys have been conducted to determine host fish presence in reaches occupied by the Cumberland pigtoe. The fish host identification study, completed by Layzer et al. (2003), identified the telescope shiner as a natural, primary host species, and the striped shiner as a marginal host species for the Cumberland pigtoe; therefore, fish surveys to determine host fish occurrences should be based largely upon the presence/absence of the telescope shiner in reaches populated by the Cumberland pigtoe.

- 3. Biological and ecological studies 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 and/or an increase in the length of the river reach inhabited by each of the four populations.**

This criterion has been partially met. Layzer et al. (2003) identified glochidial fish hosts of the Cumberland pigtoe and studied other life history aspects of the species, including its reproductive cycle and habitat utilization (see section II.C.1.a. and II.C.1.e. for further discussion on species biology and habitat). The population densities and/or lengths of occupied river reaches have not substantially increased as a result of required recovery measures because most of the recovery measures are either ongoing or have not been completed. However, additional populations of Cumberland pigtoe have been discovered in the Collins River drainage in Liberty Creek, North Prong Barren Fork, Witty Creek, Hills Creek, and West Fork Hickory Creek (Ahlstedt et al. 2004).

The Cumberland pigtoe mussel will be considered for delisting when the likelihood of the species becoming threatened in the foreseeable future has been eliminated by the achievement of the following criteria:

- 1. Through protection of existing populations and successful establishment of reintroduced populations or the discovery of additional populations, a total of six distinct viable populations exist. These populations must be separated to the extent that it is unlikely that a single event would eliminate or significantly reduce more than one of these populations.**

While six populations may presently be extant, it is not clear whether this criterion has been met. Recruitment of Cumberland pigtoe in the Collins River and North Prong Barren Fork has been reported (Ahlstedt et al. 2004). However, to accurately assess whether each of the known extant populations are viable, the length of inhabited stream reaches and amount of successful recruitment taking place in each inhabited reach would be needed. In addition, a population structure and genetic diversity study might verify whether the currently separated Cumberland pigtoe populations in the upper Caney Fork River system are genetically distinct and thus fulfill the criterion.

- 2. Two distinct naturally reproduced year classes exist within each of the six populations. Both year classes must have been produced within 10 years, and one year class within 5 years, of the recovery**

date. Within 1 year of the recovery date, gravid females and the mussel's host fish must be present in each river.

This criterion has not been met. A genetic study has not been completed to confirm whether the existing populations in the Calfkiller and Collins rivers have been isolated long enough to be genetically distinct. A population structure and genetic diversity study might be appropriate to identify if some or all existing Cumberland pigtoe populations in the upper Caney Fork River system are distinct. Regardless of genetic analyses, surveys to assess the year-class strengths and fecundity of individuals in the separate populations, fish surveys to determine host fish presence in reaches occupied by the six Cumberland pigtoe populations, and/or estimates of recruitment success for each of the populations would be needed to identify whether these populations are viable.

- 3. Studies of the mussel's biological and ecological requirements have been completed and recovery measures developed and implemented from these studies have been successful, as evidenced by an increase in population density and/or an increase in the length of the river reach inhabited by each of the six populations.**

This criterion has been partially met, as described under Section II.B.3.3.

- 4. No foreseeable threats exist that would likely threaten the survival of any of these six populations.**

This criterion has not been met. Some threats identified in the recovery plan (Service 1992), reduction of historical habitat, fragmented populations, and hydrological impacts affecting the extant populations that resulted from impoundment by Great Falls Dam, for example are impossible to control. However, threats related to water and habitat quality impacts from land uses affecting some populations (agriculture and silviculture, for example) can, and are being addressed (see Sections II.C.2.a-e).

- 5. Where habitat had been degraded, noticeable improvements in water and substratum quality have occurred.**

As most of the upper Caney Fork River system is in private ownership, adequate documentation to demonstrate that this criterion has been satisfied may be unattainable throughout the entire remaining range of Cumberland pigtoe, due to the time frame required to restore degraded habitat and water quality such that noticeable improvement and habitat appropriate for mussels is demonstrated.

C. Updated Information and Current Species Status

1. Biology and Habitat

a. Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Historically, and based on recent collections, the Cumberland pigtoe likely inhabited all large and mid-sized tributary streams, and some small tributary streams in the Caney Fork River basin upstream of Great Falls in middle Tennessee. The species was collected from the Collins River (tributary to the Caney Fork River) and Hickory Creek (tributary to the Collins River), and, likely, also occurred in the mainstem Caney Fork River (Service 1992).

In recent decades, isolated populations of the Cumberland pigtoe have been found in short reaches of tributaries throughout the upper Caney Fork watershed, but concentrated in the Collins River system (Anderson 1990; Widlak 1992). Since completion of the recovery plan, additional populations of the Cumberland pigtoe have been discovered in Liberty Creek (tributary to South Prong Barren Fork, Coffee County, Tennessee), North Prong Barren Fork (tributary to Barren Fork River, Warren County, Tennessee), Witty Creek (tributary to Barren Fork River, Warren County, Tennessee), Hills Creek (tributary to Collins River, Warren County, Tennessee) and West Fork Hickory Creek (tributary to Hickory Creek, Coffee County, Tennessee) (Anderson 1990; Widlak 1992; Ahlstedt et al. 2004). Ahlstedt et al. (2004) noted recruitment of Cumberland pigtoe was occurring in the Collins River and North Prong Barren Fork.

Since finalization of the recovery plan, a single, fresh dead adult specimen that was considered by some to be Cumberland pigtoe, was discovered outside of the Caney Fork River system. This individual was collected at the Arnold Engineering Development Center on August 14, 1993, in Bradley Creek, a tributary to the Elk River (Coffee County, Tennessee) (J. Widlak, pers. comm. 1995; Parmalee and Bogan 1998) and has been included in the University of Tennessee McClung Museum mollusk collection (Catalog Number 965) (P. Shute, pers. comm. 2002). Follow-up surveys of Bradley Creek in 1993 and 1994 found no additional specimens that approach this species (P. Shute, pers. comm. 2002; Mullen et al. 1995). Dr. D. H. Stansbery of Ohio State University suggested that, if valid, its presence in Bradley Creek may have been the result of the individual gaining access to the creek via stream capture of the Caney Fork headwaters (Mullen et al. 1995). Dinkins, Steve Ahlstedt, and Bob Butler compared it with the range of available Cumberland pigtoe

specimens in the McClung Museum mollusk collection, and concluded that the original identification of the specimen as Cumberland pigtoe was incorrect (Gerald Dinkins, University of Tennessee McClung Museum collection Curator, personal communication with Peggy Shute, 2015).

Recent and long-term monitoring data are not available to establish population trends; therefore, the status of the Cumberland pigtoe is currently considered uncertain. The Service is presently coordinating with Tennessee Wildlife Resources Agency (TWRA) and other partners to resurvey the mainstem Calfkiller River in 2014 to determine the species status in that system. Surveys also need to be conducted on a consistent and repeated basis in the Falling Water River (not previously surveyed) and in upper Caney Fork River streams, previously surveyed by Ahlstedt et al. (2004), to better determine population trends and status of the Cumberland pigtoe.

Layzer et al. (2003) conducted a study to determine the glochidial fish hosts and other life history aspects of the Cumberland pigtoe. Telescope shiners were determined to be a primary host for glochidia of the Cumberland pigtoe, and striped shiner appeared to be a marginal host. Telescope shiners collected from the Collins River were infested with one to seven Cumberland pigtoe glochidia per fish. A single glochidium metamorphosed on 1 of 19 striped shiners exposed to glochidia.

Layzer et al. (2003) found that 88% of individual Cumberland pigtoes collected in surveys were 42 to 50 mm (1.7 to 2 in) long and that gravid females ranged from 42 to 54 mm (1.7 to 2.1 in) long. The mean annual increase for 33 recaptured individuals was 0.42-mm, and 45% of all individuals had no measurable growth between years.

Layzer et al. (2003) determined that Cumberland pigtoes became gravid by the end of June until August. The inflated marsupial gills were pinkish-red, as opposed to the more flaccid white gills of non-gravid mussels. Examination of conglutinates revealed that they consisted primarily of unfertilized eggs and contained few (3–6) or no glochidia. No gravid individuals have been found at other times of the year, indicating a short-term summer breeding period, typical of the Ambleminae (Anderson 1990).

Layzer et al. (2003) indicated that most Cumberland pigtoes encountered during surveys were in sand, while a few were collected from a mixture of sand, gravel, and small cobble. Anderson (1990) described the species as occupying similar substrate, but also indicated that all Cumberland pigtoe populations were found only in streams that had eroded down to expose limestone outcroppings. The species inhabits riffles and shoals, typically in reaches with moderately strong currents and depths ranging from 10 cm

(3.9 in) to approximately 1 meter (39.4 in) (Anderson 1990; Bogan and Parmalee 1998).

b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

The species' recovery plan (Service 1992) indicates that natural gene flow among Cumberland pigtoe populations is no longer possible because populated stream reaches are physically isolated from each other by impoundments and unsuitable habitat. Therefore, long-term genetic viability of remaining populations may be questionable. However, while the lifespan of the Cumberland pigtoe has not been reported, it is likely that multiple generations have recruited into populations isolated nearly 100 years ago, since impoundment of Great Falls Dam (in 1917, Tennessee Valley Authority 2015). Isolated populations may be sustained if they are large enough, and contain suitable genetic heterogeneity. Other populations (e.g., in the Calfkiller River and Cane Creek) isolated by larger distances or less suitable habitat from other populations (the Barrens Fork population cluster, for example) may not contain suitable levels of heterogeneity or a sufficient number of individuals for long-term persistence. A population structure and genetic diversity study that defines individual populations and identifies levels of genetic diversity within and among populations could provide more definitive information on this possibility.

The recovery plan (Service 1992) includes a task to determine the number of individuals required to maintain a viable population and indicates that, "factors that will influence effective population size include sex ratio, length of the species' reproductive life, fecundity, and extent of exchange of genetic material within the population, plus other life history aspects". In addition to a population structure and genetic diversity study, additional research is necessary to determine effective population sizes for the Cumberland pigtoe and to develop propagation technology for future population reintroduction efforts.

c. Taxonomic classification or changes in nomenclature:

The Cumberland pigtoe mussel was first described by Lea (1838). The recently created genus, *Pleuronaia* (Williams et al. 2008), which includes the species along with Tennessee pigtoe (formerly *Fusconaia barnesiana*) (Lea 1838) and slabside pearl mussel (formerly *Lexingtonia dolabelloides*) (Lea 1840), all restricted to the Cumberland and/or Tennessee River drainages, was created as a subgenus by Frierson (1927). *Pleuronaia* has since been elevated to genus level based on phylogenetic analysis of DNA sequence data (Campbell et al. 2005; Bogan et al., unpublished data, as cited in Williams et al. 2008) and shell morphology

(i.e., shallow umbo cavity) (Simpson 1900; Williams et al. 2008). The Service will recognize *Pleuonaia*; however, to formally change the Federal List of Threatened and Endangered Wildlife, it will require a notice in the *Federal Register* to formally make this technical change to the species' name.

d. Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g., corrections to the historical range, change in distribution of the species' within its historic range, etc.):

Additional populations of the Cumberland pigtoe have been discovered within its historical range since the recovery plan was completed. These include: Liberty Creek (tributary to South Prong Barren Fork, Coffee County, Tennessee), North Prong Barren Fork (tributary to Barren Fork River, Warren County, Tennessee), Witty Creek (tributary to Barren Fork River, Warren County, Tennessee), Hills Creek (tributary to Collins River, Warren County, Tennessee) and West Fork Hickory Creek (tributary to Hickory Creek, Coffee County, Tennessee) (Anderson 1990; Widlak 1992; Ahlstedt et al. 2004). In addition, the single record reported from outside the upper Caney Fork River system (Bradley Creek, a tributary to the Elk River of the Tennessee River drainage in Coffee County, Tennessee) is apparently based on a miss-identification (see Section II.3.C.1.a).

In 2014, surveys of the mainstem Calfkiller River were conducted to determine the species' current status in that system. No live Cumberland pigtoe were encountered during these surveys. Several relic shells of the species were found in reaches of the Calfkiller River within White County, Tennessee (Jeff Simmons, Aquatic Biologist with Tennessee Valley Authority, and Don Hubbs, State Malacologist with Tennessee Wildlife Resources Agency, personal communication with Todd Shaw, Service, 2014 and 2015). Re-surveys of other streams in the upper Caney Fork River system, originally surveyed by Ahlstedt et al. (2004), and a survey of the Falling Water River, as suggested by Ahlstedt et al. (2004), should also be conducted in the near future to determine the status of the species in those systems.

e. Habitat or ecosystem conditions:

Anderson (1990) and Ahlstedt et al. (2004) described the Cumberland pigtoe as being scattered throughout short reaches of suitable habitat within the streams described under II.C.1.a. in the upper Caney Fork River drainage. The total amount of suitable habitat available to the species has not been quantified but has likely decreased over the past few decades due to habitat degradation.

2. Five-Factor Analysis

a. Present or threatened destruction, modification or curtailment of its habitat or range:

Great Falls Dam and its impoundment, Great Falls Reservoir, remain a threat to the Cumberland pigtoe due to the dam having isolated and fragmented its persisting populations. While known host fish species for the Cumberland pigtoe (telescope shiners and striped shiners) continue to persist in the upper Caney Fork River drainage, operation of Great Falls Dam creates a barrier to movement of fish populations in the upper Caney Fork River mainstem and its major tributaries. This impediment, which was constructed in 1917, has likely reduced host fish densities and/or eliminated populations of host fish, hindering reproductive success of the Cumberland pigtoe. The dam may also preclude movement of host fish into the Calfkiller River, further affecting reproduction of the Cumberland pigtoe.

Great Falls Dam impounded several miles of the Caney Fork and lower Collins rivers, reducing the amount of suitable habitat available to the Cumberland pigtoe (Service 1992). The species has been unable to adapt to these habitat changes. Sedimentation from impoundment has vastly altered the shoal habitat inhabited by the species in areas inundated by the dam (Anderson 1990; Parmalee and Bogan 1998; Layzer et al. 2003).

Widlak (1992) reported a Cumberland pigtoe population from Big Hickory Creek (tributary to Hickory Creek, Warren County, Tennessee), which was discovered after the recovery plan was written. However, that population is considered extirpated (Widlak 1992).

Host fishes are also likely to be impacted by excessive sedimentation, as a result of the impoundment. Wood and Armitage (1997) identified at least five impacts of sedimentation on fish, including (1) reduction of growth rate, disease tolerance, and gill function; (2) reduction of spawning habitat and egg, larvae, and juvenile development; (3) modification of migration patterns; (4) reduction of food availability through the blockage of primary production; and (5) reduction of foraging efficiency.

Portions of the Caney Fork and Collins river basins are listed as impaired by the State of Tennessee on the most recent final 303(d) list (year 2012) (Tennessee Department of Environment and Conservation 2014). Pollutants, their causes, and pollutant sources, identified on the list as occurring in streams known to support Cumberland pigtoes include *Escherichia coli*, as a result of pasture grazing, in 54.5 miles of West Fork Hickory Branch (Coffee County), and water chemistry imbalances (iron,

manganese and pH), as a result of abandoned mining, in 5.8 miles of the Collins River (Grundy County). Portions of the Calfkiller River and Cane Creek have also been included on the 303(d) list as impaired water bodies. However, these stream reaches are located in Putnam County, outside of Calfkiller River (White County), and Cane Creek (Van Buren County) sites known to be occupied by the Cumberland pigtoe.

Layman et al. (1993), Simmons and Layzer (2004), and Simmons (2004) identified potential and actual threats to the bluemask darter (*Etheostoma akatulo*), another federally listed species which also occurs only in large streams of the upper Caney Fork River drainage. These threats would also affect the Cumberland pigtoe and include:

- pesticides, herbicides and fertilizers used by the plant nursery industry
- water withdrawals for irrigation of nurseries could reduce habitat or degrade water quality during low flows
- habitat alteration and destruction from gravel dredging; gravel dredging could increase siltation and water turbidity in downstream perennial reaches
- siltation and agricultural runoff in the Collins River
- acid drainage from historical coal mines in the Cumberland Plateau reaches of stream systems
- logging of upland areas resulting in decreased aquifer recharge, changes in the annual hydrograph, and overland runoff to streams
- water quality degradation and bank instability caused by livestock access, removal of riparian vegetation and encroaching streamside development
- hydrologic alteration and habitat degradation in lower reaches of streams due to operation of Great Falls Reservoir.

Some efforts have been undertaken for the purpose of reducing non-point sources of sediment in waters inhabited by Cumberland pigtoes. The Service's Tennessee Ecological Services Field Office has coordinated with a private landowner to construct 2,500 feet of livestock exclusion fencing and one off-stream livestock water development on the Calfkiller River under the Partners for Fish and Wildlife Program. The TWRA recently partnered with a private landowner on a bank stabilization project along several hundred feet of stream in the headwaters of the Collins River mainstem. These enhancements are expected to improve stream water quality and benefit the Cumberland pigtoe.

b. Overutilization for commercial, recreational, scientific, or educational purposes:

Overutilization is not known to be a threat to this species.

c. Disease or predation:

Disease and predation are not known to be factors in the decline of this species. However, freshwater mussel diseases are poorly known, so they cannot be discounted as a possible threat to the Cumberland pigtoe. We will continue to conduct life history studies to monitor for these aspects.

d. Inadequacy of existing regulatory mechanisms:

The Cumberland pigtoe and its habitat are afforded limited protection from water quality degradation under the Clean Water Act of 1977 (33 U.S.C. 1251 et seq.) and the Tennessee Water Quality Control Act of 1977. These laws focus on point-source discharges, and many water quality problems are the result of non-point source discharges. Therefore, these laws and corresponding regulations have been inadequate to halt population declines and degradation of habitat for the Cumberland pigtoe.

In addition to the Federal listing, the Cumberland pigtoe is "Listed Endangered" by the State of Tennessee under the Tennessee Nongame and Endangered or Threatened Wildlife Species Conservation Act of 1974 (Tennessee Code Annotated §§70-8-101-112). According to this act "... it is unlawful for any person to take, attempt to take, possess, transport, export, process, sell or offer for sale or ship nongame wildlife, or for any common or contract carrier knowingly to transport or receive for shipment nongame wildlife." Further, regulations included in the Tennessee Wildlife Resources Commission Proclamation 00-15 Endangered or Threatened Species state the following: except as provided for in Tennessee Code Annotated, Section 70-8-106 (d) and (e), it shall be unlawful for any person to take, harass, or destroy wildlife listed as threatened or endangered or otherwise to violate terms of Section 70-8-105 (c) or to destroy knowingly the habitat of such species without due consideration of alternatives for the welfare of the species listed in (1) of this proclamation, or (2) the United States list of Endangered fauna. Potential collectors of this species would be required to have a state collection permit.

Since listing, section 7 of the Act has required Federal agencies to consult with the Service when projects they fund, authorize, or carry out may affect the species. However, the lack of Federal authority over the many actions likely impacting Cumberland pigtoe habitat has become apparent. Many of the threats (including those identified at the time of listing, during recovery planning and since development of the recovery plan) involve activities that likely do not have a Federal nexus (such as water quality changes resulting from development, county and state road

maintenance, water withdrawals or indiscriminate logging) and, thus, may not result in section 7 consultation. Although the take prohibitions of section 9 of the Act do apply to these types of activities and their effects on the Cumberland pigtoe, enforcement of section 9 prohibitions is difficult, at best.

The Service is not informed when many activities are being considered, planned or implemented; therefore, we have no opportunity to provide input into the design of the project or to inform project proponents of the need for a section 10 permit. Unlike higher profile species, conservation of the Cumberland pigtoe is not valued by the public to the extent that citizens would report to the Service the likelihood of habitat destruction or illegal taking. A non-regulatory approach to providing for conservation of the Cumberland pigtoe may be most effective in alleviating threats and providing for conservation of the mussel.

Several stream reaches within the Caney Fork and Collins river watersheds are listed as impaired by the State of Tennessee on the most recent final 303(d) list (year 2012) (Tennessee Department of Environment and Conservation 2014). Pollutants, their causes and pollutant sources, identified on the list, which occur in streams known to support Cumberland pigtoes, have been included under II.C.2.a. Partnerships between agencies (Service, Natural Resources Conservation Service, U.S. Geological Service, Tennessee Department of Environment and Conservation (TDEC) Division of Community Assistance, TDEC Division of Water Supply, Tennessee Department of Agriculture), and landowners continue to be fostered in attempt to improve water quality conditions in these watersheds.

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

As indicated in the recovery plan (Service 1992), existing Cumberland pigtoe populations inhabit only short stream reaches, rendering them vulnerable to extirpation from stochastic effects, such as accidental toxic chemical spills or extreme droughts. Such events could impact or eliminate one or more of the individual populations, dependent upon where the spill occurred, its rate of transmission and dispersal characteristics. The Collins River Valley, in particular, is used extensively for commercial plant nurseries, increasing the likelihood of a toxic agricultural chemical spill and contamination of stream substrate, which could impact a population(s) of Cumberland pigtoes. Three of the five populations originally identified in the recovery plan (Barren Fork River, Hickory Creek, and the mainstem Collins River) are located within the Collins River drainage. Other sources of potential spills, which could occur within any of the streams inhabited by the Cumberland pigtoe, might involve accidents involving vehicles transporting chemicals over

bridge crossings, or intentional releases into streams of chemicals used in agricultural or residential applications.

As also indicated in the recovery plan (U.S. Fish and Wildlife Service 1992), because the populated reaches are physically isolated from each other by impoundments and unsuitable habitat, recolonization of any extirpated population would be unlikely without human intervention. 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 and decreasing their ability to adapt to environmental changes (Allendorf and Luikart 2007). Haag and Williams (2013) suggest that the overriding conservation issue with mussels is population fragmentation—specifically if action is needed, when, and what actions might be appropriate. However, while the recovery plan suggests that long-term genetic viability of the remaining isolated Cumberland pigtoe populations may be questionable because natural gene flow among populations is no longer possible, the century-long persistence of isolated populations may indicate some populations may contain sufficient size and genetic diversity to be sustained. The status of genetic viability of these isolated populations has not been studied.

D. Synthesis

The Cumberland pigtoe was listed due to reduction of its historical range and ongoing threats to its continued existence. The species appears extirpated from the mainstem Caney Fork River and lower Hickory Creek (Service 1992). Since the recovery plan was written, additional populations of the Cumberland pigtoe have been discovered in several other upper Caney Fork River drainage streams, including Liberty Creek, North Prong Barren Fork, Witty Creek, Hills Creek, and West Fork Hickory Creek (Ahlstedt et al. 2004).

While the species may persist in streams where it currently occurs, natural recovery may be precluded throughout the entirety of its known range due to sediment, contaminants, and continued operations at Great Falls Dam that manipulate Great Falls Reservoir pool elevations. These threats have fragmented Cumberland pigtoe populations and continue to affect water quality and habitat. The potential for stochastic events such as toxic chemical spills also remain a threat to the Cumberland pigtoe. Unless these threats are addressed and/or new populations are discovered or created using propagated individuals, achieving existing recovery criteria to reestablish the species will be problematic.

While some life history aspects of the Cumberland pigtoe have been studied since the recovery plan was finalized, resulting in new information about the species' glochidial fish hosts, reproductive cycle and habitat utilization (Layzer et al. 2003), much of the recovery criteria in the recovery plan have not been met. Comprehensive surveys to locate and quantify Cumberland pigtoes in the upper Caney Fork River drainage have not

been attempted in over a decade. The total amount of suitable habitat available to the species has also not been quantified.

Due to a combination of its historically limited distribution, currently fragmented populations, inability to expand its existing range, and ongoing threats, the Cumberland pigtoe continues to be in danger of extinction throughout its range. Therefore, the status of the Cumberland pigtoe as endangered remains appropriate. Presently, much uncertainty exists regarding recovery of the species. Thus, the recovery priority number for the Cumberland pigtoe should remain 5, as the degree of threat remains high and the potential for recovery is low.

III. RESULTS

A. Recommended Classification:

 X No change is needed

B. New Recovery Priority Number N/A

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

1. Use TDEC's most current 303(d) list and any other information available to determine specific pollutants and causative factors impacting the Cumberland pigtoe and/or its habitat, and identify sources of pollutants to prioritize sites for working with private landowners to reduce such threats. Additionally, identify major landowners in the drainages occupied by Cumberland pigtoes who should be targeted for cooperative conservation efforts to prevent future risk of threats associated with anticipated land uses.
2. Continue conducting life history studies of the Cumberland pigtoe, particularly studies to assist in determining effective population sizes for the species. Such studies would involve researching factors which influence effective population size, including sex ratio, length of reproductive life, fecundity, extent of exchange of genetic material, and other life history aspects.
3. Use existing state and federal regulations and develop partnerships (local watershed projects) with federal and state agencies, local governments, nurserymen, agricultural groups, coal mining interests, conservation organizations, and local landowners and other interested individuals to protect the species and its habitat.
4. Conduct a population structure and genetic diversity study of the Cumberland pigtoe. Such a study would determine the level of gene flow among seemingly isolated populations to assist in defining individual populations and determine the amount of inbreeding (levels of genetic diversity) within populations.
5. Resurvey stream reaches in the upper Caney Fork River drainage previously surveyed by Ahlstedt et al. 2004, in addition to surveying the Falling Water River, to determine

and update the status of the Cumberland pigtoe. These surveys should be conducted in conjunction with surveys to quantify the amount of suitable habitat for the species.

6. Assure that all Cumberland mussel collections and observations are represented by records in databases maintained by TVA's Regional Natural Heritage Project and Tennessee Division of Natural Areas' – Natural Heritage program.

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**U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW
Cumberland Pigtoe (*Pleurobema gibberum*)**

Current Classification: **Endangered**

Recommendation resulting from the 5-Year Review:

☐ Downlist to Threatened
☐ Uplist to Endangered
☐ Delist
☒ No change is needed

Appropriate Listing/Reclassification Priority Number, if applicable _____

Review Conducted By: Ross "Todd" Shaw, Tennessee Ecological Services Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve Mary E Jennings Date 4/20/15

REGIONAL OFFICE APPROVAL:

Lead Regional Director, Fish and Wildlife Service

for Approve Franklin Jones Date 8/24/15

APPENDIX A
Summary of peer review for the 5-year review of
Cumberland Pigtoe (*Pleurobema gibberum*)

A. Peer Review Method:

E-mails were sent to S.A. Ahlstedt and D.W. Hubbs on July 30, 2014, and G.R. Dinkins on September 16, 2014, requesting their assistance in providing a peer review of the draft Cumberland Pigtoe 5-Year Review.

B. Peer Review Charge:

The following instructions and other information were included in the e-mails sent to peer reviewers:

The U.S. Fish and Wildlife Service (Service) is conducting a 5-year review of the appropriateness of the current listing of the Cumberland pigtoe (*Pleurobema gibberum*) as an endangered species under provisions of the Endangered Species Act of 1973, as amended (Act). On September 21, 2007, we published a notice in the *Federal Register* announcing our intent to conduct this review on this species for which our office has the lead responsibility under section 4(c)(2)(A) of the Act. At that time, we requested any new information on the Cumberland pigtoe since the time of its listing in 1991. In order to support the Service's interest in making its decision based on the best available science, portions of the draft review need to be subjected to an appropriate level of peer review. Due to your expertise regarding this species, we request that you peer review the attached portion of the document. We must receive your review comments within 30 days of the date of this email (July 30, 2014) in order to consider them in our final review document.

The goals of peer review during this process are (1) to ensure that the best available biological data, scientifically accurate analyses of those data, and the reviews of recognized experts are used in the decision-making process; and (2) to indicate to the public, to other agencies, to conservation organizations, and to personnel within the Service that the best available data and scientific analyses were used in the decision-making process.

The following materials are enclosed for use during your review:

Peer Review in Endangered Species Act Activities - This July 1, 1994, *Federal Register* notice established a peer review process for all listing and recovery actions taken under the authorities of the Endangered Species Act.

The Biological Portion of the Draft 5-Year Review – This is included as part of the draft material that we hope you will review.

The Literature Cited section of the Draft 5-Year Review - The list is enclosed (attached to the draft as one file).

We appreciate your assistance in ensuring that this review is based on the best available science. If you have any questions or if we can provide additional information, please contact Todd Shaw by telephone at 931/525-4985, or via email at ross_shaw@fws.gov.

C. Summary of Peer Review Comments/Report:

Steve Ahlstedt's comments were comprised of the following: "Concerning the review, more survey work would probably turn up additional populations. You did a great job on this. The commercial nurseries on the Plateau need to be regulated concerning what chemicals they are using and water withdrawals".

We also sought internal Service review from Bob Butler in our Asheville Field Office and he provided many editorial and technical comments, particularly regarding the need for genetic research. Most of his comments have been incorporated into this document.

Don Hubbs had no additional comments to add.

Gerry Dinkins provided a few editorial and technical comments, most importantly, in regards to the inclusion of an erroneous record of the species from the Elk River system (Bradley Creek, Coffee County, Tennessee). His comments have been incorporated into this document, and the mis-identification of the Bradley Creek specimen has also been addressed in this review.

D. Response to Peer Review:

We have agreed with the peer reviewer comments and have incorporated their suggested edits in the final 5-year review, where appropriate.

