Cumberland pigtoe

(Pleuronaia gibber)

Status Review:

Summary and Evaluation

Cumberland pigtoe, Calfkiller River. Photo by David Pelren, FWS.

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

August 2022

STATUS REVIEW
Cumberland pigtoe (*Pleuronaia gibber*)

GENERAL INFORMATION

Current Classification: Endangered

Lead Field Office: Tennessee Ecological Services Field Office

Review Author: David Pelren, (931) 528-6481

Reviewers:

Lead Regional Office: Atlanta Regional Office, Carrie Straight (404) 679-7226

Date of original listing: June 6, 1991 (56 FR 21084)

Methodology used to complete the review: In accordance with section 4(c)(2) of the Endangered Species Act of 1973, as amended (Act), the purpose of a status review is to assess each threatened species or endangered species to determine whether its status has changed and if it should be classified differently or removed from the Lists of Threatened and Endangered Wildlife and Plants. The U.S. Fish and Wildlife Service (Service) evaluated the biology, habitat, and threats of the Cumberland pigtoe to inform this status review.

We announced initiation of this review in the Federal Register on June 23, 2021 (86 FR 32965) with a 60-day comment period. During the comment period, we received public comments from the National Council for Air and Stream Improvement, Inc., Niki Nicholas (Big South Fork National River and Recreation Area), and Jeff Simmons (Tennessee Valley Authority (TVA)). See Appendix A for details on the specific comments and how the Service addressed them. The primary sources of information used in this analysis were the 1991 final listing rule (56 FR 21084), the 1992 recovery plan, peer-reviewed reports, agency reports, unpublished survey data and reports, and personal communication with recognized experts. This review was completed by the U.S. Fish and Wildlife Service, Tennessee Ecological Services Field Office (TNFO), Cookeville, Tennessee. All literature and documents used for this review are on file at the TNFO. All recommendations resulting from this review are the result of thoroughly reviewing the best available information on the Cumberland pigtoe.

We have not received significant new information, interpreted previously reviewed information in a new, significant light since the last review of the species, and the level of public interest is low and non-controversial; therefore, no peer review was conducted.

FR Notice citation announcing the species is under active review:
June 23, 2021 (86 FR 32965)

Species' Recovery Priority Number (48 FR 43098) at start of 5-year review: The Cumberland pigtoe's recovery priority number is 5, indicating a high degree of threat and low potential for recovery.

Review History:
A previous 5-year review recommending no change in status was published on August 24, 2015.

REVIEW ANALYSIS

Listed Entity
Cumberland pigtoe (*Pleuronaia gibber*) Lea 1838

Taxonomy and nomenclature:
The Service published a direct final rule on February 17, 2022 (87 FR 8960) with an effective date of May 18, 2022, to revise the taxonomy of the Cumberland pigtoe to *Pleuronaia gibber*. The accepted species name at the time of listing (1991) was Cumberland pigtoe (*Pleurobema gibberum*); however, molecular studies by Campbell et al. (2005) and Campbell and Lydeard (2012) supported a reassignment of *Pleurobema gibberum* to the genus *Pleuronaia*. Additionally, Williams et al. (2017) corrected the gender agreement of the specific name of *Pleuronaia gibberum* to *gibber*. The best available information continues to indicate that the species is a valid entity (Williams et al. 2017; FMCS 2021).

Distinct Population Segment (DPS) (61 FR 4722)
The Endangered Species Act defines species as including any subspecies of fish or wildlife or plant, and any distinct population segment of any species of vertebrate wildlife. This definition limits listing of a DPS to vertebrate species only. Because the species under review is not a vertebrate, the DPS policy does not apply.

Recovery Criteria

Recovery Plan or Outline:
Recovery Plan for Cumberland Pigtoe Mussel (*Pleurobema gibberum*), August 13, 1992.

Recovery plans are not regulatory documents but are intended to provide guidance to the Service, States, and other partners on methods of minimizing threats to listed species and on criteria that may be used to determine when recovery is achieved. If the recovery criteria defined in the plan are still valid, meeting recovery criteria can indicate that the species no longer requires protections under the Act. However, when recommending whether a listed species should be delisted, the Service must apply the factors in section 4(a) of the Act (84 FR 45020).

Downlisting 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 exists. The populations shall be distributed within the upper*

Caney Fork River system and can include the present populations or newly discovered or created populations.

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.*
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.*

Delisting 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.*
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.*
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.*
4. *No foreseeable threats exist that would likely threaten the survival of any of these six populations.*
5. *Where habitat had been degraded, noticeable improvements in water and substrate quality have occurred.*

To date, none of the recovery criteria have been achieved for the Cumberland pigtoe. A more thorough update on each population is available below in the Biology and Habitat Summary section of this document.

Biology and Habitat Summary

The recovery plan (Service 1992) listed isolated populations in short reaches of five waters within the Caney Fork watershed: Barren Fork, Calfkiller River, Cane Creek, Hickory Creek, and Collins River. Since completion of the recovery plan, additional individuals have been documented in Hills Creek (tributary to Collins River), West Fork Hickory (tributary to Hickory Creek), Liberty Creek (tributary to South Prong Barren Fork), and Witty Creek (tributary to Barren Fork). A detailed description of each population is available in the previous 5-year review (Service 2015). This overview of populations in Table 1 and the following discussion is intended to provide an update of information regarding qualitative survey efforts since the previous status review (Service 2015). The known distributional area of the species is depicted in the species range map (Figure 1).

Table 1. Total Cumberland pigtoe mussels recorded from recent Caney Fork drainage surveys.

Waterway (Direct Tributary)	2016	2017	2018	2019	2020	2021	2022
Cane Creek (Caney Fork)	0			X	19		
Calfkiller River (Caney Fork)	0		0	1			2
Collins River (Caney Fork)					20		
Hickory Creek (Collins River)				0		5	
Barren Fork (Collins River)						8	
Witty Creek (South Prong Barren)						1	
Hills Creek (Collins River)			0			1	

Cane Creek –The Cumberland pigtoe population in Cane Creek is small but resilient with evidence of recent recruitment and higher numbers found (18 individuals in a recent effort) near and upstream of the Sweetgum community (upstream of area impounded by Great Falls Dam) (Simmons 2021). Simmons (2021) indicated that substrates downstream of Sweetgum are

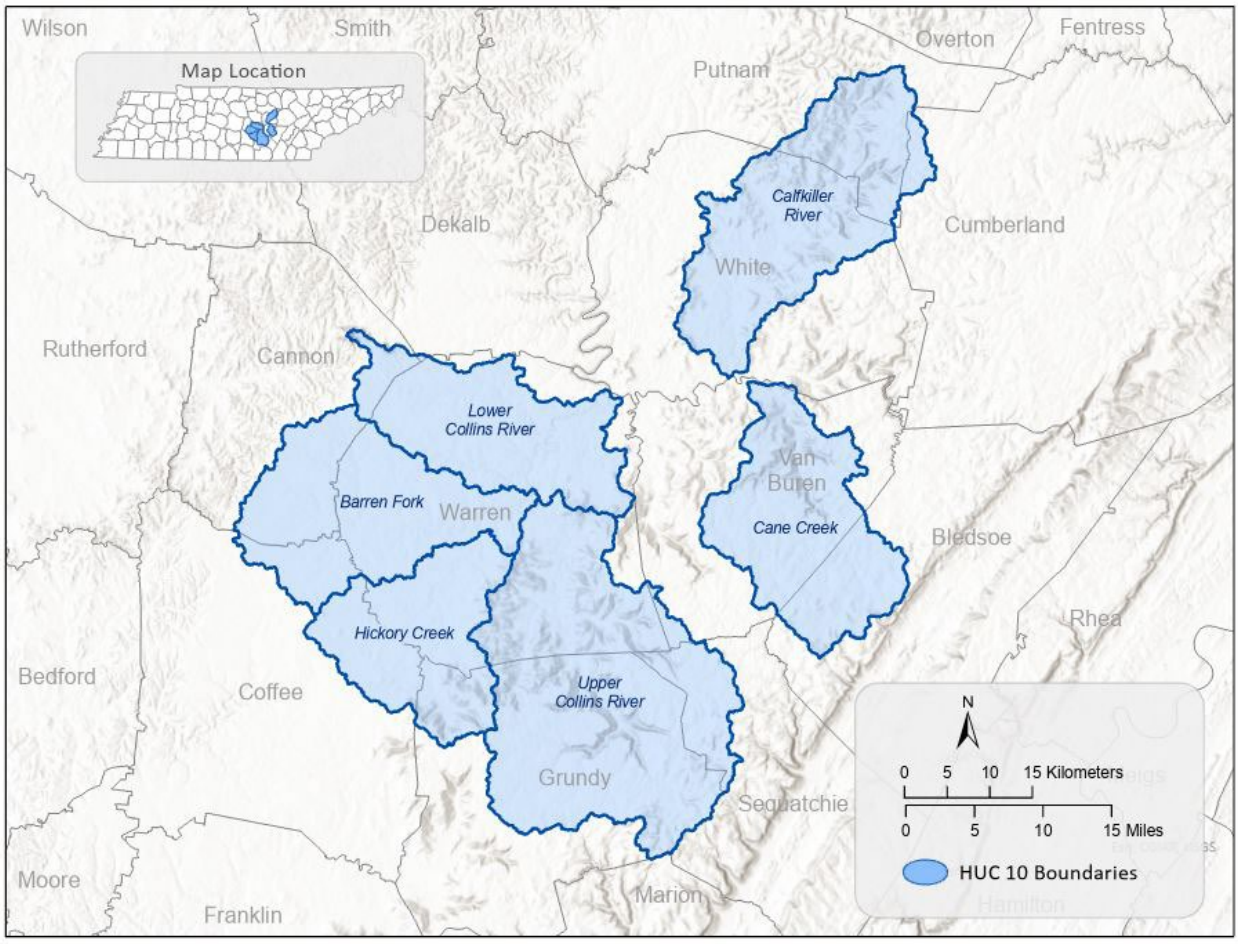

Figure 1: Current distribution of the Cumberland pigtoe in Tennessee, based on occurrence records from streams in which the species is still considered extant.

significantly embedded with sediment and reported finding only one live specimen in the downstream habitat. Although the known extent of habitat occupied in Cane Creek is rather limited, this population remains viable.

Calfkiller River - Simmons (2021) found only two live Cumberland pigtoe mussels in the Calfkiller River since 2014 despite extensive and focused search efforts (over 56 hours). Two additional specimens of the species were documented by the author of this review and Andy Ford (Service) in the Calfkiller River in 2022. All four mussels were larger individuals and may represent an aging and non-recruiting population. Sediment deposition was also documented during recent inspections at the surveyed sites and may indicate periodic or chronic pollutant releases, with subsequent effects to the mussel. The Calfkiller River population appears to be exhibiting continued impairment at the level observed during the latest status review (Service 2015).

Collins River – Recent surveys by Simmons (2021) resulted in findings of the Cumberland pigtoe at lower densities than historically reported, though it still represents the most resilient population in terms of numbers, recent recruitment, and occupied stream miles. Impairment was noted in substrate embeddedness levels and nutrient enrichment (algal blooms); additionally, there has been increased water withdrawal (likely by adjacent nursery operations) (Simmons 2021). Habitat remains relatively intact in the upper reaches of the Collins River (especially upstream of the Grundy County line), but more impacted downstream of McMinnville (Warren County). Overall, integrity of the Collins River appears to have declined since 2001 in terms of the species' density and habitat conditions, especially along the middle to lower reaches of the river.

Hickory Creek - Simmons (2021) found four live and one fresh-dead Cumberland pigtoe in Hickory Creek in 2021. He surveyed a site on West Fork Hickory Creek without finding this species, and higher sediment levels were observed relative to that of Hickory Creek's substrate sediment level. This population appears to have maintained a similar level of health since survey efforts in 2004 and the most recent status review (Service 2015), but habitat degradation is of concern in portions of the watershed.

Barren Fork of Collins River, including Witty Creek - Simmons (2021) found six live Cumberland pigtoes in the Barren Fork at the same site where Ahlstedt et al. (2004) had also found six individuals in 2004, and also documented a slight range extension by documenting two live individuals of the species at a site just upstream of McMinnville in a reach not surveyed previously. However, suitable mussel habitat was sporadic at both locations as stable cobble/gravel/sand habitats were rare. Researchers from Tennessee Technological University collected a single Cumberland pigtoe from Whitty Creek in 2021. Overall, the Barren Fork population appears stable.

Hills Creek - Simmons (2021) found only one live Cumberland pigtoe in Hills Creek at a site that was previously surveyed by Ahlstedt et al. (2004) in 2004, and the individual was old. The site was somewhat impaired, as the substrate was dominated by unstable, shifting piles of sand. Overall, like the Collins River watershed as a whole, health of the Hills Creek population appears to have declined since 2004.

Rocky River and Caney Fork mainstem - No Cumberland pigtoes have been documented from these waters. They are not considered to be occupied by the species, as Simmons (2021) confirmed its apparent absence during recent surveys.

Threats (Five-Factor Analysis) Summary

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

Great Falls Reservoir was inundated in conjunction with construction of Great Falls Dam in 1917, and it remains a threat to the Cumberland pigtoe due to fragmentation and isolation of persisting populations. While known host fish species for the Cumberland pigtoe (i.e., the telescope shiner and striped shiner) 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.

Portions of the Caney Fork and Collins River basins are listed as impaired by the State of Tennessee on the 303(d) list (year 2020) (Tennessee Department of Environment and Conservation 2021). Pollutants and their sources that continue to be identified on the list as occurring in streams known to support the Cumberland pigtoe include *Escherichia coli,* as a result of pasture grazing, in 54.5 miles of West Fork Hickory Creek (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 (White County) and Cane Creek (Van Buren County) are also included as impaired water bodies on the 303(d) list. However, sites known to be occupied by the Cumberland pigtoe are not within these stream reaches.

Continuing evidence of ongoing water withdrawals, sediment transport, and nutrient enrichment in the Collins River watershed was observed during recent mussel surveys there (Simmons, 2021). An active timber harvest operation was also recognized by the author of this review within the upper portion of the Calfkiller River watershed in June 2022. The adequacy of best management practices has not been investigated; but further inspection would be appropriate, based on observation of sediment in pools of the upper Calfkiller River.

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

The Cumberland pigtoe is not known to have any commercial value, and overutilization has not otherwise been identified as a problem.

Disease or predation:

We have no evidence to suggest that disease and predation are not known to be factors in the decline of this species.

Inadequacy of existing regulatory mechanisms:

Protections afforded the Cumberland pigtoe through regulatory mechanisms have not changed since the most recent 5-Year Status Review (Service 2015). Several stream reaches within the

Caney Fork and Collins River watersheds continue to be included on the list of waters that are impaired by the State of Tennessee on the most recent final 303(d) list (year 2020) (Tennessee Department of Environment and Conservation 2021). 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 by existing regulatory mechanisms in the foreseeable future.

Agricultural exemptions to water quality regulations are of concern regarding threats to habitats occupied by the Cumberland pigtoe. Attention to conservation measures in association with the nursery industry, livestock operations, municipal wastewater, and logging operations would likely benefit streams relative to pollutant inputs (including sediment and toxicants) and water quantity. Updates to regulations, greater levels of regulatory enforcement, and/or cooperative efforts within the current regulatory framework will be necessary for recovery of this species.

Other natural or manmade factors affecting its continued existence:

The recovery plan (Service 1992) indicates that existing Cumberland pigtoe populations inhabit only short stream reaches, rendering them vulnerable to extirpation as a result of stochastic events such as accidental toxic chemical spills and extreme droughts. 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). The status of genetic viability of these isolated populations has not been studied.

We consider climate change to be a potential threat to the persistence and long-term viability of remaining Cumberland pigtoe populations. Small and isolated populations are less resilient to natural stochastic events (e.g., floods, drought, etc.) (Hastie *et al.* 2001; Haag and Warren 2008). Haag and Warren documented mussel declines of 65-83 percent in small streams in the Bankhead National Forest in Alabama following extreme drought in 2000. Several studies have been conducted in recent years on thermal tolerances of freshwater mussels and their hosts. Pandolfo *et al.* (2012) examined ten 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 and 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 and 38.1°C, with a mean of 33.1°C.

In its Fifth Assessment Report, the Intergovernmental Panel on Climate Change (IPCC) concluded that warming of the climate system is unequivocal (IPCC 2014). Stream temperatures in the Southeast have increased roughly 0.2°C to 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 pigtoe. There is uncertainty about the specific effects of climate change on the Cumberland pigtoe 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).

Synthesis

The Cumberland pigtoe is persisting within all known populations, and most populations exhibit low resilience. The Collins River and Cane Creek populations include multiple age classes (including smaller individuals). However, as a whole, the species has low-density, fragmented populations with a limited range. Sediment transport and other water quality-related issues appear to continue as challenges throughout the range of the species. Attention to conservation measures in association with the nursery industry, livestock operations, municipal wastewater, and logging operations would likely benefit streams relative to pollutant inputs (including sediment and toxicants) and water quantity. Updates to regulations, greater levels of regulatory enforcement, and/or cooperative efforts within the current regulatory framework will be necessary for recovery of this species.

Due to a combination of the species' limited distributional area, fragmented populations, the 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 species as endangered remains appropriate. Significant uncertainty currently exists regarding its recovery. 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.

RECOMMENDED FUTURE ACTIVITIES

Implement conservation actions recommended in the Cumberland pigtoe Recovery Plan (Service 1992), 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).

RESULTS / SIGNATURES

U.S. FISH AND WILDLIFE SERVICE
Status Review of Cumberland pigtoe (*Pleuronaia gibber*)

Status Recommendation:
On the basis of this review, we recommend the following status for this species. A 5-year review presents a recommendation of the species status. Any change to the status requires a separate rulemaking process that includes public review and comment, as defined in the Endangered Species Act.

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist *(Indicate reasons for delisting per 50 CFR 424.11)*:
____ *The species is extinct*
____ *The species does not meet the definition of an endangered or threatened species.*
____ *The listed entity does not meet the statutory definition of a species.*
__X__ No change needed

New Recovery Priority Number (see 48 FR 43098 and correction, 48 FR 51985): N/A

FIELD OFFICE APPROVAL:

Field Supervisor, Tennessee Ecological Services Field Office, Fish and Wildlife Service

DANIEL ELBERT Digitally signed by DANIEL ELBERT
Date: 2022.08.03 17:57:37 -05'00'

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

REFERENCES

Ahlstedt, S.A., M.T. Fagg, R.S. Butler and J.F. Connell. 2004. Status of Freshwater Mussel Populations in the Caney Fork River System, Tennessee. Prepared for: U.S. Fish and Wildlife Service, Ecological Services, Cookeville, TN. U.S. Geological Survey, Knoxville, Tennessee; Tennessee Wildlife Resources Agency, Morristown, Tennessee;

Allendorf, F.W. and G. Luikart. 2007. Conservation and the genetics of populations. Malden, Massachusetts, Blackwell Publishing. 642pp.

Anderson, R.M. 1990. Status survey of the Cumberland pigtoe pearly mussel (Pleurobema gibberum). Tennessee Cooperative Fishery Research Unit, Tennessee Technological University, Cookeville, TN. Unpublished report. Submitted to the U.S. Fish and Wildlife Service, Asheville Field Office, Asheville, NC. 10 pp.

Byers, E. and S. Norris. 2011. Climate change vulnerability assessment of species of concern in West Virginia. West Virginia Division of Natural Resources, Elkins, West Virginia. 72 pp.

Campbell D.C. and C. Lydeard. 2012. Molecular systematics of *Fusconaia* (Bivalvia: Unionidae: Ambleminae). *American Malacological Bulletin* 30:1-17.

Campbell, D.C., J.M. Serb, J.E. Buhay, K.J. Roe, R.L. Minton and C. Lydeard. 2005. Phylogeny of North American amblemines (Bivalvia, Unionoida): prodigious polyphyly proves pervasive across genera. Invertebrate Biology 124(2):131-164.

Daraio, J.A., J.D. Bales, and T.J. Pandolfo. 2014. Effects of land use and climate change on stream temperature II: Threshold exceedance duration projections for freshwater mussels. Journal of the American Water Resources Association 50:1177-1190.

Freshwater Mollusk Conservation Society (FMCS). 2016. A national strategy for the conservation of native freshwater mollusks. Freshwater Mollusk Biology and Conservation 19: 1-21.

Freshwater Mollusk Conservation Society (FMCS). 2021. The 2021 checklist of freshwater bivalves (Mollusca: Bivalvia: Unionida) of the United States and Canada. Considered and approved by the Bivalvia Names Subcommittee 9 August 2021. Accessed online at https://molluskconservation.org/MServices_Names-Bivalves.html on July 12, 2022

Haag, W.R. and M.L. Warren Jr. 2008. Effects of severe drought on freshwater mussel assemblages. Transactions of the American Fisheries Society 137:1165-1178.

Hastie, L.C., P.J. Boon, M.R. Young, and S. Way. 2001. The effects of a major flood on an endangered freshwater mussel population. Biological Conservation 98:107-115.

Intergovernmental Panel on Climate Change (IPCC). 2014. Climate change 2014 synthesis report. Available at http://ipcc.ch/report/ar5/.

Kaushal, S.S., G.E. Likens, N.A. Jaworski, M.L. Pace, A.M. Sides, D. Seekell, K.T. Belt, D.H. Secor, and R.L. Wingate. 2010. Rising stream and river temperatures in the United States. Frontiers in Ecology and the Environment 8: 461-466.

Layzer, J.B., Adair, B., Saha, S., and L.M. Woods. 2003. Glochidial hosts and other aspects of the life history of the Cumberland pigtoe *(Pleurobema gibberum).* Southeastern Naturalist. 291):73-84.

Lea, I. 1838. Description of new freshwater and land shells. Transaction of the American Philosophical Society 6:1-154.

Lea. I. 1840. Descriptions of new freshwater and land shells. Transaction of the American Philosophical Society 1(13):284-289.

Pandolfo, T., T. Kwak, and W. Cope. 2012. Thermal tolerances of freshwater mussels and their host fishes: species interactions in a changing climate. Freshwater Mollusk Biology and Conservation 15(1):69.

Parmalee, P.W., and A.E. Bogan. 1998. The Freshwater Mussels of Tennessee. University of Tennessee Press, Knoxville.

Simmons, J. W. 2021 Personal Communication. Tennessee Valley Authority. Email to Anthony Ford on August 21, 2021.

Tennessee Department of Environment and Conservation. 2021. Final Version Year 2020 303(d) List. Collins River Basin and Caney Fork River Basin. Division of Water Resources. https://www.tn.gov/content/dam/tn/environment/water/watershed-planning/wr_wq_cwa-integrated-305b-2020.pdf Accessed 2022.

Tennessee Valley Authority. 2015. Great Falls Dam. http://www.tva.gov/sites/greatfalls.htm. Accessed 2015.

U.S. Fish and Wildlife Service. 2015. Cumberland Pigtoe (*Pleurobema gibberum* = *Pleuronaia gibberum*) 5-Year Review: Summary and Evaluation. Cookeville, Tennessee. 23 pp.

U.S. Fish and Wildlife Service (Service). 1992. Recovery Plan for Cumberland Pigtoe Mussel *(Pleurobema gibberum).* Atlanta, Georgia. 26 pp.

Widlak, J. 1992. As cited *in* U.S. Fish and Wildlife Service. 1992. Recovery Plan for Cumberland Pigtoe Mussel *(Pleurobema gibberum).* Southeast Region Office, Atlanta, Georgia. 26 pp.

Williams, J.D., A.E. Bogan, R.S. Butler, K.S. Cummings, J.T. Garner, J.L. Harris, N.A. Johnson, and G.T. Watters. 2017. A revised list of the freshwater mussels (Mollusca: Bivalvia: Unionida) of the United States and Canada. *Freshwater Mollusk Biology and Conservation* 20:33-58.

Appendix A. Summary of peer review for the 5-year Review of Pleuronaia gibber

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 range of the Cumberland pigtoe, 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 have previously been recognized by the Service. The comments submitted by NCASI are the same as other public comments the organization has provided regarding other aquatic species (e.g. bluemask darter, slender chub, duskytail darter, snail darter, and Cumberland elktoe). In this 5-Year Status Review, we discuss threats from stream inflows of sediment due to resource extraction, agricultural practices, urbanization, and silviculture (see the discussion of five-factor analysis).

We received comments from Niki Nicholas, Superintendent of the Big South Fork National River and Recreation Area (BSFNRRA) in conjunction with a status review of the Cumberland elktoe. Her comments provided updated information regarding only the Cumberland elktoe and, therefore, are not included here.

Jeff Simmons, TVA (2021, pers. comm.), provided the following excerpted comments (in italics):

Some errors that I found in the last 5 year review:

P. 4 North Prong Barren Fork- This stream was reported in Ahlstedt et al. 2004 in error; this locality is actually on Barren Fork proper (TN Hwy 287 x-ing). Therefore, no P. gibber have ever been found in North Prong Barren Fork.

P. 4 West Fork Hickory Creek- Indicated as "newly discovered population" since completion of recovery plan. The only collection from here is one relict shell (Ahlstedt et al. 2004). May want to re-word since this wouldn't represent a "population".

P.12 "Widlak (1992) reported a Cumberland pigtoe population from Big Hickory Creek, however that population is considered extirpated". Big Hickory Creek is the same as Hickory Creek. As far as we know, they still occur here.

The following is a brief synopsis of current status of each population:

Collins River drainage:
Our recent surveys have detected Pleuronaia gibber, but at lower densities than historically reported. During the course of bluemask darter sampling from 2001 to 2020, I have seen habitat conditions in the Collins River decline drastically. Much more sediment is present, substrates are more embedded, the river turns brown after rain events (never saw this until about 2017), much more nutrient enrichment as evidenced by algal blooms, and there has been increased water withdrawal by nurseries (diesel pumps run all day, all summer long). The river is still in relatively good shape in the upper reaches from the Grundy County line, upstream to Hwy 56 crossing. We surveyed a lower reach at the Hwy 70S crossing near McMinnville and found a few P. gibber relicts and only four live Villosa species. Pretty bad. Similar results at a site in Hills Creek that was surveyed by Ahlstedt in 2004- we found only one old live P. gibber. Substrate was dominated by unstable, shifting sand piles.

Barren Fork of the Collins:
We found six live P. gibber in the Barren Fork at the same site where Ahlstedt had also found six individuals in 2004. We also sampled a site just upstream of McMinnville in a reach that has never been surveyed. We found two live P. gibber here. At both of these locations, mussels were sporadic and were in stable gravel/cobble/sand habitats that were rare. We plan to sample Hickory Creek to update status in that stream sometime in the near future.

Cane Creek:
Pleuronaia gibber appears to be doing well at one location in Cane Creek, near Sweetgum. This is also the last known location for Pegias fabula in the upper Caney Fork. We surveyed several downstream locations, to the reservoir backwaters, and found one live P. gibber. Downstream of Sweetgum, substrates are embedded from sediment input.

Calfkiller River:
Since 2014, 56 hours of focused mussel snorkel surveys have been conducted. During this time, only two live P. gibber have been found (both old individuals). Based on relict shell, they were once distributed throughout a majority of the river upstream of Great Falls Reservoir. I am very worried about this population. As you are probably aware, we have been working to reintroduce bluemask darters to the Calfkiller River. These efforts have been unsuccessful and we believe that periodic toxicity is limiting survivability. Monterey WWTP discharges into the Falling Water River upstream of a sink hole. A dye trace study (attached) found that water entering this sink re-emerges via Twenty Springs into the Calfkiller River. This WWTP has had a history of significant violation of its NPDES permit. I have a bunch of information on this if you would like to discuss further.

Rocky River and Caney Fork:
No Pleuronaia gibber have been documented from these streams. We have recently surveyed and confirmed the absence of this species.

Lastly, a population genetics study is needed to determine the relationships of P. gibber populations before they are completely extirpated (i.e. Calfkiller). This information is necessary

for future management decisions such as population augmentation/reintroduction (If I had to bet, I would think that the Cane Creek population is most closely related to the Calfkiller). I have attached a recent paper that provides evidence of long-term population separation (~140,000 years in the case of bluemask darter) between eastern and western portions of the drainage.

Simmons' comments were instrumental in updating our knowledge of the species and its habitat. His comments were incorporated into the "Biology and Habitat Summary" and Threats (Five-Factor Analysis) Summary of this 5-Year Status Review.