

Finerayed Pigtoe
Fusconaia cuneolus

**5-Year Review:
Summary and Evaluation**

**U.S. Fish and Wildlife Service
Southeast Region
Asheville Ecological Services Field Office
Asheville, North Carolina**

5-YEAR REVIEW

Finerayed Pigtoe (*Fusconaia cuneolus*)

I. GENERAL INFORMATION

A. Methodology used to complete the review

This 5-year status review was completed by the species' recovery lead biologist in the U.S. Fish and Wildlife Service's (USFWS) Asheville, North Carolina Ecological Services Office. A *Federal Register* notice announcing the review and requesting information was published on July 28, 2006 (71 FR 42871) and a 60-day comment period was opened. No significant information was received in response to the notice. Our sources of information for this 5-year review include the final rule listing this species under the Endangered Species Act (Act), the Recovery Plan (USFWS 1984), peer reviewed scientific publications, unpublished reports, and information and communications from qualified biologists or experts. No part of this review was contracted to an outside party. This review also underwent peer review by three experts familiar with the species (see Appendix A). Comments received were evaluated and incorporated as appropriate.

B. Reviewers

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C. Background

- 1. Federal Register Notice citation announcing initiation of this review:**
July 28, 2006: 71 FR 42871
- 2. Species status:** FY 2011 Recovery Data Call: Stable
- 3. Recovery achieved:** 1 (1=0-25% recovery objectives achieved)

4. Listing history

Original Listing

FR notice: 41 FR 24062

Date listed: June 14, 1976

Entity listed: species

Classification: endangered

5. Associated rulemakings:

72 FR 52434; September 13, 2007; Establishment of Nonessential Experimental Population Status for 15 Freshwater Mussels, 1 Freshwater Snail, and 5 Fishes in the Lower French Broad River and in the Lower Holston River, Tennessee.

66 FR 43808; August 21, 2001; Establishment of Nonessential Experimental Population Status for 16 Freshwater Mussels and 1 Freshwater Snail (Anthony's Riversnail) in the Free-Flowing Reach of the Tennessee River below the Wilson Dam, Colbert and Lauderdale Counties, Alabama. Correction.

66 FR 32250; June 14, 2001; Establishment of Nonessential Experimental Population Status for 16 Freshwater Mussels and 1 Freshwater Snail (Anthony's Riversnail) in the Free Flowing Reach of the Tennessee River below the Wilson Dam, Colbert and Lauderdale Counties, Alabama.

6. Review History:

Final Recovery Plan: 1984

A previous 5-year review for this species was noticed on November 6, 1991 (56 FR 56882). In that review, the status of many species was simultaneously evaluated with no in-depth assessment of the five factors, threats, etc. as they pertained to the individual species. In particular, no changes were proposed for the status of this species in that review.

Recovery Data Call: 2011, 2010, 2009, 2008, 2007, 2006, 2005, 2004, 2003, 2002, 2001, and 2000

7. Species' Recovery Priority Number at start of review (48 FR 43098):

5. This number indicates a species with a high degree of threat and a low recovery potential.

8. Recovery Plan

Name of plan: Recovery Plan [for the] Fine-rayed Pigtoe Pearly Mussel (*Fusconaia cuneolus*)

Date issued: September 19, 1984

II. REVIEW ANALYSIS

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

The Act 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 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? Yes**
 - 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)? 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 finereyed pigtoe will be considered for delisting when the following criteria are met:

1. A population of the finereyed pigtoe, with evidence of recent recruitment (specimens age 5 or younger), exists in (a) North Fork Holston River, Hawkins County, TN, (b) Powell River between Buchanan Ford (PRM 99.2), Claiborne County, TN, and Fletcher Ford (PRM 117.4), Lee County, VA, (c) Clinch River between Kelly Branch (CRM 155.7), Claiborne County, TN, and Cedar Bluff (CRM 322.6), Tazewell County, VA, (d) Little River, Russell County, VA, and Copper Creek, Scott County, VA (tributaries of Clinch River), (e) Elk River between ERM 70.5 and ERM 105.4, Lincoln County, TN, (f) Paint Rock River, Jackson County, AL, and (g) Sequatchie River, Sequatchie County, TN. These populations are distributed widely enough within their rivers such that a single adverse event in a river would be unlikely to result in the total loss of that population.

- *viable population* – a reproducing population that is large enough to maintain sufficient genetic variation to enable it to evolve and respond to natural habitat changes. Defining the number of individuals needed to meet this definition is one of the recovery tasks.
- *population center* – a single shoal or grouping of shoals which contain *Fusconaia cuneolus* in such close proximity that they can be considered as belonging to a single breeding unit.

Seven populations of the finereyed pigtoe occurred at the time the 1984 Recovery Plan was written. These populations included the Clinch (including two Virginia tributaries, Copper Creek and Little River), Powell, North Fork Holston (including a tributary, Possum Creek), Little (Tennessee), Sequatchie, Paint Rock, and Elk Rivers. The occurrences of this species in Copper Creek and Little River are confined to lower reaches of these streams and likely contiguous with and dependent upon the Clinch River population for sustainability.

The Clinch River drainage population has declined since the 1980s, particularly in Virginia, but has improved in recent years. This population is distributed along a total of about 80 river miles (RMs), in addition to the lowermost reaches of Copper Creek and Little River, continues to exhibit evidence of recruitment, and represents the only clearly viable population rangewide. In Powell River the species was relatively uncommon in the 1980s but has further declined to the point of being possibly extirpated or if extant has declined to nearly undetectable levels. The population in North Fork Holston River persists in the vicinity of the Virginia/Tennessee state line and has recently been discovered in a Virginia tributary in this reach, Possum Creek. The species is very rare in the North Fork Holston River drainage and there is no evidence of recent recruitment, making its status there very tenuous. Only two individuals have ever been collected in Little River, Tennessee; the status of that population is unknown. The Paint Rock River population was rare in the 1980s but has further declined to the point where if it persists it may do so at nearly undetectable levels. The finereyed pigtoe is considered extirpated from Sequatchie and Elk Rivers given that no evidence of its occurrence has been detected in either stream since about 1980.

Continuing threats from a suite of stressors—coal mining, urbanization, agriculture, and toxic chemical spills—may compromise the continued existence of the finereyed pigtoe throughout its range. USFWS is working with researchers and natural resource managers at Virginia Polytechnic Institute and State University (VPI), Virginia Department of Game and Inland Fisheries (VDGIF), Department of Mines, Minerals, and Energy (VDMME), Tennessee Wildlife Resources Agency (TWRA), Alabama Department of Conservation and Natural Resources (ADCNR), U.S Geological Survey (USGS), Office of Surface Mining (OSM), Tennessee Valley Authority (TVA), The Nature Conservancy (TNC), and other partners to reduce pollutants in streams and improve the status of the species.

In order to recover the finereyed pigtoe in the upper Tennessee River drainage it will be necessary to augment existing populations and to reintroduce the species into appropriate habitat within its historical range. It is imperative that propagation technology be developed for the species. Extant populations are too small to allow direct translocation of adult animals to accomplish these goals. It may take several years to develop culture technology for the finereyed pigtoe before augmentation and reintroduction efforts could even be attempted.

Other primarily habitat-related issues must also be addressed before recovery can progress. In Elk River a recent agreement between TVA and USFWS seeks to improve tailwater conditions (e.g., thermal, oxygen, flow regimes) below Tim's Ford Dam. Some early success has been demonstrated with reintroducing hatchery propagated federally listed mussels into Elk River, but the finereyed pigtoe is not currently one of them. Survival has been excellent and they appear to be growing. Augmentation of the finereyed pigtoe in North Fork Holston River downstream of Saltville, Virginia, is unlikely in the near future due to residual contaminated sediments from industrial pollution. Reintroduction efforts in Sequatchie River are precluded as a result of poor water quality related to coal mining. Similarly, population augmentation in Powell River in all but a limited reach in Tennessee may be futile unless coal mining issues in that watershed are addressed and ameliorated and habitat conditions improve to the point where the finereyed pigtoe can successfully reproduce and recruit without human intervention. Habitat conditions in Clinch and Paint Rock Rivers appear to be suitable (based on the status of other mussel species) to make population expansion and augmentation in these streams a viable recovery option if cultured individuals could be produced. If the finereyed pigtoe population in Clinch River can be improved through augmentation efforts, the species in Copper Creek and Little River (Virginia) would likely benefit.

2. Through re-establishment and/or discoveries of a new population, a viable population exists in one additional stream/river or stream/river corridor that historically maintained the species. The viable population will contain at least two population centers which are dispersed to the extent that a single adverse event would be unlikely to eliminate the finereyed pigtoe from its newly discovered or re-established location. Mussel surveys must document that three year-classes, including one year-class of age 10 or older, have been naturally produced within each of the population centers.

This species is included in a Non-essential Experimental Population (NEP) designation for 16 mussels and 1 snail in the reach of Tennessee River below TVAs Wilson Dam in Colbert and Lauderdale Counties, Alabama. Currently no individuals of this species have been reintroduced at this location. In addition, another multi-species NEP has been published that includes this species in the lower portions of French Broad and Holston Rivers in Knox County, Tennessee,

where tailwater conditions (e.g., thermal, oxygen, flow regimes) continue to be improved for the species and its host fishes (typically shiners). Until culture technology is developed, however, it is unlikely that sustainable experimental populations of the finereyed pigtoe can be created in these NEPs. Nolichucky, upper Holston, Pigeon, and Little (Tennessee) Rivers have also been identified by regional mussel managers as possible reintroduction streams for this species. USFWS is working with TVA, ADCNR, TWRA, and other partners to improve tailwater habitat for mussels and host fishes (e.g., thermal, oxygen, flow regimes) below TVA impoundments. The only previously unknown population of the finereyed pigtoe to have been discovered since 1984 is in Possum Creek, a tributary of lower North Fork Holston River (Winston and Neves 1997) and part of that river's population.

3. The species and its habitats are protected from present and foreseeable anthropogenic and natural threats that may interfere with the survival of any of the populations.

Some limited progress has been made regarding this criterion; however, we do not anticipate meeting this criterion in the near future. USFWS is working with VPI, VDGIF, VDMME, TWRA, ADCNR, USGS, OSM, TVA, TNC, and other partners to improve the status of the finereyed pigtoe throughout its range. There are projects in most streams of current occurrence that are intended to repair and restore streambanks, riparian areas, and instream habitats, as well as reduce contaminants from upland activities. These efforts have provided protection to finereyed pigtoe habitat and reduced runoff in their watersheds.

4. Noticeable improvements in coal-related problems and substrate quality have occurred in the Powell River, and no increase in coal or other energy-related impacts occurs in the Clinch River.

Noticeable improvements in coal-related problems and substrate quality in Powell River are not readily identifiable over the past two decades. However, a limited reach in Tennessee has improved habitat quality. In Clinch River, an upper reach from Carbo to Nash Ford in Virginia has also shown signs of improvement in substrate and water quality, and mussel and fish densities appear to be increasing. In addition, the reach downstream from Carbo to the confluence with Lick Creek is showing signs of faunal recovery from catastrophic toxic spills around 1970 at a coal-fired power plant and chronic release of pollutants from the power plant and nearby coal mining activities. The endangered shiny pigtoe, which often co-occurs with the finereyed pigtoe, and the threatened yellowfin madtom have recently been rediscovered in this reach, and newly-recruited individuals of common mussel species have also been observed there.

Although the production of coal in Virginia has declined by more than half since 1990 according to VDMME, it is anticipated that coal and particularly natural gas production looking forward may reverse that trend based on current energy

demands, human population growth, and construction on a hybrid energy power plant that is nearing completion on the upper Clinch River in Virginia. Therefore, impacts from these activities may continue for the foreseeable future. The Virginia and Southwest Virginia Field Offices of USFWS are working with VDMME, OSM, coal mining and natural gas extraction interests, and other partners to better protect habitat for Clinch and Powell River finereyed pigtoe populations from these activities.

C. Updated Information and Current Species Status

1. Biology and Habitat

a. Abundance, population trends (e.g. increasing, decreasing, stable), demographic features, or demographic trends:

Clinch River, Virginia and Tennessee: The finereyed pigtoe was abundant in Clinch River as recently as the 1980s but was starting to show signs of decline by the end of the decade (Bruenderman 1989). Since then it has become much more uncommon. Systematic mussel surveys conducted on Clinch River over the past 30 years by TVA, USGS, VDGIF, VPI, and other biologists indicated that the species continued to decline until recent years. Approximately every five years since 1979, a varying number of sites (6–15) have been surveyed for mussels using quantitative (0.25 m² quadrats) and qualitative methods (Ahlstedt and Tuberville 1997, Ahlstedt et al. 2005, Jones et al. in press). Densities of the finereyed pigtoe declined by two-thirds between 1979 and 1994. This mussel was found in six of seven sites surveyed in 1979 and dropped to being found in only four of eight sites surveyed in 1994. Annual sampling at three sites in Tennessee from 2004–2009 yielded 20 live individuals from two sites among 1,123 quadrats sampled. Four live individuals were found over two sampling periods in 2004 and 2009 among 2,101 quadrats sampled at 15 sites. In recent years the decline of the finereyed pigtoe in Clinch River seems to have stabilized and the population is currently thought to be improving, although it continues to be rare. Since 2000, low numbers of individuals have regularly been located during periodic sampling efforts, particularly in the Tennessee portion of the river, and recent recruitment is evident. The species occurs sporadically in about 80 river miles (RMs) of the Clinch River mainstem in two disjunct reaches—the upper river in eastern Russell County, Virginia (~50 RMs) and the lower river in Hancock County, Tennessee (~30 RMs)—separated by a mussel “dead zone” caused by various pollution sources (Jones et al. in press). Despite having lost a considerable percentage of its historical abundance, the Clinch River population of the finereyed pigtoe represents the largest currently remaining and may be the only viable population.

Copper Creek, Virginia: A portion of the Clinch River population resides in this tributary. Six live individuals were collected at 1 of 36 sites sampled in 1980 (Ahlstedt 1981). A single live individual was found among 20 sites sampled in 1998 (Fraley and Ahlstedt 2000). Three live individuals and two fresh dead

specimens were collected at 5 of 43 sites sampled during 2003–04 (Hanlon et al. 2009). The finereyed pigtoe is currently very rare in Copper Creek, and may rely on the source population in Clinch River for sustainability.

Little River, Virginia: A portion of the Clinch River population also resides in the lowermost reach of this tributary. Two live individuals were collected at 1 of 16 sites sampled in 1989–90 (Church 1991). Subsequent surveys have been conducted in Little River since 1991 but have failed to document the species (S.D. Hanlon, USFWS, pers. comm., 2012). Its current status in Little River is unknown.

Powell River, Virginia and Tennessee: The finereyed pigtoe population in Powell River was considered one of the best rangewide when the Recovery Plan (USFWS 1984) was written but has declined over the past 30 years. A dieoff of unknown cause was reported in 1983 by Ahlstedt and Jenkinson (1986). Even common species (e.g., *Actinonaias pectorosa*) appear to be declining in Powell River based on a decrease in subadults located in 1978 and 1988 (Wolcott and Neves 1994). Approximately every five years since 1979, quantitative (quadrats) mussel sampling has been conducted at a varying number of sites (6–19); two live individuals were found in 1988, but none have been collected since (Ahlstedt and Tuberville 1997, Ahlstedt et al. 2005). A single live individual was found in 2004 during qualitative sampling (N. Eckert, VDGIF, pers. comm., 2007). A survey of 21 sites over 102 river miles during 2008–09 did not locate live or fresh dead finereyed pigtoes (Johnson et al. in press). The authors suggested that if the finereyed pigtoe was extant in Powell River, it occurred at nearly undetectable levels. A limited reach in Tennessee has shown signs of improving habitat quality (J.W. Jones, USFWS, pers. comm., 2012). Recent evidence of recruitment in other imperiled mussel species (Johnson et al. in press)—particularly in this reach of the lower Powell River—provides hope that the finereyed pigtoe persists in the river.

North Fork Holston River, Virginia and Tennessee: The finereyed pigtoe was known in recent decades from a short reach of this river in the vicinity of the state line. Sampling in 1995 produced live individuals at RM 6.1 in Virginia (Henley and Neves 1999). A small population persists in North Fork Holston River in this vicinity, where two old live individuals were found in 2005, but sampling at the Tennessee site yielded no evidence of its continued existence (W.F. Henley, VPI, pers. comm., 2005). There is no evidence that the finereyed pigtoe has recruited in this stream in decades and the population may be dying out.

Possum Creek, Virginia: A portion of the North Fork Holston River population resides in this tributary that flows eastward just north of the state line. A fresh dead specimen and 11 relic shells were found at 2 of 3 sites sampled in 1995–96 (Winston and Neves 1997). The specimens were found from ~RM 4 downstream. Possum Creek represents the only new occurrence for the finereyed pigtoe since

the Recovery Plan (USFWS 1984) was written. Its current status in Possum Creek is unknown.

Little River, Tennessee: There are only two records for the finereyed pigtoe in this upper Tennessee River tributary. Single live individuals of this species were encountered in 1981 and 2007 (S.A. Ahlstedt, USGS retired; D. Hubbs, TWRA, pers. comm., 2012). No other evidence of this species from Little River has been found, although survey efforts in the river have been minimal. The current status of this finereyed pigtoe population is unknown.

Sequatchie River, Tennessee: A single live individual was observed among 10 sites sampled in 1980 (Hatcher and Ahlstedt 1982). No other evidence of this species from Sequatchie River has been found since. Coal mining takes place in portions of the headwaters. The finereyed pigtoe is considered extirpated from Sequatchie River (S.A. Ahlstedt, USGS retired, pers. comm., 2007).

Paint Rock River, Alabama: A very small population of finereyed pigtoe is known from this middle Tennessee River tributary. One live individual and one fresh dead specimen were collected from 2 of 18 sites in 1991 and were estimated to be 13–14 years in age (Ahlstedt 1995–96). This species was not detected during field work conducted at two mainstem sites in 2002 (Godwin 2002) or at several sites sampled in 2004 (J. Garner, ADCNR; J. Godwin, Alabama Natural Heritage Program, pers. comm., 2004) and 2006 (M. Gangloff, Auburn University, pers. comm., 2006). No live individuals or fresh dead shells of the species were observed during a survey of 41 sites over 55 river miles in 2008 (Fobian et al. 2008). Not detected in over 20 years, the status of the species has continued to deteriorate to the point of being possibly extirpated or if extant has declined to nearly undetectable levels. The fact that Fobian et al. (2008) noted recruitment in several other imperiled mussels—including the closely related shiny pigtoe—provides some hope that the finereyed pigtoe persists in the river.

Elk River, Tennessee: A single live individual of the finereyed pigtoe was observed during a 120-mile TVA float survey of Elk River in 1980 (Ahlstedt 1983). The species has not been collected since despite several collecting efforts (e.g., float survey RM 105.5–112.7 in 1990, Hubbs et al. [1991]; 4 sites in 1997, Madison and Layzer [1998]; 16 sites in 1999, USFWS [1999]; several sites in 2000, Garner [2001]; 4 sites in 2001, [Hubbs 2002]; 5 sites in 2005, [Ahlstedt et al. 2006]; 3 sites in 2011, P.D. Johnson, ADCNR, pers. comm., 2011). The finereyed pigtoe is currently considered extirpated from Elk River (S.A. Ahlstedt, USGS retired, pers. comm., 2006).

b. Genetics, genetic variation, or trends in genetic variation:

No information is currently known concerning the species' population genetics. However, a project has been funded and is underway to assess a comparative genetics study of several conchologically similar upper

Tennessee River drainage species, including the finereyed pigtoe (J.W. Jones, USFWS, pers. comm., 2012).

c. Taxonomic classification or changes in nomenclature:

There has been no change in the classification or nomenclature of this species. However, there is a possibility that *Fusconaia cuneolus* and the closely related and similarly endangered shiny pigtoe, *F. cor*, are merely phenotypic variants of a single taxon (J.W. Jones, USFWS, pers. comm., 2007). A taxonomic distinction study is needed to solve this issue.

d. Spatial distribution, trends in spatial distribution, or historical range:

Two of the seven finereyed pigtoe populations known at the time the Recovery Plan was published (USFWS 1984) are now considered extirpated (Sequatchie and Elk Rivers). Considerable declines have also occurred in Clinch, Powell, and Paint Rock Rivers since 1980, and it remains near extirpation in a very short reach of North Fork Holston River. These losses further restricts the number of river miles currently occupied by this imperiled species and reduces its overall abundance, making it even more susceptible to extinction. The status of the population in Little River, Tennessee, remains unknown. Its status has improved in recent years in Clinch River, which represents the majority of its current global range.

e. Habitat

Suitable habitat for the finereyed pigtoe is sporadic in the middle and upper Tennessee River drainage. Impoundments and secondarily episodic and chronic toxic events have vastly reduced the amount of available habitat for the species. Some restricted habitat reaches within its historical range are considered to have improved enough to consider finereyed pigtoe augmentations or reintroductions (e.g., Clinch River, Virginia; Powell River, Tennessee; Paint Rock River, Alabama). Collaborative efforts between USFWS, TVA, ADCNR, TWRA, and other partners are attempting to improve water quality conditions in certain impoundment tailwaters (e.g., Elk River). USFWS is working with VPI, VDGIF, TWRA, ADCNR, USGS, TVA, TNC, and other partners to improve habitat and water quality conditions throughout the range of the species primarily through riparian restoration projects. The Virginia and Southwest Virginia Field Offices of USFWS are working with VDMME, OSM, coal mining and natural gas extraction interests, and other partners to better protect habitat for Clinch and Powell River finereyed pigtoe populations from these activities.

f. Other

The life history of the finereyed pigtoe was studied in Clinch River, Virginia (Bruenderman 1989, Bruenderman and Neves 1993). This species is a short-term brooder and is gravid from mid-May through late July. Most glochidia are released in mid-June as conglomerates that mature from pink to a peach color. Host fishes identified through natural and laboratory-induced infections include river chub (*Nocomis micropogon*); whitetail (*Cyprinella galactura*), white (*Luxilus albeolus*), telescope (*Notropis telescopus*), and Tennessee (*Notropis leuciodus*) shiners; central stoneroller (*Campostoma anomalum*); mottled sculpin (*Cottus bairdii*); and fathead minnow (*Pimephales promelas*). It lives to approximately 35 years.

Propagation efforts on this species are still in their infancy but it appears to be incredibly difficult to culture. Short-term brooders have very short spawning and glochidial brooding seasons. Coupled with its rarity and the tendency for gravid females to abort glochidia when disturbed, locating and successfully securing gravid broodstock is difficult. White Sulphur Springs National Fish Hatchery and VPI are among culture facilities working to develop propagation technology for short-term brooders. Their efforts should increase our level of knowledge and aid in its recovery.

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

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

The finereyed pigtoe Recovery Plan (USFWS 1984) listed impoundment, siltation, and pollution as the “major causes” for the decline of this species. The Elk River population is now considered extirpated due primarily to altered flow conditions below Tim’s Ford Dam. Impacts include cold-water releases and detrimental hydropeaking flows that have destabilized banks and the stream channel, thus reducing mussel habitat and fish host availability primarily in the middle and secondarily in lower Elk River. USFWS and its partners, (e.g., VDGIF, VDMME, TWRA, ADCNR, USGS, OSM, TVA, TNC) are working on reducing siltation and other pollutant runoff and improving stream habitat conditions throughout the range of the finereyed pigtoe through various funding sources that serve to improve streambank and riparian habitats, ameliorate the effects of tailwater releases, and attempt to minimize the effects of coal mining and other activities on mussels.

Several coal mining related pollutants may have significantly affected mussel habitat in Clinch and Powell Rivers and have likely contributed to the decline of the finereyed pigtoe (Price et al. 2011). Two catastrophic toxic spills occurred in the upper Clinch River, Virginia, around 1970 at a coal-fired power plant (Cairns

et al. 1971, Hampson et al. 2000). In addition, chronic wastewater effluent discharge from the power plant and polluted waters from a tributary, Dump's Creek—which is influenced by active mining, coal-processing effluent, coal ash settling pond leachate, and a coal fly ash landfill—affects this reach (Hull et al. 2006). Collectively, various pollutants in this reach have created a mussel “dead zone” (Jones et al. in press). The Powell River also has a long history of perturbations from coal mining activities. The role that coal mining has played in the decline of the mussel fauna in Powell River in Virginia was summarized by Wolcott and Neves (1990, 1994). The impacts from various coal mining activities on the aquatic fauna were reviewed by Hull et al. (2006). Mine-related pollutants that likely contributed to the decline of the finereyed pigtoe (e.g., water column ammonia, arsenic and other metals in sediments) were identified by Price et al. (2011). Although they noted a general decline in these contaminants in Clinch and Powell Rivers over the past several decades, total dissolved solids continue to rise, especially in reaches of these streams where mining is still active. Research indicates that Powell River mussel populations were inversely correlated with coal fines in the substrate. When coal fines were present, decreased filtration times and increased movements were noted in laboratory-held mussels (Kitchel et al. 1981).

Although the production of coal in Virginia has declined by more than half since 1990 (VDMME 2012), it is anticipated that production of coal and particularly natural gas looking forward may reverse that trend based on current energy demands and human population growth. In fact, construction on a hybrid energy power plant is nearing completion on upper Clinch River in Virginia. Scores of active and inactive mines are known from Virginia and five mine tailings pond spills were reported from 1995–1999 in the upper Clinch and Powell River drainages (Hampson et al. 2000). Such mines may continue to be sources of pollutants that negatively affect finereyed pigtoe populations.

Researchers and managers have speculated for decades on the causes for widespread mussel declines in the eastern U.S., including losses of finereyed pigtoe populations. Conducting an assessment of the many factors that have been blamed for mussel declines since the major dam construction era of the mid-1900s (e.g., sedimentation, pollutants, eutrophication), Haag (2012) speculates that pesticides and ammonia—among habitat factors—are potentially responsible for broadscale losses of the fauna. These pollutants have primarily agricultural origins, although they are also associated with developmental activities. Pesticides may adhere to sediment particles in the substrate and ammonia tends to occur at higher concentrations in interstitial benthic habitats. Both substances are thus prevalent in habitats where mussels occur, and may prove especially detrimental to the health of juveniles, which pedal feed on sediments in interstitial habitats. An emerging threat is the increasing prevalence of pharmaceutical and related substances in surface waters. Many of these chemical compounds act as endocrine disruptors in mussels and fishes that are known to alter physiological processes, especially metabolism and reproduction (Haag 2012). In rivers these

compounds are most prevalent downstream of municipal wastewater outfalls and in reaches with high livestock concentrations—both being areas where ammonia concentrations also tend to be high.

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

Overutilization for commercial, recreational, scientific or educational purposes was not specifically considered to be a limiting factor in the finereyed pigtoe Recovery Plan (USFWS 1984). We have no new information to indicate that this has changed.

c. Disease or predation:

The finereyed pigtoe Recovery Plan (USFWS 1984) did not specifically discuss disease or predation as limiting factors for this species. Disease has long been suspected as a cause of mussel declines, particularly in episodic dieoffs (e.g., Neves 1986). In assessing factors that have realistically contributed to widespread declines in mussel populations, Haag (2012) suggested that disease was potentially a leading cause. However, virtually nothing is known regarding mussel diseases, making this field essentially wide open for future research.

In North Fork Holston River, the muskrat (*Ondatra zibethicus*) has been documented as an important predator of the closely related shiny pigtoe (Neves and Odum 1989). However, we have no new definitive information that would indicate that predation is a limiting factor in the recovery of the finereyed pigtoe at this time.

d. Inadequacy of existing regulatory mechanisms:

The inadequacy of existing regulatory mechanisms was not specifically considered to be a limiting factor in the finereyed pigtoe Recovery Plan (USFWS 1984). The finereyed pigtoe is listed as endangered by the states of Tennessee and Virginia and protected by regulation in Alabama. Though these designations prohibit collection of the species without a valid state collecting permit, they do not provide any protection to the species from other forms of take or offer any regulatory protection to its habitat.

Many activities in this mussel's habitat occur without any coordination with the USFWS and are reviewed and regulated (if at all), only by state and local regulatory agencies for compliance with any applicable state and local regulations and ordinances¹. State and local regulations and ordinances that are adequate to

¹ Unless it can be proven: (1) in a federal court of law that violation of section 9 of the Act, which prohibits the “take” of federally listed species, or other federal regulation, has occurred as a result of the activity; or, (2) that violation of section 9 will occur and a permit pursuant to section 10(a)(1)(B) of the Act is required. However, under

protect the species and its habitat from the effects of residential and commercial development activities; private road construction, maintenance, and runoff; agriculture and forestry activities, etc., are few or poorly enforced. Many of these activities in finereyed pigtoe streams continue to impact the species and its habitat and potentially limit its recovery.

While we have had success through section 7 of the Act in eliminating or reducing impacts to the finereyed pigtoe and its habitat from some federal activities (activities subject to section 7 of the Act, or activities that are authorized, permitted, funded, or carried out by federal agencies), we have not been successful in eliminating all of the adverse effects from all of these activities. Several of these activities have adversely affected the species and its habitat, at least in the short-term, and potentially limit its recovery².

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

Rare species with small, highly disjunct populations like the finereyed pigtoe may suffer various threats from inherently small population size (summarized in USFWS 2004). Limited geographic range and rarity make its populations extremely vulnerable to localized extinctions from stochastic disturbances and decreased fitness from reduced genetic diversity. Potential sources of such disturbances include accidental spills involving vehicles transporting chemicals over roadway stream crossings inhabited by the finereyed pigtoe and accidental or intentional release of chemicals used in agricultural or residential applications. Impoundments, spills, and other human-induced changes are a significant threat to aquatic organisms due to the genetic concerns associated with small, geographically isolated populations. This can be especially true for a species such as the finereyed pigtoe whose historical populations were connected along mainstem rivers and multiple tributaries. 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 first major extinction wave for mussels was the direct result of the broadscale impoundment of larger rivers in the eastern U.S. (Haag 2009). A second extinction wave appears inevitable due to small populations of mussels slowly dying out due to attrition and other factors in isolated stream reaches (Haag 2012).

D. Synthesis

the former scenario impact(s) to the species has (have) already occurred or is (are) occurring, and the later requires notification of the Service of the impending activity.

² Section 7 (a)(2) of the Act requires federal agencies to ensure that their activities do not “jeopardize the continued existence” of federally-listed species or “destroy or adversely modify designated critical habitat”; however, it does not prohibit federal activities that adversely affect the species, its habitat, or designated critical habitat if these affects fall below the jeopardy and/or destruction/adverse modification of critical habitat thresholds.

In summary, none of the recovery criteria for the finereyed pigtoe have been met. Primary threats to the species (e.g., from coal mining, urbanization, agriculture, toxic chemical spills) remain similar to what they were in 1976 when it was listed as endangered and to what they were in 1984 when the Recovery Plan (USFWS 1984) was written. Although there have been few significant improvements regarding threats to the species rangewide, USFWS and numerous partners are working to reduce impacts from various activities detrimental to its recovery. In recent years, some restricted habitat reaches within its historical range are considered to have improved enough to consider finereyed pigtoe augmentations or reintroductions (e.g., Clinch River, Virginia; Powell River, Tennessee; Paint Rock River, Alabama). Despite coal mining in Virginia having declined in recent decades, production of coal and particularly natural gas may increase due to factors such as demographic trends, energy demand, and ongoing construction of a hybrid energy power plant on upper Clinch River. Since the 1984 Recovery Plan (USFWS 1984) was published the Sequatchie and Elk River populations are likely extirpated, while the status of the species in Little River, Tennessee, is unknown. The populations in Powell, North Fork Holston, and Paint Rock Rivers continue to decline, have displayed no recent evidence of recruitment, and are of questionable viability. Generally, these finereyed pigtoe populations are small, linearly distributed, and reach limited, making them especially susceptible to stochastic events, such as chemical spills. For decades the Clinch River population trended downward in status until recently improving, though it is still rare. The finereyed pigtoe population in Clinch River is sporadically distributed over about 80 RMs and represents the only population that is considered sizable, displays evidence of recent recruitment, and is unquestionably viable. Despite the long-term decline in the status of the finereyed pigtoe, we consider the overall status of the species to have been stable over the past few years, due primarily to the relatively extensive Clinch River population which now comprises the vast percentage of its global abundance. In assessing all available information on the current conservation status of the finereyed pigtoe, we believe it continues to meet the definition of an endangered species.

III. RESULTS

A. Recommended Classification:

 x **No change is needed**

IV. RECOMMENDATIONS FOR FUTURE ACTIONS (in general order of importance)

- Develop juvenile propagation and growout technology.
- Reintroduce individuals through release of propagated juveniles and/or release of infected host fishes in other streams within the historical range (e.g., Nolichucky, upper Holston, Pigeon, and Little (Tennessee) Rivers; Tennessee River below Wilson Dam; possibly lower French Broad/Holston and Elk Rivers if thermal, oxygen, and flow regimes are corrected) that have suitable habitat and water quality conditions.
- Augment and expand extant populations through propagation of juveniles and/or release of infected host fishes.

- Determine how much genetic variation is sufficient to maintain long term population viability.
- Determine the degree of threat (especially coal mining in Clinch and Powell Rivers) to each stream in which this species occurs.
- Determine extent and viability of all currently known populations.
- Survey for and assess populations of potential host fishes in the NEP tailwaters in Tennessee River, lower French Broad and Holston Rivers, and other potential reintroduction sites.
- Conduct a taxonomic distinctiveness study to determine the validity of this species and its relatedness to the shiny pigtoe, *Fusconaia cor*.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Finerayed pigtoe (*Fusconaia cuneolus*)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review

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

Review Conducted By: Bob Butler, Asheville Ecological Services Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve  Date 8/7/12

The lead Field Office must ensure that other offices within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. The lead field office should document this coordination in the agency record.

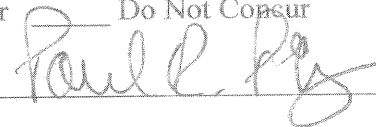
REGIONAL OFFICE APPROVAL:

 Lead Regional Director, Fish and Wildlife Service

Approve  Date 10/2/12

Cooperating Assistant Regional Director, Fish and Wildlife Service

☒ Concur ☐ Do Not Concur

Signature  Date 10/23/13

APPENDIX A: Summary of peer review for the 5-year review of finereyed pigtoe (*Fusconaia cuneolus*)

Reviewers: *A list of peer reviewers is provided above on page 21.*

A. Peer Review Method: A draft 5-year review of the finereyed pigtoe was sent to each of three reviewers, as an attachment to an email or via mail, requesting their review and any other changes or additions that should be included in the document. All three reviewers have extensive knowledge of this and/or similar species.

B. Peer Review Charge: Reviewers were charged with providing a review of the document including any other comments and/or additions they felt were appropriate to include. Reviewers were not asked to comment on the legal status of the species.

C. Summary of Peer Review Comments/Report: Reviewers responded by email or by mail. All reviewers did not suggest that the status of the species needed to be changed and generally thought the information in the document provided to them was accurate. They did provide some additional data, references, and recommendations for future actions that were incorporated into the 5-year review as appropriate, as well as making minor editorial corrections.

D. Response to Peer Review: Recommendations from the reviewers were incorporated into the document as appropriate. These consisted primarily of additional information concerning the status of certain populations, threats to the species, additional references, and recommendations for future actions.