

**Dromedary Pearlymussel**  
*Dromus dromas* (Lea, 1834)



Photo by Tom Schirtz, McClung Museum of Natural History and Culture  
57 mm length. UTMM Lot no. 4674

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

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

**5-YEAR REVIEW**  
Dromedary Pearlymussel (*Dromus dromas*)

**I. GENERAL INFORMATION**

**A. Methodology used to complete this review**

The Fish and Wildlife Service (Service) provided public notice of its intent to initiate a 5-year review for the species and opened a 60-day public comment period for the 5-year review in the Federal Register on May 7, 2018 (83 FR 20092). During this comment period, we obtained information on the status of this species from several experts; additional data was also obtained from the recovery plan, peer-reviewed scientific literature, unpublished reports, and our state partners. Once all known literature and information was collected for this species, the review was drafted and submitted by Gerald Dinkins of the McClung Museum of Natural History and Culture, University of Tennessee (UTMM) to the lead field office. The Tennessee Ecological Services Field Office (TN Field Office) finalized the review and made the classification recommendation. All literature and documents used for this review are on file at the TN Field Office in Cookeville, Tennessee. A draft of this document was peer-reviewed by experts familiar with the Dromedary Pearlymussel and other mollusks (see Appendix A). The Service evaluated the comments received from these experts and incorporated them as appropriate into this 5-year review.

**B. Reviewers**

**Lead Region** – Southeast Region, Atlanta, GA:  
Kelly Bibb (404) 679-7132

**Cooperating Regional Office** – Northeast Region, Hadley, MA:  
Martin Miller (413) 253-8615

**Lead Field Office** – Tennessee Ecological Services, Cookeville, TN:  
Anthony Ford (931) 525-4982; David Pelren (931) 525-4974

**Cooperating Field Offices**

Virginia: Rose Agbalog, (276) 623-1233; Jess Jones, (540) 231-2266;  
Alabama: Evan Collins (251) 441-5837  
Kentucky: Michael Floyd (502) 695-0468

**C. Background**

**1. Federal Register Notice citation announcing initiation of this review:**  
May 7, 2018; 83 FR 20092.

**2. Species status: Declining.** The Dromedary Pearlymussel historically occurred throughout the Cumberland and Tennessee River drainages in the states of Alabama, Kentucky, Tennessee, and Virginia, but is presently limited to the Clinch and Powell rivers near the Virginia-Tennessee border. The population in the Clinch River has suffered recent declines possibly related to an on-going mussel die-off that was first documented in 2016. The Powell River population remains viable, but less robust than the one in the Clinch River. Both remaining populations are small and highly localized and have declined since the last 5-year review in 2011.

**3. Recovery achieved:** 1 = 0%-25% recovery objectives achieved

#### **4. Listing history**

##### **Original Listing**

FR Notice: 54 FR 39850

Date Listed: September 28, 1989

Entity Listed: Species

Classification: Endangered

#### **5. Associated rulemakings**

Establishment of Nonessential Experimental Population (NEP) 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, AL, Final Rule, June 14, 2001, 66 FR 32250; Correction to Final Rule, August 21, 2001, 66 FR 43808.

Establishment of Nonessential Experimental Population (NEP) Status from 15 Freshwater Mussels, 1 Freshwater Snail, and 5 Fishes in the Lower French Broad River and in the Lower Holston River, Tennessee, Final Rule, September 13, 2007, 72 FR 52434.

#### **6. Review History**

Each year, the Service reviews and updates listed species information into the Recovery Ad-hoc Report to support the required Recovery Report to Congress (RRC). Prior to that and until 2013, we submitted information for the annual Recovery Data Call (RDC) that included status assessments such as "Declining", "Improving", "Stable", or "Unknown" for the Dromedary Pearlymussel. While the RDC is no longer being conducted, we continue to show species status (see section I.C.2. above) as part of our 5-year reviews. The most recent evaluation for this mussel to inform the Recovery Report to Congress was completed in 2019. The previous 5-year review for the Dromedary Pearlymussel was completed on August 19, 2011 (Service 2011),

and no change to the species' endangered status was recommended at that time.

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

4c (high degree of threat and a low potential for recovery for a species; C indicates conflict with construction or other development; the taxonomy is monotypic genus)

**8. Recovery Plan**

Name of plan: Recovery Plan for Dromedary Pearly Mussel *Dromus dromas* (Lea, 1834); *Dromus dromas* form *caperatus* (Lea, 1845)  
Date issued: July 9, 1984

**II. REVIEW ANALYSIS**

**A. Application of the 1996 Distinct Population Segment (DPS) policy**  
The Endangered Species 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 and will not be addressed further in this review.

**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 there is 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 Dromedary Pearlymussel shall be considered recovered or no longer in need of Federal Endangered Species Act protection, when the following criteria are met:

1. *A viable population<sup>1</sup> of D. dromas exists in the Clinch River from the backwaters of Norris Reservoir upstream to approximately CRM 226 and in the Powell River from the backwaters of Norris Reservoir upstream to approximately PRM 130. These two populations are dispersed throughout each river so that it is unlikely that any one event would cause the total loss of either population.*

**Status:** This criterion has not been met. Natural reproduction is currently known in only two populations (Powell River and Clinch River near the Tennessee/Virginia border), as evidenced by observations of multiple size classes. However, recent die-offs in the Clinch River are possibly affecting viability of the species. No increase in population density or area of occurrence in either river reach has been observed since the previous review (2011). In fact, it appears that, at least in the Clinch River, the population density and area of occurrence is shrinking.

2. *Through reestablishments and/or discoveries of new populations, viable populations exist in three additional rivers. Each of these rivers will contain a viable population that is distributed such that a single event would be unlikely to eliminate D. dromas from the river system.*

**Status:** This criterion has not been met. All historical populations other than the Powell and Clinch rivers are either extirpated or of unknown status. The two populations that are of unknown status but may be non-viable or extirpated are the populations in the mainstem Cumberland River and Tennessee River. All other populations are believed to be extirpated.

A small number of Dromedary Pearlymussel were translocated from the Clinch River, Tennessee, to the Tennessee River at Muscle Shoals, Alabama (n=80) in 2003 (Williams *et al.* 2008), and into the upper Big South Fork, Kentucky (n=19) in 2008 (McGregor *et al.* 2008). The Dromedary Pearlymussels that were reintroduced below Wilson Dam were placed in holding pens, and when last checked in the summer of 2018, 8 of the original 80 animals were recovered live. Their persistence 15 years after the original stocking may suggest that water quality and habitat conditions are favorable for the species and future reintroductions efforts (Williams *et al.* 2008; Garner 2020, pers. comm.). The Big South Fork Cumberland River introductions do not appear to have been successful as subsequent surveys in the Big South Fork in Kentucky and Tennessee sections of the river have not detected live individuals (Haag and Cicerello 2016, McGregor 2012, Dinkins and Dinkins 2018, G. Dinkins 2019, unpublished data).

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<sup>1</sup> The Recovery Plan defines a viable population as a reproducing population that is large enough to maintain sufficient genetic variation to enable it to evolve and respond to natural habitat changes. The number of individuals needed to meet this criterion will be determined as one of the recovery tasks.

3. *The species and its habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the populations.*

**Status:** This criterion has not been met. The Recovery Plan indicated that the primary reasons for the species' imperilment across its historical range were impoundments, habitat loss and water quality deterioration, industrial and municipal pollution, acid mine drainage, and siltation resulting from mining, agriculture, and construction activities. These threats to the species remain. The Dromedary Pearlymussel may be especially vulnerable to these threats compared to other freshwater mussel species, given its restricted distribution to short reaches of the Powell and Clinch rivers.

Die-offs of the mussel community in the Clinch River, beginning at the Tennessee-Virginia state line and extending at least 27 miles downriver have occurred since 2016 and as recent as fall 2019. These die-offs have been potentially linked to five undescribed viruses that may be contributing in development of an unknown disease. Numerous fresh-dead Dromedary Pearlymussels have been collected and vouchered in the UTMM mollusk collections since 2016, in 2016 alone, 451 fresh-dead Dromedary Pearlymussels were recovered from five locations in the Clinch River (river miles 181.3, 178.7, 175.0, 174.8, and 172.2) for archiving. Densities of Dromedary Pearlymussel prior the die-off were documented at 0.39 (1999) and 0.19 (2004) individuals/m<sup>2</sup> (Ahlstedt et al. 2016); and recent densities have been recorded at 0.16 (2016) and 0.13 (2017) individuals/m<sup>2</sup> (Lane 2018, unpublished data) at Kyles Ford (river mile 189.6). It appears that this threat continues to threaten one of the two remaining populations of this species (Agbalog 2019, pers. comm.).

4. *Noticeable improvements in coal-related problems and substrate quality have occurred in the Powell River, and no foreseeable increase in coal-related siltation occurs in the Clinch River. If the Cumberland River, including its tributaries, is selected for transplants or new populations are discovered, then these improvements in coal-related problems and substrate quality also apply to these streams.*

**Status:** This criterion has not been met. Jones *et al.* (2018) noted that water quality in the Clinch River has not improved over the last decade, and attributed the mussel decline in the Clinch River to a variety of factors, including degraded water and sediment quality associated with coal-mining activities. Jones *et al.* (2018) summarized data, analyses, and discussion available in Krstolic *et al.* (2013), Johnson *et al.* (2014), Price *et al.* (2014) Zipper *et al.* (2014), and Cope and Jones (2016) and concluded that water quality in upper Clinch River is adversely affected by increased levels of contaminants, including dissolved solids, trace metals, and polycyclic aromatic hydrocarbons, which in turn may limit mussel survival and

reproduction. Threats to the species continue as a result of ongoing impacts due to mining activities.

None of the recovery criteria described above have been met for the Dromedary Pearlymussel. No populations have been successfully established, and no new populations have been discovered. Thus, there are currently only two known populations remaining, and the area of known distribution has been significantly reduced in both rivers. Further, these two populations are separated by Norris Reservoir. Given that the species cannot maintain viable populations in impoundments, genetic exchange between these populations has likely not occurred since the reservoir was impounded in 1933. The Dromedary Pearlymussel's presence in the mainstem Cumberland and Tennessee rivers has not been documented for several decades and is likely extirpated outside of a few translocated animals from the Clinch River. Despite application of existing Federal and State laws and regulations, the species continues to be subjected to adverse effects from activities such as resource extraction for mining, natural gas development, timber, and road maintenance activities. These threats to the species' continued existence persist throughout its range.

## C. Updated Information and Current Species Status

### 1. Biology and Habitat

#### a. New information on the species' biology and life history:

When the Recovery Plan was published in 1984, only very limited data on the species' life history existed. Since then, reproduction, demography, and propagation has been reported by Jones *et al.* (2004) and is summarized herein. Laboratory host fish trials identified nine species of darters (Percidae) and one species of sculpin (Cottidae) as suitable fish hosts. Although, one of the darter species that was shown to be a suitable fish host (Roanoke Darter, *Percina roanoka*) does not occur in the same drainage with the Dromedary Pearlymussel. Female Dromedary Pearlymussels were gravid from October through May, and the conglutinates were contained only in the water-tubes of the outer gills; conglutinates were observed in all of the water-tubes from the anterior to the posterior portion of the gill. Gravid females were present throughout the year, but mature glochidia were observed only in conglutinates extracted in April and May, which coincided with the peak in percentage of gravid females. Relic shells and shells from recently dead individuals ranged in age from 3 to 25 years (Mean = 12 years). Based on shell length, most individuals were mature by 6 to 9 years of age. Other laboratory tests confirmed the Dromedary Pearlymussel is bradyctytic (long-term brooder), but unlike most other lampsiline species, the female does not have a mantle lure and conglutinates are released over a relatively short period of time once glochidia are mature.

The mean age of the population in the Clinch River studied by Jones *et al.* (2004) was 10 to 12 years, but the authors conceded that the mean age would possibly have been lower if smaller, subsurface individuals were included in the age and growth analysis. Nonetheless, the presence of many small- to medium-size live specimens suggested the population in the Clinch River study was reproducing. The mean shell length of dead and live individuals collected from the Clinch River in 1999 to 2000 was 51.3 mm (SE = 1.6, median = 53.0 mm, range = 27 – 83 mm). Lengths of shells from dead individuals (N = 81) and live individuals (n = 81) from the Clinch River were not significantly different ( $p > 0.05$ ) (Jones *et al.* 2004).

In 2016, the mean shell length of dead Dromedary Pearlymussels collected during the mussel die-off in the Clinch River and delivered to the UTMM was 52.4 mm (SE = 0.43, median = 52.0, range = 27 – 80 mm) (Dinkins 2019, unpublished data). In 2017, the mean shell length of dead Dromedary Pearlymussels collected during the mussel die-off was 55.6 mm (SE = 2.0, median = 54.0 mm, range = 38 – 72) (Dinkins 2019, unpublished data). These more recent length distributions are similar to those collected during the earlier study by Jones *et al.* (2004), indicating continued recent recruitment and multiple size classes in the Clinch.

**b. Abundance, population trends, demographic features, or demographic trends:** The Dromedary Pearlymussel's status in the main channel Cumberland and Tennessee rivers in Tennessee is likely extirpated. It was last seen alive in the lower Tennessee River near Watts Bar in the upper Chickamauga Reservoir in Tennessee during monitoring conducted between 1983-85 (Ahlstedt and McDonough 1995-1996) and in the Cumberland River near Carthage (Smith County), Tennessee in 1994 (Hubbs 1994). It is also considered extirpated in both rivers in Alabama and Kentucky (Williams *et al.* 2008, Haag and Cicerello 2016). Except for the Clinch and Powell rivers, the Dromedary Pearlymussel is considered to be extirpated in all other tributary rivers throughout its historical range. The Clinch River population currently exhibits greater viability than that of the Powell River (Hubbs 2019e, pers. comm.). However, long-term viability of the species is of concern due to the large number of fresh-dead Dromedary Pearlymussels recovered as part of the mussel die-off in the Clinch River in 2016 (N = 451) and 2017 (N = 21).

During a dive survey of mussels in the Tennessee portion of the Clinch River in 2019, the Dromedary Pearlymussel ranked 27<sup>th</sup> (0.3% of mussels documented). Three individuals of the species were found at two sites (CRM 178.6 and 177.9), with a catch per unit effort of 0.1 individual per hour of searching (Hubbs 2019a). In the Powell River (2008-09), the Dromedary Pearlymussel comprised between 0.52-0.78% of the overall



mussel relative abundance (quantitative and semi-quantitative efforts) with estimated densities of between 0.02-0.03 individuals per square meter at sites where it was found (Johnson *et al.* 2012).

**c. Genetics, genetic variation, or trends in genetic variation:** There is no new information available on genetics, genetic variation, or trends in genetic variation.

**d. Taxonomic classification or changes in nomenclature:** A revised list of the freshwater mussels of the United States and Canada was recently published by Williams *et al.* (2017), updating changes in mussel nomenclature and systematic taxonomy from the previous checklist by Turgeon *et al.* (1998). No taxonomic changes were made to the Dromedary Pearlymussel and the current nomenclature is consistent and follows that in Williams *et al.* (2017).

**e. Spatial distribution, trends in spatial distribution, or historical range:** The Dromedary Pearlymussel is endemic to the Tennessee and Cumberland River drainages in Alabama, Mississippi, Kentucky, Tennessee and Virginia. In the Tennessee River drainage, it occurred in the main channel from the mouth upstream to Knoxville, and in the following tributaries: Limestone Creek (Alabama), Flint River (Alabama), Widows Creek (Alabama), Bear Creek (Mississippi), Elk River (Tennessee), Hiwassee River (Tennessee), Holston River (Tennessee), Clinch River (Tennessee and Virginia), Powell River (Tennessee and Virginia), Little Pigeon River (Tennessee), and Little Tennessee River (Tennessee). In the Cumberland River, it was documented in the main channel from the mouth upstream to Cumberland Falls, and in the following tributaries: Harpeth River (Tennessee), Caney Fork River (Tennessee), Obey River (Tennessee), and Big South Fork Cumberland River (Kentucky). A single valve recovered from the Wickliffe Mounds located on the bluffs of the Mississippi River, Ballard County, Kentucky, about three miles downstream of the mouth of the Ohio River (Wesler 2001) suggests the species may have also occupied a few miles of the lower Ohio River and an adjacent reach of the Mississippi River. A specimen in the University of Michigan, Museum of Zoology (UMMZ) from the Barren River in Kentucky is attributed to a river that is outside the historically documented range for the species and is presumed to represent a locality error. Currently, the Dromedary Pearlymussel is restricted to approximately 31 miles of the Powell River (Powell River mile 90 to 120) and 54 miles of the Clinch River (Clinch River mile 172 to 226). A summary of the historical distribution of the Dromedary Pearlymussel is provided in Table 1.

The species was historically widespread in the Tennessee and Cumberland River systems. In the Tennessee River system, including archaeological

records, it occurred throughout the Clinch River drainage from the confluence with the Tennessee River upstream to the Clinch River and Powell River in southwestern Virginia. It also occurred in the lower reaches of several other Tennessee River tributaries, including the Holston, Little Pigeon, Little Tennessee, Hiwassee, Flint, and Elk rivers, as well as Limestone, Widows, and Bear creeks. In the Cumberland River system, it occurred in lower reaches of the Big South Fork of the Cumberland, Harpeth, Caney Fork, and Obey rivers. In all, approximately 1,810 miles of water in the Tennessee and Cumberland River systems were historically occupied by this species. Currently, the Dromedary Pearlymussel is considered extant only in 54 miles of the Clinch River and 31 miles of the Powell River, a 95% reduction in number of river/stream miles occupied.

**f. Habitat or ecosystem conditions:** The Dromedary Pearlymussel inhabits shoal habitat that includes a stable mixture of gravel and clean sand (Parmalee and Bogan 1998; Williams *et al.* 2008).

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

Of the five listing factors discussed below, “overutilization for commercial, recreation, scientific, or educational purposes” and “disease or predation” are not thought to be threats to the species and were not addressed by recovery criteria included in the Recovery Plan. We have no new information on either of these listing factors to indicate this has changed; however, they are included below with brief comments.

**a. Present or threatened destruction, modification, or curtailment of its habitat or range:** When the recovery plan was completed in 1984, the only extant populations were in the main channel Tennessee and Cumberland rivers, and in the Clinch and Powell rivers. The species was considered to be “extremely rare” in the Tennessee River when only three live Dromedary Pearlymussels were found during an extensive survey conducted in 1978 by Tennessee Valley Authority (TVA) personnel in the Tennessee River from Walden Gorge to Fort Loudon Dam (river mile 446 to 602); all three individuals were found within a single 0.6 river mile segment (Pardue 1981). In 1983, a live Dromedary Pearlymussel was found in this same general vicinity (Ahlstedt and McDonough 1995-1996). The location of this individual was revisited in 1993, but the species could not be found. The species was reported to be extirpated from the Tennessee River (Ahlstedt and McDonough 1995-1996). Attempts to establish non-essential, experimental populations below Wilson Dam on the Tennessee River, Douglas Dam on the French Broad River, and Cherokee Dam on the Holston River are considered to have been unsuccessful (Hubbs 2019b, pers. comm.). In the Cumberland River, two

live Dromedary Pearlymussels were found at river mile 296.8 by TVA in 1976, along with a live individual in a commercial musseling boat at river mile 293 (TVA 1976). In 1994, a single live Dromedary Pearlymussel was found in the Cumberland River at river mile 298.5 (Hubbs 1994). Extensive sampling in this reach of the river since then has failed to produce live Dromedary Pearlymussels (Hubbs 2019d, pers. comm.). For all practical purposes, the only viable populations remaining are the Clinch and Powell rivers near the Virginia-Tennessee border. The recovery plan included habitat loss and water quality deterioration, attributed to impoundments, industrial and municipal pollution, acid mine drainage, and siltation resulting from mining, agriculture, and construction activities, as the primary reasons for the decline of this species. The current status of the species is likely still attributable to these threats.

**b. Overutilization for commercial, recreational, scientific or educational purpose:** In the late 1970's, live Dromedary Pearlymussels were occasionally taken by commercial shellers plying the Cumberland River in and around Rome Landing, Tennessee (Parmalee *et al.* 1980; Hubbs 2019c, pers. comm.), but the species was rarely encountered and mostly consisted of old, non-reproducing individuals. Overutilization for commercial, recreational, scientific or educational purposes was not considered to be a significant threat in the Recovery Plan, and given that commercial harvesting has dramatically declined since the recovery plan was developed, the threat of commercial overutilization to the species is negligible.

**c. Disease and predation:** In 2016, 2017, and 2019, several thousand mussels died of unknown cause(s) in several miles of the Clinch River just downstream of the Tennessee/Virginia border. Sampling of obviously sick and moribund mussels by the Service revealed five undescribed viruses that may contribute in development of an unknown disease, but the identity of the causative agent(s) remains unknown (Richard 2018, pers. comm.). In 2016, 3,533 fresh dead mussels were recovered and delivered to the McClung Museum for archiving, including 451 Dromedary Pearlymussels. In 2017, 654 fresh dead mussels were recovered and brought to the McClung Museum for archiving, including 22 Dromedary Pearlymussels. We have no other information on disease or predation of the Dromedary Pearlymussel, but it appears that whatever is causing sudden and dramatic mortality in the mussel community of the Clinch River near the Tennessee/Virginia border has the potential to be a threat to the long-term viability of the Dromedary Pearlymussel in the Clinch River.

**d. Inadequacy of existing regulatory mechanisms:** The Dromedary Pearlymussel and its habitats are afforded limited protection from water quality degradation under the Clean Water

Act of 1977 (33 U.S.C. 1251 et seq.) and state laws, such as Tennessee's Water Quality Control Act of 1977 (T.C.A. 69-3-101) and Virginia's State Water Control Act (§ 62.1). 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 Dromedary Pearlymussel.

This mussel is afforded protections against take under Section 9 of the Act, by the State of Tennessee by the Tennessee Nongame and Endangered or Threatened Wildlife Species Conservation Act (1974) (Tennessee Code Annotated 70-8-101 through 70-8-112), and Virginia under Title 29.1 of their Game, Inland Fisheries, and Boating laws (Chapter 5, Article 6) (Virginia Code Annotated § 29.1-564, (1972) c. 329, § 29-232; (1977) c. 377; (1987) c. 488).

Under the Tennessee Nongame and Endangered or Threatened Wildlife Species Conservation Act of 1974 (Tennessee Code Annotated §§ 70-8-101-112), "...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. Virginia law (§ 29.1-564) prohibits the, "taking, transportation, possession, sale, or offer for sale within the Commonwealth of any fish or wildlife appearing on any list of threatened or endangered species published by the United States Secretary of the Interior pursuant to the provisions of the federal Endangered Species Act of 1973 (P.L. 93-205), or any modifications or amendments thereto, is prohibited except as provided in § 29.1-568."

**e. Other natural and manmade factors affecting its continued existence:** Because the Dromedary Pearlymussel was primarily a species of the main channel Cumberland and Tennessee rivers and tributary rivers, the recovery plan listed the network of dams constructed by TVA and the U.S. Army Corps of Engineers (USACE) in the Tennessee and

Cumberland River drainages as the single greatest factor contributing to this species' decline. The plan also indicated that some populations have been affected by alteration of stream flow and temperature regime below reservoirs. Examples are Norris Dam (lower Clinch River), Center Hill Dam (Caney Fork River), Dale Hollow Dam (Obey River), and Wolf Creek Dam (mainstem Cumberland River). The Dromedary Pearlymussel now exists in only two relatively small, free-flowing reaches of the Clinch River and Powell River that are now separated by impounded reaches of Norris Reservoir. This isolation could result in a reduction of genetic variability that might affect the species' ability to evolve and respond to natural habitat changes.

No information was provided in the Recovery Plan relative to the threat posed by nonnative species such as Asian Clams, Zebra Mussels, or Asian Carp, and all three invasive species are now present in the Tennessee River drainage. However, we have no data indicating these invasive species are affecting the Dromedary Pearlymussel.

The number of individuals remaining in the Clinch and Powell rivers is unknown but appears to be relatively low. Both populations are extremely vulnerable to extirpation from intentional or accidental toxic chemical spills, habitat modification, progressive degradation from land surface runoff (nonpoint-source pollutants) and natural stochastic events (e.g., floods, drought).

As a consequence of the Dromedary Pearlymussel being limited to two viable populations, there is the likelihood of decreased fitness from reduced genetic diversity. Species that are restricted in range and population size are more likely to suffer loss of genetic diversity due to genetic drift, potentially increasing their susceptibility to inbreeding depression, decreasing their ability to adapt to environmental changes, and reducing the fitness of individuals (Soule 1980, Hunter 2002, Allendorf and Luikart 2007). The long-term viability of a species is founded on the conservation of numerous local populations throughout its geographic range (Harris 1984). These separate populations are essential for the species to recover and adapt to environmental change (Noss and Cooperrider 1994, Harris 1984). The level of isolation seen in the Dromedary Pearlymussel makes natural recovery of extirpated populations virtually impossible without human intervention.

#### **D. Synthesis**

The Dromedary Pearlymussel is currently in decline, and its current area of known distribution is limited to the Clinch and Powell rivers near the Virginia-Tennessee border. It has likely been extirpated from the Tennessee River (where it was believed extant at the time the recovery plan was written in 1983) and the

Cumberland River (where it has not been found alive since 1994). Historically, the Dromedary Pearlymussel occupied approximately 1,810 miles of rivers and streams in Tennessee, Virginia, Alabama, Mississippi and Kentucky. Across its range, the species' area of known occupation has diminished to only 85 miles (a 95% reduction in range). The population in the Clinch River remain the most robust, but has suffered recent declines as a possible result of an on-going mussel die-off that was first documented in 2016. The Powell River population remains viable, but less robust than the one in the Clinch River. Both remaining populations are small and highly localized and have declined since the last 5-year review in 2011. Because the Dromedary Pearlymussel remains restricted in distribution and continues to remain vulnerable to threats, we believe that no status change is required at this time as it still meets the Act's definition of endangered.

### III. RESULTS

- A. **Recommended Classification: Endangered** - No change is needed for the existing classification for the Dromedary Pearlymussel.
- B. **New Recovery Priority Number:** N/A.

### IV. RECOMMENDATIONS FOR FUTURE ACTIONS

- Develop and implement a plan to quantify and monitor surviving populations.
- Reintroduce into other streams within the historical range that have suitable habitat and water quality. For example, the following streams were recommended by the Cumberland Region Mollusk Restoration Committee (2010):
  - Alabama (Tennessee River Drainage)
    - Tennessee River main steam below Wilson and Guntersville dams
    - Elk River
    - Limestone Creek
  - Tennessee (Tennessee River Drainage)
    - Tennessee River main steam below Pickwick Dam
    - Upper and Lower French Broad River
    - Lower Holston River
    - Lower Pigeon River
    - Hiwassee River
    - Nolichucky River
    - Elk River
  - Tennessee-Kentucky (Cumberland River Drainage)
    - Big South Fork
- Conduct studies to determine the cause of the mussel die-offs in the Clinch River.

- Work with landowners of priority recovery or restoration parcels to identify, fund, and implement management actions to improve water quality.
- Continue to educate the public about water quality and freshwater mussels.

## V. REFERENCES

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- Ahlstedt, S.A., M.T. Fagg, R.S. Butler, J.F. Connell, and J.W. Jones. 2016. Quantitative monitoring of freshwater mussel populations from 1979-2004 in the Clinch and Powell Rivers of Tennessee and Virginia, with miscellaneous notes on the fauna. *Freshwater Mollusk Biology and Conservation* 19:1-18.
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Table 1. Historical and present occurrence of Dromedary Pearlymussel. Data taken from museum records available online in Invertebase, UMMZ, UTMM, Haag and Cicerello (2016), Parmalee and Bogan (1998), Williams *et al.* (2008), and from sources indicated in the footnotes.

Waterbody	County(s)	State	Last Year Observed	Present Status	App. No. of River Miles Occupied (Historical/Current)
Cumberland River	Livingston, Lyon, Pulaski, Wayne, Russell, Cumberland, Clinton, Warren	KY	1950's	Extirpated	391/0
	Clay, Jackson, Smith, Stewart, Montgomery, Cheatham, Davidson, Sumner, Wilson, Trousdale, Jackson	TN	1994 <sup>a</sup>	Uncertain but likely extirpated	
Big South Fork Cumberland River	Pulaski, Wayne, McCreary	KY	1940's	Extirpated	22/0
	Scott (introduced)	TN	2008 <sup>b</sup>	-	
Caney Fork River	Smith, DeKalb	TN	1950's	Extirpated	27/0
Harpeth River	Davidson, Cheatham	TN	1800's	Extirpated	60 <sup>c</sup> /0
Obey River	Clay	TN	1939	Extirpated	9/0
Tennessee River	Colbert, Jackson, Lauderdale, Limestone, Marshall, Morgan	AL	ca. 1918	Extirpated	652/0
	Knox, Meigs, Hamilton, Hardin, Marion, Decatur, Giles, Rhea, Roane, Perry	TN	1983-85 <sup>d</sup>	Uncertain but likely extirpated	
	Livingston	KY	Archaeological record	Extirpated	
Bear Creek	Tishomingo	MS	Early 1900's	Extirpated	33/0
Clinch River	Scott	VA	2019	Extant	226/54
	Anderson, Campbell, Claiborne, Union, Grainger, Hancock, Knox	TN	2019	Extant <sup>e</sup>	
Powell River	Lee	VA	2018	Extant	127/31
	Union, Claiborne, Hancock, Campbell	TN	2016	Extant <sup>f</sup>	
Hiwassee River	Bradley, McMinn	TN	Archaeological record <sup>g</sup>	Extirpated	24/0
Little Tennessee River <sup>h</sup>	Monroe	TN	Archaeological record	Extirpated	30/0
Tellico River <sup>i</sup>	Monroe	TN	Archeological record	Extirpated	5/0
Holston River	Knox, Jefferson, Grainger, Hamblen, Sullivan	TN	1940's	Extirpated	141/0
Elk River	Giles (Ortmann 1925 record, but no specimen exists)	TN	1925	Extirpated	43/0
Little Pigeon River <sup>j</sup>	Sevier	TN	Archeological record	Extirpated	5/0
Limestone Creek	Limestone (Michigan Collection)	AL	No date given for specimen in UMMZ collection	Extirpated	15 <sup>j</sup>
Barren River	Unknown (UMMZ collection)	KY	Unknown		0 <sup>l</sup>
Widows Creek	Jackson (UMMZ collection)	AL	Unknown	Extirpated	0 <sup>m</sup>
Total:					1810/85

<sup>a</sup>Hubbs (1994); <sup>b</sup>McGregor *et al.* (2008); <sup>c</sup>Approximate distance; type locality for Dromedary Pearlymussel designated by Johnson (1974) as the Harpeth River, Cumberland River, near Nashville, Tennessee. <sup>d</sup>Ahlstedt and McDonough (1995-1996); <sup>e</sup>Extant only in Hancock and Claiborne counties; <sup>f</sup>Parmalee and Hughes 1994; <sup>h</sup>Bogan (1983); <sup>i</sup>Parmalee and Klippel (1984); <sup>j</sup>Parmalee (1988); <sup>k</sup>Approximate distance; collecting locality given as Big Limestone Cr., Limestone Co., AL (UMMZ Lot No. 98574). 30 miles of Big Limestone Creek lies in Limestone County, Alabama; based on the size of creek the likely collecting locality was in the lower reach; <sup>l</sup>Considered herein to represent a locality error based on known historical distribution; <sup>m</sup>precise collection locality unknown, but considered herein to be at or near the confluence with Tennessee River based on small size Widow Creek.

**U.S. FISH AND WILDLIFE SERVICE**  
**5-YEAR REVIEW of Dromedary Pearlymussel (*Dromus dromas*)**

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

  X   **No change is needed**

Review Conducted By: Anthony Ford and David Pelren, Tennessee Ecological Services Field Office, with assistance from Gerald Dinkins, University of Tennessee.

**FIELD OFFICE APPROVAL:**

Lead Field Supervisor, Fish and Wildlife Service

Approve \_\_\_\_\_ Date April 29, 2020

*\* Since 2014, Southeast Region Field Supervisors have been delegated authority to approve 5-year reviews that do not recommend a status change. Field Supervisor signature on this document reflects:*

1.   X   *We have no new information, received no new public comments, and the original five factor analysis remains an accurate reflection of the species current status.*
2. \_\_\_\_\_ *We have obtained a small amount of new information that we have summarized in Appendix B, received no new public comments, and the original five factor analysis remains an accurate reflection of the species current status.*

***OTHER REGIONAL OFFICE APPROVAL:***

*We provided this 5-year review to the following regional and/or field offices for their concurrence prior to finalizing the document: North Atlantic-Appalachian Region and Virginia Field Office. We will retain any comments that we received, as well as verification of concurrence from other regions, in the administrative record for this 5-year review.*

**APPENDIX A: Summary of peer review for the 5-year review of the Dromedary Pearlymussel (*Dromus dromas*)**

Peer Review Method:

This document was peer-reviewed internally by multiple cooperating Ecological Services field offices within the range of the Dromedary Pearlymussel. Reviewers of this document include: Rose Agbalog (Abingdon, VA), Martin Miller (Hadley, MA), and Evan Collins (Daphne, AL).

No formal public comments were received following the Federal Register Notice citation announcing initiation of this review. Since minimal new information was obtained since the last 5-year review in 2011, we did not seek external independent peer review of this document. As we continue to support recovery actions with partners, we look forward to having additional data and surveys for our next 5-year review, and the Service will determine if external peer review is appropriate at that time.