Birdwing pearlymussel (*Conradilla caelata [=Lemiox rimosus]*)
Dromedary pearlymussel (*Dromus dromas*)
Cracking pearlymussel (*Hemistena lata*)

5-Year Review:
Summary and Evaluation

August 2011

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

5-YEAR REVIEW

Species reviewed: Birdwing pearlymussel (*Conradilla caelata* [=*Lemiox rimosus*])
Dromedary pearlymussel (*Dromus dromas*)
Cracking pearlymussel (*Hemistena lata*)

I. GENERAL INFORMATION

A. Methodology used to complete the review

A notice was published in the Federal Register on July 28, 2006, announcing the 5-year status review for these species. It was sent to various Federal and State government agencies, universities, and others who might have information about one or more of the species. Reviewers were asked to provide comments and any relevant information about the current status of the species within 60 days of the Federal Register notice announcing initiation of the review. Other sources of information included the final rule listing these species under the Endangered Species Act, the species' recovery plans, and scientific publications. All recommendations resulting from this review are a result of thoroughly reviewing all available information on these species. No part of this review was contracted to an outside party.

One response to the request for comments was received from Chuck Nicholson of the Tennessee Valley Authority.

B. Reviewers

Lead Region—Southeast Region: Nikki Lamp; 404/679-7118, nikki_lamp@fws.gov
Lead Field Office—Cookeville, TN: Jim Widlak; 931/528-6481 (ext. 202), james_widlak@fws.gov
Cooperating Field Office—Abingdon, VA: Shane Hanlon; 276/623-1233
Cooperating Region—Northeast Region: Mary Parkin; 617-417-3331

C. Background

1. Federal Register notice citation announcing initiation of this review
July 28, 2006; 70 FR 55157

2. Species status
2010 Recovery Data Call

Birdwing pearlymussel	-	Stable
Dromedary pearlymussel	-	Uncertain
Cracking pearlymussel	-	Uncertain

3. Recovery achieved
"1" for all 3 mussels; 1 = 0-25% recovery objectives achieved (2010 Recovery Data Call)

4. Listing history
Original Listing

Birdwing pearlymussel
FR Notice: 41 FR 24062
Date Listed: June 14, 1976
Entity Listed: Species
Classification: Endangered

Dromedary pearlymussel
FR Notice: 41 FR 24062
Date Listed: June 14, 1976
Entity Listed: Species
Classification: Endangered

Cracking pearlymussel
FR Notice: 54 FR 39850
Date Listed: September 28, 1989
Entity Listed: Species
Classification: Endangered

5. Associated rulemakings

Final rules were published for the establishment of non-essential experimental populations of the birdwing pearlymussel, dromedary pearlymussel, and cracking pearlymussel in the Tennessee River below Wilson Dam in Alabama (USFWS 2001) and in the lower French Broad River and Holston River in Tennessee (USFWS 2007).

6. Review history

2002 recovery data call

Birdwing pearlymussel	-	Declining
Dromedary pearlymussel	-	Declining
Cracking pearlymussel	-	Declining

2003 recovery data call

Birdwing pearlymussel	-	Declining
Dromedary pearlymussel	-	Declining
Cracking pearlymussel	-	Declining

2004 recovery data call

Birdwing pearlymussel	-	Stable
Dromedary pearlymussel	-	Declining
Cracking pearlymussel	-	Declining

2005 recovery data call

Birdwing pearlymussel	-	Stable
Dromedary pearlymussel	-	Stable
Cracking pearlymussel	-	Declining

2006 recovery data call

Birdwing pearlymussel	-	Stable
Dromedary pearlymussel	-	Stable
Cracking pearlymussel	-	Declining

2007 recovery data call

Birdwing pearlymussel	-	Stable
Dromedary pearlymussel	-	Stable
Cracking pearlymussel	-	Uncertain

2008 recovery data call

Birdwing pearlymussel	-	Stable
Dromedary pearlymussel	-	Stable
Cracking pearlymussel	-	Uncertain

2009 recovery data call

Birdwing pearlymussel	-	Stable
Dromedary pearlymussel	-	Uncertain
Cracking pearlymussel	-	Uncertain

2010 recovery data call

Birdwing pearlymussel	-	Stable
Dromedary pearlymussel	-	Uncertain
Cracking pearlymussel	-	Uncertain

An email dated September 26, 2006, from Chuck Nicholson, Tennessee Valley Authority (TVA), summarized the status of each species. The birdwing pearlymussel population in the Duck River appears to be stable, but those in the Powell River and Clinch River continue to be adversely affected by coal fines and are declining. Populations of the cracking pearlymussel in the Powell River and Clinch River are also declining as a result of the effects of coal fines. Tennessee Valley Authority reservoir operations and non-point source pollution are contributing to the decline of the populations in the Elk River and mainstem of the Tennessee River. The only known reproducing populations of the dromedary pearlymussel occur in the Powell River and Clinch River. Coal fines continue to contribute to the decline in those populations.

7. Species' recovery priority number at start of review

Birdwing pearlymussel	-	4c
Dromedary pearlymussel	-	4c
Cracking pearlymussel	-	4

(4 indicates a high degree of threat and low recovery potential; C indicates conflict with construction or other development)

8. Recovery plan or outline

Birdwing pearlymussel
Name of Plan: Recovery Plan for the Birdwing Pearly Mussel *Conradilla caelata* (Conrad, 1834)
Date Issued: July 9, 1984
Dates of Previous Revisions: None

Dromedary pearlymussel
Name of Plan: Recovery Plan for the Dromedary Pearly Mussel *Dromus dromas* (Lea, 1834); *Dromus dromas* form *caperatus* (Lea 1845)
Date Issued: July 9, 1984
Dates of Previous Revisions: None

Cracking pearlymussel
Name of Plan: Recovery Plan for the Cracking Pearlymussel (*Hemistena* [=*Lastena*] *lata*)
Date Issued: July 9, 1991
Dates of Previous Revisions: None

II. REVIEW ANALYSIS

A. Application of the 1996 distinct population segment (DPS) policy

1. Are the species under review listed as a DPS?
No. The Endangered Species Act defines species as including any subspecies of fish, wildlife, or plant, and any distinct population segment of any species of vertebrate wildlife. This definition limits listing DPS to only vertebrate species of fish and wildlife. Because the species under review are invertebrates, the DPS policy is not applicable.

B. Recovery Criteria

1. Do these species have final, approved recovery plans?
YES

2. Do the recovery plans contain recovery (i.e., downlisting or delisting) criteria? YES

3. Adequacy of recovery criteria

a. Do the recovery criteria reflect the best available (i.e., most up-to-date) information on the biology of the species and their habitats?

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

4. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing supporting information. For threats-related recovery criteria, please note which of the 5 listing factors are addressed by that criterion. If any of the 5 listing factors is not relevant to these species, please note that here.

Dromedary pearlymussel

There are no downlisting criteria for this species. This species shall be considered recovered, i.e., no longer in need of Federal Endangered Species Act protection, when the following criteria are met:

1) *A viable* population of dromedary pearlymussel 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.*

2) *Through reestablishment 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 this mussel from the river system.*

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.*

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.*

**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. The number of individuals needed to meet this criterion will be determined as one of the recovery tasks.*

Birdwing pearlymussel

There are no downlisting criteria for this species. The delisting criteria are as follows:

1) *A viable population of birdwings exists in the Clinch River from the backwaters of Norris Reservoir upstream to approximately CRM 280 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.*

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 birdwings from the river system. (If the Duck River Columbia Dam project is not completed and a viable population of the species continues to exist in the Duck River, only two additional populations will be needed to meet this criterion.)*

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.*

4) *Noticeable improvements in coal-related problems and substrate quality have occurred in the Powell River, and no increase in coal-related siltation has occurred in the Clinch River.*

None of the four criteria have been met for either species. Despite application of existing Federal and State laws to proposed actions, the species and their habitats continue to be subjected to adverse effects from activities such as coal mining, bridge construction, and wastewater discharges. New populations have not been reestablished or discovered. The Columbia Dam project, however, was not completed; the project was terminated and there are no future plans to construct the dam, so the birdwing pearlymussel population in the Duck River is still viable.

Cracking pearlymussel

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

1) *Through protection of existing populations and through successful establishment of reintroduced populations or the discovery of additional populations, a total of five distinct viable populations exist. The populations shall be distributed throughout the Ohio River basin as follows: one in the upper Tennessee River system, one in the middle to lower Tennessee River system, one in the Cumberland River system, one in a Kentucky tributary to the Ohio River other than the Cumberland River, and one in the Wabash River system.*

2) *One naturally reproduced year class exists within each of the five populations. The year class must have been produced within 5 years of the downlisting date. Within 1 year of the downlisting date, gravid females of the species and its host fish must be present in each river.*

3) *Biological and ecological studies have been completed, and the 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 five populations.*

The cracking pearlymussel will be considered for removal from Endangered Species Act protection when the likelihood of the species becoming threatened in the foreseeable future has been eliminated by the achievement of the following criteria:

1) *Through protection of existing populations and successful establishment of reintroduced populations or the discovery of additional populations, a total of eight 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. The populations shall be distributed throughout the Ohio River basin as follows: two in the upper Tennessee River system, two in the middle to lower Tennessee River system, one in the Cumberland River system, one in a Kentucky tributary to the Ohio River other than the Cumberland River, and two in the Wabash River system.*

2) *Two distinct naturally reproduced year classes exist within each of the eight 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 of the species and its 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 eight populations.*

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

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

None of the recovery criteria described above have been met for the cracking pearlymussel. No populations have been successfully established, and no new populations have been discovered. Despite application of existing Federal and State laws and regulations, the species continues to be subjected to adverse effects from activities such as development, agriculture, and highway construction. Also, threats to the species' continued existence persist throughout its range.

Recovery Plan Tasks

Birdwing pearlymussel and Dromedary pearlymussel

1.1. Continue to utilize existing legislation and regulations (Federal and State endangered species laws, water quality requirements, stream alteration regulations, etc.) to protect the species and its habitat.

This action has not been met for either species. Although existing Federal and State laws and regulations are applied to actions conducted in areas within the ranges of the birdwing pearlymussel and dromedary pearlymussel, and the population of the birdwing pearlymussel in the Duck River appears to be stable, the species and their habitats continue to undergo adverse effects from various construction and development activities.

1.2.1. Determine species' present distribution and status.

This action has been met. Comprehensive surveys have been conducted recently within the species' ranges. The current distribution and status of the birdwing pearlymussel and dromedary pearlymussel are known.

1.2.2. Characterize the habitat and ecological association and determine essential elements (biotic and abiotic factors) of its habitat for all life history stages.

This action has been partially met. General information is available about the habitat and ecological associations of the birdwing pearlymussel and dromedary pearlymussel.

Data is lacking, however, concerning specific habitat and ecological requirements of adults and juveniles.

1.2.3. Determine the extent of the species' preferred habitat.

This action has been partially met for these species. Surveys have provided general information about water depth, flow velocities, and substrate types typically associated with the species. As part of the TVA-sponsored Cumberlandian Mollusk Conservation Program, rivers in the Tennessee River Basin were evaluated in 1980, 1981, and 1982 to determine areas containing habitat suitable for reintroduction of mussels.

1.2.4. Present the above information in a manner that identifies essential habitat and specific areas in need of protection.

This action has been partially met for these species. Malacologists have identified some areas that should be protected to maintain the best known populations of the species.

1.3.1. Determine impacts of coal industry related pollution on non-endangered species.

This action has been partially met. Studies have been conducted and are ongoing to determine the effects of contaminants on mussels. Metals such as copper, lead, and mercury accumulate in the shell and soft tissues (Imlay 1982). Ammonia (Augspurger 2003) and copper are toxic to mussels at relatively low concentrations. The full extent of effects to mussels from coal industry related contaminants is not fully known, however.

1.3.2. Investigate and inventory other factors negatively impacting the species and their environments.

This action has not been met for either species. However, review of Federal projects under section 7 of the Endangered Species Act provides qualitative and anecdotal evidence that actions that result in sedimentation of streams, reductions in dissolved oxygen or temperature, and destabilization of substrate likely have adverse effects on these species and all mussels.

1.3.3. Solicit information on proposed and planned projects that may impact the species.

This is an ongoing activity. Projects requiring State and/or Federal permits are reviewed to determine if impacts to the species may occur. Projects are coordinated with appropriate agencies to find ways to avoid or minimize impacts to the species and habitat.

1.3.4. Determine measures that are needed to minimize and/or eliminate any adverse impacts and implement where necessary.

This is an ongoing activity. General measures, such as Best Management Practices (e.g., installation of sediment control structures, stabilization of disturbed areas, no operation of equipment in stream channel), are required for projects that may affect the species. Also, during the review process, project-specific measures to protect the species and habitat may be incorporated into project plans.

1.4.1. Meet with local government officials and regional and local planners to inform them of our plans to attempt recovery and request their support.

This action has not been met for either species. Successful completion of this action is difficult because of State and local government administration changes. Therefore, garnering support for species' recovery is an ongoing process.

1.4.2. Work with local, State, and Federal agencies to encourage them to utilize their authorities to protect the species and its river habitat.

This is an ongoing activity. We continue to encourage agencies to utilize their authorities to protect the species and their habitats. We seek to form partnerships with governmental and non-governmental agencies and groups to work toward recovery of the species.

1.4.3. Meet with local mining and industry interests and solicit their support in implementing protective actions.

This action has not been met for either species.

1.4.4. Meet with landowners adjacent to the species' population centers and inform them of the project and encourage their support in habitat protection measures.

This is an ongoing activity. Through the Service's Partners for Fish and Wildlife Program, we meet with landowners to accomplish this action.

1.4.5. Develop an educational program using such items as slide/tape shows and brochures. Present this material to business groups, civic groups, youth groups, church organizations, etc.

This is an ongoing activity. We conduct periodic outreach efforts involving various schools, groups, and organizations to inform them about the status of freshwater mussels and the importance of protecting these species and their habitats.

1.5. Investigate the use of Scenic River status, mussel sanctuaries, land acquisition, and/or other means or combinations to protect the species.

This action has been partially met for these species. Several reaches of the Clinch River have been protected as a result of projects conducted under the Service's Partners for Fish and Wildlife Program. Also, the Tennessee Stream Mitigation Program recently funded a project in 2006 on the Clinch River to stabilize an eroding section of riverbank and protect a mussel shoal downstream.

2.1. Survey rivers within the species' ranges to determine the availability and location of suitable transplant sites. This can include areas for population expansion within rivers where the species presently exists.

Sites have been surveyed and identified as suitable locations for transplants of mussels, including the birdwing pearlymussel. Transplants of the species were conducted in 1980 as part of the TVA's Cumberlandian Mussel Conservation Program. Also, final rules were published for the establishment of non-essential experimental populations of the birdwing pearlymussel, dromedary pearlymussel, and cracking pearlymussel in the Tennessee River below Wilson Dam in Alabama (USFWS 2001) and in the Lower

French Broad River and the Lower Holston River in Tennessee (USFWS 2007).

2.2. Identify and select sites for transplants.

This action has been partially met. The Tennessee River below Wilson Dam and the Lower French Broad River and Holston River have been selected for transplants of the birdwing pearlymussel and dromedary pearlymussel.

2.3. Investigate and determine the best method of establishing new populations; i.e., introduction of adult mussels, juveniles, infected fish, artificially cultured individuals, or other means or combinations.

This action is ongoing. Studies are underway to determine the best method for reintroductions. Adult mussels, propagated juveniles, and/or infected fish hosts have been released to determine which method produces the best potential for survival, growth, and reproduction.

2.4. Introduce the species within their historic ranges where it is likely they will become established.

This action has not been met for the birdwing pearlymussel or the dromedary pearlymussel. Transplants of birdwing pearlymussels conducted in 1980 did not result in establishment of viable populations. Studies are currently underway to establish populations of mussels through reintroductions, including federally listed species. Initial transplants of birdwing pearlymussels have been made below Wilson Dam. Future efforts are likely to include the birdwing pearlymussel and dromedary pearlymussel.

2.5. Implement the same protective measures for these introduced populations as outlined for established populations in 1.2 and 1.4.

This action has not been met for either species. Individuals introduced into the Tennessee River below Wilson Dam are designated as non-essential experimental populations.

3. Conduct life history studies not covered under section 1.2; i.e., fish hosts, age and growth, reproductive biology, longevity, natural mortality factors, and population dynamics.

This action has been partially met. Studies have provided some data concerning fish hosts and reproductive biology of several mussel species, including the birdwing pearlymussel and dromedary pearlymussel. Confirmed fish hosts for the birdwing pearlymussel include the greenside darter (*Etheostoma blennioides*), bluebreast darter (*E. camurum*), redline darter (*E. rufilineatum*), Tennessee snubnose darter (*E. simoterum*), and banded darter (*E. zonale*) (Jones et al. 2009). Fish hosts of the dromedary pearlymussel include the black sculpin (*Cottus baileyi*), greenside darter, fantail darter (*E. flabellare*), Tennessee snubnose darter, channel darter (*Percina copelandi*), gilt darter (*P. evides*), Roanoke darter (*P. roanoka*), tangerine darter (*P. aurantiaca*), and logperch (*P. caprodes*) (Jones et al. 2004). Data is lacking, however, concerning recruitment, survival, and other demographic information.

4. Determine the number of individuals required to maintain a viable population.

   This action has not been met for either species. The recovery plans cite theoretical considerations presented in the literature that the minimum number of individuals of a species needed to establish a viable population is 500. Actual numbers needed in a natural ecosystem, however, are expected to be much larger.

5. Investigate the necessity for habitat improvement and if feasible and desirable identify techniques and sites for improvement to include implementation.

   This action has not been fully met for either species. A project completed in 2006 by the Tennessee Stream Mitigation Program on the Clinch River stabilized an eroding riverbank at Kyles Ford and resulted in reduction of sediment on a downstream mussel shoal. Also, projects conducted under the Service's Partners for Fish and Wildlife Program have excluded livestock from the river, restored riparian vegetation, and protected high-quality mussel habitat.

6. Develop and implement a program to monitor population levels and habitat conditions of presently established populations as well as introduced and expanding populations.

This action has not been met specifically for the birdwing pearlymussel or dromedary pearlymussel. Monitoring programs are being developed for other listed mussels that have been transplanted. Those programs will be applied to the birdwing pearlymussel and dromedary pearlymussel transplants below Wilson Dam, and will be applied to other sites where the species are transplanted.

7. Assess overall success of recovery program and recommend action (delist, continued protection, implement new measures, other studies, etc.)

This is an ongoing activity. Periodic status reviews are conducted for these species to determine if changes in status are appropriate.

Cracking pearlymussel

1.1. Continue to utilize existing legislation and regulations (Federal Endangered Species Act, Federal and State surface mining laws, water quality regulations, stream alteration regulations, etc.) to protect the species and its habitat.

This action has not been met. Although Federal and State laws and regulations are applied during review of projects, the cracking pearlymussel continues to decline. It is not known, however, if adequacy or enforcement of existing regulations is contributing to the decline.

1.2.1. Meet with appropriate Federal, State, and local government officials and regional and local planners to inform them of our plans to attempt recovery and request their support.

This is an ongoing activity. Meetings with various Federal, State, and local officials are held as needed and support for recovery efforts is requested.

1.2.2. Meet with local business, mining, logging, farming, and/or industry interests and elicit their support in implementing protective actions.

This is an ongoing activity. Meetings are held as needed with various interests and support for recovery efforts is requested.

1.2.3. Develop an educational program using such items as slide/tape shows, brochures, etc. Present this material to business groups, civic groups, youth groups, schools, church organizations, etc.

This is an ongoing activity. We conduct periodic outreach efforts involving various schools, groups, and organizations to inform them about the status of freshwater mussels and the importance of protecting species and their habitats.

1.3. Consider and, if determined necessary, use land acquisition as a means of protecting present and reintroduced populations.

This action has not been met. No land acquisition to protect the cracking pearlymussel has been considered to date.

2.1. Conduct life history research on the species to include such factors as reproduction, food habits, age and growth, and mortality rates.

This action is in progress but has not been completed.

2.2. Characterize the species' habitat requirements (relevant physical, biological, and chemical components) for all life history stages.

This action has not yet been initiated.

2.3. Determine present and foreseeable threats to the species.

Major threats to the species and its habitat include coal mining, oil and gas exploration, highway and bridge construction, municipal and industrial discharges, and residential, industrial, and commercial development. However, specific information concerning the nature and mechanisms of various threats is lacking.

2.4. Investigate the relationships with nonnative bivalves.

This action has not yet been initiated.

2.5. Based on the biological data and threat analysis, investigate the need for management, including habitat improvement.

Implement management, if needed, to secure viable populations.

This action has been partially met. Improvement and protection of habitat has been implemented in the Clinch River through projects sponsored by the Service's Partners for Fish and Wildlife Program and the Tennessee Stream Mitigation Program.

2.6. Determine number of individuals required to maintain a viable population.

This action has not been met. The species' recovery plan cites theoretical considerations presented in the literature that the minimum number of breeding individuals needed to establish a viable population is 500. The actual population size needed to provide 500 breeding individuals in a natural ecosystem, however, is expected to be much larger.

3. Search for additional populations and/or habitat suitable for reintroduction efforts.

This is an ongoing activity. Surveys for various purposes continue to be conducted within the species' range. Live or fresh-dead individuals have been found recently in the Clinch River and Elk River.

4.1. Determine the need, appropriateness, and feasibility of augmenting and expanding existing populations.

A final rule was recently published designating the Tennessee River below Wilson Dam as a site for establishment of nonessential experimental populations of freshwater mussels and fish (USFWS 2001). The cracking pearlymussel is one of the species included in that rule. However, no introductions of this species have been conducted below Wilson Dam to date.

4.2. Develop a successful technique for reestablishing and augmenting populations.

This action has not been met for the cracking pearlymussel. Efforts are ongoing to develop such techniques for other mussel species. These techniques may be applied to the cracking pearlymussel in the future.

4.3. Coordinate with appropriate Federal and State agency personnel, local governments, and interested parties to identify streams suitable for augmentation and reintroduction and those most easily protected from further threats.

This action has not been fully met. Service biologists coordinated with appropriate Federal and State agencies, local government, and interested parties during development of the designation of non-essential experimental populations in the Tennessee River below Wilson Dam (USFWS 2001).

4.4. Reintroduce the species into its historic range and evaluate success.

This action has not been met for this species. To date, no individuals of this species were included in the initial reintroduction below Wilson Dam.

4.5. Implement the same protective measures for introduced populations that were outlined for established populations.

This action has not been met. Designation of a reintroduced population as a non-essential experimental population does not carry the same protection under the Endangered Species Act as that for natural populations.

5. Develop and implement cryogenic techniques to preserve the species' genetic material until such time as conditions are suitable for reintroduction.

This action has not been met. Attempts were made in the mid-1980s at cryogenic preservation of mussel gametes and larvae; however, successful preservation was not achieved. Preservation of freshwater mussels had not been attempted prior to that time, and techniques had therefore not been developed.

6. Develop and implement a program to monitor population levels and habitat conditions of presently established populations as well as newly discovered, introduced, or expanding populations.

This action has not been met for this species. Monitoring programs have been developed and implemented for other mussel species, including some listed species. These programs will be applied to the cracking pearlymussel in the future.

7. Annually assess overall success of the recovery program and recommend action (modify recovery objectives, delist, continue to protect, implement new measures, or other studies, etc.).

   This is an ongoing activity. Population trends, status, and threats are reviewed annually through the Service's Recovery Data Call. Periodic status reviews are conducted to determine if changes in status are warranted.

C. Updated Information and Current Species Status

1. Biology and habitat

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

The cracking pearlymussel is still found in the Clinch River and Elk River, but these populations are declining as a result of coal fines (Nicholson 2006, pers. comm.). Cracking pearlymussel populations in the Elk River and mainstem of the Tennessee River are also declining. The species is thought to be extirpated or is thought to occur in numbers too low to maintain viability from other streams within its historic range (e.g., French Broad River, Powell River, Cumberland River, Big South Fork, Ohio River, Wabash River).

The dromedary pearlymussel is still known to reproduce in the Clinch River and Powell River (Nicholson 2006, pers. comm.). The population in the Cumberland River persists, but is no longer reproducing.
The birdwing pearlymussel population in the Duck River appears to be stable, while the populations in the Powell and Clinch River are declining (Nicholson 2006, pers. comm.). The status of historic birdwing pearlymussel populations in the Holston River and Elk River is unknown.

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

No information is available concerning the genetics or genetic trends of any of the three species.

c. Taxonomic classification or changes in nomenclature:

There have been no changes in taxonomic classification or nomenclature for any of the three species.

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

There is no new information concerning the spatial distribution or changes in distribution for any of the three species.

e. Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

No new information is available concerning the habitat or ecosystem for any of the three species.

f. Other:

There is no other new information available relevant to any of the three species.

2. Five factor analysis (threats, conservation measures, and regulatory mechanisms)

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

Over the past five years, biologists working in the Clinch River upstream from Norris Lake in Tennessee have reported the presence of increasing amounts of coal fines in the river. There have been no obvious adverse effects to the mussels in the Tennessee reach of the river to date, but malacologists report declines in overall mussel numbers, including the birdwing, dromedary, and cracking pearlymussels, in the Virginia reach. Impacts from

increased mining activity in the upper Clinch River drainage could eventually have adverse effects on the best known populations of the dromedary pearlymussel and cracking pearlymussel. The population of the birdwing pearlymussel in the Clinch River will also be affected. The final listing rule for the birdwing pearlymussel and dromedary pearlymussel attributes endangerment of the species to Factors A, B, and/or D. The final listing rule for the cracking pearlymussel indicates that Factor A is a major factor in the endangered status of the species.

b. Over-utilization for commercial, recreational, scientific, or educational purposes:

No new information is available. The final listing rule for the birdwing pearlymussel and dromedary pearlymussel attributes endangerment of the species to Factors A, B, and/or D. The final listing rule for the cracking pearlymussel speculates that because of its rarity, the species could be susceptible to take by collectors. However, there have been no observations or anecdotal evidence of collection of this species.

c. Disease or predation:

No new information is available. The final listing rule for the birdwing pearlymussel and dromedary pearlymussel does not indicate that this is a factor in the status of the species. The final listing rule for the cracking pearlymussel indicates that there is no evidence that disease or predation threatens the survival of the species.

d. Inadequacy of existing regulatory mechanisms:

No new information is available. The final listing rule for the birdwing pearlymussel and dromedary pearlymussel attributes endangerment of the species to Factors A, B, and/or D. The final listing rule for the cracking pearlymussel indicates that listing the species would afford it additional protection from take under section 7 and section 10 of the Endangered Species Act.

These three species and their habitats are afforded limited protection from water quality degradation under the Clean Water Act of 1977 (33 U.S.C. 1251 et seq.) and the Tennessee Water Quality Control Act of 1977. These laws

focus on point-source discharges, and many water quality problems are the result of non-point source discharges. Therefore, these laws and corresponding regulations have been inadequate to halt population declines and degradation of habitat for these mussels.

All three pearlymussels are listed as endangered in the States of Virginia and Tennessee and are protected from take, sale, or transportation under State laws. Under the Code of Virginia § 29.1-564, "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."

Under the Tennessee Nongame and Endangered or Threatened Wildlife Species Conservation Act of 1974 (Tennessee Code Annotated §§ 70-8-101-112), "[I]t 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." Under these regulations, potential collectors of listed species are required to have a State collection permit. However, in terms of project management, this regulation only provides for the consideration of alternatives, and does not require the level of project review afforded by the Endangered Species Act. Therefore, Factor D continues to be a threat to all three pearlymussels.

e. Other natural or manmade factors affecting the species' continued existence:

No new information is available. The final listing rule for the birdwing pearlymussel and dromedary pearlymussel does not indicate that this is a major factor contributing to the species' endangered status.

The final listing rule for the cracking pearlymussel indicates that the known populations are small and genetically isolated. Population numbers in the Elk River, Powell River, Tennessee River, and Green River are likely below those needed to maintain long-term viability. Long-term climatic changes may result in impacts to the status of the cracking pearlymussel; however, no significant impacts are anticipated for this species in the foreseeable future.

Beginning in 1993, operational changes made at Normandy Dam by the TVA as part of its Reservoir Release Improvement Program have had beneficial effects on the aquatic fauna of the Duck River, including the birdwing pearlymussel. Population numbers of native fish and mussels have stabilized as a result of increased dissolved oxygen and higher water temperature of the release from Normandy Dam. The birdwing pearlymussel has not been collected from the Elk River since 1980 or from the Holston River since the early 1900s, however. Populations currently persist in the Powell River and the Clinch River, but they are declining.

Coldwater releases and peaking hydropower operation at Tims Ford Dam continue to affect the mussel populations in the Elk River. The cracking pearlymussel was collected in the Elk River in 1997 however, and there is evidence of recent recruitment of the species in the Elk River. The species has not been collected from the Buffalo River since the mid-1960s or from the Duck River since the early 1920s.

Coldwater releases from Wolf Creek Dam (Cumberland River, Kentucky), Dale Hollow Dam (Obey River, Tennessee), and Center Hill Dam (Caney Fork River, Tennessee) have adversely affected the mussel populations in the middle reach of the Cumberland River. Although the dromedary pearlymussel persists in that reach, low water temperatures have precluded reproduction. The species has

not been collected from the mainstem Tennessee River since the mid-1960s or from the Holston River since the early 1900s. It has not been collected in the Elk River since the mid-1920s.

D. **Synthesis** – The birdwing pearlymussel population in the Duck River appears to be stable at this time. The populations in the Powell River and Clinch River, however, are likely declining as a result of coal mining, agricultural operations, and development in those watersheds. The species has likely been eliminated from the Elk River and the Holston River.

The only known reproducing populations of the dromedary pearlymussel occur in the Powell River and Clinch River. Development, reservoir operations, and pollution have contributed to the decline of the species in the mainstem Tennessee River. Coldwater releases from three dams have resulted in cessation of reproduction of the population in the Cumberland River.

The cracking pearlymussel populations in the Powell River and Clinch River are likely declining due to sedimentation (i.e., coal fines). The population in the mainstem Tennessee River is declining due to development, reservoir operations, and pollution. Although the population in the Elk River is apparently reproducing, it is being affected by agricultural operations and reservoir operations.

In order to achieve the recovery criteria for these species, it will be necessary to successfully propagate juveniles and raise those juveniles to a size at which they can be introduced into historic habitat with the maximum potential for survival. It will also be necessary to remove threats to the species and their habitats so viable populations can be established and maintained.

To date, some progress has been made in achieving the recovery criteria. Birdwing pearlymussels and dromedary pearlymussels have been successfully propagated. Juveniles have been placed in some areas, but long-term monitoring will be needed to determine if these introductions will succeed and if viable populations will be established. Threats to the species remain and elimination of those threats will require long-term efforts. Coal mining impacts are still prevalent in the Powell River and are increasing in the Clinch River. Also, streams needed for establishment of new populations within the species' historic ranges are limited due to impacts from development activities, highway and bridge construction,

discharges from municipal and industrial sources, mining, and agricultural activities.

III. RESULTS

A. Recommended Classification:

_____ Yes, downlist to Threatened
_____ Yes, uplist to Endangered
_____ Yes, delist
_____X_____ No, no change is needed

B. New Recovery Priority Number:

N/A

C. If applicable, indicate the Listing and Reclassification Priority Number (FWS only):

Reclassification (from Threatened to Endangered) Priority Number:
N/A
Reclassification (from Endangered to Threatened) Priority Number:
N/A
Delisting (Removal from list regardless of current classification) Priority Number:
N/A

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

- Develop propagation technology for the cracking pearlymussel and birdwing pearlymussel. Continue propagation of the dromedary pearlymussel for augmentation of extant populations and reestablishment of new populations.

- Augment existing populations to ensure viability.

- Reestablish populations into suitable habitat in other streams within the species' historic ranges.

- Work with other Federal agencies, State agencies, individuals, and other partners to restore, maintain, and protect suitable habitat in the rivers containing extant and reestablished populations of these species.

- Continue to explore the feasibility of cryogenic preservation of gametes and/or larvae of the birdwing pearlymussel, dromedary pearlymussel, and cracking pearlymussel. Advances in cryopreservation technology since previous efforts with mussels may now make this technique of protecting genetic material feasible.

V. REFERENCES

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW OF
BIRDWING PEARLYMUSSEL
DROMEDARY PEARLYMUSSEL
CRACKING PEARLYMUSSEL

Current Classification Endangered (all 3 species)

Recommendation resulting from the 5-Year Review

_____ **Downlist to Threatened**
_____ **Uplist to Endangered**
_____ **Delist**
__X__ **No change is needed**

Appropriate Listing/Reclassification Priority Number _____N/A_____

Review Conducted By _____Jim Widlak_____

FIELD OFFICE APPROVAL

Lead Field Supervisor, Fish and Wildlife Service

Approve _____ Date 6/13/11

REGIONAL OFFICE APPROVAL

Lead Regional Director, Fish and Wildlife Service

Approve _____ Date 7/26/11

Cooperating Regional Director, Fish and Wildlife Service

__X__ Concur _____ Do Not Concur

Signature _____ Date 8/19/11

Acting Regional Director