

RICHARD J. NEYRS

Ahlstedt  
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**DRAFT PLAN**  
**AUGMENTATION AND REINTRODUCTION**  
**OF FRESHWATER MUSSEL POPULATIONS**  
**IN THE DUCK RIVER, TENNESSEE**

by

**Steven Ahlstedt**  
**U. S. Geological Survey**  
**1820 Midpark Drive, Suite A**  
**Knoxville, TN 37921**

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## I. INTRODUCTION

This document presents a proposal to restore all freshwater mussels that occurred historically in the Duck River. The ultimate goals for recovery are to 1) maintain existing populations and 2) restore viable populations to former historic range and 3) recover endangered species so they may be delisted. Specifically, the following actions are proposed (see Table 1): 1) augment existing populations of three federally listed mussels (*Epioblasma sp. cf. capsaeformis*, *Lemiox rimosus*, and *Quadrula intermedia*), 2) augment existing populations of non-listed mussels, 3) reintroduce via culture and propagation or movement of adults 11 extirpated listed species. The proposed actions for the federally listed mussels are: (1) consistent with the purposes of the 1973 Endangered Species Act, (2) identified as tasks in the US Fish and Wildlife Service's approved recovery plans for these species. It is unlikely that these federally listed species can be reclassified from endangered to threatened or recovered and removed from the Act's protection without augmenting and expanding existing populations and reestablishing populations back into historical habitats like the Duck River. Similar efforts for these and other federally listed, candidate, and non-listed mussels are ongoing in other southeastern river systems including the Clinch, Powell, French Broad, Pigeon, Nolichucky, Holston, North Fork Holston, Estill Fork of the Paint Rock, and Big South Fork Cumberland River.

## II. BACKGROUND

The Duck River, is located in south-central Tennessee, and is one of the largest tributaries to the Tennessee River located entirely within the state (Figure 1). The river was named for the large number of ducks found on the stream during early exploration in central Tennessee and is formed at three springs near Hoodoo in Coffee County (Garrett 1991). The Duck flows in a westerly direction for approximately 468 km where it joins the Tennessee River in Humphreys County. The river drains as estimated 8,100 km<sup>2</sup> of the southern portion of the Eastern Highland Rim, the Nashville Basin, and the southern portion of the Western Highland Rim (Theis 1936, Schilling and Williams 2002).

The freshwater mussel fauna in the southeastern United States is globally significant. Of the 297 mussel species known from the US, over 90 percent occur in the Southeast. Approximately 34-71 percent of all mussels are imperiled, defined here to include species endangered, threatened, or of special concern (Neves et al. 1997). The freshwater mussel fauna that exists today in streams like the Duck River is but a small fraction of a fragmented and disjunct fauna that nationwide has managed to survive extensive human perturbations. From a nationwide perspective, the Duck River may be considered as having one of the most biologically diverse faunas with 146 species of fish, 53 mussel species, and 22 snail species. Some of the 53 mussel species are reported as single live individuals but based upon museum records and published surveys, as many as 74 species may have occurred in the Duck. Many of the freshwater mussels found here are Although the decline is considerable, recent mussel surveys have documented recent reproduction, recruitment, and range extentions for most of the extant fauna (Ahlstedt et

al. 2004). The fish fauna is considered relatively intact and in very good condition (E. Scott and C. Saylor, Tennessee Valley Authority, pers. comm.). For the purposes of restoring mussels in the Duck River, mussel recovery efforts will occur throughout the free-flowing reaches of the river downstream from TVA's Normandy Dam (Duck River Mile 248.6), Coffee County.

On October 27, 2004, a meeting was held in Columbia to address restoring mussel biodiversity and reintroduction of extirpated federally listed species back into the Duck River. Representatives from the following state and federal governmental and non-governmental conservation groups were present: Tennessee Wildlife Resources Agency (Richard Kirk, Donald Hubbs); Minnesota Department of Natural Resources (Mike Davis); US Fish and Wildlife Service (Region 3, Susan Rogers, Gary Wege; Region 4, Timothy Merritt, Geoff Call, Robert Butler); US Geological Survey (Steven Ahlstedt); Tennessee Valley Authority (Stephanie Chance); The Nature Conservancy (Leslie Colley); Tennessee Aquarium Research Institute (Dr. Paul Johnson); Richard Biggins (US Fish and Wildlife Service, retired); Larry Murdock (Duck River Development Agency). All individuals present supported initiating mussel recovery efforts in the Duck River.

### **III. PROJECT OBJECTIVE**

**Restore freshwater mussel biodiversity and their ecological functions to the Duck River and further the recovery of federally endangered mussels through augmenting of existing populations and reintroducing confirmed extirpated populations.**

Augmenting and reintroducing confirmed extirpated populations in the Duck River would: (1) increase the likelihood of recruitment in currently occupied habitat, (2) increase the expansion rate of species into suitable, unoccupied historical habitat, (3) increase the chance of the species' continued existence in currently occupied river reaches, (4) reestablish historical populations, (5) assist in creating viable populations, which could lead to recovery (delisting) of some currently listed species, and (6) stabilize declining non-listed species, potentially eliminating the need for federal listing.

#### **IV. METHOD**

##### **A. Maintain current mussel conservation efforts with the Duck**

This is currently being accomplished through TVA's Reservoir Release Improvement Program that has increased minimum flows and oxygen aeration of water released from Normandy Dam. Improvements have been made in the de-chlorination process at Shelbyville Waste Water Treatment Plant along with industrial discharges. The Nature Conservancy also has ongoing projects to protect water quality and restore the riparian corridor along the river and tributary streams (Big Rock Creek).

**B. Augment existing federally listed and non-listed mussel populations with juveniles propagated from stock collected from the Duck River**

Population augmentations would be conducted as follows: (1) gravid females would be collected from the Duck and brought to propagation facilities (e. g., Tennessee Cooperative Fish and Wildlife Research Unit, Cookeville, Tennessee; Virginia Cooperative Fish and Wildlife Research Unit, Blacksburg, Virginia; Tennessee Aquarium Research Institute, Cohutta, Georgia, (2) juveniles would be produced, (3) the adult females along with propagated juveniles would be returned to the Duck.

**C. Reintroduce federally listed and non-listed species (see Table 1) that historically inhabited the Duck River using adults and propagated juveniles from populations outside the Duck**

Reintroductions would be conducted using adults and propagated juveniles. The juvenile propagation and reintroduction procedures would be similar to the augmentation procedures outlined under Number 2, above. However, as the species to be reintroduced no longer occurs in the Duck River, the parental stock would come from outside the Duck. Adults for reintroduction would also be collected from outside the Duck. **No federally listed mussels will be reintroduced into habitat that currently has no listed species.**

#### **D. Monitor the progress of the project**

The partners will assist in monitoring (based on availability of funds) the project to determine if: (1) project has a reasonable chance of success, (2) methods need to be revised, (3) additional research is needed, (4) project objectives are reasonable, (5) project should continue.

#### **V. MUSSEL POPULATIONS TO BE AUGMENTED OR REINTRODUCED**

[**Augment**-culture, propagation, and/or movement of adults]

[**Reintroduce**-culture, propagation, and/or movement of adults]

[**No action**-species very common]

*Actinonaias ligamentina* (augment)

*Actinonaias pectorosa* (augment)

*Alasmidonta marginata* (augment)

*Alasmidonta viridis* (reintroduce, source Little Tennessee and Mills River, NC)

*Amblema plicata* (augment)

*Anodonta suborbiculata* (no action)

*Arcidens confragosus* (augment)

*Cumberlandian monodonta* (reintroduce, source Clinch River, TN)

*Cyclonaias tuberculata* (augment)

*Cyprogenia stegaria* E (reintroduce, source Clinch River, TN)

*Ellipsaria lineolata* (augment)

*Elliptio crassidens* (augment, reintroduce, source Tennessee River)

*Elliption dilatata* (augment)

*Epioblasma brevidens* E (reintroduce, source Clinch River, TN)

*Epioblasma sp. cf. capsaeformis* E (augment)

*Epioblasma florentina walkeri* E (reintroduce, source Indian Creek, VA)

*Epioblasma lenior* (extinct)

*Epioblasma phillipsii* (extinct)

*Epioblasma torulosa torulosa* E (extinct)

*Epioblasma triquetra* (augment, source Clinch River, TN)

*Epioblasma turgidula* E (extinct)

*Fusconaia barnesiana* (augment)

*Fusconaia ebena* (no action)

*Fusconaia flava* (augment)

*Hemistena lata* E (reintroduce, source Clinch River, TN)

*Lampsilis cardium* (augment)

*Lampsilis fasciola* (augment)

*Lampsilis ovata* (augment)

*Lampsilis teres* (augment)

*Lasmigona complanata* (augment)

*Lasmigona costata* (augment)

*Lasmigona sp. cf. holstonia* (reintroduce, Pocahontas Creek, Collins River, TN)

*Lemios rimosus* E (augment)

*Leptodea fragilis* (augment)

*Leptodea leptodon* E (reintroduce, source Meramec River, AK)



*Lexingtonia dolabelloides* (augment)

*Ligumia recta* (augment)

*Ligumia subrostrata* (reintroduce, source Hatchie River, TN)

*Medionidus conradicus* (augment)

*Megalonaias nervosa* (augment)

*Obliquaria reflexa* (augment)

*Obovaria retusa* E (extremely rare, no action)

*Obovaria subrotunda* (augment)

*Pegias fabula* E (reintroduce, source Big South Fork Cumberland River, TN)

*Plethobasus cooperianus* E (reintroduce, source Tennessee River)

*Plethobasus cyphus* (reintroduce, source Clinch River, TN)

*Pleurobema clava* E (reintroduce, source Alleghany River, PA)

*Pleurobema cordatum* (augment)

*Pleurobema oviforme* (augment)

*Pleurobema rubrum* (augment)

*Pleurobema sintoxia* (augment)

*Potamilus alatus* (augment)

*Potamilus ohiensis* (no action)

*Ptychobranhus fasciolaris* (augment)

*Ptychobranhus subtentum* (reintroduce, source Clinch River, TN)

*Pyganodon grandis* (no action)

*Quadrula c. cylindrica* (augment)

*Quadrula apiculata* (no action)

*Quadrula fragosa* E (reintroduce, source St. Croix River, MN)

*Quadrula intermedia* E (augment)

*Quadrula metanevra* (augment)

*Quadrula pustulosa* (augment)

*Quadrula quadrula* (augment)

*Strophitus undulatus* (augment)

*Toxolasma cylindrellus* E (reintroduce, source Estill Fork Paint Rock River, AL)

*Toxolasma lividus* (augment)

*Tritogonia verrucosa* (augment)

*Truncilla donaciformis* (augment)

*Truncilla truncata* (augment)

*Utterbackia imbecillis* (no action)

*Villosa fabalis* (reintroduce, source Alleghany River, PA)

*Villosa iris* (augment)

*Villosa taeniata* (augment)

*Villosa vanuxemensis* (augment)

## **VI. PROTECTING THE GENETIC INTEGRITY OF THE DUCK RIVER**

### **MUSSEL FAUNA**

The following procedures will be followed to protect the genetic integrity of the Duck River mussel fauna during recovery efforts:

**A. Population Augmentation –adding individuals to existing populations in the Duck River:**

- Juvenile mussels will be propagated using brood stock from the Duck River. To reduce homozygosity, at least 10 gravid females, whenever possible will be used over the life of the reintroduction project. With some very rare species, this number may not be attainable.

**B. Reintroduction—returning juveniles or adults to historical habitat in the Duck River:**

- Juveniles and adults for reintroduction that come from outside the Duck River. To match as close as possible the genetics of the species that once existed in the Duck, the adults and brood stock for the reintroductions will be collected using the following criteria (in order of decreasing importance):
  - 1) Collect donor animals from populations in adjacent stream/tributary system in the same physiographic province.
  - 2) Collect donor animals from populations in adjacent stream/tributary system in an adjacent physiographic province.
  - 3) Collect donor animals from the only source population with sufficient adults to produce progeny.

### **C. Other genetic considerations:**

- Priority should be given to critically imperiled endemic taxa versus, wide-ranging taxa when considering a propagation, augmentation, and reintroduction program.
- Donor populations should not be chosen strictly on the basis of ease in obtaining brood stock.
- Increasing genetic heterozygosity of propagated individuals to fullest extent possible should be a significant consideration.

## **VII. PROTECTING THE DUCK RIVER AGAINST THE INVASION OF ZEBRA MUSSELS**

To ensure that zebra mussels are not accidentally introduced into the Duck River during this recovery effort, the following precautions will be taken when adult mussels are collected from zebra mussel infested areas (Gatenby et al. 1998):

- Scrub native mussels with a plastic brush or scour-pad at the site of capture to remove all zebra mussels.
- Hold scrubbed native mussels in quarantine for a minimum of 30 days.
- Inspect native mussels for zebra mussels again after 30 days. If any are found, native mussels will be scrubbed again and quarantined for another 30 days.

- Only when native mussels are determined to be free of zebra mussels will they be released into the Duck River.

## **VIII. HISTORICALLY RICH MUSSEL FAUNA OF THE DUCK RIVER**

Based on published surveys and museum records, the 74 species listed in this restoration plan are reported historically from the Duck River (Ahlstedt et al. 2004). Of these, four species (*Epioblasma phillipsii*, *Lampsilis abrupta*, *Obovaria retusa*, and *Plethobasus cooperianus*) are questionable because no records exist for their occurrence in the Duck. However, all had access to the rich mussel beds of the Tennessee River and therefore are included as being part of the Duck River mussel fauna. All 74 species with the exception of those considered extinct are candidates for restoration in the river.

## **IX. LITERATURE CITED**

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A substitution from Clinch R. to Duck R. Hubbs 2004