PLAN FOR THE POPULATION RESTORATION AND CONSERVATION OF IMPERILED FRESHWATER MOLLUSKS OF THE CUMBERLANDIAN REGION

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*The Cumberlandian Region Mollusk Restoration Committee represents biologists from state, federal, and non-governmental natural resource organizations. The committee, which grew out of a core group of individuals that attended the annual Tennessee Wildlife Resource Agency Rare Mollusk Recovery meeting, worked several years on drafting this Plan.

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INTRODUCTION

The Tennessee and Cumberland River systems, draining portions of seven states (Alabama, Georgia, Kentucky, Mississippi, North Carolina, Tennessee and Virginia), compose the Cumberlandian Region (Region) (Ortmann 1924). Historically, the Region supported the richest freshwater mussel (Bivalvia: Unionacea) fauna in the world (Johnson 1980). At least 107 mussel taxa in the families Unionidae and Margaritiferidae are known from the Region (Parmalee & Bogan 1998). Greater than one-third of this fauna is endemic to the Region.

Unfortunately, the Region also has by far the highest number of imperiled mussels of any major region in the country (NatureServe 1998). Fourteen species known from the region, including several endemics, are now considered to be extinct (Neves 1993). Currently, a significant proportion of the Regional fauna is composed of mussel species that are federally protected under the Endangered Species Act (ESA) (26, including two formally undescribed listed taxa), are candidate species for federal protection (4), or are otherwise considered imperiled globally (14) by Williams et al. (1993) (three additional taxa with extant Regional populations but not generally recognized by authorities are also deemed imperiled). Numbers of imperiled mussel species continue to increase as divergent forms are recognized and other taxa continue to decline. Our state of knowledge regarding the conservation status of snails is much less clear but appears to be similarly worrisome. Dozens of major impoundments, altered thermal, hydrologic and chemical regimes downstream from dams, episodic and chronic chemical spills, channelization, mining activities and sedimentation have contributed to the demise of this extraordinary fauna (Neves 1993, Williams et al. 1993).

Extant populations have become highly fragmented and isolated in stream reaches that are vulnerable to natural and anthropogenic stochastic events (e.g. droughts, disease, toxic spills); however, habitat conditions have improved in some stream reaches where many of these species occurred historically. In recent years, technology and techniques to propagate certain rare mussel species have been developed and/or refined. Opportunities to augment extant

populations and to reintroduce populations in historical habitats are now available to resource managers. This document outlines some of the opportunities that are available for these recovery activities in the states of Alabama, Kentucky, Mississippi, North Carolina, Tennessee and Virginia portions of the Region. Georgia is omitted from the Plan since it has a miniscule portion of the Tennessee River system that is considered of very low population restoration potential. For the purpose of this Plan, the Region herein includes the entire portions of the lower Tennessee and Cumberland Rivers, contrary to the definition of the Region by Ortmann (1924) which omits the two lower main stems.

A total of 57 mussel and 25 snail taxa are addressed in the Plan. This number includes 35 federally listed (31 mussels and 4 snails), 5 candidate mussels, and 42 other species (21 mussels and 21 snails) deemed imperiled within the Region. The total comprises all of the extant mussel species endemic to the Region but omits some widespread species that may be regionally imperiled but appear secure in other portions of their respective ranges.

The FWS has recently implemented Strategic Habitat Conservation (SHC) to effectively manage federal trust resources and their habitats at the landscape scale. The five elements of conservation biology that collectively comprise SHC include biological planning, conservation design, conservation delivery, assumption-based research and outcome-based monitoring. Although the Plan addresses issues under each of the facets of SHC, a companion document is being prepared by partners to specifically apply imperiled mollusk population restoration in the Region within the components of SHC.

GOALS AND OBJECTIVES

The goal of this Plan is to provide a framework for the restoration of freshwater mollusk resources and their ecological functions to appropriate reaches of the Cumberlandian Region through the reintroduction, augmentation (R/A) and controlled propagation of priority mollusks. The Plan prioritizes propagation and R/A activities for Region mollusks and provides guidelines for resource managers and recovery partners. The Plan is not a legal document and is not intended to replace or supersede published recovery plans for listed mollusks.

The objectives of this Plan are to:

1) Comply with the FWS controlled propagation policy for federally listed species (FWS & NMFS 2000)
2) Establish basic protocols for propagating imperiled mollusks
3) Ensure communication and coordination among partners prior to R/A actions
4) Prioritize mollusk species for R/A actions
5) Recommend priority R/A and related conservation actions for these species
6) Identify and prioritize stream reaches where potential exists for successful restoration actions
7) Identify existing federal and state requirements for permitting R/A actions
8) Consider and identify alternative R/A activities involving federally listed mollusks (i.e. *alternative analysis*, FWS & NMFS 2000)

Specific activities that are <u>not</u> covered under this plan:

1) The document is not intended to be a formal recovery plan and does not carry legal status. Periodic updates to the plan will be required as species and habitat status in the Region change (approximately every 5 years)
2) The plan is not intended to provide technical guidance for propagation and R/A activities
3) The plan cannot answer all specific management needs for each species. Management guidelines will develop as propagation, R/A activities and basic research progress. Specific management objectives for each R/A locality will begin to be addressed in the site plan.

JUSTIFICATION FOR CONTROLLED PROPAGATION, REINTRODUCTION AND AUGMENTATION OF FRESHWATER MOLLUSKS

Recovery plans summarize threats to the aquatic species of the Cumberlandian Region and outline recovery tasks necessary to protect and recover them. The major obstacle to recovery of mollusks and other aquatic species in the Region is the fragmentation of riverine habitats by dams and impounded waters. Most imperiled mollusks now occupy a few localized stream reaches and are sometimes restricted to a single site. Some isolated stream reaches where mollusks were extirpated due to historical pollution events or other causes have improved to a degree that mollusks may now persist. However, dams or extensive areas of impounded waters

prevent re-colonization and gene-flow through the processes of immigration and emigration. In addition, some species have become exceedingly rare, with low reproductive and recruitment success. Such species often require extensive efforts to locate in the wild for recovery efforts. Isolated mollusk populations are also threatened by inbreeding depression and stochastic events. Other complications include the lack of knowledge concerning the life history requirements of freshwater mollusks, particularly mussel host fishes. Because of these conditions human intervention is required to manage and restore populations of federally protected and other imperiled species, including:

1) Develop technology and culture facilities for holding endangered and threatened mollusks
2) Produce individuals through captive propagation for research and technology development
3) Produce individuals for reintroduction of species into restored or recovered habitats
4) Maintain captive populations of critically endangered mollusks
5) Produce individuals for augmenting existing populations
6) Translocation of adults for R/A

Since the mid-1990's, the FWS has been working with state and private partners to locate populations of imperiled mollusks in the Region and develop appropriate protocols and facilities for holding and propagation. As a result, progeny of several federally protected and other imperiled mollusks are being produced in culture facilities in sufficient quantities to initiate limited, controlled releases of propagated species into improved riverine habitats.

PARTNERS

State and federal agencies and private conservation partners have been cooperating in developing holding and propagation technology for several imperiled species (a list of mollusk conservation partners can be found in Appendix I). Mollusks are currently held and propagated for research and recovery efforts at facilities in accordance with various recovery plan objectives and FWS controlled propagation policy for federally protected species (FWS & NMFS 2000). In addition to existing FWS policy, some states may also have additional requirements to working with imperiled mollusks. Participation by state natural resource agencies in the restoration of federally listed species in state waters is granted under current Section 6 agreements with the FWS. A summary of these state requirements are listed in Appendix VI.

DEFINITIONS

Alternatives Analysis – A consideration of recovery options (e.g., direct translocation, controlled propagation, do-nothing, habitat restoration) prior to initiating R/A actions.

Ark Population – A temporary or permanent population of a species established for the purpose of preserving genetic stock. Such a population could be captive or maintained in the wild.

Augmentation – Addition of individuals to an existing population. Augmentation potentially increases the likelihood of population success for reproduction, host infection (mussels) and ultimately successful recruitment within sparsely occupied habitat. It may be used to expand the range of a species within habitats accessible to existing populations, reducing the likelihood of extirpation due to localized catastrophic events.

Brood stock – Adult mollusks from which juveniles are propagated.

Controlled propagation – The production of individuals within a managed environment. Propagated individuals can be used for research purposes or for *reintroduction* or *augmentation* to support recovery efforts.

Recruitment – Incorporation of juveniles into a population as a result of successful reproduction.

Reintroduction – The release of mollusks into a historically-occupied stream reach where the species no longer occurs, and where natural immigration from extant populations is unlikely to occur. Reintroductions may be accomplished by translocation of adults from extant populations or through the release of hatchery-propagated individuals. Reintroductions should be supplemented for multiple years to determine if conditions are appropriate for survival, reproduction and recruitment. A reintroduction will be considered successful only if natural recruitment occurs. As defined herein, a reintroduction may also include the introduction of adults or progeny into a stream for which there is no prior record of the species' occurrence as long as the stream is located within its historical range.

Source population – Origin from which translocated mollusks or brood stock originate.

Species complex – A morphologically, ecologically, and/or biologically variable “species” that putatively consists of more than one species.

Translocation – Moving individuals from one site to another.

PROTOCOLS OF CONTROLLED PROPAGATION

Any parties wishing to conduct controlled propagation of imperiled mollusks must should abide by the following basic protocols:

1) Present a detailed plan to the FWS and/or the appropriate state agency(ies) outlining their expertise, facilities and methodology, species to be propagated, brood stock source, disposition of progeny, etc. Such a plan is mandatory for federally protected species.
2) Provide justification for the work, including benefits
3) Obtain all necessary state and federal permits
4) Take all necessary precautions to prohibit the potential introduction or spread of diseases and parasites into controlled environments or suitable habitat
5) Conduct all activities in a manner that will prevent the escape or accidental introduction of individuals outside of their historical range
6) Preserve propagated individuals for genetic analyses
7) Keep detailed notes and records of life history observations, fecundity, survival and mortality, water chemistry, seasonality and any other conditions/observations important to successful propagation of these species

POPULATION REINTRODUCTION OR AUGMENTATION

R/A is accomplished through the release of cultured progeny from the closest genetic stock or through the translocation of adults (see *brood stock* and *source population* selection criteria below). Such activities have not been conducted for many of these species, and are considered individual experiments.

Reintroduction is intended to reestablish populations, provide genetic refugia, and reduce the potential of extinction due to catastrophic events. The potential for genetic swamping is also

less of an issue in reintroductions.

Augmentation may be appropriate when necessary to maintain a population at a given location. Augmentation carries some risk of disease introduction (an unknown but apparently low risk with mollusks, Grizzle & Brunner 2007) and/or possible genetic swamping (Appendix IV).

The ability to propagate any species will always be resource limited (e.g., time, money, brood stock availability, space). Reintroduction will be the preferred recovery option for most species because:

1) Augmentation does not increase the number of populations and therefore is less likely to move a federally protected species towards downlisting or delisting
2) Augmentation will not address recruitment failure if driven by habitat loss
3) Reintroduction carries little apparent risk to existing populations
4) Success is easier to document for reintroductions than with augmentations

Species Prioritization

Species have been prioritized for R/A according to degree of imperilment, distribution and magnitude and imminence of threats (Appendix II). These prioritizations are subjective based on current understanding of the above factors. Categories are defined as:

Tier 1: Taxa facing imminent extinction or extirpation from the Region. These generally include 1) critically imperiled federally listed species endemic to the Region and 2) taxa reduced to a few (~5 or fewer) populations globally.

Tier 2: Taxa threatened with extinction or extirpation from the Region. These generally include 1) a mix of imperiled species that are federally listed, endemic to the Region, and/or reduced to a relatively few (~20 or fewer) populations globally, 2) species complexes that have at least one form deserving of Tier 1 or 2 status and 3) species that may be jeopardized by significant habitat degradation.

Tier 3: Taxa that have experienced a significant decline in range and abundance or are extirpated from the Region. These generally include 1) several of the more stable species

endemic to the Region, 2) wide ranging species that are peripheral in the Region and 3) species declining due to habitat degradation.

Species accounts

Appendix II contains individual species accounts for each tier of imperiled species prioritized herein. These accounts include information specific to propagation and translocation options. An explanation of information fields within each species account is included.

Population R/A opportunities

Currently, there are a limited number of streams in the Region that are apparently suitable for population R/A efforts. The best options are prioritized in the Species Accounts section (Appendix II). These priority streams were selected with various goals and criteria established in the individual species accounts. Additional streams may become physically capable of supporting imperiled populations in the future. Mollusk populations in some stream reaches may require augmentation to reach critical levels required for reproduction and recruitment.

Permits

The ESA requires individuals to acquire Section 10 Recovery Permits in order to collect, propagate or conduct research, including R/A activities on federally protected species. Other federal agencies may also require Special Use permits prior to collecting on their lands and consultation with these agencies (i.e., USFS, NPS) when conducting R/A activities with federally listed species. State permits are also required to collect any native species or conduct R/A activities. Permit requirements and contacts for various states in the Region are provided in Appendix VIII.

The ESA requires individuals to acquire Section 10 Recovery Permits in order to collect, propagate or conduct research, including R/A activities on federally protected species. Other federal agencies may also require Special Use permits prior to collecting on their lands or when conducting R/A activities. State permits are also required to collect any native species or conduct R/A activities. Permit requirements and contacts for various Basin states are provided in Appendix VI.

Site R/A plan

Partners wishing to plan, sponsor, or conduct specific R/A actions with federally protected species will produce a R/A plan (site plan) prior to conducting any activities. Site plans for potential R/A activities will be developed and distributed to the appropriate FWS and state offices at least 20 days prior to release. It is understood that collection of gravid females, successful production of progeny, number of progeny produced, etc. is difficult to predict. Site plans should include as much information as possible, including:

1) Species priority
2) The location where animals are to be introduced
3) Status of the target species at the site and why R/A is necessary
4) An *Alternatives Analysis*
5) Relationship of the R/A site to other populations of the target species
6) Current habitat conditions at the R/A site
7) Possible limiting factors at the R/A site
8) Source of the animals for R/A (adults, juveniles, culture facility-produced or wild)
9) Source of the stock (location and drainage)
10) Monitoring plan and responsibilities
11) Cooperating and responsible partners
(12) Copies of all appropriate permits and other pertinent information

An example of a completed site plan is presented in Appendix III. Site plan information should be summarized in the Mollusk Propagation, Reintroduction and Augmentation Reporting form provided in Appendix IV.

Stream selection

Streams for augmentation or reintroduction should be selected based on consideration of historical and current distribution of the species; habitat conditions; past, present or future threats; and ongoing habitat conservation efforts in the drainage. All R/A efforts for a species within a particular drainage should be focused on limited sites until conditions adequate for survival are verified. Concentrating efforts at fewer sites will reduce risks, monitoring costs and will facilitate genetic modeling. See Monitoring section for minimum monitoring recommendations.

Source population selection:

Source populations for brood stock or translocation for R/A activities should be carefully considered if more than one population is available. To the greatest extent feasible, animals used in R/A activities should come from or be progeny of brood stock from a population nearest in drainage distance to the R/A site. Selection should follow these priorities:

1) A population in the same stream/tributary system in the same physiographic province
2) A population in an adjacent stream/tributary system in the same physiographic province
3) A population in an adjacent stream/tributary system in an adjacent physiographic province
4) No more than 5% of the source population should be removed for translocation

Proper consideration of genetic impacts on recipient and donor populations should be made prior to any R/A activities (Jones et al. 2006, see summary table in Appendix V). Very little is known of genetic differences among mollusk populations across drainages as they relate to expressions in morphology, behavior, and other forms of habitat adaptation. In order to avoid potential inbreeding effects, it is preferred that propagated juveniles from an individual female mussel be used only once per site. Gravid mussels used to produce juveniles for stocking will be uniquely marked and returned to the point of capture or other approved release sites. Subsequent releases should come from appropriate wild mussel stock whenever possible. Snail brood stock should be used only for a single breeding season, marked and returned to point of capture. Subsequent adult snail breeding stock will be selected from a different shoal, if possible.

Monitoring

The party conducting the release is responsible for a monitoring schedule, which is specified in the site plan. Because R/A strategies are under development, routine monitoring is critical to determine success. The following are minimum recommendations since each R/A activity is specific and may require tailored monitoring plans. Monitoring reports will be prepared and distributed to appropriate state and federal agencies

1) Mussels – annual monitoring for 3 years beginning 3rd year after release, triennially thereafter for 6 years
2) Snails – annual monitoring for 3 years after release and again during year 5

If it is determined that survival is precluded by current habitat conditions, the R/A should be discontinued and appropriate agencies notified. If an alternate site is available, a new site plan should be modified accordingly.

Reporting

Recovery partners conducting propagation studies, R/A releases, or monitoring studies will provide an annual report of activities to the FWS and appropriate state agencies, including:

1) A brief description of their propagation and/or R/A program, including objectives and status
2) List of cooperators
3) Activities conducted, research accomplished, propagation or reintroduction efforts achieved
4) A brief description of the status of R/A populations
5) A completed R/A activities form(s) as presented in Appendix IV

In the future, data will be compiled in a R/A data repository and made available to all partners.

DISPOSITION OF EXCESS PROGENY FROM RESEARCH ACTIVITIES

Propagation efforts or host fish trials may result in excess juvenile mussels or snails. Excess cultured offspring should be considered for:

1) R/A releases (with appropriate site plan)
2) Toxicity testing
3) Other existing experimental needs
4) Archival at an appropriate institution for future genetic analyses

REGULATORY AND VOLUNTARY OPTIONS

Experimental population designation

Section 10(j) of the ESA requires the Service to designate the release of any population of a listed species outside of its current range as either an essential or non-essential experimental population if the location of release is wholly separate geographically from existing populations. Due to their small geographic range and the contiguous nature of the riverine ecosystem, all reintroductions conducted within the drainages where listed mollusks historically occurred are considered within their current geographical range and are not appropriate for an experimental

designation. Experimental population designation will be considered only if future releases are proposed outside the historical range of the species. No such introductions are currently being considered.

Safe harbor agreements

Safe Harbor Agreements (SHA) are voluntary arrangements between the FWS and cooperating non-Federal landowners intended to promote voluntary management for listed species on non-Federal property. Under a SHA, the landowner must conduct activities or manage lands in such a way as to provide a net conservation benefit to listed species; in return, the participating landowner is assured that no additional future regulatory restrictions will be imposed. A SHA results in the issuance of a permit to the landowner authorizing any necessary future incidental take that may occur as a result of their conservation actions. Also, the permit allows the landowner to take any covered species that are above the baseline as an incidental consequence of otherwise lawful activity. At this time, most, if not all foreseeable R/A activities will occur within State-owned waters where current land use activities are compatible with survival of mollusk species.

PLAN REVIEW

This plan is a working document subject to modification based on results of current and future research, survey and recovery activities involving mollusk propagation, augmentation or reintroduction. Recovery partners will review the Plan at least every five years or as needed to incorporate new information, protocols, etc. as they become available for species herein included (provide comments to Bob Butler, FWS, Asheville, NC). Current contact information for partners is presented in Appendix I, and regulatory requirements for each state are presented in Appendix VI.

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Appendix I. A list of current federal, state and private Cumberlandian Region mollusk conservation and recovery partners.

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Appendix II-A. List of mussels considered to be conservation priorities in the Cumberlandian Region with NatureServe G rank and Endangered Species Act status. Tier assignments generally reflect the degree of immediate imperilment for each taxon (see text). Taxa with high R/A potential are denoted with an asterisk (*).

#	Species, Common Name	G Rank	Federal Status
	Tier 1:		
1	*Anodontoides denigrata*, Cumberland Papershell	G1	
2	**Dromus dromas,* Dromedary Pearlymussel	G1	Endangered
3	**Epioblasma capsaeformis*, Oyster Mussel	G1	Endangered
4	**Epioblasma* sp. cf. *capsaeformis*, lower Tenn. R. form	G1	Endangered
5	*Epioblasma florentina walkeri*, Tan Riffleshell	G1	Endangered
6	*Epioblasma florentina* ssp. cf. *walkeri*, Tenn. R. form	G1	Endangered
7	*Fusconaia cor*, Shiny Pigtoe	G1	Endangered
8	*Fusconaia cuneolus*, Finerayed Pigtoe	G1	Endangered
9	*Hemistena lata*, Cracking Pearlymussel	G1	Endangered
10	*Lampsilis virescens*, Alabama Lampmussel	G1	Endangered
11	*Lasmigona* sp. cf. *holstonia*, Barrens form	G1G2	
12	**Lemiox rimosus*, Birdwing Pearlymussel	G1	Endangered
13	*Pegias fabula*, Littlewing Pearlymussel	G1	Endangered
14	*Plethobasus cicatricosus*, White Wartyback	G1	Endangered
15	*Plethobasus cooperianus*, Orangefoot Pimpleback	G1	Endangered
16	*Quadrula cylindrica strigillata*, Rough Rabbitsfoot	G1	Endangered
17	*Quadrula intermedia*, Cumberland Monkeyface	G1	Endangered
18	*Quadrula sparsa*, Appalachian Monkeyface	G1	Endangered
19	*Toxolasma cylindrellus*, Pale Lilliput	G1	Endangered
	***N* = 19**		
	Tier 2:		
20	*Cumberlandia monodonta,* Spectaclecase	G2G3	Candidate
21	**Cyprogenia stegaria*, Fanshell	G1	Endangered
22	**Epioblasma brevidens*, Cumberlandian Combshell	G1	Endangered
23	*Fusconaia subrotunda*, Longsolid	G3	
24	*Obovaria subrotunda*, Round Hickorynut	G4	
25	*Plethobasus cyphyus*, Sheepnose	G3	Candidate
26	*Pleurobema oviforme*, Tennessee Clubshell	G3	
27	*Pleurobema plenum*, Rough Pigtoe	G1	Endangered
28	*Pleurobema rubrum*, Pyramid Pigtoe	G2	
29	*Pleuronaia barnesiana*, Tennessee Pigtoe	G2	
30	*Pleuronaia dolabelloides*, Slabside Pearlymussel	G2	Candidate
31	*Pleuronaia gibberum*, Cumberland Pigtoe	G2	Endangered
32	**Ptychobranchus subtentum*, Fluted Kidneyshell	G2G3	Candidate
33	*Villosa iris*, Rainbow	G5	
34	*Villosa perpurpurea*, Purple Bean	G1	Endangered
35	**Villosa taeniata*, Painted Creekshell	G3G4	
36	*Villosa trabalis*, Cumberland Bean	G1	Endangered

	***N* = 17**		
	Tier 3:		
37	**Actinonaias ligamentina*, Mucket	G4	
38	**Actinonaias pectorosa*, Pheasantshell	G4	
39	*Alasmidonta atropurpurea,* Cumberland Elktoe	G1G2	Endangered
40	*Alasmidonta raveneliana,* Appalachian Elktoe	G1	Endangered
41	*Epioblasma obliquata obliquata*, Catspaw	G1	Endangered
42	**Epioblasma triquetra*, Snuffbox	G3	
43	**Lampsilis abrupta*, Pink Mucket	G2	Endangered
44	*Lasmigona holstonia*, Tennessee Heelsplitter	G3	
45	*Leptodea leptodon*, Scaleshell	G1	Endangered
46	**Medionidus conradicus*, Cumberland Moccasinshell	G3G4	
47	*Obovaria retusa*, Ringpink	G1	Endangered
48	*Pleurobema clava*, Clubshell	G2	Endangered
49	*Pleurobema cordatum*, Ohio Pigtoe	G3	
50	*Pleurobema sintoxia*, Round Pigtoe	G4	
51	*Quadrula cylindrica cylindrica,* Rabbitsfoot	G3	
52	*Quadrula fragosa*, Winged Mapleleaf	G1	Endangered
53	*Simpsonaias ambigua*, Salamander Mussel	G3	
54	**Toxolasma lividum*, Purple Lilliput	G2	
55	**Venustaconcha sima*, no common name	G3?	
56	*Villosa fabalis*, Rayed Bean	G1G2	Candidate
57	**Villosa vanuxemensis*, Mountain Creekshell	G4	
	***N* = 21**		

The following Cumberlandian Region federally listed mussels were not included in this prioritization because they are likely extinct:

Epioblasma florentina florentina, Yellow Blossom; *Epioblasma torulosa gubernaculum,* Green Blossom; *Epioblasma torulosa torulosa,* Tubercled Blossom; and *Epioblasma turgidula,* Turgid Blossom.

Appendix II-B. List of snails considered to be conservation priorities in the Cumberlandian Region with NatureServe G rank and Endangered Species Act status. Tier assignments generally reflect the degree of immediate imperilment for each taxon. Taxa with high R/A potential are denoted with an asterisk (*).

#	Species, Common Name	G Rank	Federal Status
	Tier 1:		
1	**Athearnia anthonyi*, Anthony's Riversnail	G1	Endangered
2	**Campeloma decampi*, Slender Campeloma	G1	Endangered
3	**Elimia nassula*, Round-Rib Elimia	G1	
4	**Elimia perstriata*, Engraved Elimia	G1	
5	*Elimia troostiana*, Mossy Elimia	G1	
6	*Leptoxis umbilicata*, Umbilicate Rocksnail	G1	
7	*Marstonia ogmorhaphe*, Royal Marstonia	G1	Endangered
8	**Marstonia scalariformis*, Moss Pyrg	G1	
9	**Pleurocera corpulenta*, Corpulent Hornsnail	G1	
	***N* = 9**		
	Tier 2:		
10	**Elimia christyi*, Knotty Elimia	G1	
11	*Elimia striatula*, File Elimia	G2	
12	**Io fluvialis*, Spiny Riversnail	G2	
13	**Lithasia curta*, Knobby Rocksnail	G1	
14	**Lithasia lima*, Warty Rocksnail	G2	
15	**Marstonia pachyta*, Armored Marstonia	G1	Endangered
	***N* = 6**		
	Tier 3:		
16	**Elimia aternia*, Coal Elimia	G2	
17	*Elimia curreyana*, Amber Elimia	G3	
18	**Elimia porrecta*, Nymph Elimia	G2	
19	**Elimia strigosa*, Brook Elimia	G2	
20	*Elimia teres*, Elegant Elimia	G1	
21	**Lithasia duttoniana*, Helmet Rocksnail	G2	
22	**Lithasia pinguis*, Smooth Rocksnail	G2	
23	**Lithasia salebrosa*, Muddy Rocksnail	G3	
24	*Pleurocera alveare,* Rugged Hornsnail	G3	
25	*Pleurocera pyrenella*, Skirted Hornsnail	G2	
	***N* = 10**		

APPENDIX III: Cumberlandian Region priority species accounts[1]

Format Explanation

(1) priority number within tier ***Scientific name* – Common Name:** as they appear in Turgeon et al. (1998) or in the published literature (e.g., *Anodontoides denigrata* -- Cumberland Papershell, Cicerello & Schuster 2003). Species are listed alphabetically within tiers.

Prioritization: Tier [1 – 3] **Global status:** NatureServe status [G1–G5]

Conservation status:
Federal: endangered, threatened, candidate, none
- AFS: for non-federally listed species only and based on Williams et al. (1993): endangered (E), threatened (T), vulnerable (species of concern) (V), none (currently stable) or not determined (ND)

State: only those conservation categories pertaining to species covered in the plan are included.
- AL - based on Mirarchi et al. (2004): extirpated (EX); extirpated, conservation action underway (EXc); highest conservation concern (P1); high conservation concern (P2); none
- KY - based on KSNPC (2005): endangered (E), threatened (T), special concern (S), historic (H), extirpated (EX), none
- MS - based on MDWFP (2000): endangered (E), none
- NC - based on LeGrande et al. (2008): endangered (E), threatened (T), special concern (SC), significantly rare (SR)
- TN - same as federal status
- VA - based on Neves (1991): endangered (E), threatened (T), special concern (SC), none

Streams with extant occurrences: Extant populations are based on approximately post-1980 occurrences unless subsequent data suggests otherwise. Stream names are understood to be "rivers" unless stated otherwise and arranged in the following order: 1) Tennessee/Cumberland main stem dam tailwaters (exclusive of Wheeler), 2) Tennessee/Cumberland main stem reservoirs, 3) Tennessee/Cumberland tributary dam tailwaters and 4) from the Tennessee/ Cumberland headwaters downstream. Populations in some stream systems without dispersal barriers may represent a single, larger population (e.g., Big South Fork drainage) but all streams of occurrence are listed here separately. Populations that are possibly extirpated are marked with a "?" after the stream name or state code for multiple states of occurrence. Upper and lower Tennessee River system generally refers to upstream and downstream of northeastern AL, respectively; upper and lower Clinch refers to upstream and downstream of Norris Reservoir, respectively; upper and lower Holston refers to upstream of John Sevier Detention Reservoir and downstream of Cherokee Reservoir, respectively; upper and lower North Fork

[1] Literature citations and personal communications have been intentionally omitted from the species accounts.

Holston refers to upstream of Saltville, VA, and in the vicinity of the VA/TN state line, respectively; and upper, middle and lower Pigeon refers to upstream of Canton, NC, between Canton and the NC/TN state line and in the watered reach downstream of the state line, respectively; and upper and lower Cumberland River system generally refers to upstream and downstream of the vicinity of the central KY/TN state line, respectively. Federally protected species having streams designated as critical habitat (CH) by the FWS (FWS 2004) are noted.

Population status: Summary of overall population status and characteristics (e.g., size, recruitment) for R/A actions. References to Cumberland and Caney Fork are understood to be below Cumberland Falls and Great Falls, respectively, unless otherwise stated. References to five-year reviews (5YR) conducted by the FWS for federally protected species are noted where applicable. Basic recovery criteria (i.e., number of streams with viable populations needed for downlisting (E to T) or delisting (T to recovered)) from published recovery plans for federally protected species is also included. Taxa that were not recognized by recent authorities (e.g., Williams et al. 1993, Turgeon et al. 1998) and putative species complexes are noted.

Habitat restoration and threats: A summary of habitat recovery activities and threats is included here but excluded from individual species accounts since much of this information does not apply specifically to R/A activities. Language on beneficial habitat related activities and threats that pertain to multiple species in specific watersheds (in parentheses) are listed here: 1) ADCNR, ADEM, EPA, FWS, KDFWR, KDOW, NPS, TNC, NCWRC, NRCS, TDEC, TVA, TWRA, USACE, USFS, VDGIF, grassroots watershed groups, landowners and other partners are involved in habitat restoration through various landowner programs (e.g., CWA, Farm Bill, Landowners Incentive Program, Partners for Fish and Wildlife), land purchases and educational outreach (Region wide); 2) ADEM, FWS, KDOW, MDEQ, NCDWQ, TDEC, USACE and VDEQ are involved in regulatory actions (e.g., permitting pollution discharge, instream aggregate mining) to protect habitat and water quality (Region wide), 3) improved water quality/quantity releases from FERC (e.g., Cheoah) and TVA (e.g., Elk, Duck) regulated reservoirs and 4) threats assessments are being conducted by FWS, TNC, USGS and various state resource agencies. The following general threats potentially affect all species in the Region: chemical contaminants, agricultural and silvicultural runoff, lack of riparian buffers, sedimentation, urbanization and other developmental activities, hydrological alterations and the

potential for toxic spills. More watershed-specific threats include: 1) coal mining activities (e.g., upper Clinch, Powell, Emory drainages; upper Cumberland system [from Big South Fork and Rockcastle drainages upstream]); 2) oil and gas exploration (e.g., upper Clinch, Powell, Emory drainages, upper Cumberland system); 3) water withdrawal (i.e., Emory, Duck, upper Caney Fork drainage); 4) hypolimnetic discharges (e.g., lower Clinch, Elk, Cumberland, Caney Fork); 5) poor water quality due to insufficient releases from dams (e.g., all regional tailwaters); 6) instream aggregate mining (e.g., lower Tennessee, Elk, Buck Cr., upper Caney Fork drainage) and 7) navigation channel maintenance activities (e.g., Tennessee, Cumberland). Most threats have the potential to hinder R/A efforts.

Potential augmentation streams: A list of streams that may currently warrant augmentation. In general, augmentations are considered the lesser restoration option to reintroduction (see text).

Potential reintroduction streams: A list of streams that may currently provide suitable habitat for a reintroduction attempt. Reintroductions are generally the preferred restoration option over augmentation. Relative prioritization for mussels (H = high, M = medium, L = low) of streams is determined for reintroduction activities. Streams are arranged the same as under "extant occurrences" within prioritization categories. Streams in multiple states may be assigned different prioritizations. The Tennessee River (Muscle Shoals) NEP refers to FWS (2002), the lower French Broad/Holston River NEP refers to FWS (2007), the Duck RP refers to Ahlstedt & Johnson (2005) and the Big South Fork EA refers to NPS (2003). Federally protected species having streams designated as CH are noted. A list of high priority streams for reintroduction options in the Region and their priority species is presented in Appendix IV.

Reproductive biology: Summary of life history data primarily as it relates to R/A actions. Host fishes may not be native to the Region and some names may not reflect the current taxonomic status of common names.

Propagation difficulty: Relative prioritization of difficulty in culturing (high, medium, low) based on ease in procuring brood stock, bradyticty versus tachticty, unknown host species, risk of aborting, low fertilization rate, survivorship in the lab, growout potential and other factors.

Recommended priority actions: Specific translocation-related activities needed for recovery that pertain to most species, and are excluded from individual accounts.

Mussels: 1) determine suitable glochidial hosts, 2) assess availability of glochidial hosts, 3) develop or improve juvenile propagation technology, 4) develop artificial culture medium, 5) determine nutritional requirements for juveniles and adults, 6) determine habitat requirements, 7) develop grow-out to subadult stage, 8) attempt streamside host infestations, 9) reintroduce populations and/or augment extant populations, 10) search for additional populations, 11) establish and maintain ark population(s) when necessary and 12) rescue and salvage individuals when necessary to save the species from extinction or a population from extirpation.

Snails: 1) develop or improve juvenile propagation technology for R/A activities, 2) search for additional populations, 3) establish and maintain ark populations when necessary and 4) rescue and salvage individuals when necessary to save the species from extinction or a population from extirpation.

Recommended priority actions do not necessarily align with prioritized recovery tasks in recovery plans for federally listed species. Agencies and other entities that are propagating species covered in the Plan or are otherwise involved in some aspect of implementation of these actions include ADCNR, CFI, CZ, DHNFH, FWS, KDFWR, NCWRC, NPS, OSM, OSUM, TTU, TWRA, TVA, USFS, USGS, VDGIF, VPI, WSNFH, WSSNFH and WCNFH.

R/A potential: Relative prioritization (high, medium, low) in the Region is based on several factors (e.g., degree of imperilment, ease of finding gravid individuals, knowledge of life history, size of source population, difficulty of propagation, quality of potential R/A streams). The species having high R/A potential are highlighted in Appendix II.

Abbreviations used in this section and in the Species Accounts: AABC = Alabama Aquatic Biodiversity Center, ADCNR = Alabama Department of Conservation and Natural Resources, ADEM = Alabama Department of Environmental Management, AFS = American Fisheries Society, CFI = Conservation Fisheries, Inc., CH = Critical Habitat, CWA = Clean Water Act, CZ = Columbus [OH] Zoo, DHNFH = Dale Hollow National Fish Hatchery, EA = Environmental

Assessment, EPA = US Environmental Protection Agency, FERC = Federal Energy Regulatory Commission, KDFWR = Kentucky Department of Fish and Wildlife Resources, KDOW = Kentucky Division of Water, MDEQ = Mississippi Department of Environmental Quality, MDWFP = Mississippi Department of Wildlife, Fisheries and Parks, MMNS = Mississippi Museum of Natural Sciences, NCDWQ = North Carolina Division of Water Quality, NCWRC = North Carolina Wildlife Resources Commission, NCSU = North Carolina State University, NEP = Nonessential Experimental Population, NPS = National Park Service, NRCS = Natural Resources Conservation Service, OSM = Office of Surface Mining, OSUM = Ohio State University Museum of Biological Diversity, RP = restoration plan, TDEC = Tennessee Department of Environment and Conservation, TNC = The Nature Conservancy, TTU = Tennessee Technological University, TVA = Tennessee Valley Authority, TWRA = Tennessee Wildlife Resources Agency, USACE = U.S. Army Corps of Engineers, USFS = US Forest Service, FWS = US Fish and Wildlife Service, USGS = US Geological Survey, VDEQ = Virginia Department of Environmental Quality, VDGIF = Virginia Department of Game and Inland Fisheries, VPI = Virginia Polytechnic Institute and State University, WCNFR = Wolf Creek National Fish Hatchery, WSNFH = Warm Springs National Fish Hatchery and WSSNFH = White Sulphur Springs National Fish Hatchery.

MUSSELS

Tier 1

(1) *Anodontoides denigrata* – Cumberland Papershell

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: none AFS: ND state: KY-E,TN-none

Streams with extant occurrences: Cumberland River system – Clear Fork, KY (Cumberland); Laurel Fork, KY (above Falls); Marsh Cr., KY; South Fork Rockcastle, KY; Laurel Fork, KY (Rockcastle); Sinking Cr., KY; Bone Camp Cr., TN; Buffalo, Cr., TN; Smith Cr., TN.

Population status: Endemic to the Cumberlandian Region, this species is restricted to small and medium streams of the Cumberlandian Plateau in the upper Cumberland system mostly below Cumberland Falls. This valid taxon, whose distribution is highly disjunct from its sister species, *Andontoides ferussacianus*, was not recognized by recent authorities. Its status rangewide is poorly known. The once sizable Marsh Creek population appears to have declined.

Potential augmentation streams: none.

Potential reintroduction streams: Cumberland River system – Rockcastle, KY (H); Middle Fork Rockcastle, KY (H); Clear Fork, TN (Big South Fork) (H); Crooked Cr., TN (H); Cumberland above Falls, KY (M); Rock Cr., KY (M); North Prong Clear Fork, TN (M); White Oak Cr., TN (M); North White Oak Cr., TN (M); Little South Fork, KY (L).

Reproductive biology: Unknown.

Propagation difficulty: Unknown.

Recommended priority actions:

1) Conduct status survey
2) Describe life history
3) Reintroduce into Rockcastle, Clear Fork (TN), Crooked Cr.

R/A potential: Low.

(2) *Dromus dromas* – Dromedary Pearlymussel

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: E
state: AL-EXc, KY-EX, TN-E, VA-E

Streams with extant occurrences: Tennessee River system – upper Clinch, VA/TN; Powell, VA/TN. **Cumberland River system** – Cumberland main stem tailwaters: Cordell Hull, TN?

Population status: Endemic to the Cumberlandian Region, this species is distributed in large streams in the Region. It may now be restricted to the Clinch and Powell; although an old individual was collected in the Cumberland in 1994, the species may have become extirpated there. The upper Clinch in TN contains a large localized population that is recruiting and viable but populations on the VA side of the Clinch and in the Powell are declining. The Cumberland population, which may already be extirpated, is affected by coldwater releases that have eliminated many mussel species from the river. The Clinch population represents an opportunity to translocate adults for R/A activities. However, loss of the Clinch population would put this species near the edge of extinction. Five populations are needed for recovery.

Potential augmentation streams: Tennessee River system – upper Clinch, VA. **Cumberland River system** – none.

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL (M) [NEP], Pickwick Landing, TN (M), Guntersville, AL (L); Tennessee tributary tailwaters: lower French Broad/Holston, TN (H) [NEP], Elk, AL (H), TN (M) [pending water quality/quantity improvements]; Nolichucky, TN (H); upper French Broad, TN (M); lower Pigeon, TN (M); Hiwassee, TN (M); upper Holston, TN (L); Limestone Cr., AL (L). **Cumberland River system –** Big South Fork, TN/KY (H) [EA].

Reproductive biology: Bradytictic. Gravid females observed primarily during winter. Hosts identified through laboratory induced infections include Greenside, Fantail, Gilt and Tangerine Darters and Blotchside Logperch, while Black sculpin, Logperch and Tennessee Snubnose, Channel and Roanoke Darters were marginal hosts.

Propagation difficulty: Medium. This species has been successfully propagated.

Recommended priority actions:

1) Reintroduce into Nolichucky, Elk (AL), Big South Fork with translocated adults
2) Augment upper Clinch (VA) population with translocated adults
3) Conduct host survey of Wilson tailwaters
4) Trial reintroduction into Wilson tailwaters with translocated adults

R/A potential: High.

(3) *Epioblasma capsaeformis* – Oyster Mussel

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: E
state: AL-EXc, KY-E, TN-E, VA-E

Streams with extant occurrences: Tennessee River system – upper Clinch, VA/TN [CH]; Powell, VA/TN? [CH]; Nolichucky, TN [CH]. **Cumberland River system** – Big South Fork, TN/KY [CH].

Population status: Endemic to the Cumberlandian Region, this species is distributed in medium and large streams throughout the Region. With the recognition of *E.* sp. cf. *capsaeformis* in the lower Tennessee system, the species considered here is now restricted to the upper Tennessee system, having been potentially extirpated from the Cumberland system. A large population exists in the upper Clinch, TN (~500,000 individuals) but it is considered very rare in the Nolichucky and Big South Fork and may be extirpated from the Powell. The Clinch population represents an opportunity to translocate adults for R/A activities. Its virtual restriction to a single river reach makes it highly susceptible to extinction. A 5YR is in progress. Six populations are needed for downlisting while nine populations are needed for recovery (the recovery plan considered both species to be a single taxon; actual number of streams needed for recovery of this form should be fewer).

Potential augmentation streams: Tennessee River system – upper Clinch, VA; Nolichucky, TN. **Cumberland River system** – Big South Fork, TN/KY [EA].

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL (M) [NEP]; Tennessee tributary tailwaters: lower French Broad/Holston, TN (H) [NEP], Elk, AL (H), TN (M) [pending water quality/quantity improvements]; Paint Rock, AL (H); Copper Cr., VA (M) [CH]; Emory, TN (M); upper North Fork Holston, VA (M), upper French Broad, TN (M); lower Pigeon, TN (M); Hiwassee, TN (M); Estill Fork, AL (M); upper Holston, TN (L); Little Pigeon, TN (L); Bear Cr., AL/MS (L) [CH]. **Cumberland River system** – Rockcastle, KY (H); Buck Cr., KY (M) [CH]; Little South Fork, KY (L).

Reproductive biology: Bradytictic. Hosts identified through laboratory induced infections include Banded Sculpin and Gilt, Dusky, Redline, Spotted, Bluebreast and Wounded Darters. This species is short lived (generally <12 years) and has a high natural mortality rate.

Propagation difficulty: Medium. This species has been successfully propagated.

Recommended priority actions:

1) Reintroduce into Paint Rock, Rockcastle with translocated adults
2) Conduct host survey of Wilson tailwaters
3) Trial reintroduction into Wilson tailwaters with translocated adults
4) Augment upper Clinch (VA), Nolichucky, Big South Fork populations

R/A potential: High.

(4) *Epioblasma* sp. cf. *capsaeformis* – lower Tennessee River form

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: E
state: TN-E

Streams with extant occurrences: Tennessee River system – Duck, TN [CH].

Population status: An undescribed Cumberlandian endemic (as confirmed by genetic, morphologic and other data), this species was restricted to large streams in the lower Tennessee system but is currently restricted to the Duck. The Duck population is large and expanding in a 28-mile reach of the middle portion of the river and represents an opportunity to translocate adults for R/A activities. Its current restriction to a single river reach makes it highly susceptible to extinction. A 5YR is in progress. Six populations are needed for downlisting while nine populations are needed for recovery (the recovery plan considered both species to be a single taxon; actual number of streams needed for recovery of this form should be fewer).

Potential augmentation streams: none.

Potential reintroduction streams: Tennessee River system – Limestone Cr., AL (H); Tennessee main stem tailwaters: Wilson, AL (M) [NEP], Pickwick Landing, TN (M); Bear Cr., AL (M); Buffalo, TN (M); Shoal Cr., TN/AL (L).

Reproductive biology: Bradytictic. Glochidial hosts include Fantail, Greenside and Redline Darters.

Propagation difficulty: Low

Recommended priority actions:

1) Reintroduce into Limestone Cr.
2) Host survey of Wilson tailwaters
3) Trial reintroduction into Wilson tailwaters, Bear Cr., Buffalo with translocated adults

R/A potential: High.

(5) *Epioblasma florentina walkeri* – Tan Riffleshell

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: E
state: KY-E, TN-E

Streams with extant occurrences: Cumberland River system – Big South Fork, TN/KY.

Population status: Endemic to the Cumberlandian Region, this species is distributed in medium and large streams in the Cumberland system. With the recognition of *E. florentina* ssp. cf. *walkeri* in the upper Tennessee system, the species considered here is now restricted to the Big South Fork. This population is recruiting and occurs sporadically in a 20-mile reach of the river. Its current restriction to a single river reach makes it highly susceptible to extinction. A 5YR is in progress. Four populations are needed for recovery (the recovery plan considered both subspecies to be a single taxon; actual number of streams needed for recovery of this form could be fewer).

Potential augmentation streams: Cumberland River system – Big South Fork, TN/KY [EA].

Potential reintroduction streams: Cumberland River system – Rockcastle, KY (H); Buck Cr., KY (M); Clear Fork, TN (M); Little South Fork, KY (L); East Fork Stones, TN (L); Red, KY/TN (L).

Reproductive biology: Bradytictic. Hosts identified through laboratory induced infections includes sculpins and Fantail, Redline and Greenside Darters.

Propagation difficulty: Medium.

Recommended priority actions:

1) Reintroduce into Rockcastle, Buck Cr.
2) Augment Big South Fork population

R/A potential: Medium.

(6) *Epioblasma florentina* ssp. cf. *walkeri* – Tennessee River form

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: E
state: TN-E, VA-E

Streams with extant occurrences: Tennessee River system – Indian Cr., VA (Clinch); upper Clinch, VA; Middle Fork Holston, VA; Hiwassee, TN?

Population status: An undescribed Cumberlandian endemic (as confirmed by genetic, morphologic and other data), it is found in medium streams in the Tennessee system and currently may be restricted to Indian Cr. (upper Clinch drainage); individuals have not been found in the Middle Fork Holston since ~1998 nor the Hiwassee since ~1992. A Clinch, VA, chemical spill in 1998 resulted in the extirpation of the population occurring in the main stem, effectively restricting it to Indian Cr. This population is declining, and represents one of the most imperiled mussel species in the Region. Its virtual restriction to a single stream reach makes it highly susceptible to extinction. The species is currently being reintroduced into Clinch, VA. A 5YR is in progress. Four populations are needed for recovery (the recovery plan considered both subspecies to be a single taxon; actual number of streams needed for recovery of this form should be fewer).

Potential augmentation streams: Tennessee River system – Indian Cr., VA; Clinch, VA.

Potential reintroduction streams: Tennessee River system – Tennessee tributary tailwaters: lower French Broad/Holston, TN (H), Elk, AL (H), TN (M) [pending water quality/quantity improvements]; upper Clinch, VA/TN (H); Paint Rock, AL, (H); Duck, TN (H) [RP]; Copper Cr., VA (M); upper North Fork Holston, VA (M); South Fork Holston, VA (M); lower Pigeon, TN (M); Hurricane Cr., AL (M); Estill Fork, AL (M).

Reproductive biology: Bradytictic. Hosts identified through laboratory induced infections include Banded and Mottled Sculpins and Fantail, Greenside, Redline and Snubnose Darters, with the Fantail Darter being most suitable.

Propagation difficulty: Medium. This species has been successfully propagated.

Recommended priority actions:

1) Augment Indian Cr., Clinch (VA) populations
2) Reintroduce into upper Clinch (VA/TN), Paint Rock, Elk (AL), Duck

R/A potential: Medium.

(7) *Fusconaia cor* – Shiny Pigtoe

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: E
state: AL-P1, TN-E, VA-E

Streams with extant occurrences: Tennessee River system – upper Clinch, VA/TN; Copper Cr., VA; Powell, VA/TN; upper North Fork Holston, VA; Paint Rock, AL.

Population status: Endemic to the Cumberlandian Region, this species is restricted to medium and large streams in the upper half of the Tennessee system. The best populations are the upper Clinch, upper North Fork Holston (appears to be in decline) and Paint Rock. It is possibly extirpated from the Elk since it was last reported live (one individual) in 1990 but not during several subsequent surveys. In the upper North Fork Holston, a mussel die-off since ~2000 has occurred above Saltville, VA. A 5YR is in progress. Nine populations are needed for recovery.

Potential augmentation streams: none.

Potential reintroduction streams: Tennessee River system – Tennessee tributary tailwaters: Elk, AL (H), TN (M), lower French Broad/Holston, TN (M) [NEP] [pending water quality/quantity improvement]; Nolichucky, TN (H); lower Pigeon, TN (H); Tennessee main stem tailwaters: Wilson, AL (M) [NEP]; upper French Broad, TN (M); upper Holston, TN (L).

Reproductive biology: Tachytictic. Gravid females are found in late spring and summer. Hosts identified through laboratory induced infections include Telescope, Warpaint, Whitetail, Striped and Tennessee Shiners.

Propagation difficulty: High.

Recommended priority actions:

1) Reintroduce into Nolichucky, Elk (AL)

R/A potential: Low

(8) *Fusconaia cuneolus* – Finerayed Pigtoe

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: E
state: AL-P1, TN-E, VA-E

Streams with extant occurrences: Tennessee River system – upper Clinch, VA/TN; Little, VA; Copper Cr., VA; Powell, VA/TN; lower North Fork Holston, TN; Little, TN; Paint Rock, AL?

Population status: Endemic to the Cumberlandian Region, this species is restricted to medium and large streams in the upper half of the Tennessee system. In the 1980s it was once the most common federally listed mussel in the Clinch. Currently, most populations appear to be in decline. Nowhere is the species abundant, although the best population still occurs in the Clinch, TN. A 5YR is in progress. Nine populations are needed for recovery.

Potential augmentation streams: Tennessee River system – Little, TN; Paint Rock, AL.

Potential reintroduction streams: Tennessee tributary tailwaters: Elk, AL (H), TN (M), lower French Broad/Holston, TN (M) [NEP] [pending water quality/quantity improvements]; Nolichucky, TN (H); lower Pigeon, TN (H); Tennessee main stem tailwaters: Wilson, AL (M) [NEP]; upper North Fork Holston, VA (M); upper French Broad, TN (M); Hiwassee, TN (M); Emory, TN (L); upper Holston, TN (L); Limestone Cr., AL (L).

Reproductive biology: Tachytictic. Spawning occurs in May and gravid females can be found until late July. Hosts identified through laboratory induced infections include River Chub; Whitetail, White, Telescope, Tennessee Shiners; Central Stoneroller; Mottled Sculpin and Fathead Minnow.

Propagation difficulty: High.

Recommended priority actions:

1) Reintroduce into Nolichucky, Elk (AL)
2) Augment Little, Paint Rock populations

R/A potential: Low

(9) *Hemistena lata* – Cracking Pearlymussel

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: E
state: AL-P1, KY-EX, TN-E, VA-E

Streams with extant occurrences: Tennessee River system – Tennessee tributary tailwaters: Elk, TN/AL; upper Clinch, VA?/TN. **Cumberland River system** – none.

Population status: This species was distributed in large streams in the Ohio basin, but it is currently restricted to the Region. Two populations remain, the best one being in the Clinch, TN, whil the Elk population is extremely small. Its virtual restriction to a single river reach makes it highly susceptible to extinction. Five populations are needed for downlisting (including two populations in the upper and lower Tennessee, respectively, and Cumberland systems) while eight populations are needed for recovery (including two populations each in the upper and lower Tennessee, respectively, and Cumberland systems).

Potential augmentation streams: Tennessee River system – Tennessee tributary tailwaters: Elk, AL.

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL (H) [NEP], Pickwick Landing, TN (H); Tennessee tributary tailwaters: lower French Broad/Holston, TN (M) [NEP] [pending water quality/quantity improvement]; Nolichucky, TN (H); Duck, TN (H) [RP]; upper French Broad, TN (M); upper Holston, TN (L); Buffalo, TN (L). **Cumberland River system** – Big South Fork, TN/KY (H) [EA].

Reproductive biology: Tachytictic. Host identified through laboratory induced infections include Banded Sculpin, Streamline Chub, Central Stoneroller, Tennessee Shiner, Whitetail Shiner and Fantail Darter.

Propagation difficulty: High. This species has been successfully propagated.

Recommended priority actions:

1) Reintroduce into Nolichucky, Duck, Big South Fork
2) Augment Elk (AL) population

R/A potential: Low

(10) *Lampsilis virescens* – Alabama Lampmussel

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: E
state: AL-P1, TN-none

Streams with extant occurrences: Tennessee River system (all AL) – Paint Rock, Estill Fork.

Population status: Endemic to the Cumberlandian Region, this species is restricted to medium streams in the middle Tennessee system. The Paint Rock drainage population represents the only extant occurrence. It is rare but apparently recruiting at a low level. The configuration of the two stream occurrences make it linearly distributed and highly susceptible to extinction. Three populations are needed for recovery.

Potential augmentation streams: none.

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL (H) [NEP], Guntersville, AL (L); Tennessee tributary tailwaters: lower French Broad/Holston, TN (H), Elk, AL (H), TN (M) [pending water quality/quantity improvement]; upper Clinch, TN (H); Emory, TN (H); Nolichucky (H); upper French Broad, TN (M); lower Pigeon, TN (M); Obed, TN (M); Hurricane Cr., AL (M); Limestone Cr., AL (M); Larkin Fk., AL (L); Shoal Cr., TN/AL (L).

Reproductive biology: Bradytictic. Hosts identified from laboratory induced infections include Rock and Largemouth Basses, Green Sunfish and Bluegill (marginal host).

Propagation difficulty: High. This species has been successfully propagated.

Recommended priority actions:

1) Reintroduce into upper Clinch (TN), Emory, Elk (AL)

R/A potential: Low

(11) *Lasmigona* sp. cf. *holstonia* – Barrens form

Prioritization: Tier 1 **Global status:** G1G2 **Conservation status:** federal: none AFS: ND state: TN-none

Streams with extant occurrences: Tennessee River system – none. **Cumberland River system (all TN)** – Collins, North Prong Barren Fork, Liberty Cr., Pocahontas Br., Witty Cr.

Population status: An undescribed Cumberlandian endemic, it is restricted to small streams of the Barrens region of central Tennessee. This valid taxon, whose distribution is disjunct from its sister species, was not recognized by recent authorities. Its range, which is an area of high endemism, historically included the uppermost Duck but extant populations currently occur in the Caney Fork drainage above Great Falls. A sizable population occurs in Pocahontas Br. Other populations are extremely small, some having declined in recent years.

Potential augmentation streams: none.

Potential reintroduction streams: Tennessee River system – upper Duck, TN (L). **Cumberland River system (all TN)** – Hickory Cr. (H), Little Hickory Cr., (H), West Fork Hickory Cr. (H), Hills Cr. (H), Scott Cr. (M).

Reproductive biology: Probably bradytictic. Biology presumably similar to its congener *L. holstonia*. Possibly uses sculpins as fish host since the mussel lives in small spring-fed streams. Other *Lasmigona* species spawn in winter.

Propagation difficulty: Medium.

Recommended priority actions:

1) Describe life history
2) Reintroduce into Hickory Cr., Little Hickory Cr.

R/A potential: Low.

(12) *Lemiox rimosus* – Birdwing Pearlymussel

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: E
state: AL-EXc, TN-E, VA-E

Streams with extant occurrences: Tennessee River system – upper Clinch, VA/TN; Powell, TN; Duck, TN.

Population status: Endemic to the Cumberlandian Region, this species is restricted to large streams in the Tennessee system. The largest extant population occurs in the Duck. Populations were estimated at 40,000 individuals in 1982 but it has expanded its range and increased population levels since TVA made improvements to minimum flows and oxygen aeration from Normandy Dam. The Duck population represents an opportunity to translocate adults for R/A activities. It is considered uncommon in the Clinch and on the verge of extirpation in the Powell. Five populations are needed for recovery.

Potential augmentation streams: none.

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL (M) [NEP]; Tennessee tributary tailwaters: Elk, AL (H), TN (M), lower French Broad/Holston, TN (M) [NEP] [pending water quality/quantity improvements]; Nolichucky, TN (H); Paint Rock (H); upper French Broad, TN (M); lower Pigeon, TN (M); upper Holston, TN (L); Buffalo, TN (L).

Reproductive biology: Bradytictic. Gravid individuals found from fall to spring. Hosts identified from laboratory induced infections include Greenside, Banded and Snubnose Darters.

Propagation difficulty: Low. This species has been successfully propagated.

Recommended priority actions:

1) Reintroduce into Nolichucky, Paint Rock, Elk (AL)
2) Conduct host survey of Wilson tailwaters
3) Trial reintroduction into Wilson tailwaters, Paint Rock with translocated adults

R/A potential: High.

(13) *Pegias fabula* – Littlewing Pearlymussel

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: E
state: AL-EX, KY-E, NC-E, TN-E, VA-E

Streams with extant occurrences: Tennessee River system – upper Clinch, VA; Little, VA; upper North Fork Holston, VA; Little Tennessee, NC. **Cumberland River system** – Horse Lick Cr., KY; Big South Fork, TN/KY; Cane Cr., TN.

Population status: Endemic to the Cumberlandian Region, this species is distributed in small to large streams in the Region. Extant occurrences are highly disjunct, with the best population in the Big South Fork. Other populations are extremely small and some are close to extirpation. Eight populations are needed for downlisting (including 4 populations each in the Tennessee and Cumberland systems) while 13 populations are needed for recovery (including 8 populations in the Tennessee and 5 populations in the Cumberland systems).

Potential augmentation streams: none.

Potential reintroduction streams: Tennessee River system – Tennessee tributary tailwaters: Elk, AL (H), TN (M), lower French Broad/Holston, TN (M) [pending water quality/quantity improvements]; upper Clinch, TN (H); Nolichucky, TN (H); Duck, TN (H) [RP]; Emory, TN (M); Obed, TN (M); South Fork Holston, VA (M); upper French Broad, TN (M); lower Pigeon, TN (M); Hiwassee, TN (M); Copper Cr., VA (L); Fountain Cr., TN (L). **Cumberland River system** – Rockcastle, KY (H); Middle Fork Rockcastle, KY (H); Sinking Cr., KY (H); Buck Cr., KY (H); Roundstone Cr., (M); Clear Fork, TN (M); Collins, TN (M); Big Hickory Cr., TN (M); Little South Fork, KY (L); Kennedy Cr., KY (L); East Fork Stones, TN (L); Harpeth, TN (L); Red, KY/TN (L); Whippoorwill Cr., KY (L).

Reproductive biology: Bradytictic. Gravid females are found from September to March. Hosts identified through laboratory induced infections include Greenside and Emerald Darters and sculpins.

Propagation difficulty: High. This species has been successfully propagated.

Recommended priority actions:

1) Reintroduce into upper Clinch (TN), Nolichucky, Duck, Rockcastle

R/A potential: Medium.

(14) *Plethobasus cicatricosus* – White Wartyback

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: E
state: AL-P1, KY-EX, TN-E

Streams with extant occurrences: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL. **Cumberland River system** – none.

Population status: This species was distributed in large rivers in the lower Ohio basin but is currently restricted to the Region in the Tennessee below Wilson Dam. Six live individuals (including two subadults) have been collected since ~1995. Its current restriction to a single river reach makes it highly susceptible to extinction. Three populations are needed for recovery.

Potential augmentation streams: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL (H).

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Pickwick Landing, TN (H), Guntersville, AL (L); Tennessee tributary tailwaters: Elk, AL (H), TN (M), lower French Broad/Holston, TN (M) [NEP] [pending water quality/quantity improvements], Duck, TN (H). **Cumberland River system** – Cumberland main stem tailwaters: Cordell Hull, TN (L) [pending water quality/quantity improvement], Barkley, KY (L).

Reproductive biology: Presumably tachytictic, gravid during spring and summer. Host fish are unknown.

Propagation difficulty: High.

Recommended priority actions:

1) Describe life history
2) Augment Wilson tailwaters population
3) Reintroduce into Pickwick Landing, Duck

R/A potential: Low.

(15) *Plethobasus cooperianus* – Orangefoot Pimpleback

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: E
state: AL-P1, KY-E, TN-E

Streams with extant occurrences: Tennessee River system – Tennessee main stem tailwaters: Chickamauga, TN, Pickwick Landing, TN, Kentucky, KY. **Cumberland River system** – none.

Population status: This species was distributed in large rivers in the Ohio basin but is currently restricted to the lowermost Ohio and Tennessee. The population that occurred in the Cumberland River ~1980 is considered extirpated. Populations are small but recruitment was documented in the mid-1990s below Pickwick Landing Dam. Five stream populations are needed for recovery.

Potential augmentation streams: Tennessee River system – Tennessee main stem tailwaters: Pickwick Landing, TN.

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL (H), Guntersville, AL (L); Tennessee tributary tailwaters: lower French Broad/Holston, TN (H) [NEP], Elk, AL (H), TN (M) [pending water quality/quantity improvements]; Duck, TN (H) [RP]. **Cumberland River system** – Cumberland main stem tailwaters: Cordell Hull, TN (L) [pending water quality/quantity improvement], Barkley, KY (L); Big South Fork, TN/KY (L) [EA].

Reproductive biology: Tachytictic. Gravid females are found in June and July. Host fish are unknown.

Propagation difficulty: High.

Recommended priority actions:

1) Describe life history
2) Reintroduce into Wilson tailwaters, Elk (AL), Duck
3) Augment Pickwick Landing population

R/A potential: Low.

(16) *Quadrula cylindrica strigillata* – Rough Rabbitsfoot

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: E
state: TN-E, VA-E

Streams with extant occurrences: Tennessee River system (all CH) – upper Clinch, VA/TN; Indian Cr., VA (Clinch); Copper Cr., VA; Powell, VA/TN.

Population status: Endemic to the Cumberlandian Region, this species is restricted to large streams in the uppermost Tennessee system. Populations are currently restricted to the Clinch drainage and Powell River. Evidence of recent recruitment is noted for the Clinch main stem but other stream populations are in danger of extirpation. A 5YR is in progress. Three populations are needed for downlisting while four populations are needed for recovery.

Potential augmentation streams: Tennessee River system – upper Clinch, VA.

Potential reintroduction streams: Tennessee River system – upper North Fork Holston, VA (H); Possum Cr., TN/VA (M); South Fork Holston, VA (M); upper Holston, TN (L); Middle Fork Holston, VA (L).

Reproductive biology: Tachytictic. Gravid females are found from late spring to early summer. Hosts identified through laboratory induced infections include Spotfin and Whitetail Shiners and Bigeye Chub.

Propagation difficulty: High. This species has been successfully propagated.

Recommended priority actions:

1) Reintroduce into upper North Fork Holston (VA)
2) Augment upper Clinch (VA) population

R/A potential: Low.

(17) *Quadrula intermedia* – Cumberland Monkeyface

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: E
state: AL-EXc, TN-E, VA-E

Streams with extant occurrences: Tennessee River system – Powell, VA/TN; Duck, TN.

Population status: Endemic to the Cumberlandian Region, this species is restricted to large streams in the Tennessee system. It currently exists only in the Duck and Powell. A viable expanding population occurs in the Duck but mostly older individuals are found in the Powell, which has declined significantly since ~1980. A 5YR is in progress. Four populations are needed for recovery.

Potential augmentation streams: none.

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL (M) [NEP]; Tennessee tributary tailwaters: Elk, AL (H), TN (M), lower French Broad/Holston, TN (M) [NEP] [pending water quality/quantity improvements]; upper Clinch, VA/TN (H); Nolichucky, TN (H); South Fork Holston, VA (M); upper French Broad, TN (M); upper Holston, TN (L); Buffalo, TN (L).

Reproductive biology: Tachytictic. Gravid females are found in May and June. Hosts identified through laboratory induced infections include the Tennessee Shiner and Streamline and Blotched Chubs.

Propagation difficulty: High.

Recommended priority actions:

1) Reintroduce into upper Clinch (TN), Nolichucky

R/A potential: Low.

(18) *Quadrula sparsa* – Appalachian Monkeyface

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: E
state: TN-E, VA-E

Streams with extant occurrences: Tennessee River system – upper Clinch, VA; Powell, VA/TN.

Population status: Endemic to the Cumberlandian Region, this species is restricted to large streams in the upper Tennessee system. It currently occurs in the Powell and Clinch, but each is of questionable viability due to past and continued declines. The population in the upper Clinch was rediscovered in 2003 after a 25+ year absence from collections. A 5YR is in progress. Three populations are needed for recovery.

Potential augmentation streams: Tennessee River system – upper Clinch, VA.

Potential reintroduction streams: Tennessee River system – Tennessee tributary tailwaters: Elk, AL (H), TN (M), lower French Broad/Holston, TN (M) [NEP] [pending water quality/quantity improvement]; upper Clinch, TN (H); Nolichucky, TN (H); lower Pigeon, TN (M); Hiwassee, TN (M); upper Holston, TN (L).

Reproductive biology: Tachytictic. Spawning is presumed to occur from May to July based on congeners. Host fish are unknown, but laboratory induced infections of glochidia on a congener (Q*uadrula intermedia*) identified Streamline and Blotched Chubs.

Propagation difficulty: High.

Recommended priority actions:

1) Reintroduce into upper Clinch (TN), Nolichucky, Elk (AL)
2) Augment upper Clinch (VA) population

R/A potential: Low.

(19) *Toxolasma cylindrellus* – Pale Lilliput

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: E
state: AL-P1, TN-E

Streams with extant occurrences: Tennessee River system – Estill Fork, TN/AL.

Population status: Endemic to the Cumberlandian Region, this species is restricted to small streams in the lower Tennessee system. It currently exists only in Estill Fork of the Paint Rock drainage and appears to be viable. Its current restriction to a single river reach makes it highly susceptible to extinction. Five populations are needed for recovery.

Potential augmentation streams: Tennessee River system – Estill Fork, TN/AL (H).

Potential reintroduction streams: Tennessee River system – Paint Rock, AL (H); Limestone Cr., AL (H); Duck, TN (H) [RP]; Hurricane Cr., AL (M); Big Rock Cr., TN (M); Tennessee tributary tailwaters: Elk, AL (M), Elk, TN (L) [pending water quality/quantity improvement]; Shoal Cr., TN/AL (L).

Reproductive biology: Bradytictic. Hosts include Rock and Largemouth Basses; Redbreast and Longear Sunfishes; Warmouth; Greenside Darter and Creek Chub.

Propagation difficulty: Medium.

Recommended priority actions:

1) Augment Estill Fork population
2) Reintroduce into Paint Rock, Limestone Cr., Duck

R/A potential: Medium.

Tier 2

(20) *Cumberlandia monodonta* – Spectaclecase

Prioritization: Tier 2 **Global status:** G2G3 **Conservation status:** federal: C AFS: T state: AL-P1, KY-E, TN-none, VA-E

Streams with extant occurrences: Tennessee River system – Tennessee main stem tailwaters: Guntersville, AL, Wilson, AL, Pickwick Landing, TN; upper and lower Clinch, VA/TN; Nolichucky, TN; Duck, TN. **Cumberland River system –** Cumberland tributary tailwaters: Caney Fork, TN?

Population status: This species is distributed in large rivers in the Mississippi basin. The Clinch has the only stronghold population in the Region but that population appears to be in decline. Most other regional populations are apparently small and of unknown status although some evidence of recent recruitment has been observed in the Tennessee in AL. The Caney Fork population, which may already be extirpated, is affected by coldwater releases that have eliminated many mussel species from the river. A proposed rule for federal listing is in progress.

Potential augmentation streams: Tennessee River system – Nolichucky, TN; Duck, TN.

Potential reintroduction streams: Tennessee River system – Tennessee tributary tailwaters: Elk, AL (H), TN (M), lower French Broad/Holston, TN (M) [pending water quality/quantity improvements]; upper French Broad, TN (M); lower Pigeon, TN (M); upper Holston, TN (L). **Cumberland River system –** Big South Fork, TN/KY (H) [EA].

Reproductive biology: Tachytictic. Host fish are unknown; over 60 species of fish have been tested for host suitability without success.

Propagation difficulty: High.

Recommended priority actions:

1) Describe life history
2) Reintroduce into Elk (AL), Big South Fork
3) Augment Nolichucky, Duck populations

R/A potential: Low.

(21) *Cyprogenia stegaria* - Fanshell

Prioritization: Tier 2 **Global status:** G1 **Conservation status:** federal: E
state: AL-P1, KY-E, TN-E, VA-E

Streams with extant occurrences: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL, Pickwick Landing, TN, Kentucky, KY; upper Clinch, VA/TN. **Cumberland River system –** none.

Population status: This species is distributed in medium and large streams in the Ohio basin. The Clinch has the largest population remaining in the Region, although a small recruiting population exists in the Tennessee, particularly below Pickwick Landing Dam. It is extirpated from the Cumberland system. A 5YR is in progress. Nine populations are needed for downlisting (including single populations in the upper and lower Tennessee and Cumberland systems) while 12 populations are needed for recovery (including 2 populations each in the upper and lower Tennessee systems and 1 population in the Cumberland system).

Potential augmentation streams: none.

Potential reintroduction streams: Tennessee River system – Tennessee tributary tailwaters: lower French Broad/Holston, TN (H) [NEP], Elk, AL (H), TN (M) [pending water quality/quantity improvements]; Nolichucky, TN (H); Duck, TN (H) [RP]; upper French Broad, TN (M); lower Pigeon, TN (M); upper Holston, TN (L). **Cumberland River system –** Big South Fork, TN/KY (H) [EA]; Cumberland main stem tailwaters: Cordell Hull, TN (L) [pending water quality/quantity improvement], Barkley, KY (L).

Reproductive biology: Bradytictic. Gravid females are found in winter. The best hosts identified through laboratory induced infections include Greenside, Tangerine and Roanoke Darters; and Blotchside Logperch, while Banded and Mottled Sculpins, Logperch and Tennessee Snubnose and Banded Darters were marginal hosts.

Propagation difficulty: Medium. This species has been successfully propagated.

Recommended priority actions:

1) Reintroduce into Nolichucky, Elk (AL), Duck, Big South Fork

R/A potential: High.

(22) *Epioblasma brevidens* – Cumberlandian Combshell

Prioritization: Tier 2 **Global status:** G1 **Conservation status:** federal: E
state: AL-P1, KY-E, MS-E, TN-E, VA-E

Streams with extant occurrences (all CH): Tennessee River system – upper Clinch, VA/TN; Powell, VA/TN; Bear Cr., AL/MS; Duck, TN. **Cumberland River system –** Buck Cr., KY; Big South Fork, TN/KY.

Population status: Endemic to the Cumberlandian Region, this species is found in medium and large streams throughout much of the Region. Currently, this species is restricted to a few isolated streams including the Clinch which supports the largest recruiting population in the Tennessee system and the Big South Fork, which contains the largest extant population in the Cumberland system. All other populations are small; the population in the Duck is extremely rare if not extirpated having not been seen since 1993 despite subsequent surveys. The Clinch population represents an opportunity to translocate adults for R/A activities. A 5YR has been completed. Six populations are needed for downlisting while nine populations are needed for recovery.

Potential augmentation streams: Tennessee River system – Bear Cr., AL/MS; Duck, TN.

Potential reintroduction streams: Tennessee River system – Tennessee tributary tailwaters: lower French Broad/Holston, TN (H) [NEP], Elk, AL (H), TN (M) [pending water quality/quantity improvements]; Nolichucky, TN (H) [CH]; Paint Rock, AL (H); Limestone Cr., AL (H); Copper Cr., VA (M); upper French Broad, TN (M); lower Pigeon, TN (M); Hiwassee, TN (M); Tennessee main stem tailwaters: Guntersville, AL (L), Wilson, AL (L) [NEP]; upper Holston, TN (L). **Cumberland River system –** Rockcastle, KY (H); Middle Fork Rockcastle, KY (H); Harpeth, TN (L); Red, KY/TN (L).

Reproductive biology: Bradytictic. Spawning occurs in late summer with gravid females observed from early May to June. Hosts identified through laboratory induced infections include Logperch; Wounded, Redline, Bluebreast, Snubnose, Spotted and Greenside Darters and Banded, Black and Mottled Sculpins.

Propagation difficulty: Low.

Recommended priority actions:

1) Reintroduce into Nolichucky, Paint Rock, Rockcastle
2) Augment Bear Cr., Duck populations

R/A potential: High.

(23) *Fusconaia subrotunda* – Longsolid

Prioritization: Tier 2 **Global status:** G3 **Conservation status:** federal: none AFS: V state: AL-P1, KY-S, NC-SR, TN-none, VA-none

Streams with extant occurrences: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL; Tennessee tributary tailwaters: lower Holston, TN; upper Clinch, VA/TN; Powell, VA/TN; Little, NC; Nolichucky, TN; Tellico, TN; Hiwassee, TN; Paint Rock, AL; Estill Fork, AL; Elk, TN. **Cumberland River system –** Cumberland main stem tailwaters: Cordell Hull, TN.

Population status: This species is distributed in medium and large streams in the Ohio basin. It is extirpated from the Cumberland system. Once very common in the Clinch and Powell, populations have been on the decline for 20 years. However, the best viable population still occurs in the Clinch, primarily in TN. Although several shell forms have been described from the Region, none are currently recognized as taxonomically valid; however, a rangewide taxonomic study is needed.

Potential augmentation streams: none.

Potential reintroduction localities: Tennessee River system – Tennessee tributary tailwaters: Elk, AL (H), lower French Broad/Holston, TN (M) [pending water quality/quantity improvements]; Paint Rock, AL (H); Tennessee tailwaters: Guntersville, AL (L), Pickwick Landing, TN (M), Kentucky, KY (M); Holston, TN (M); lower Pigeon, TN (M); Limestone Cr., AL (M). **Cumberland River system** – Big South Fork, TN/KY (H) [EA]; Rockcastle, KY (H); Cumberland main stem tailwaters: Barkley, KY (L).Clear Fork, TN (L); East Fork Stones, TN (L); Harpeth, TN (L); Red, KY/TN (L).

Reproductive biology: Tachytictic. Host fish are unknown, but laboratory induced infections of glochidia on congeners suggest cyprinids.

Propagation difficulty: High.

Recommended priority actions:

1) Reintroduce into Paint Rock, Elk (AL), Rockcastle, Big South Fork

R/A potential: Medium.

(24) *Obovaria subrotunda* - Round Hickorynut

Prioritization: Tier 2 **Global status:** G4 **Conservation status:** federal: none AFS: V state: AL-P1, KY-none, MS-none, TN-none

Streams with extant occurrences: Tennessee River system – Paint Rock, AL; Bear Cr., AL; Duck, TN. **Cumberland River system** – Rockcastle, KY?; Buck Cr., KY; Red, TN.

Population status: This species is distributed in small to large streams in the Ohio and Great Lakes basins. Once widely distributed and abundant in the lower two-thirds of both the Tennessee and Cumberland systems, this species has become increasingly rare in the Region. The only sizable population occurs in the Duck while smaller populations occur in the Paint Rock and Buck Cr. Other populations appear marginal at best. A status review is in progress.

Potential augmentation streams: Tennessee River system – Paint Rock, AL.

Potential reintroduction streams: Tennessee River system – Tennessee tributary tailwaters: Elk, AL (H), TN (M), lower French Broad/Holston, TN (M) [pending water quality/quantity improvements]; Nolichucky, TN (H); Limestone Cr., AL (H); Tennessee main stem tailwaters: Wilson, AL (M), Pickwick Landing, TN (M); upper French Broad, TN (M); lower Pigeon, TN (M); Hurricane Cr., AL (M); Larkin Fork, AL (L); Bear Cr., MS (L). **Cumberland River system** – Big South Fork, TN/KY (H) [EA]; Cumberland main stem tailwaters: Barkley, KY (L); Little South Fork, KY (L); Kennedy Cr., KY (L); Wolf, TN (L); East Fork Stones, TN (L); Harpeth, TN (L); Red, KY/TN (L); Whippoorwill Cr., KY (L).

Reproductive biology: Bradytictic. Hosts identified through laboratory induced infections include Variegate, Frecklebelly, Speckled, Greenside and Emerald Darters.

Propagation difficulty: Medium.

Recommended priority actions:

1) Reintroduce into Nolichucky, Elk (AL), Limestone Cr., Big South Fork
2) Augment Paint Rock population

R/A potential: Medium.

(25) *Plethobasus cyphyus* - Sheepnose

Prioritization: Tier 2 **Global status:** G3 **Conservation status:** federal: C AFS: T state: AL-P1, KY-E, TN-none, VA-E

Streams with extant occurrences: Tennessee River system – Tennessee main stem tailwaters: Guntersville, AL, Wilson, AL, Pickwick Landing, TN, Kentucky, KY; Tennessee reservoirs: Wheeler, AL; Tennessee tributary tailwaters: lower Holston, TN; upper Clinch, VA/TN; Powell, VA/TN; Duck, TN. **Cumberland River system** – Cumberland main stem tailwaters: Barkley, KY?

Population status: This species is distributed in large rivers in the Mississippi basin. The Clinch in TN and VA has the best population in the Region, but it is relatively small. It is apparently recruiting in the Tennessee below Wilson and Kentucky Dams, but its status below Barkley Dam is unknown. Although sizable, the population in the lower Holston is non-recruiting. All other populations are small. The lower Holston population may be large enough for translocating adults. A proposed rule for federal listing is in progress.

Potential augmentation streams: Tennessee River system – Duck, TN (H).

Potential reintroduction streams: Tennessee River system – Tennessee tributary tailwaters: lower French Broad, TN (H), Elk, AL (H), TN (M) [pending water quality/quantity improvement]; Nolichucky, TN (H); upper French Broad, TN (M); lower Pigeon, TN (M); Hiwassee, TN (M); upper Holston, TN (L). **Cumberland River system** – Big South Fork, TN/KY (H); Cumberland main stem tailwaters: Cordell Hull, TN (L) [pending water quality/quantity improvement].

Reproductive biology: Tachytictic. Host fish are unknown but potentially include Sauger.

Propagation difficulty: High.

Recommended priority actions:

1) Salvage lower Holston population for R/A activities
2) Reintroduce into Nolichucky, lower French Broad, Elk (AL) with translocated adults from lower Holston
3) Reintroduce into Big South Fork
4) Augment Duck population

R/A potential: Medium.

(26) *Pleurobema oviforme* – Tennessee Clubshell

Prioritization: Tier 2 **Global status:** G3 **Conservation status:** federal: none AFS: V state: AL-P1, KY-E, NC-E, TN-none, VA-none

Streams with extant occurrences: Tennessee River system – Tennessee main stem tailwaters: Watts Bar, TN; upper Clinch, VA/TN; Plum Cr., VA; Indian Cr., VA (Clinch); Little, VA; Copper Cr., VA; North Fork Clinch, VA/TN; Blackwater Cr., VA/TN; Powell, VA/TN; Obed, TN; Daddys Cr., TN; upper North Fork Holston, VA; Lick Cr., VA; Laurel Cr., VA; Cove Cr., VA; Big Moccasin Cr., VA; Possum Cr., VA; South Fork Holston, VA; Middle Fork Holston, VA; Little, TN; Little Tennessee, NC; Tellico, TN; Citico Cr., TN; Hiwassee, NC/TN; Sequatchie, TN; Paint Rock, AL; Hurricane Cr., AL; Estill Fork, TN/AL; Larkin Fork, AL; Factory Cr., TN; Duck, TN; Buffalo, TN. **Cumberland River system –** Rockcastle, KY; Horse Lick Cr., KY; Buck Cr., KY; Big South Fork, TN/KY; Little South Fork, KY; Kennedy Cr., KY; Beaver Cr., KY; Wolf, TN; Whippoorwill Cr., KY.

Population status: Endemic to the Cumberlandian Region, this species is found in small to large streams throughout most of the Region. There are multiple putative forms. In the Tennessee system, a large-river form (*P. o. holstonense*) currently appears to be nearly extirpated, a more common headwaters form (*P. o. argenteum*), an uncommon Blue Ridge form, (*P. o. ravenelianum*) and the "typical" *P. oviforme*. The Cumberland system may also have its own form which is rare and declining. Therefore, our present concept of the species may contain multiple imperiled ESUs. Brood stock and release locations for R/A activities should not be attempted pending resolution of taxonomic issues. Exceptions would be for Cumberland system actions using Cumberland system brood stock and to attempt establishing a population in the Hiwassee a few miles below the existing population at the Appalachia Powerhouse where the habitat is good despite cool water temperatures. The population that currently exists in the dewatered reach just above the powerhouse would serve as adult stock for this trial activity.

Potential augmentation streams: Tennessee River system – Hiwassee, TN. **Cumberland River system** – Rockcastle, KY; Big South Fork, TN/KY [EA].

Potential reintroduction streams: Tennessee River system – none. **Cumberland River system** – Middle Fork Rockcastle, KY (H); Roundstone Cr., KY (M); East Fork Stones, TN (M); Red, KY/TN (M).

Reproductive biology: Tachytictic. Hosts identified through laboratory induced infections include Whitetail and Common Shiners, River Chub, Central Stoneroller and Fantail Darter.

Propagation difficulty: High.

Recommended priority actions:

1) Determine taxonomic relationship between putative forms
2) Determine differences in life history between putative forms
3) Determine historical range of putative forms
4) Trial augmentation into Hiwassee below Appalachia Powerhouse
5) Reintroduce into Middle Fork Rockcastle

6) Augment Rockcastle, Big South Fork populations
7) Trial reintroduction into East Fork Stones, Red

R/A potential: Low.

(27) *Pleurobema plenum* - Rough Pigtoe

Prioritization: Tier 2 **Global status:** G1 **Conservation status:** federal: E
state: AL-P1, KY-E, TN-E, VA-E

Streams with extant occurrences: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL, Pickwick Landing, TN; upper Clinch, TN. **Cumberland River system** – Cumberland main stem tailwaters: Cordell Hull, TN.

Population status: This species is distributed in large rivers in the Ohio basin. It has become extirpated from the entire Cumberland (last collected ~1980) and most of the Tennessee systems. The only recruiting population in the Region occurs locally in the Clinch, but it is not large. It is extremely rare in the lower Tennessee main stem. The largest population rangewide occurs in the Green, KY which may offer the best practical choice for brood stock selection for lower Tennessee and Cumberland R/A actions. A 5YR is in progress. Six stream populations are needed for recovery.

Potential augmentation streams: Tennessee River system – Tennessee main stem tailwaters: Pickwick Landing, TN.

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Kentucky, KY (H), Guntersville, AL (L); Tennessee tributary tailwaters: Elk, AL (H), TN (M), lower French Broad/Holston, TN (M) [NEP] [pending water quality/quantity improvement]; Nolichucky, TN (H); Duck, TN (H); upper French Broad, TN (M); Hiwassee, TN (M); Paint Rock, AL (M). **Cumberland River system** – Big South Fork, TN/KY (M); Cumberland main stem tailwaters: Barkley, KY (L).

Reproductive biology: Tachytictic. Host fish are unknown.

Propagation difficulty: High.

Recommended priority actions:

1) Describe life history
2) Reintroduce into Nolichucky, Duck, Kentucky tailwaters
3) Augment Pickwick Landing population

R/A potential: Low.

(28) *Pleurobema rubrum* – Pyramid Pigtoe

Prioritization: Tier 2 **Global status:** G2 **Conservation status:** federal: none AFS: T state: AL-P1, KY-E, TN-none, VA-E

Streams with extant occurrences: Tennessee River system – Tennessee main stem tailwaters: Watts Bar, TN, Guntersville, AL, Wilson, AL, Pickwick Landing, TN; Tennessee tributary tailwaters: lower Clinch, TN; upper Clinch, VA/TN; Paint Rock, AL; Duck, TN. **Cumberland River system –** Cumberland main stem tailwaters: Cordell Hull, TN.

Population status: This species is distributed in large rivers in the Ohio and Mississippi basins. Its best populations in the Region are now restricted to the Clinch and Duck where both populations are limited but recruiting. The current status of populations in the main stem Tennessee are unknown, but they appear to be extremely rare. The Cumberland population, which may already be extirpated, is affected by coldwater releases that have eliminated many mussel species from the river.

Potential augmentation streams: Tennessee River system – Paint Rock, AL.

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Kentucky, KY (H); Tennessee tributary tailwaters: Elk, AL (H), TN (M), lower French Broad/Holston, TN (M) [pending water quality/quantity improvements]; Nolichucky, TN (H); upper French Broad, TN (M); lower Pigeon, TN (M); Limestone Cr., AL (M); upper Holston, TN (L). **Cumberland River system –** Big South Fork, TN/KY (M) [EA]; Cumberland main stem tailwaters: Barkley, KY (L).

Reproductive biology: Tachytictic. Host fish are unknown.

Propagation difficulty: High.

Recommended priority actions:

1) Describe life history
2) Reintroduce into Nolichucky, Elk (AL)
3) Augment Paint Rock population

R/A potential: Low.

(29) *Pleuronaia barnesiana* – Tennessee Pigtoe

Prioritization: Tier 2 **Global status:** G2 **Conservation status:** federal: none AFS: V state: AL-P2, NC-E, TN-none, VA-SC

Streams with extant occurrences: Tennessee River system – Tennessee tributary tailwaters: Elk, TN; upper Clinch, VA/TN; North Fork Clinch, VA (headwaters); South Fork Clinch, VA; Cavitts Cr, VA; Plum Cr., VA; Indian Cr., VA (Clinch); Thompson Cr., VA; Little, VA; Indian Cr., VA (Little); Copper Cr., VA; North Fork Clinch, VA/TN; Blackwater Cr., VA/TN; Powell, VA/TN; Wallen Cr., VA; Indian Cr., VA/TN (Powell); upper North Fork Holston, VA; Laurel Cr., VA; Big Moccasin Cr., VA; Possum Cr., VA; Middle Fork Holston, VA; Fifteen Mile Cr., VA; Beaver Cr., VA/TN; Nolichucky, TN; Little Chucky Cr., TN; Little Pigeon, TN; West Prong Little Pigeon, TN; Little, TN; Little Tennessee, NC; Tellico, TN; East Chickamauga Cr., GA; Paint Rock, AL; Hurricane Cr., AL; Estill Fork, TN/AL; Larkin Fork, AL; Flint, AL; Limestone Cr., AL; Round Island CR., AL; Second Cr., AL; Elk, TN; Duck, TN; Big Rock Cr., TN; Buffalo, TN.

Population status: Endemic to the Cumberlandian Region, this species is found in small to large streams throughout the Tennessee system. There are two putative forms. The Duck contains the largest (and possibly only) population of the swollen, large-river form (*F. b. tumescens*); this population should be considered separate from other populations until proven otherwise. The relatively more common compressed headwater form (*F. b. bigbyensis*) occurs in the upper two-thirds of the system but rarely in large numbers. Brood stock and release locations for R/A activities should not be attempted pending resolution of taxonomic issues.

Potential augmentation streams: none.

Potential reintroduction streams: none.

Reproductive biology: Tachytictic. Spawning is presumed to occur from late spring to mid-summer based on congeners. Hosts identified through laboratory induced infections include Whitetail and Tennessee Shiners and stonerollers.

Propagation difficulty: High.

Recommended priority actions:

1) Determine taxonomic relationship between putative forms
2) Determine differences in life history between putative forms
3) Determine historical range of putative forms

R/A potential: Low.

(30) *Pleuronaia dolabelloides* – Slabside Pearlymussel

Prioritization: Tier 2 **Global status:** G2 **Conservation status:** federal: C AFS: T state: AL-P1, KY-H, MS-E, TN-none, VA-T

Streams with extant occurrences: Tennessee River system – Tennessee tributary tailwaters: Elk, TN; upper Clinch, VA/TN; Powell, VA/TN; upper North Fork Holston, VA; Big Moccasin Cr., VA; Middle Fork Holston, VA; Hiwassee, TN; Paint Rock, AL; Hurricane Cr., AL; Estill Fork, AL; Larkin Fork, AL; Elk, TN; Bear Cr., AL/MS; Duck, TN. **Cumberland River system** – none.

Population status: Endemic to the Cumberlandian Region, this species is found in medium and large streams primarily in the Tennessee system, although it was historically known from the lower Cumberland system. The Duck and Paint Rock appear to have the best viable populations, while most other populations apparently have low viability due to past and continued declines. Populations in the upper North and Middle Forks Holston Rivers have been significantly reduced by mussel die-offs of unknown causes since the mid-1990s. The Duck population represents an opportunity to translocate adults for R/A activities. Although a genetics study determined that this was not a species complex, individuals should not be translocated between the upper and lower Tennessee system.

Potential augmentation streams: none.

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL (M), Pickwick Landing, TN (M), Guntersville, AL (L) [pending host fish surveys]; Tennessee tributary tailwaters: Elk, AL (H), lower French Broad/Holston, TN (M) [pending water quality/quantity improvement]; Nolichucky, TN (H); Limestone Cr., AL (H); upper French Broad, TN (M); lower Pigeon, TN (M); Little, TN (M); upper Holston, TN (L). **Cumberland River system** – Cumberland main stem tailwaters: Cordell Hull, TN (L); Harpeth, TN (L); Red, KY/TN (M).

Reproductive biology: Tachytictic. Spawning occurs in May and gravid females are found until late July. Hosts identfied through laboratory induced infections include Popeye, Roseyface, Saffron, Silver, Telescope and Tennessee Shiners.

Propagation difficulty: High.

Recommended priority actions:

1) Reintroduce into Nolichucky, Limestone Cr., Elk (AL)
2) Conduct host fish survey in Wilson, Cordell Hull tailwaters
3) Trial reintroduction into Wilson, Cordell Hull tailwaters, Red

R/A potential: Low.

(31) *Pleuronaia gibberum* – Cumberland Pigtoe

Prioritization: Tier 2 **Global status:** G1 **Conservation status:** federal: E
state: TN-E

Streams with extant occurrences: Cumberland River system (all TN) **–** Cane Cr., Calfkiller, Collins, Hills Cr., North Prong Barren Fork, Liberty Cr., Witty Cr., Hickory Cr.

Population status: Endemic to the Cumberlandian Region, this species is restricted to medium streams of the Barrens region of central Tennessee in the Caney Fork drainage above Great Falls. A record from Bradley Cr. (Elk drainage) is unsubstantiated. The best populations occur in the Collins, Hills Cr. and North Prong Barren Fork. Several of the Collins drainage streams are essentially a single population. Four populations are needed for downlisting while six populations are needed for recovery.

Potential augmentation streams: none.

Potential reintroduction streams: Cumberland River system (all TN) – Barren Fork (H), South Prong Barren Fork (H), West Fork Hickory Cr. (H), Scott Cr. (M), Little Hickory Cr. (M).

Reproductive biology: Tachytictic. Gravid females are found from late June to early August. Hosts identified through laboratory induced infections include Telescope and Striped Shiners.

Propagation difficulty: High.

Recommended priority actions:

1) Reintroduce into Barren Fork, South Prong Barren Fork, West Fork Hickory Cr.

R/A potential: Low.

(32) *Ptychobranchus subtentum* – Fluted Kidneyshell

Prioritization: Tier 2 **Global status:** G2G3 **Conservation status:** federal: C AFS: V state: AL-EX, KY-E, MS-E, TN-none, VA-none

Streams with extant occurrences: Tennessee River system – upper Clinch, VA/TN; Little, VA; Indian Cr., VA (Clinch); Copper Cr., VA; Powell, VA/TN; upper North Fork Holston, VA; Middle Fork Holston, VA. **Cumberland River system –** Horse Lick Cr., KY; Buck Cr., KY; Big South Fork, TN/KY?; Rock Cr., KY; Little South Fork, KY; Wolf, TN; Town Branch, TN; West Fork Obey, TN.

Population status: Endemic to the Cumberlandian Region, this species is distributed in medium and large streams in much of the Region. It has been extirpated from all but the headwaters of the Tennessee and only a few small populations persist in the Cumberland River systems. The Clinch, TN supports a huge population. A sizable but declining population occurs in the upper North Fork Holston. Other populations are small and highly disjunct. In the Cumberland system, the species is declining and becoming very rare and near extirpation at several sites. The Clinch and North Fork Holston populations represent opportunities to translocate adults for R/A activities.

Potential augmentation streams: Tennessee River system – upper Clinch, VA. **Cumberland River system –** Big South Fork, TN/KY [EA].

Potential reintroduction streams: Tennessee River system – Tennessee tributary tailwaters: Elk, AL (H), TN (M), lower French Broad/Holston, TN (M) [pending water quality/quantity improvements]; Nolichucky, TN (H); Paint Rock, AL (H); Limestone Cr., AL (H); Duck, TN (H) [RP]; Tennessee main stem tailwaters: Wilson, AL (M); South Fork Holston, VA (M); upper French Broad, TN (M); lower Pigeon, TN (M); Hiwassee, TN (M); upper Holston, TN (L). **Cumberland River system –** Rockcastle, KY (H); Clear Fork, TN (H); Middle Fork Rockcastle, KY (M); Roundstone Cr., (L); Kennedy Cr., KY (L); East Fork Stones, TN (L); Harpeth, TN (L); Red, KY/TN (L).

Reproductive biology: Bradytictic. Hosts identified through laboratory induced infections include include Banded Sculpin and Redline, Rainbow, Fantail and Barcheek Darters.

Propagation difficulty: Low. This species has been successfully propagated.

Recommended priority actions:

1) Reintroduce into Nolichucky, Paint Rock, Elk (AL), Duck, Rockcastle
2) Augment upper Clinch (VA), Big South Fork populations

R/A potential: High.

(33) *Villosa iris* – Rainbow

Prioritization: Tier 2 **Global status:** G5 **Conservation status:** federal: none AFS: none state: AL-none, KY- none, NC-SC, TN-none, VA-E

Streams with extant occurrences: Tennessee River system – upper Clinch, VA/TN, North Fork Clinch, VA (headwaters); South Fork Clinch, VA; Lincolnshire Br., VA; Cavitts Cr, VA; Plum Cr., VA; West Fork Plum Cr., VA; Deskin Cr., VA; Indian Cr., VA (Clinch); Little, VA; Indian Cr., VA (Little); Thompson Cr., VA; Weaver Cr., VA: Copper Cr., VA; North Fork Clinch, VA/TN; Blackwater Cr., VA/TN; Powell, VA/TN; Wallen Cr., VA; Hardy Cr., VA; Indian Cr., VA/TN (Powell); Emory, TN; Obed, TN; Daddys Cr., TN; upper Holston, TN; upper and lower North Fork Holston, VA/TN; Lick Cr., VA; Laurel Cr., VA; Cove Cr., VA; Big Moccasin Cr., VA; Possum Cr., VA; Middle Fork Holston, VA; Hungry Mother Cr., VA; Nolichucky, TN; Little Tennessee, NC; Tuckasegee, NC; Tellico, TN; Citico Cr., TN; Hiwassee, NC/TN; Spring Cr., TN; Sequatchie, TN; Crow Cr., TN; Paint Rock, AL; Hurricane Cr., AL; Estill Fork, TN/AL; Larkin Fork, AL; Lick Fork, AL; Flint, AL; Limestone, Cr., AL; Piney Cr., AL; Factory Cr., TN; Duck, TN. **Cumberland River system** – Rockcastle, KY; Middle Fork Rockcastle, KY; Horse Lick Cr., KY; Towne Cr., KY; Buck Cr., KY; Big South Fork, TN/KY; Rock Cr., KY; Clear Fork, TN; White Oak Cr., TN; New, TN; Wolf, TN; West Fork Obey, TN; Harpeth, TN; Red, KY/TN. There are probably many more populations than those listed here.

Population status: This species is distributed in small to large streams in the Mississippi and Great Lakes basins. There are multiple putative forms in the Region. Therefore, our present concept of the species may contain multiple ESUs if not species. Although most forms appear common, at least one (upper Tennessee system) is potentially imperiled. Brood stock and release locations for R/A activities should not be attempted pending resolution of taxonomic issues. An exception is to attempt establishing a population in the Hiwassee a few miles below the Appalachia Powerhouse where the habitat is good despite cool water temperatures. The population that currently exists in the dewatered reach just above the powerhouse would serve as adult stock for this trial activity.

Potential augmentation streams: Hiwassee, TN.

Potential reintroduction streams: none.

Reproductive biology: Bradytictic. Hosts identified through laboratory induced infections include Smallmouth, Largemouth, Spotted, Suwanee and Rock Basses and Western Mosquitofish. It is capable of having multiple spawns throughout the year.

Propagation difficulty: Low. This species has been successfully propagated.

Recommended priority actions:

1) Trial augmentation into Hiwassee below Appalachia Powerhouse
2) Determine taxonomic relationship between putative forms
3) Determine differences in life history between putative forms
4) Determine historical range of putative forms

R/A potential: High.

(34) *Villosa perpurpurea* – Purple Bean

Prioritization: Tier 2 **Global status:** G1 **Conservation status:** federal: E
state: TN-E, VA-E

Streams with extant occurrences: Tennessee River system – upper Clinch, VA [CH]; Indian Cr., VA (Clinch) [CH]; Copper Cr., VA [CH]; Emory, TN; Obed, TN [CH]; Beech Cr., TN [CH].

Population status: Endemic to the Cumberlandian Region, this species is restricted to small and medium streams in the upper Tennessee system. The best population occurs in Beech Cr. Other populations are at extremely low levels and may not be recruiting. A 5YR has been completed. Four populations are needed for downlisting while five populations are needed for recovery.

Potential augmentation streams: Tennessee River system – upper Clinch, VA; Emory, TN.

Potential reintroduction streams: Tennessee River system – Tennessee tributary tailwaters: lower French Broad/Holston, TN (H) [pending water quality/quantity improvement]; upper Clinch, TN (H); Nolichucky, TN (H); Daddys Cr., TN (M); upper North Fork Holston, VA (M); upper French Broad, TN (M); lower Pigeon, TN (M); Powell, VA/TN (L) [CH]; upper Holston, TN (L).

Reproductive biology: Bradytictic. Gravid females are found in late winter and early spring. Hosts identified through laboratory induced infections include Redline, Fantail, Greenside, Striped, Barcheek and Stripetail Darters and sculpins.

Propagation difficulty: Low.

Recommended priority actions:

1) Reintroduce into upper Clinch (TN), Nolichucky
2) Augment upper Clinch (VA), Emory populations

R/A potential: Low.

(35) *Villosa taeniata* – Painted Creekshell

Prioritization: Tier 3 **Global status:** G3G4 **Conservation status:** federal: none AFS: none state: AL-none, KY-none, TN-none

Streams with extant occurrences: Tennessee River system – Paint Rock, AL; Hurricane Cr., AL; Estill Fork, AL; Butler Cr., TN; Duck, TN; Big Rock Cr., TN; Buffalo, TN. **Cumberland River system –** Rockcastle, KY; Laurel Fork, KY (Rockcastle); Middle Fork Rockcastle, KY; South Fork Rockcastle, KY; Horse Lick Cr., KY; Roundstone Cr., KY; Sinking Cr., KY; Buck Cr., KY; Big South Fork, TN/KY; Rock Cr., KY; Little South Fork, KY; Buffalo Cr., TN; Brimstone Cr., TN; Beaver Cr., KY; Otter Cr., KY?; Wolf, TN; Roaring, TN; Smith Fork, TN; East Fork Stones, TN; West Fork Stones, TN; Middle Fork Stones, TN; Red, KY; Whippoorwill Cr., KY; Little, KY; South Fork Little, KY. There are probably more populations than those listed here.

Population status: Endemic to the Cumberlandian Region, this species is restricted to small to large streams in the lower Tennessee and Cumberland systems. There are multiple putative forms in the Region. Therefore, our present concept of the species may contain multiple ESUs if not species. Sizable populations remain in several streams in the Cumberland system. Brood stock and release locations for R/A activities should not be attempted pending resolution of taxonomic issues.

Potential augmentation streams: none

Potential reintroduction streams: none.

Reproductive biology: Bradytictic. Hosts identified through laboratory induced infections include Rock Bass.

Propagation difficulty: Low.

Recommended priority actions:

1) Determine taxonomic relationship between putative forms
2) Determine differences in life history between putative forms
3) Determine historical range of putative forms

R/A potential: High.

(36) *Villosa trabalis* - Cumberland Bean

Prioritization: Tier 2 **Global status:** G1 **Conservation status:** federal: E
state: AL-EX, KY-E, NC-SR, TN-E, VA-none

Streams with extant occurrences: Tennessee River system – Little Chucky Cr., TN?; Hiwassee, TN. **Cumberland River system –** Rockcastle, KY; Laurel Fork, KY (Rockcastle); Middle Fork Rockcastle, KY; Horse Lick Cr., KY; Sinking Cr., KY; Buck, Cr., KY; Big South Fork, TN/KY.

Population status: Endemic to the Cumberlandian Region, this species is distributed in small to large streams in much of the Region. Most populations in the Tennessee system are extirpated although the Hiwassee population is substantial but restricted to a very short reach. Cumberland system populations are mostly small with the exception of Sinking Cr, (Rockcastle drainage population) and Big South Fork. The Hiwassee population represents an opportunity to translocate adults for R/A activities. A 5YR is in progress. Five populations are needed for recovery, including at least one population in the Tennessee system).

Potential augmentation streams: Tennessee River system – none. **Cumberland River system –** Rockcastle, KY.

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL (M) [NEP] , Guntersville, AL (L) [pending host fish surveys]; Tennessee tributary tailwaters: lower French Broad/Holston, TN (H) [NEP], Elk, AL (H), TN (M) [pending water quality/quantity improvements]; upper Clinch, VA/TN (H); Nolichucky, TN (H); Paint Rock, AL (H); upper French Broad, TN (M); lower Pigeon, TN (M); Little Tennessee, NC (M); Hiwassee, NC (L). **Cumberland River system –** Roundstone Cr., KY (M); Clear Fork, TN (M); Rock Cr., KY (M); Little South Fork, KY (L); Kennedy Cr., KY (L); Wolf, TN (L); East Fork Stones, TN (L); Red, TN (L).

Reproductive biology: Bradytictic. Hosts identified through laboratory induced infections include Striped, Fantail, Redline and Greenside Darters and Banded Sculpin.

Propagation difficulty: Low. This species has been successfully propagated.

Recommended priority actions:

1) Reintroduce into upper Clinch (TN), Nolichucky, Paint Rock, Elk (AL)
2) Conduct host fish survey in Wilson tailwaters
3) Augment upper Clinch (VA) population

R/A potential: Medium.

Tier 3

(37) *Actinonaias ligamentina* – Mucket

Prioritization: Tier 3 **Global status:** G4 **Conservation status:** federal: none AFS: none state: AL-P1, KY-none, TN-none, VA-none

Streams with extant occurrences: Tennessee River system – Tennessee main stem tailwaters: Pickwick Landing, TN; Tennessee reservoirs: Wheeler, AL; Tennessee tributary tailwaters: lower French Broad/Holston, TN; upper Clinch, VA/TN; Powell, VA/TN; Nolichucky, TN; Paint Rock, AL; Duck, TN. **Cumberland River system –** Cumberland main stem tailwaters: Cordell Hull, TN; Rockcastle, KY.

Population status: This species is distributed in medium and large streams in the Mississippi and Great Lakes basins and throughout most of the Region. Populations are sizable in the Clinch and Powell, TN, but are small elsewhere. The Cumberland population, which consists solely of older individuals and is experiencing recruitment failure, is affected by coldwater releases that have eliminated many mussel species from the river. The Clinch population represents an opportunity to translocate adults for R/A activities. The putative upper Tennessee drainage form (*A. l. gibba*) may be distinct. Brood stock and release locations for R/A activities should not be attempted pending resolution of taxonomic issues.

Potential augmentation streams: none.

Potential reintroduction streams: none.

Reproductive biology: Bradytictic. Gravid females are found from late summer to early fall. Reported hosts include Banded Killifish; Black and White Crappies; Sauger; Yellow Perch; Green and Orangespotted Sunfishes; and Largemouth, Smallmouth, White and Rock Basses.

Propagation difficulty: Low. This species has been successfully propagated.

Recommended priority actions:

1) Determine taxonomic relationship between putative forms
2) Determine differences in life history between putative forms
3) Determine historical range of putative forms

R/A potential: High.

(38) *Actinonaias pectorosa* – Pheasantshell

Prioritization: Tier 3 **Global status:** G4 **Conservation status:** federal: none AFS: V state: AL-EX, KY-none, TN-none, VA-none

Streams with extant occurrences: Tennessee River system – Tennessee tributary tailwaters: Elk, AL/TN; upper Clinch, VA/TN; Indian Cr., VA (Clinch); Copper Cr., VA; Powell, VA/TN; upper North Fork Holston, VA/TN; Middle Fork Holston, VA; South Fork Holston, VA; Elk, TN; Duck, TN; Buffalo, TN. **Cumberland River system –** Cumberland above Falls, KY; Marsh Cr., KY; Rockcastle, KY; Buck Cr., KY; Big South Fork, TN/KY; Little South Fork, KY; Wolf, TN; Red, TN.

Population status: Endemic to the Cumberlandian Region, this species is distributed in medium and larger streams throughout the Region, including Cumberland River above the Falls. The largest populations occur in the Clinch, TN and Cumberland. The Duck and Big South Fork populations are small but recruiting. Most other populations appear to be in decline. The Clinch and Cumberland populations represent opportunities to translocate adults for R/A activities.

Potential augmentation streams: none.

Potential reintroduction streams: Tennessee River system – Tennessee tributary tailwaters: lower French Broad/Holston, TN (H), Elk, AL (H) [pending water quality/quantity improvements]; Nolichucky, TN (H); lower Pigeon, TN (H); Hiwassee, TN (H); Paint Rock, TN (H); Tennessee main stem tailwaters: Wilson, AL (M), Pickwick Landing, TN (M), Guntersville, AL (L); Emory, TN (M); upper French Broad, TN (M); Paint Rock, AL (M); upper Holston, TN (L). **Cumberland River system –** Clear Fork, TN (M); Smith Fork, TN (M); New, TN (L); East Fork Stones, TN (L); Harpeth, TN (L); Whippoorwill Cr., KY (L).

Reproductive biology: Bradytictic. Hosts identified through laboratory induced infections include Largemouth, Smallmouth, Spotted and Rock Basses.

Propagation difficulty: Low. This species has been successfully propagated.

Recommended priority actions:

1) Reintroduce into Nolichucky, Paint Rock, Elk (AL)

R/A potential: High.

(39) *Alasmidonta atropurpurea* – Cumberland Elktoe

Prioritization: Tier 2 **Global status:** G1G2 **Conservation status:** federal: E
state: KY-E, TN-E

Streams with extant occurrences: Cumberland River system – Laurel Fork, KY (above Falls) [CH]; Marsh Cr., KY [CH]; Sinking Cr., KY [CH]; Big South Fork, TN/KY [CH]; Rock Cr., KY; Clear Fork, TN [CH]; North Prong Clear Fork, TN [CH]; Crooked Cr., TN [CH]; White Oak Cr., TN [CH]; Bone Camp Cr., TN [CH]; New, TN [CH]; Buffalo Cr., TN; North White Oak Cr., TN [CH]; Rock Cr., KY [CH].

Population status: Endemic to the Cumberlandian Region, this species is restricted to small and medium streams of the Cumberland Plateau in the upper Cumberland River system. A large diffuse population occurs in the Big South Fork drainage (e.g., main stem; New River; Clear, North Prong Clear Forks; Crooked, White Oak, Bone Camp, Buffalo, North White Oak Creeks.). Other populations are small. The Big South Fork population represents an opportunity to translocate adults for R/A activities. A 5YR has been completed. Five populations are needed for downlisting while seven populations are needed for recovery.

Potential augmentation streams: none.

Potential reintroduction streams: Cumberland River system – Cumberland above Falls (M).

Reproductive biology: Tachytictic. Gravid females are found in winter. Hosts identified through laboratory induced infections include Northern Hogsucker, Banded Sculpin and Fantail and Redline Darters.

Propagation difficulty: High.

Recommended priority actions:

1) Trial reintroduction into Cumberland above Falls

R/A potential: Medium.

(40) *Alasmidonta raveneliana* – Appalachian Elktoe

Prioritization: Tier 3 **Global status:** G1 **Conservation status:** federal: E
state: NC-E, TN-E

Streams with extant occurrences: Tennessee River system – upper French Broad, NC; Little, NC; Mills, NC; upper Pigeon, NC; Nolichucky, NC/TN; North Toe, NC; South Toe, NC; Cane Cr., NC; Little Tennessee, NC; Tuckaseegee, NC; Cheoah, NC.

Population status: Endemic to the Cumberlandian Region, this species is restricted to medium streams of the Blue Ridge Mountains in the upper Tennessee system. The once large population in the upper Little Tennessee has experienced a massive dieoff from unknown causes. A sizable but highly localized population persists in the upper French Broad, Little and Mills. Other populations are generally small. A portion of the Cane population was recently decimated by WWTP effluents in non-compliance of state standards but habitat remains intact. The French Broad drainage population represents an opportunity to translocate adults for R/A activities. A 5YR is in progress. Four populations are needed for downlisting while six populations are needed for recovery.

Potential augmentation streams: Tennessee River system – Cane, NC.

Potential reintroduction streams: Tennessee River system – Oconaluftee, NC (H); Tennessee tributary tailwaters: middle Pigeon, NC (M) [pending water quality/quantity improvement]; upper French Broad, TN (M); Davidson, NC (M); lower Pigeon, TN (M).

Reproductive biology: Tachytictic. Release glochidia primarily in May and June. Hosts identified through laboratory induced infections include Mottled and Banded Sculpins, redhorses, minnows and darters.

Propagation difficulty: High.

Recommended priority actions:

1) Reintroduce into Oconaluftee
2) Augment Cane population

R/A potential: Medium.

(41) *Epioblasma obliquata obliquata* – Catspaw

Prioritization: Tier 3 **Global status:** G1 **Conservation status:** federal: E
state: AL-EX, KY-E, TN-E

Streams with extant occurrences: Tennessee River system – none. **Cumberland River system** – none.

Population status: This species is distributed in medium and large streams in the Ohio basin but is extirpated from the Region. It is now believed restricted to Killbuck Cr. and possibly its parent stream, the Walhonding, in OH. Efforts are on-going to bring species into captivity for propagation efforts. However, surveys in 2006 and 2007 have yielded only live males. Its current restriction to a single stream reach makes it highly susceptible to extinction. Four populations are needed for downlisting (including one each in the states of Kentucky and Tennessee) while six populations are needed for recovery (including two in Kentucky and one in Tennessee).

Potential augmentation streams: none.

Potential reintroduction streams: Tennessee River system – Duck, TN (H); Tennessee main stem tailwaters: Wilson, AL (M) [NEP], Pickwick Landing, TN (M), Kentucky, KY (M). **Cumberland River system** – Big South Fork, TN/KY (H); Cumberland main stem tailwaters: Cordell Hull, TN (L) [pending water quality/quantity improvement].

Reproductive biology: Bradytictic. Host fish are unknown, but laboratory induced infections of glochidia on congeners suggest darters and sculpins.

Propagation difficulty: High.

Recommended priority actions:

1) Continue to survey for brood stock
2) Describe life history

R/A potential: Low.

(42) *Epioblasma triquetra* – Snuffbox

Prioritization: Tier 3 **Global status:** G3 **Conservation status:** federal: none AFS: T state: AL-P1, KY-E, MS-E, TN-none, VA-E

Streams with extant occurrences: Tennessee River system – upper Clinch, VA/TN; Powell, VA/TN; Nolichucky, TN?; Paint Rock, AL; Elk, TN/AL; Duck, TN. **Cumberland River system –** Buck Cr., KY.

Population status: This species is distributed in medium and large streams in the Mississippi and Great Lakes basins. Sizable populations occur in the Clinch, TN, and Paint Rock; all other populations in the Region are small. A proposed rule for federal listing is in progress.

Potential augmentation streams: Tennessee River system – Tennessee tributary tailwaters: Elk, AL; Nolichucky, TN; Duck, TN. **Cumberland River system –** none.

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL (H), Pickwick Landing, TN (H), Guntersville, AL (L); Tennessee tributary tailwaters: lower French Broad/Holston, TN (H) [pending water quality/quantity improvement]; Nolichucky, TN (H); upper French Broad, TN (M); lower Pigeon, TN (M); Hiwassee, TN (M); Limestone Cr., AL (M); upper Holston, TN (L); Bear Cr., AL/MS (L). **Cumberland River system –** Rockcastle, KY (H); Big South Fork, TN/KY (H) [EA]; Little South Fork, KY (L); East Fork Stones, TN (L); Harpeth, TN (L); Red, KY/TN (L).

Reproductive biology: Bradytictic. Hosts identified through laboratory induced infections include Logperch, Blackside Darter and Banded Sculpin.

Propagation difficulty: Low. This species has been successfully propagated.

Recommended priority actions:

1) Reintroduce into Nolichucky, Rockcastle, Big South Fork
2) Augment Nolichucky, Elk (AL), Duck populations
3) Trial reintroduction into Limestone Cr.

R/A potential: High.

(43) *Lampsilis abrupta* – Pink Mucket

Prioritization: Tier 3 **Global status:** G2 **Conservation status:** federal: E
state: AL-P1, KY-E, TN-E

Streams with extant occurrences: Tennessee River system – Tennessee main stem tailwaters: all; Tennessee tributary tailwaters: lower French Broad/Holston, TN; upper Clinch, TN; Paint Rock, AL; Bear Cr., AL. **Cumberland River system –** Cumberland main stem tailwaters: Cordell Hull, TN; Cumberland reservoirs: Old Hickory, TN.

Population status: This species is distributed in large rivers in the Mississippi basin. It is uncommon but recruiting in some main stem tailwaters of the Region (e.g., Tennessee, Pickwick Landing, possibly Guntersville, Wilson). The Cumberland population, although recruiting at a low level, is affected by coldwater releases that have eliminated many mussel species from the river. Tributary records except for the Clinch are not considered chance occurrences from having highly mobile hosts and not true populations. A 5YR is in progress. Recovery criteria are not contingent upon additional populations in the Region.

Potential augmentation streams: Tennessee River system – upper Clinch, TN; Paint Rock, AL.

Potential reintroduction streams: Tennessee River system – Tennessee tributary tailwaters: Elk, AL (H), TN (M) [pending water quality/quantity improvement]; Nolichucky, TN (H); Duck, TN (H) [RP]; Emory, TN (M); upper French Broad, TN (M); upper Holston, TN (L); Hiwassee, TN (L). **Cumberland River system –** Cumberland main stem tailwaters: Barkley, KY (H); Rockcastle, KY (M); Big South Fork, TN/KY (M).

Reproductive biology: Bradytictic. Hosts identified through laboratory induced infections include Smallmouth, Spotted and Largemouth Basses; Sauger and Walleye.

Propagation difficulty: Low. This species has been successfully propagated.

Recommended priority actions:

1) Reintroduce into Nolichucky, Elk (AL), Duck, Barkley tailwaters
2) Augment upper Clinch (TN), Paint Rock populations

R/A potential: High.

(44) *Lasmigona holstonia* – Tennessee Heelsplitter

Prioritization: Tier 3 **Global status:** G3 **Conservation status:** federal: none AFS: V state: AL-P2, NC-E, TN-none, VA-E

Streams with extant occurrences: Tennessee River system – upper Clinch, VA; North Fork Clinch, VA (headwaters); South Fork Clinch, VA; Cavitts Cr, VA; Plum Cr., VA; West Fork Plum Cr., VA; Indian Cr., VA (Clinch); Copper Cr., VA?; North Fork Clinch, VA/TN; Blackwater Cr., VA/TN; upper North Fork Holston, VA; Middle Fork Holston, VA; Beech Cr., TN; Mills, NC; Iotla Cr., NC; Sequatchie, TN. There are probably many more populations than those listed here.

Population status: Endemic to the Cumberlandian Region, this species is distributed in small streams in the upper Tennessee system. Populations in the Mobile Basin that have been attributed to this species are likely a distinct taxon. Extant populations may exist in unsampled extremely small streams. Sizable populations occur in the Clinch headwaters and possibly in tributaries of the French Broad, Holston and Hiwassee. The populations in the Mills and some Little Tennessee tributaries in NC may represent a distinct Blue Ridge form. Populations in the Clinch headwaters represent opportunities to translocate adults for R/A activities.

Potential augmentation streams: none.

Potential reintroduction streams: Tennessee River system – Obed, TN (H); Nolichucky, TN (H); Little, TN (H); Hiwassee, TN (H); Little, VA (M); Emory, TN (M); White's Cr., TN (M); Clear Cr., TN (M); lower Pigeon, TN (M); Tellico, TN (M); upper Holston, TN (L).

Reproductive biology: Bradytictic. Gravid females are found in February. Hosts identified through laboratory induced infections include Mottled Sculpin, Margined Madtom and Fantail and Greenside Darters.

Propagation difficulty: Medium. This species has been successfully propagated.

Recommended priority actions:

1) Reintroduce into Obed, Nolichucky, Hiwassee

R/A potential: Low.

(45) *Leptodea leptodon* – Scaleshell

Prioritization: Tier 2 **Global status:** G1 **Conservation status:** federal: E
state: AL-EX, KY-EX, TN-E

Streams with extant occurrences: Tennessee River system – none. **Cumberland River system –** none.

Population status: This species is distributed in medium and large rivers in the Mississippi basin but is extirpated from east of the Mississippi, including the Region. With the exception of the Meramec, Bourbeuse and Gasconade in MO, all streams listed as supporting the scaleshell are based on a few or single specimens collected during recent surveys. A recovery plan is in progress.

Potential augmentation streams: none.

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL (H), Pickwick Landing, TN (H), Kentucky, KY (M), Guntersville, AL (L); Tennessee tributary tailwaters: lower French Broad/Holston (H) [pending water quality/quantity improvement]; Duck, TN (H) [RP]; upper Holston, TN (L). **Cumberland River system** – Big South Fork, TN/KY (M) [EA].

Reproductive biology: Bradytictic. Gravid females are found from August to June. Hosts identified through laboratory induced infections include Freshwater Drum.

Propagation difficulty: High.

Recommended priority actions:

1) Reintroduce into Wilson, Pickwick Landing tailwaters, Duck

R/A potential: Low.

(46) *Medionidus conradicus* – Cumberland Moccasinshell

Prioritization: Tier 3 **Global status:** G3G4 **Conservation status:** federal: none AFS: V state: AL-P1, KY-none, TN-none, VA-none

Streams with extant occurrences: Tennessee River system – upper Clinch, VA/TN; Cavitts Cr, VA; Indian Cr., VA (Clinch); Little, VA; Indian Cr., VA (Little); Copper Cr., VA; Blackwater Cr., VA/TN; Powell, VA/TN; Wallen Cr., VA; Indian Cr., VA/TN (Powell); Obed, TN; upper North Fork Holston, VA; Lick Cr., VA; Laurel Cr., VA; South Fork Holston, VA; Middle Fork Holston, VA; Hungry Mother Cr., VA; Tellico, TN; Citico Cr., TN; Paint Rock, AL; Hurricane Cr., AL; Estill Fork, TN/AL; Duck, TN. **Cumberland River system –** Rockcastle, KY; Middle Fork Rockcastle, KY; Horse Lick Cr., KY; Buck Cr., KY; Big South Fork, TN/KY; Little South Fork, KY; Beaver Cr., KY; Obey, TN; Wolf, TN; Cane Cr., TN; Red, KY/TN.

Population status: Endemic to the Cumberlandian Region, this species is distributed in small to large streams throughout the Region. The largest populations occur in the Clinch and Powell with sizable populations in the Duck, Obed and upper North Fork Holston. Remaining populations are mostly small. A reintroduction into the upper Holston, TN, appears to have failed. The Clinch population represents an opportunity to translocate adults for R/A activities.

Potential augmentation streams: none.

Potential reintroduction streams: Tennessee River system – Tennessee tributary tailwaters: lower French Broad/Holston, TN (H), Elk, AL (H), TN (M) [pending water quality/quantity improvements]; Nolichucky, TN (H); lower Pigeon, TN (H); Little, TN (H); Hiwassee, TN (H); Emory, TN (M); upper French Broad, NC/TN (M); North Fork Clinch, VA/TN (L); upper Holston, TN (L); Possum Cr., VA (L), Bear Cr., AL/MS (L). **Cumberland River system –** Clear Fork, TN (M); White Oak Cr., TN (M); North White Oak Cr., TN (M); Kennedy Cr., KY (L); Rock Cr., KY (L); New, TN (L); Kennedy Cr., KY (L); East Fork Stones, TN (L); Harpeth, TN (L).

Reproductive biology: Bradytictic. Hosts identified through laboratory induced infections include Fantail, Rainbow, Striped, Redline, Wounded, Bluebreast and Tippecanoe Darters and Warmouth.

Propagation difficulty: Low.

Recommended priority actions:

1) Reintroduce into Nolichucky, Elk (AL), lower Pigeon
2) Trial reintroduction into Clear Fork (TN)

R/A potential: High.

(47) *Obovaria retusa* – Ringpink

Prioritization: Tier 3 **Global status:** G1 **Conservation status:** federal: E
state: AL-P1, KY-E, TN-E

Streams with extant occurrences: Tennessee River system – none. **Cumberland River system** – none.

Population status: This species is distributed in large rivers in the Ohio basin but is extirpated from the Region. This critically imperiled species persists only in the Green, KY, where it is extremely rare. Surveys for brood stock continue. Six populations are needed for downlisting (including two each in Kentucky and Tennessee) while nine populations are needed for recovery (including two populations in Kentucky with one in either the lower Tennessee or Cumberland and another in an Ohio tributary in Kentucky and two populations in the Tennessee system).

Potential augmentation streams: none.

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL (H), Pickwick Landing, TN (H); Tennessee tributary tailwaters: lower French Broad/Holston, TN (M) [NEP], Elk, AL (M) [pending water quality/quantity improvement]; upper Clinch, TN (H); Duck, TN (H) [RP]; upper French Broad, TN (M). **Cumberland River system** – Cumberland main stem tailwaters: Cordell Hull, TN (L) [pending water quality/quantity improvement], Barkley, KY (L).

Reproductive biology: Probably bradytictic. Biology presumably similar to its congener *O. subrotunda*. Host fish are unknown.

Propagation difficulty: Medium.

Recommended priority actions:

1) Continue to survey for brood stock
2) Describe life history

R/A potential: Low.

(48) *Pleurobema clava* – Clubshell

Prioritization: Tier 3 **Global status:** G2 **Conservation status:** federal: E
state: AL-EX, KY-E, TN-E

Streams with extant occurrences: Tennessee River system – none. **Cumberland River system** – none.

Population status: This species is distributed in small to large streams in the Ohio basin but is extirpated from the Region. Due to its similarity with *P. oviforme*, its historical distribution in the Region is questionable. It appears to have occurred in the lower Tennessee and Cumberland systems. There are questionable records for the Duck in 2004 and Big South Fork in 2002. A study is needed to determine if historical records in the Region are valid. The population in the Green, KY could potentially provide brood stock for propagation efforts in the Region if they are warranted. Recovery criteria are not contingent upon additional populations in the Region.

Potential augmentation streams: none.

Potential reintroduction streams: none.

Reproductive biology: Tachytictic. Hosts identified through laboratory induced infections include Striped Shiner, Central Stoneroller, Blackside Darter and Logperch.

Propagation difficulty: Medium.

Recommended priority actions:

1) Determine taxonomic relationship with *P. oviforme*
2) Determine if records from the Region are valid

R/A potential: Medium.

(49) *Pleurobema cordatum* – Ohio Pigtoe

Prioritization: Tier 3 **Global status:** G3 **Conservation status:** federal: none AFS: V state: AL-none, KY-none, TN-none, VA-E

Streams with extant occurrences: Tennessee River system – Tennessee main stem tailwaters: all; Tennessee tributary tailwaters: lower Clinch, TN, lower French Broad/Holston, TN; upper Clinch, TN; Nolichucky, TN; Paint Rock, AL; Duck, TN. **Cumberland River system –** Cumberland main stem tailwaters: all.

Population status: This species is distributed in large rivers in the Ohio basin. A sizable population occurs in the Pickwick Landing tailwaters. Large populations may also occur in other Tennessee and Cumberland main stem tailwaters but are primarily non-recruiting. The middle Cumberland population is affected by coldwater releases that have eliminated many mussel species from the river.

Potential augmentation streams: none.

Potential reintroduction streams: Tennessee River system – Tennessee tributary tailwaters: Elk, AL (L), TN (L) [pending water quality/quantity improvement]; upper French Broad, TN (L); upper Holston, TN (L); Hiwassee, TN (L). **Cumberland River system –** Rockcastle, KY (L); Big South Fork, TN/KY (L) [EA]; Harpeth, TN (L); Red, TN (L).

Reproductive biology: Tachytictic. Gravid females are found in June. Hosts identified through laboratory induced infections include Bluegill and Rosefin Shiner.

Propagation difficulty: High.

Recommended priority actions:

1) Conduct host fish survey in Region tailwaters

R/A potential: Low.

(50) *Pleurobema sintoxia* – Round Pigtoe

Prioritization: Tier 3 **Global status:** G4 **Conservation status:** federal: none AFS: none state: AL-P1, KY-none, TN-none

Streams with extant occurrences: Tennessee River system – Tennessee main stem tailwaters: Guntersville, AL, Wilson, AL; Tennessee tributary tailwaters: lower Holston, TN; Nolichucky, TN; Duck, TN. **Cumberland River system** – Cumberland main stem tailwaters: Cordell Hull, TN; Rockcastle, KY; Horse Lick Cr., KY; Big South Fork, TN/KY.

Population status: This species is distributed in medium and large streams in the Mississippi basin. The largest population in the Region exists in the Big South Fork. All other populations are small and may be experiencing recruitment failure. The Cumberland population is affected by coldwater releases that have eliminated many mussel species from the river. The Big South Fork population represents an opportunity to translocate adults for R/A activities.

Potential augmentation streams: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL (M), Guntersville, AL (L) [pending host fish surveys]; Tennessee tributary tailwaters: lower Holston, TN (H) [pending water quality/quantity improvements]; Nolichucky, TN (H); Duck, TN (H). **Cumberland River system –** Cumberland main stem tailwaters: Cordell Hull, TN (M) [pending water quality/quantity improvement]; Rockcastle, KY (M); Horse Lick Cr., KY (L); Big South Fork, TN/KY (L).

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Pickwick Landing, TN (M), Kentucky, KY (M) [pending host fish surveys]; Tennessee tributary tailwaters: Elk, AL (H), TN (M), lower French Broad, TN (M) [pending water quality/quantity improvements]; upper Clinch, TN (H); Paint Rock, AL (H); upper French Broad, TN (M); lower Pigeon, TN (M); upper Holston, TN (L); Hiwassee, TN (L). **Cumberland River system –** Cumberland main stem tailwaters: Barkley, KY (L); Middle Fork Rockcastle, KY (L); Little South Fork, KY (L); East Fork Stones, TN (L); Harpeth, TN (L); Red, KY/TN (L).

Reproductive biology: Tachytictic. Gravid females are found from late spring to early summer. Hosts identified through laboratory induced infections include Spotfin Shiner, Bluntnose Minnow, Northern Redbelly Dace and possibly Bluegill.

Propagation difficulty: High.

Recommended priority actions:

1) Conduct host fish survey in Region tailwaters
2) Reintroduce into upper Clinch (TN), Paint Rock, Elk (AL)

R/A potential: Low.

(51) *Quadrula cylindrica cylindrica* – Rabbitsfoot

Prioritization: Tier 3 **Global status:** G3 **Conservation status:** federal: none AFS: T state: AL-P1, KY-T, MS-E, TN-none

Streams with extant occurrences: Tennessee River system – Tennessee main stem tailwaters: Pickwick Landing, TN, Kentucky, KY; Tennessee tributary tailwaters: Elk, TN; Paint Rock, AL; Bear Cr., AL/MS; Duck, TN. **Cumberland River system –** East Fork Stones, TN; Red, KY/TN.

Population status: This species is distributed in medium and large streams in the Mississippi and Great Lakes basins. The Duck has the largest population in the Region while populations in the Paint Rock and Tennessee main stem tailwaters (Pickwick Landing and Kentucky) are also recruiting. Remaining populations are small with those in the Cumberland system on the verge of extirpation. The Paint Rock and Duck populations represent opportunities to translocate adults for R/A activities.

Potential augmentation streams: none.

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL (H), Guntersville, AL (L); Tennessee tributary tailwaters: lower French Broad/Holston, TN (M) [pending water quality/quantity improvement]; Nolichucky, TN (H); Emory, TN (M); upper French Broad, TN (M); lower Pigeon, TN (M); Hiwassee, TN (M); Limestone Cr., AL (M); Buffalo, TN (M); Shoal Cr., TN/AL (L). **Cumberland River system –** Rockcastle, KY (H); Big South Fork, TN/KY (H) [EA]; Cumberland main stem tailwaters: Barkley, KY (M); Little South Fork, KY (L); Clear Fork, TN (L); Harpeth, TN (L); Red, KY/TN (L).

Reproductive biology: Tachytictic. Spawning probably occurs from May to July. Hosts identified through laboratory induced infections include Cardinal, Striped, Blacktail, Emerald, Red, Bluntface, Spotfin and Rosyface Shiners.

Propagation difficulty: High.

Recommended priority actions:

1) Reintroduce into Nolichucky, Elk (AL), Wilson tailwaters, Big South Fork
2) Trial reintroduction into Limestone Cr.

R/A potential: Low.

(52) *Quadrula fragosa* – Winged Mapleleaf

Prioritization: Tier 2 **Global status:** G1 **Conservation status:** federal: none AFS: V state: KY-EX, TN-E

Streams with extant occurrences: Tennessee River system – none. **Cumberland River system –** none.

Population status: This species is distributed in large rivers in the Mississippi basin but is extirpated from the Region. Current populations are restricted to MN/WI (St. Croix), MO (Bourbeuse), AR (Ouachita, Saline) and OK (Little). Recruitment has been induced in the St. Croix with the introduction of caged fish infected with glochidia. Three populations are needed for downlisting and five populations are needed for recovery.

Potential augmentation streams: None.

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL (L) [NEP], Pickwick Landing, TN (L); Duck, TN (H) [RP]. **Cumberland River system –** Big South Fork, TN/KY (M) [EA]; Cumberland main stem tailwaters: Barkley, KY (L).

Reproductive biology: Tachytictic. Hosts identified through laboratory induced infections include Channel and Blue Catfishes.

Propagation difficulty: High. The species is being propagated with some success.

Recommended priority actions:

1) Reintroduce into Duck

R/A potential: Low.

(53) *Simpsonaias ambigua* – Salamander Mussel

Prioritization: Tier 3 **Global status:** G3 **Conservation status:** federal: none AFS: V state: KY-T, TN-none

Streams with extant occurrences: Tennessee River system – Duck, TN. **Cumberland River system –** none.

Population status: This species is distributed in medium and large streams in the Mississippi and Great Lakes basins. Historically, this species was considered to occur in the Region only in the Cumberland system, where all populations are now considered extirpated. However, the species was recently discovered in the lower Duck in 2003. This species may have been overlooked since it is often found under slab rocks where its host (*Necturus*) resides. The status of the Duck population is unknown, but source populations are available in portions of the Ohio basin (e.g., Allegheny, PA).

Potential augmentation streams: Tennessee River system – Duck, TN.

Potential reintroduction streams: Tennessee River system – Buffalo, TN (M). **Cumberland River system –** Smith Fork, TN (M); Red, KY/TN (M); East Fork Stones, TN (L); Harpeth, TN (L).

Reproductive biology: Bradytictic. Gravid females are found from October to May. Host is an amphibian, the Mudpuppy.

Propagation difficulty: Unknown.

Recommended priority actions:

1) Trial reintroduction into Buffalo, Smith Fork, Red
2) Augment Duck population

R/A potential: Low.

(54) *Toxolasma lividum* – Purple Lilliput

Prioritization: Tier 3 **Global status:** G2 **Conservation status:** federal: none AFS: V state: AL-none, KY-E, TN-none, VA-E

Streams with extant occurrences: Tennessee River system – Tennessee main stem tailwaters: Guntersville, AL, Wilson, AL; Tennessee reservoirs: Wheeler, AL; upper Clinch, TN?; Emory, TN; upper North Fork Holston, VA?; Tellico, TN; Paint Rock, AL; Hurricane Cr., AL; Estill Fork, TN/AL; Larkin Fork, AL; Lick Fork, AL; Flint, AL; Limestone Cr., AL; Piney Cr., AL; Shoal Cr., AL; Duck, TN; Big Rock Cr., TN; Buffalo, TN; Clarks, KY. **Cumberland River system –** Rockcastle, KY; Middle Fork Rockcastle, KY; Horse Lick Cr., KY; Buck Cr., KY; Little South Fork, KY; Wolf, TN.

Population status: This species is distributed in small to medium streams in the Mississippi and Great Lakes basins. Paradoxically, the species has been nearly extirpated from the upper Tennessee system but can be found in the Tennessee's Wheeler Reservoir. Sizable populations occur in the Duck and Paint Rock drainages.

Potential augmentation streams: Tennessee River system – upper Clinch, TN. **Cumberland River system –** none.

Potential reintroduction streams: Tennessee River system – Nolichucky, TN (H); lower Pigeon, TN (M); Hiwassee, TN (M). **Cumberland River system –** Big South Fork, TN/KY (H); Clear Fork, TN (M); Roundstone Cr., KY (M); Kennedy Cr., KY (L); East Fork Stones, TN (L); Harpeth, TN (L); Red, KY/TN (L).

Reproductive biology: Bradytictic. Gravid females are found in September. Hosts identified through laboratory induced infections include Green and Longear Sunfishes.

Propagation difficulty: Low.

Recommended priority actions:

1) Reintroduce into Nolichucky, Big South Fork
2) Augment upper Clinch (TN) population

R/A potential: High.

(55) *Venustaconcha sima* – no common name

Prioritization: Tier 3 **Global status:** G3? **Conservation status:** federal: none AFS: ND state: TN-none

Streams with extant occurrences: Cumberland River system (all TN) – Cane Cr., Calfkiller, Collins, Scott Cr., Hills Cr., Barren Fork, North Prong Barren Fork, South Prong Barren Fork, Liberty Cr., Pocahontas Br., Witty Cr., Hickory Cr., Little Hickory Cr.

Population status: Endemic to the Cumberlandian Region, it is restricted to small and medium streams of the Barrens region of central Tennessee in the Caney Fork drainage above Great Falls. It appears to be the upper Caney Fork drainage form of *Villosa iris* but was not recognized by AFS. Several populations represent opportunities to translocate adults for R/A activities.

Potential augmentation streams: none.

Potential reintroduction streams: none.

Reproductive biology: Bradytictic. Gravid females are found in September. Host identified through laboratory induced infections included Banded Sculpin.

Propagation difficulty: Low.

Recommended priority actions:

1) Determine taxonomic relationship with *V. iris*
2) Determine differences in life history with *V. iris*

R/A potential: High.

(56) *Villosa fabalis* – Rayed Bean

Prioritization: Tier 3 **Global status:** G1G2 **Conservation status:** federal: C AFS: V state: AL-EX?, KY-EX, TN-none, VA-none

Streams with extant occurrences: Tennessee River system – none.

Population status: This species is distributed in small to large streams in the Ohio and Great Lakes basins but is extirpated from the Region. Paradoxically it was never known from the Cumberland system. The large population in the Allegheny, PA is a possible source of individuals for adult translocations or brood stock for propagation efforts. A proposed rule for federal listing is in progress.

Potential augmentation streams: Tennessee River system – none.

Potential reintroduction streams: Tennessee River system –Tennessee tributary tailwaters: lower French Broad/Holston, TN (H), Elk, AL (H), TN (M) [pending water quality/quantity improvements]; upper Clinch, TN (H), VA (M); Nolichucky, TN (H); Duck, TN (H) [RP]; upper North Fork Holston, VA (M); South Fork Holston, VA (M); upper French Broad, TN (M); lower Pigeon, TN (M); upper Holston, TN (L).

Reproductive biology: Bradytictic. Gravid females are found in May. Hosts identified through laboratory induced infections include the Tippecanoe Tarter. Potential hosts may include sculpins; Greenside, Rainbow, Fantail, Bluebreast and Spotted Darters and Largemouth Bass.

Propagation difficulty: Unknown.

Recommended priority actions:

1) Reintroduce into upper Clinch (TN), Nolichucky, Duck

R/A potential: Medium.

(57) *Villosa vanuxemensis* – Mountain Creekshell

Prioritization: Tier 3 **Global status:** G4 **Conservation status:** federal: none AFS: V state: AL-none, KY-T, NC-T, TN-none, VA-none

Streams with extant occurrences: Tennessee River system – upper Clinch, VA/TN; Indian Cr., VA (Clinch); Little, VA; Indian Cr., VA (Little); Copper Cr., VA; North Fork Clinch, VA/TN; Blackwater Cr., VA/TN; Powell, VA/TN; Wallen Cr., VA; Hardy Cr., VA; Martin Cr., VA; Indian Cr., VA/TN (Powell); Obed, TN; upper Holston, TN; upper and lower North Fork Holston, VA/TN; Lick Cr., VA; Cove Cr., VA; Big Moccasin Cr., VA; Possum Cr., VA; South Fork Holston, VA; Middle Fork Holston, VA; Hungry Mother Cr., VA; Wolf Cr., VA; Beaver Cr., VA/TN; Nolichucky, TN; Little Pigeon, TN; Little Tennessee (Calderwood Bypass), TN; Tellico, TN; Citico Cr., TN; Hiwassee, NC/TN; Spring Cr., TN; Little Wolftever Cr., TN; North Chickamauga Cr., TN; Sequatchie, TN; Little Sequatchie, TN; Paint Rock, AL; Hurricane Cr., AL; Estill Fork, AL; Larkin Fork, AL; Paint Lick Cr., AL; Flint, AL; Limestone Cr., AL; Piney Cr., AL; Round Island Cr., AL; Swan Cr., AL; Factory Cr., TN; Buzzard Roost Cr., AL; Duck, TN; Buffalo, TN. **Cumberland River system –** Red, KY/TN; Little, KY. There are probably many more populations than those listed here.

Population status: Endemic to the Cumberlandian Region, this species is restricted to small to large streams throughout the Tennessee and lower half of the Cumberland systems. Sizable populations remain in several streams in the Tennessee system (e.g., Clinch, Duck). Several populations represent opportunities to translocate adults for R/A activities.

Potential augmentation streams: none.

Potential reintroduction streams: Tennessee River system – Tennessee tributary tailwaters: lower French Broad/Holston, TN (H), Elk, AL (H), TN (M) [pending water quality/quantity improvements]; Emory, TN (H); lower Pigeon, TN (H); Little, TN (H); upper French Broad, TN (M); Bear Cr., AL/MS (L). **Cumberland River system –** Whippoorwill Cr., KY (L), South Fork Little, KY (L).

Reproductive biology: Bradytictic. Gravid females are found from September to June. Hosts identified through laboratory induced infections include Banded, Black, Mottled and Slimy sculpins; darters in the *Etheostoma* subgenus *Nothonotus* and Rock Bass.

Propagation difficulty: Low.

Recommended priority actions:

1) Reintroduce into lower Pigeon, Elk (AL)

R/A potential: High.

SNAILS

Tier 1

(1) *Athearnia anthonyi* - Anthony's Riversnail

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: E AFS: - E state: AL-P1, TN-E

Streams with extant occurrences: Tennessee River system – Tennessee tailwaters [Nickajack, TN/AL]; Big Limestone Cr., AL; Sequatchie, TN.

Population status: Endemic to the Cumberlandian Region, this species is restricted to medium to large streams in the middle Tennessee system. It is recruiting in the Tennessee, Nickajack Dam tailwater (below confluence of Sequatchie) to just downstream of Long Island. A large recruiting population also exists in Limestone Cr., AL. A small population remains in the lower Sequatchie that was last observed recruiting in 2003. Enough adult individuals are available from populations in Limestone Cr. and possibly Tennessee for translocations. A total of 4000 individuals were transplanted from Limestone Cr. to the Wilson Dam tailwater NEP (at Buck Island) between 2003 and 2008. Recruitment of this reintroduced population was observed in 2008.

Potential augmentation streams: Tennessee River system – Sequatchie, TN.

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL (H) [NEP]; Tennessee tributary tailwaters: lower French Broad/Holston, TN (H) [NEP] [pending water quality/quantity improvement]; Nolichucky, TN (H) [only if it is determined that *A. anthonyi* is appropriate to be translocated here since closely related *A. crassa* is considered extinct].

Reproductive biology: New recruits appear in between May and July in the Limestone Cr. population. Nothing else is known about its life history.

Propagation difficulty: Unknown. It has not been cultured to date. Collection of brood stock for propagation trials should not be a problem.

Recommended priority actions:

1) Continue reintroduction into Wilson tailwaters
2) Complete updated survey efforts of the Sequatchie population
3) Determine if translocation into Nolichucky is warranted

R/A potential: High.

(2) *Campeloma decampi* - Slender Campeloma

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: E **AFS:** E
State: AL-P1 **AFS:** E

Streams with extant occurrences (all AL): Tennessee River system – Limestone, Piney, Round Island Creeks; Flint?

Population status: Endemic to the Cumberlandian Region, this species is restricted to small to medium streams in the middle Tennessee system. The range of *Campeloma decampi* has been reduced to populations in three to five Tennessee tributaries, but existing populations do not appear to be imminently imperiled.

Potential augmentation streams: None.

Potential reintroduction streams: Tennessee River system (all AL) – Paint Rock (H), Byrd Spring Swamp (H).

Reproductive biology: *Campeloma decampi* is ovoviviparous. Nothing else is known about its life history.

Propagation difficulty: Unknown. It has not been cultured to date. Collection of adequate brood stock for culture trials should not be difficult.

Recommended priority actions:

1) Verify identity of Flint population
2) Reintroduce into Paint Rock, Byrd Spring Swamp

R/A potential: Medium to high.

(3) *Elimia nassula* - Round-rib Elimia

Prioritization: Tier 2 **Global status:** G1 **Conservation status:** federal: none AFS: E state: AL-P1

Streams with extant occurrences: Tennessee River system (all AL) – Tuscumbia, Buzzard Roost, Wheeler, Big, Cave Springs.

Population status: Endemic to the Cumberlandian Region, this species is restricted to springs in the middle Tennessee system. Tuscumbia Spring, type locality of *E. nassula*, underwent "improvements" in 2001, but the snail survived in the spring run. The remaining populations are believed to be healthy. Buzzard Roost and Cave Springs are on federal property (Natchez Trace Parkway and Wheeler National Wildlife Refuge, respectively), so should be secure. Big Spring lies in a park in downtown Huntsville and the snail is extant in the spring proper but absent from the spring run (which flows through a concrete channel). The Big Spring population should be secure unless "improvements" are made.

Potential augmentation streams: None.

Potential reintroduction streams: None.

Reproductive biology: Unknown.

Propagation difficulty: Unknown. It has not been cultured to date. Collection of adequate brood stock for culture trials should not be difficult.

Recommended priority actions:

1) Determine taxonomic relationship with *Elimia perstriata*, *E. acuta and E. laqueata*
2) Survey other Tennessee drainage springs to search for additional populations

R/A potential: Medium to high.

(4) *Elimia perstriata* - Engraved Elimia

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: none AFS: E state: AL-P1

Streams with extant occurrences: Tennessee River system (all AL) – Cole Spring Br., Big Spring Br., Flint.

Population status: Endemic to the Cumberlandian Region, this species is restricted to medium streams in the middle Tennessee system. The range of *Elimia perstriata* is not well understood, but known populations do not appear to be imminently imperiled.

Potential augmentation streams: None.

Potential reintroduction streams: None.

Reproductive biology: Unknown.

Propagation difficulty: Unknown. It has not been cultured to date. Collection of adequate brood stock for culture trials should not be difficult.

Recommended priority actions:

1) Determine taxonomic relationship with *Elimia acuta*, *E. laqueata* and *E. nassula*
2) Survey other Tennessee system springs to search for additional populations

R/A potential: Medium to high.

(5) *Elimia troostiana* - Mossy Elimia

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: none AFS: E state: TN-none

Streams with extant occurrences: Tennessee River system (all TN) – Murphy Cr., Cardwell Spring, Beaver Cr.

Population status: Endemic to the Cumberlandian Region, this species is restricted to small streams and springs in the upper Tennessee system in east TN. The status of this species has not been assessed since 1994. During that survey, populations found in the streams listed above were localized.

Potential augmentation streams: Unknown.

Potential reintroduction streams: Unknown.

Reproductive biology: Unknown.

Propagation difficulty: Unknown. It has not been cultured to date. Difficulty in the collection of brood stock for culture trials is unknown.

Recommended priority actions:

1) Determine taxonomic relationship with *Elimia troostiana* and *E. arachnoidea*
2) Survey other Tennessee system springs and small streams in east TN to search for additional populations

R/A potential: Medium.

(6) *Leptoxis umbilicata* - Umbilicate Rocksnail

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: none AFS: E state: TN - none

Streams with extant occurrences: Cumberland River system – Collins, TN?; Stones, TN?; Red, TN/KY?; Ringgold Cr., TN?

Population status: Endemic to the Cumberlandian Region, this species occurs in streams in the Cumberland system. No status surveys for the Umbilicate Rocksnail have ever been conducted so its status is unknown.

Potential augmentation streams: Unknown.

Potential reintroduction streams: Unknown.

Reproductive biology: Unknown.

Propagation difficulty: Unknown. It has not been cultured to date. Difficulty in the collection of brood stock for culture trials is unknown.

Recommended priority actions:

1) Determine taxonomic relationship with *L. umbilicata* and *Leptoxis praerosa*
2) Determine status of historical populations
3) Survey for additional populations

R/A potential: unknown.

(7) *Marstonia ogmorhaphe* - Royal Marstonia

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: E AFS: E state: TN-E

Streams with extant occurrences: Tennessee River system (both TN) – Blue, Owen Springs.

Population status: Endemic to the Cumberlandian Region, this species is restricted to springs medium streams in the lower Sequatchie drainage of the Tennessee system. Both populations are believed to be currently stable, but current assessment is needed.

Potential augmentation streams: None.

Potential reintroduction streams: None.

Reproductive biology: It is believed to be an annual species. Nothing else is known about its life history.

Propagation difficulty: Unknown. The Royal Marstonia has not been cultured to date. Collection of adequate brood stock for culture trials should not be difficult.

Recommended priority actions:

1) Survey springs in the Sequatchie drainage for additional populations
2) Complete quantitative status review for the species in Blue, Owen Springs

R/A potential: Medium.

(8) *Marstonia scalariformis* - Moss Pyrg

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: none AFS: E state: AL-P1

Streams with extant occurrences: Tennessee River system (both AL) – Flint; Piney, Round Island Creeks.

Population status: Endemic to the Cumberlandian Region, this species is apparently restricted to medium to large streams in the middle Tennessee system. Its status is unknown.

Potential augmentation streams: None.

Potential reintroduction streams: Tennessee River system – Elk, AL/TN (H); Shoal Cr., AL (H); Limestone Cr, AL (M).

Reproductive biology: It is believed to be an annual species. Nothing else is known about its life history.

Propagation difficulty: Unknown. It has not been cultured to date. Collection of adequate brood stock for culture trials should not be difficult.

Recommended priority actions:

1) Survey Tennessee system tributaries for additional populations
2) Reintroduce into Elk, Shoal Cr.

R/A potential: Medium to high.

(9) *Pleurocera corpulenta* - Corpulent Hornsnail

Prioritization: Tier 1 **Global status:** G1 **Conservation status:** federal: none AFS: E state: AL-P1, TN-none

Streams with extant occurrences: Tennessee River system – Tennessee main stem tailwaters: Nickajack, TN.

Population status: Endemic to the Cumberlandian Region, this species is restricted to large streams in the middle Tennessee system. Currently, it is known only from the Tennessee main stem in the Nickajack tailwaters.

Potential augmentation streams: Tennessee River system – Tennessee main stem tailwaters: Nickajack, TN.

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Guntersville, AL (H), Wilson, AL (H).

Reproductive biology: Unknown.

Propagation difficulty: Unknown. It has not been cultured to date. Collection of adequate brood stock for culture trials may be difficult.

Recommended priority actions:

1) Complete a status assessment of the Nickajack tailwater population
2) Complete propagation trials to determine if mass production is possible
3) Augment Nickajack tailwater population
4) Survey Guntersville, Chickamauga, Watts Bar and Loudon tailwaters for additional populations
5) Reintroduce to Guntersville, Wilson tailwaters

R/A potential: Medium to high.

Tier 2

(10) *Elimia christyi* - Knotty Elimia

Prioritization: Tier 2 **Global status:** G1 **Conservation status:** federal: none AFS: T state: NC-E, TN-none

Streams with extant occurrences: Tennessee River system – Hiwassee and its larger tribs.

Population status: Endemic to the Cumberlandian Region, this species is restricted to medium to large streams in the Hiwassee drainage (Tennessee system). *Elimia christyi* populations in TN above and below the Appalachia Powerhouse appear to be fairly robust. The species was commonly encountered in a 2005 survey of the Hiwassee in Polk Co., TN. Its status in NC is unknown.

Potential augmentation streams: Unknown.

Potential reintroduction streams: Unknown.

Reproductive biology: Unknown.

Propagation difficulty: **Unknown. It has not been cultured to date.** Collection of adequate brood stock for culture trials should not be difficult.

Recommended priority actions:

1) Complete status review of the Hiwassee and to determine range and status of remaining populations
2) Complete initial culture trials and gather additional life history information

R/A potential: Medium to high.

(11) *Elimia striatula* - File Elimia

Prioritization: Tier 2 **Global status:** G2 **Conservation status:** federal: none AFS: T.

Streams with extant occurrences: Tennessee River system – none.

Population status: This species is known from the headwaters of the Conasauga (Coosa system, Mobile Basin) and adjacent streams of the middle Tennessee system. All known extant populations are in the Conasauga drainage. Its status in the Tennessee system is unknown.

Potential augmentation streams: Unknown.

Potential reintroduction streams: Unknown.

Reproductive biology: Dioecious, with females laying eggs in concentric clutches in the spring. Eggs number 5-12 per clutch and are attached to clean substrates or other shells.

Propagation difficulty: Unknown. It has not been cultured to date. Difficulty in the collection of Tennessee system brood stock for culture trials is unknown.

Recommended priority actions:

1) Survey Tennessee system streams in southeast TN and northwest GA to assess status

R/A potential: Unknown.

(12) *Io fluvialis* – Spiny Riversnail

Prioritization: Tier 2 **Global status:** G2 **Conservation status:** federal: none AFS: T state: AL-EXc, TN-none, VA-T

Streams with extant occurrences: Tennessee River system – upper Clinch, TN/VA; Powell, TN/VA; Holston, TN; North Fork Holston, VA/TN; Nolichucky, TN.

Population status: Endemic to the Cumberlandian Region, this species is restricted to large streams in the upper Tennessee system. Viable populations exist in Clinch, Powell and Nolichucky. Populations in the Holston drainage are from reintroductions. Seed source for previous translocation of adults came from large populations in these rivers. Successful translocations include North Fork Holston, TN/VA, upper Holston, TN, Pigeon, TN and Nickajack tailwaters. The Powell, VA population is currently being augmented by VDGIF.

Potential augmentation streams: Tennessee River system – Powell, VA.

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Nickajack, AL/TN (H); Pigeon, TN (H).

Reproductive biology: Egg laying is intiated once water temperatures reach 16º C. The species lays pink eggs in long strips on smooth surfaces in spring. Eggs harden to slate gray before hatching.

Propagation difficulty: Low. The species is relatively easy to propagate.

Recommended priority actions:

1) Continue reintroduction into Nickajack
2) Complete quantitative review of reintroduced populations in the Holston, Pigeon
3) Continue periodic monitoring of Clinch, Powell, and Nolichucky populations

R/A potential: High.

(13) *Lithasia curta* - Knobby Rocksnail

Prioritization: Tier 2 **Global status:** G1 **Conservation status:** federal: none AFS: E

Federal Status: None

Streams with extant occurrences: Tennessee River system – Tennessee main stem tailwaters: Kentucky, KY?

Population status: Apparently endemic to the Cumberlandian Region, this species is apparently restricted to the lower Tennessee main stem. It was last observed in the Kentucky Dam tailwaters in the late 1970s.

Potential augmentation streams: Unknown.

Potential reintroduction streams: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL (H), Pickwick Landing, TN (H).

Reproductive biology: Unknown.

Propagation difficulty: Unknown. It has not been cultured to date. Difficulty in the collection of brood stock for culture trials is unknown.

Recommended priority actions:

1) Determine taxonomic relationship with *L. verrucosa*
2) Survey Tennessee tailwaters to determine range and status
3) Reintroduce into Wilson, Pickwick Landing tailwaters

R/A potential: Unknown.

(14) *Lithasia lima* - Warty Rocksnail

Prioritization: Tier 2 **Global status:** G1 **Conservation status:** federal: none AFS: T state: AL-P2

Federal Status: none

Streams with extant occurrences: Tennessee River system – Elk AL/TN?, Sugar Cr., AL; Cypress Cr., AL; Bear Cr., AL.

Population status: Endemic to the Cumberlandian Region, this species is restricted to medium streams in the middle Tennessee system. Populations in Bear and Cypress Creeks are small and localized but appear to be healthy. Status of the Sugar Cr. and Elk populations are unknown.

Potential augmentation streams: None.

Potential reintroduction streams: None.

Reproductive biology: Unknown.

Propagation difficulty: Unknown. It has not been cultured to date. Collection of adequate brood stock for culture trials should not be difficult.

Recommended priority actions:

1) Determine taxonomic relationship with *Lithasia verrucosa*
2) Complete status survey in Elk, Sugar Cr.
3) Complete quantitative assessment of Bear, Cypress Cr. populations

R/A potential: Medium to high.

(15) *Marstonia pachyta* - Armored Marstonia

Prioritization: Tier 2 **Global status:** G1 **Conservation status:** federal: E AFS - E state: AL-P1

Streams with extant occurrences: Tennessee River system (both AL) – Limestone, Piney Creeks.

Population status: Endemic to the Cumberlandian Region, this species is restricted to the Limestone Cr. drainage (including Piney Cr.) of the middle Tennessee system. It is apparently doing well, but the two streams are now isolated since their lower reaches are impounded by Wheeler Reservoir.

Potential augmentation streams: None.

Potential reintroduction streams: None.

Reproductive biology: It is believed to be annual species, but anecdotal evidence suggests that at least some individuals live at least two years. Nothing else is known about its life history.

Propagation difficulty: High. It has not been cultured to date. Collection of adequate brood stock for culture trials should not be difficult.

Recommended priority actions: None.

R/A potential: Medium to high.

Tier 3

(16) *Elimia aterina* - Brook Elimia

Prioritization: Tier 3 **Global Status:** G2 **Conservation status:** federal: none AFS: T state: TN – none; VA – none

Streams with extant occurrences: Tennessee River system (all TN) – Ball, Big Barren, Blairs, Cox, Gap (incl. unnamed trib), Little, Little Sycamore, Old Town (incl. unnamed trib), Cedar, Doakes, Richardson, Big Spring Creeks; two unnamed tribs in Union County; Houser Spring.

Population status: Endemic to the Cumberlandian Region, this species is restricted to small streams and springs in the upper Tennessee system. The status of this species has not been addressed since 1994, but it did not appear imminently threatened at the time of that survey. The distribution of this species in VA is unknown. Populations may be robust enough for translocation.

Potential augmentation streams: None.

Potential reintroduction streams: None.

Reproductive biology: Unknown.

Propagation difficulty: Unknown. It has not been cultured to date. Collection of adequate brood stock for culture trials should not be difficult.

Recommended priority actions:

1) Complete status survey in VA
2) Complete quantitative assessment for several populations

R/A potential: Medium to high.

(17) *Elimia curreyana* - Amber Elimia

Prioritization: Tier 3 **Global status:** G3 **Conservation status:** federal: none AFS: V State: TN – none, KY - none

Streams with extant occurrences: Cumberland River system – ?

Population status: This species is known from the lower Ohio basin in streams in the Green and middle Cumberland systems. No recent survey work for the species in the Region exists, so its status in the Cumberland is unknown.

Potential augmentation streams: Unknown.

Potential reintroduction streams: Unknown.

Reproductive biology: Unknown.

Propagation difficulty: Unknown. It has not been cultured to date. Difficulty in the collection of brood stock for culture trials is unknown.

Recommended priority actions:

1) Complete status survey
2) Determine taxonomic status

R/A potential: Unknown.

(18) *Elimia porrecta* - Nymph Elimia

Prioritization: Tier 3 **Global status:** G2 **Conservation status:** federal: none AFS: T state: TN-none, VA-none

Streams with extant occurrences: Tennessee River system (all TN) – Ball, Blairs, Cawood, Cox, Gap (incl. unnamed trib), Indian, Little Sycamore, Old Town (incl. unnamed trib), Spring, Station, Cedar, Doakes (incl. unnamed trib), Mulberry Creeks; unnamed trib to Clinch.

Population status: Endemic to the Cumberlandian Region, this species is restricted to small streams in the upper Tennessee system. The status of this species has not been addressed since 1994, but it did not appear to be imminently threatened at the time of the survey. The distribution of this species in VA is unknown. In the survey report, questions arose as to the taxonomic relationship with *E. porrecta* and *E. strigosa* and some of these streams may have had one or the other taxon.

Potential augmentation streams: Unknown.

Potential reintroduction streams: Unknown.

Reproductive biology: Unknown.

Propagation difficulty: Probably high. It has not been cultured to date. Collection of adequate brood stock for culture trials should not be difficult.

Recommended priority actions:

1) Determine taxonomic relationship with *Elimia strigosa*
2) Complete status survey

R/A potential: Medium to high.

(19) *Elimia strigosa* - Brook Elimia

Prioritization: Tier 3 **Global status:** G2 **Conservation status:** federal: none AFS: state: TN-none, VA-none

Streams with extant occurrences: Tennessee River system (all TN) – Ball, Blairs, Cawood, Cox, Gap (incl. unnamed trib), Indian, Little Sycamore, Old Town (incl. unnamed trib), Spring, Station, Cedar, Doakes (incl. unnamed trib), Mulberry Creeks; unnamed trib to Clinch in Union County.

Population status: Endemic to the Cumberlandian Region, this species is restricted to small streams in the upper Tennessee system. The distribution of this species in VA is unknown. The status of this species has not been addressed since 1994, but it did not appear imminently threatened at the time of the survey. In the survey report, questions arose as to the taxonomic relationship with *E. strigosa* and *E. porrecta* and some of these streams may have had one or the other taxon. Some populations may be robust enough to support translocations, if warrented.

Potential augmentation streams: Unknown.

Potential reintroduction streams: Unknown.

Reproductive biology: Unknown.

Propagation difficulty: Probably high. It has not been cultured to date. Species will likely have a high difficulty. Collection of adequate brood stock for culture trials should not be difficult.

Recommended priority actions:

1) Determine taxonomic relationship with *E. porrecta*
2) Complete status survey

R/A potential: Medium to high.

(20) *Elimia teres* - Elegant Elimia

Prioritization: Tier 3 **Global status:** G1 **Conservation status:** federal: none AFS: EnState: TN - none

Streams with extant occurrences: Tennessee River system – ?

Population status: Endemic to the Cumberlandian Region, this species is restricted to small streams in the middle Tennessee system associated with Waldens Ridge and Signal Mt., Hamilton Co., TN. No recent survey activities have been attempted so its status is unknown.

Potential augmentation streams: Unknown.

Potential reintroduction streams: Unknown.

Reproductive biology: Unknown.

Propagation difficulty: Unknown. It has not been cultured to date. Difficulty in the collection of brood stock for culture trials is unknown.

Recommended priority actions:

1) Determine taxonomic status
2) Complete status survey

R/A potential: Unknown.

(21) *Lithasia duttoniana* - Helmet Rocksnail

Prioritization: Tier 3 **Global status:** G2 **Conservation status:** federal: none AFS: T state – TN none

Streams with extant occurrences: Tennessee River system – Duck River, TN.

Population status: Endemic to the Cumberlandian Region, this species is restricted to the Duck main stem in the lower Tennessee system. The species is abundant along channel margins in the middle and lower portions of the river. The species is not believed to be imminently threatened.

Potential augmentation streams: Unknown.

Potential reintroduction streams: None.

Reproductive biology: Females lay eggs in long circular strips, 3-6 eggs across from February - April. A single clutch constitutes several hundred eggs.

Propagation difficulty: Low. Ovipostion appears to be triggered by temperature. A more detailed study is required to discern precise thermal cues.

Recommended priority actions:

1. Determine txonomic status
2. Complete quantitative survey in the Duck

R/A potential: High.

(22) *Lithasia pinguis* - Smooth Rocksnail

Prioritization: Tier 3 **Global status:** G2 **Conservation status:** federal: none AFS: V state: TN - none

Streams with extant occurrences (both TN): Tennessee River system – Duck. **Cumberland River system –** Collins.

Population status: Endemic to the Cumberlandian Region, this species is restricted to medium streams in the middle Cumberland and lower Tennessee systems in the Barrens of central TN. It is not believed to be imminently threatened.

Potential augmentation streams (both TN): Tennessee River system – Duck. **Cumberland River system –** Collins (H).

Potential reintroduction streams: None.

Reproductive biology: Unknown.

Propagation difficulty: High. This species had low success in initial culture attempts (Duck form). Additional work will be required to successfully culture the species.

Recommended priority actions:

1) Complete status survey
2) Determine taxonomic relationship with other spp. in the *Lithasia geniculata* complex.

R/A potential: Medium to high.

(23) *Lithasia salebrosa* - Muddy Rocksnail

Prioritization: Tier 3 **Global status:** G3 **Conservation status:** federal: none AFS: V state: AL-P2, KY-S

Streams with extant occurrences: Tennessee River system – Tennessee main stem tailwaters: Wilson, AL, Pickwick Landing, TN?

Population status: This species is widely distributed in large streams in the Ohio basin, but appears to be restricted in the Region to the Tennessee main stem. It is s not believed to be imminently threatened.

Potential augmentation streams: None.

Potential reintroduction streams: Unknown.

Reproductive biology: Unknown.

Propagation difficulty: Unknown. Collection of adequate brood stock for culture trials should not be difficult.

Recommended priority actions:

1) Determine taxonomic relationship with *L*. *salebrosa* and *L. geniculata*
2) Complete status survey

R/A potential: Medium to high.

(24) *Pleurocera alveare* – Rugged Hornsnail

Prioritization: Tier 3 **Global status:** G3 **Conservation status:** federal: none AFS: V state: AL-P2, KY-S

Streams with extant occurrences: Tennessee River system – Tennessee main stem tailwaters: Wheeler, AL, Wilson, AL; Tennessee tributary tailwaters: Elk, TN/AL. **Cumberland River system –** Cumberland main stem tailwaters: upstream of Cordell Hull, TN?; Red, KY/TN.

Population status: This species is widely distributed in large streams in the lower Ohio basin. In the Region it occurs in the middle Tennessee and middle and lower Cumberland systems. Most populations appear healthy with the exception of unknown status upstream from Cordell Hull, where it was last observed in the early 1980s.

Potential augmentation streams: None.

Potential reintroduction streams: Tennessee River tributary tailwaters: Elk, AL (H).

Reproductive biology: Unknown.

Propagation difficulty: Unknown. It has not been cultured to date. Difficulty in the collection of brood stock for culture trials is unknown.

Recommended priority actions:

1) Determine taxonomic status.
2) Complete status survey
3) Determine if any populations require augmentation
4) Reintroduce into Elk

R/A potential: Medium.

(25) *Pleurocera pyrenellum* – Skirted Hornsnail

Prioritization: Tier 3 **Global status:** G2 **Conservation status:** federal: none AFS: T state: AL-P2

Streams with extant occurrences: Tennessee River system (all AL) – Brahan Spring; Beaverdam, Limestone, Piney, Round Island Creeks.

Population status: Endemic to the Cumberlandian Region, this species is restricted to small and medium streams in the middle Tennessee system, Limestone and Madison Counties, AL. Most populations appear to be healthy.

Potential augmentation streams: None.

Potential reintroduction streams: None.

Reproductive biology: Unknown.

Propagation difficulty: Unknown. It has not been cultured to date. Difficulty in the collection of brood stock for culture trials is unknown.

Recommended priority actions

1) Determine taxonomic relationship with other Tennessee system *Pleurocera* spp.
2) Complete status survey
3) Determine if any populations require augmentation

R/A potential: Medium.

Appendix IV-A. A list of high priority streams for mussel reintroduction options in the Region for priority species, priority species number (keyed to Appendix II) and total number of species per stream (*N* = x). This is an initial priority list and should not be considered to provide comprehensive options for R/A activities in the Region.

Reintroduction Stream	**Species with High Priority (*N* = no. of taxa)**
Tennessee River system (tailwaters and tributaries)	
Wilson Dam	9, 10, 15, 42, 45, 47, 51 (*N* = 7)
Pickwick Landing Dam	9, 14, 42, 45, 47 (*N* = 5)
Kentucky Dam	27, 28 (*N* = 2)
Lower French Broad/ Holston tailwaters	2, 3, 6, 10, 15, 21, 22, 25 (French Broad only), 34, 36, 38, 42, 45, 46, 56, 57 (*N* = 15)
Elk (AL) tailwaters	2, 3, 6, 7, 8, 10, 12, 13, 14, 15, 17, 18, 20, 21, 22, 23, 24, 25, 27, 28, 30, 32, 36, 38, 43, 46, 50, 56, 57 (*N* = 29)
Upper Clinch, VA	6, 17, 36, 56 (*N* = 4)
Upper Clinch, TN	6, 10, 13, 17, 18, 34, 36, 47, 50, 56 (*N* = 10)
Emory	10, 57 (*N* = 2)
Obed	44 (*N* = 1)
Upper North Fork Holston	16 (*N* = 1)
Nolichucky	2, 7, 8, 9, 10, 12, 13, 17, 18, 21, 22, 24, 25, 27, 28, 30, 32, 34, 36, 38, 42, 43, 44, 46, 51, 54, 56 (*N* = 27)
Lower Pigeon	7, 8, 38, 46, 57 (*N* = 5)
Little (TN)	44, 46, 57 (*N* = 3)
Oconaluftee	40 (*N* = 1)
Hiwassee	38, 44, 46 (*N* = 3)
Paint Rock	3, 6, 12, 19, 22, 23, 32, 36, 38, 50 (*N* = 10)
Limestone Cr.	4, 19, 22, 24, 30, 32 (*N* = 6)
Duck	6, 9, 13, 14, 15, 19, 21, 22, 27, 32, 41, 43, 45, 47, 52, 56 (*N* = 16)

Cumberland River system (tailwaters and tributaries)	
Barkley Dam	43 (*N* = 1)
Rockcastle R.	1, 3, 5, 13, 22, 23, 32, 42, 51 (*N* = 9)
Middle Fork Rockcastle R.	1, 13, 22, 26 (*N* = 4)
Sinking Cr.	13 (*N* = 1)
Buck Cr.	13 (*N* = 1)
Big South Fork	2, 9, 20, 21, 23, 24, 25, 32, 41, 42, 51, 54 (*N* = 12)
Clear Fork (TN)	1, 32 (*N* = 2)
Crooked Cr.	1 (*N* = 1)
Hills Cr.	11 (*N* = 1)
Hickory Cr.	11 (*N* = 1)
Little Hickory Cr,	11 (*N* = 1)
West Fork Hickory Cr.	11, 31 (*N* = 2)
Barren Fork	31 (*N* = 1)
South Prong Barren Fork	31 (*N* = 1)

Appendix IV-B. A list of high priority streams for snail reintroduction options in the Region for priority species. This is an initial priority list and should not be considered to provide comprehensive options for R/A activities in the Region.

Reintroduction Stream	**Species with High Priority**
Tennessee River system (tailwaters and tributaries)	
Nickajack Dam	*Io fluvialis*
Guntersville Dam	*Pleurocera corpulenta*
Wilson Dam	*Athearnia anthonyi, Pleurocera corpulenta, Lithasia curta*
Pickwick Landing Dam	*Lithasia curta*
Lower French Broad/ Holston tailwaters	*Athearnia anthonyi*
Nolichucky	*Athearnia anthonyi*
Lower Pigeon	*Io fluvialis*
Byrd Spring Swamp	*Campeloma decampi*
Elk tailwaters	*Marstonia scalariformis, Pleurocera alveare*
Paint Rock	*Campeloma decampi*
Shoal Cr.	*Marstonia scalariformis*

Appendix V. An example of a species site release plan (completed for Mobile Basin reintroduction activities). A similar plan should be filed with the appropriate state agency and FWS field office prior to stocking any federally listed species into public waters in the Cumberlandian Region.

Reintroduction Proposal for the Painted Rocksnail, *Leptoxis taeniata*, in tailwaters of Jordan Dam, Coosa River, Elmore County, Alabama, and Hatchet Creek, Coosa County, Alabama: March 2006

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Background: The Painted Rocksnail, *Leptoxis taeniata* (Conrad 1834) historically occupied the largest range of any Rocksnail in the Mobile River Basin (MRB) (Goodrich, 1922). The Painted Rocksnail was historically found in the middle and lower Coosa River and tributaries and in the Alabama River downriver to Monroe County, Alabama. In the main stem Coosa River, *L. taeniata* was distributed from Wetumpka in Elmore County, upriver to Clarence Shoals in St. Clair County (Goodrich, 1922). However, it has been eliminated from most of its range and is extant in only three Coosa River tributaries, Choccolocco Creek, Talladega County, Alabama, Buxahatchee Creek, Shelby County, Alabama, and Ohatchee Creek, Calhoun County, Alabama. The species was not recorded from the upper Coosa basin, and reports from the Cahaba River drainage were misidentified Round Rocksnail (*Leptoxis ampla*). Few historical records of the species in tributaries exist, but the Painted Rocksnail was often sympatrically distributed with *Tulatoma magnifica*. Rocksnails (*Leptoxis* spp.) in the MRB are highly imperiled as 10 of the 15 species once found in the basin are already considered extinct. Of the five remaining species, three are federally listed (*L. ampla, L. plicata, L. taeniata*) and the others are candidates (*L. foremani, L. picta*).

The Painted Rocksnail was listed as threatened by the US Fish and Wildlife Service (FWS) under the Endangered Species Act (ESA) in 1998. The Painted Rocksnail was included in a recent FWS recovery plan for six Mobile Basin gastropods (FWS, 2005). Additionally, the Alabama Department of Conservation and Natural Resources (ADCNR) has listed the species as a Priority 2 (P2), species of high conservation concern, in recent state wildlife planning efforts (Mirarchi, 2005). In both the FWS and ADCNR plans, removal of the species from the endangered species list was given as the recovery objective. Delisting of the Painted Rocksnail at the federal level will be considered when the following parameters are met:

1) There are at least three stable, viable populations (stable or increasing) for a period of 10 years (2 to 5 generations).

2) There are no apparent or immediate threats to the existing populations.

Should any of the three remaining populations be lost, delisting could be postponed, and would likely warrant elevating the species status to endangered. Additionally, at least two of the existing populations do not currently meet the definition of a "persistent population". The FWS recovery plan defines a population as "all snails occurring within a contiguous river or stream reach extending a minimum of 30 km (18 mi.)." The extent of the species distributions are very limited in Buxahatchee and Ohatchee creeks, much smaller than 30 km stream distance. Only the Choccolocco Creek population seems to be secure, but its distribution may also be < 30 km in length. Although geographically limited, the Choccolocco Creek population is extremely robust in specific sections. In fact, densities appear to exceed 250 m^2 at several locations. These populations are locally so robust they would easily support the harvest of 5,000 – 10,000 individuals for translocation efforts.

This proposal seeks to establish two new populations of the Painted Rocksnail, in a tributary of the Coosa River (Hatchet Creek) and in the main stem Coosa River, by translocating a minimum of 5,000 adults from Choccolocco Creek to each location. If successful, this could establish two additional populations of the Painted Rocksnail, representing a major step forward in recovery.

***Reintroduction Strategy*:** The reintroduction will be carried out by translocating at least 5,000 adult Painted Rocksnails from Choccolocco Creek near the CR 005 Bridge in Talladega County, into Hatchet Creek and the Coosa River. Proposed streams for the reintroductions will be as follows:

1) Hatchet Creek, Coosa County, Alabama, just downstream of the U.S. Hwy 280 Bridge.

2) Coosa River, Jordan Dam tailwaters, Elmore County, Alabama, Gray's Island Shoal.

Habitat conditions at these sites appear excellent for Painted Rocksnails. Other species of Pleuroceridae (*Elimia* spp. and/or *Pleurocera prasinata*) occur at the sites in good numbers. These species historically and currently coexist with Painted Rocksnails.

Snails will be translocated to the same sites for at least five years, following regular monitoring each fall at each reintroduction site. The current reintroduction strategy may be modified, after an assessment of the original attempt is completed in the fall of 2006.

The reintroduction should take place in March or April of 2006, as this will insure adult female *L. taeniata* will likely ovideposit at the reintroduction streams almost immediately. Successful *L. taeniata* recruitment at either reintroduction sites will be apparent during the initial fall 2006 monitoring.

Justification: Painted Rocksnails were historically found in the Coosa River at Wetumpka (numerous museum records). Although no specific museum records have been located from Hatchet Creek, there are almost no historical records from the Hatchet Creek prior to 1970. Hatchet Creek is within the historical range of the species (middle and lower Coosa River and tributaries), and the proposed reintroduction site is similar in habitat to sites where the species currently survives. In addition the occurrence in Hatchet Creek of *Tulatoma magnifica* and several federally listed mussels that were historically sympatric with Painted Roksnail are evidence that the species occurred there, but was never recorded. Both proposed streams, Hatchet Creek and the Coosa River below Jordon Dam are already designated as Critical Habitat by the FWS for 8 and 9 species of federally protected mussels respectively. Completion of an additional Critical Habitat designation for federally listed MRB snails is currently pending.

This project also seeks to use the Painted Rocksnail reintroduction into Jordon Dam tailwaters as a test case for determining threshold densities required for introduced snails to become established. Previous releases of the Interrupted Rocksnail (*Leptoxis foremani*) into Jordan Dam tailwaters have yet to establish a reproducing population. Numbers of released Interrupted Rocksnails were necessarily small due to logistical restraints in the previous culture facility and limited brood stock availability. However, the new Alabama Aquatic Biodiversity Center (AABC) will have the potential to propagate much larger numbers of Interrupted Rocksnails within two years. If a reproducing population of Painted Rocksnails can be initiated by releasing larger numbers of adult snails at this site, this will suggest a range of adult production required to establish a reproducing population of the Interrupted Rocksnail at the same locality. Previous culture efforts with both species have shown that fecundity may be more limited for *L. taeniata*.

Site preparation: Snail densities at each reintroduction site will be estimated prior to any transplantation through Surber sampling (n = 30). Calculation of initial snail densities will assist future monitoring efforts.

Scheduled release date: The release will be conducted as soon as the reintroduction proposal has been approved by project partners. The reintroduction will hopefully occur by mid-April 2006.

Future monitoring: Following the initial translocation visual (qualitative) monitoring will occur annually with quantitative monitoring every two years post-release (planned for the fall, during low-water levels). Initial monitoring of reintroduction sites will begin in the autumn of 2006. Annual augmentations (using snails transplanted from Choccolocco Creek, possibly mixed with individuals from Buxahatchee and/or Ohatchee creeks) will be carried out at the same streams for at least the next five years (5,000 individuals per site per year). However, if no survivorship can be established at the reintroduction sites after three years, translocation efforts may be stopped at one or both sites. Recent reintroduction efforts with another North American pleurocerid snail (Spiny Riversnail - *Io fluvialis*) through translocation, took 1000's of individuals and 10 years to complete successful reintroductions.

Disease risk: Although unknown, it is believed disease risk to any indigenous pleurocerids is minimal. Most likely, any "disease" that occurs in Choccolocco Creek is also indigenous to Hatchet Creek and lower reaches of Coosa River. Although these snails are known to harbor the cercaria stage of a parasitic trematode, direct disease transmission between individual pleurocerids has never been documented.

Possible reintroduction locality and recovery problems: Painted Rocksnails will be transplanted to Hatchet Creek, Coosa County, Alabama, just downstream of the U.S. Hwy 280 Bridge, and Coosa River, Jordan Dam tailwaters, Elmore County, Alabama, Gray's Island Shoal. Water quality and habitat conditions at these sites appear to be very favorable. Causal factors that resulted in the disappearance of Painted Rocksnails from Hatchet Creek are unknown. However, human perturbations in upper reaches of Choccolocco Creek, which is home to the best remaining population of Painted Rocksnails, are believed to be far more severe than those in Hatchet Creek. Extirpation of this species from tailwaters of Jordan Dam appears to be the result of diversion of most of the river's discharge through Bouldin Dam and resultant poor water quality in the channel downstream of Jordan Dam. However, initiation of minimum flows from Jordan Dam during the mid 1990's resulted in immense habitat improvements to the tailwaters. Snails and mussels which survived the years of poor flow have rebounded drastically. Problems specific to the main stem Coosa River site include direct predation by Freshwater Drum, which is believed to be considerable. The predation levels at this location may be the critical factor limiting the establishment of a *L. foremani* population at this locality. This initial predation problem is further complicated by the size of the habitat (very large) and peaking discharge below the dam. However, if a threshold of adults can be reached, the reintroduction of a new population of *L. taeniata* in the Jordon Dam tailwaters appears to be a viable recovery option.

Alternatives Analyses: Without the successful establishment of at least three additional populations, the Painted Rocksnail cannot be moved toward recovery and eventually delisted (FWS 2005).

Although the Coosa River population is geographically the closest to either Hatchet or the Coosa River below Jordon, this population is exceedingly small. A previous survey attempt located seven individuals in a one-hour dive. In fact, these numbers are too low to initiate a large captive breeding effort. Although the Buxahatchee Creek population is large enough to provide brood stock for culture efforts, it does not contain sufficient numbers to support a large translocation attempt. Although, Buxahatchee Creek is closer to the intended reintroduction sites, it would be more time intensive and expensive to culture the snails than translocate them.

The very large population of Painted Rocksnails existing in Choccolocco Creek will easily support translocation efforts, without endangering the host population (far less than 5% of the total population would be used). Additionally, translocation of a large number of individuals is preferred when establishing new populations because of increased genetic variability of the natural brood stock. *Leptoxis taeniata* is one of a few mollusks in the MRB that can be recovered through translocation attempts.

Simply augmenting existing populations in the Choccolocco Creek basin will not increase the elements of occurrence for this species, and thus cannot move the species towards de-listing.

Dams create physical barriers to natural emigration in the Coosa River basin. Therefore additional populations cannot be established naturally. A do nothing alternative will not establish new populations that promote recovery and eventual delisting of the Painted Rocksnail.

Appendix VI. The Cumberlandian Region mollusk recovery activity reporting form. This form is to be completed by the individual/organization conducting any species recovery activities in the basin. A completed form should be filed with the appropriate state agency and FWS field office, after the completion of any recovery activity. Some states (e.g., Alabama) may require additional stock reporting forms, which are shown in Appendix VI. An electronic version of this reporting form is available from the FWS and state agencies.

Cumberlandian Region Mollusk R/A Activity Reporting Form

Note: Click on bracketed text to enter requested data. Italicized brackets are optional.

I. Responsible Entity

A. [Organization/Agency]

B. [Project Point of Contact]
[Address]
[Phone Number(s)]
[Email Address]
"[Permit Number(s) - State and Federal]"

C. "[Date of Report]"

II. Type of recovery activity (check all that apply)

A. Reintoduction "[{ }]" Augmentation "[{ }]" Translocation "[{ }]"

III. Taxa group (check all that apply)

A. Mussels "[{ }]" Snails "[{ }]"

IV. Type of release (check one)

A. Adult wild mollusk "[{ }]"

B. Cultured sub-adult mollusk "[{ }]"

C. Cultured adult mollusk "[{ }]"

V. Collection information regarding donor brood stock

A. Species: "[Species, Common Name]"

B. Number collected: [Number collected]

- **i. Size range:** [Report min-max lengths (mm)]
- **ii. Sex:** *[Sex (enter N/A if unknown)]*

C. Donor population condition:

- **i. Population estimate:** *[Estimated population size]*
- **ii. Estimation method:** *[e.g., visual estimate, transect sampling, census]*
- **iii. Population viability:**
  "[Enter good, fair, poor - provide explanation if fair or poor]"

D. Collection date: [Collection date]

E. Drainage: [Drainage]

F. Latitude: [Latitude] **Longitude:** [Longitude]

G. **County, State:** [County, State]
H. **Specific locality:** [Specific locality]
I. **Additional information:** *[General comments]*

VI. Disposition of Mollusks Introduced

A. **Type of action:** "[Augmentation, Reintroduction, Translocation]"
B. **Method:** "[Relocation, Laboratory transformed juveniles, or glochidia infested fish]"
C. **If laboratory transformed juveniles, complete the following:**
   i. **Name of facility:** [Name of facility]
   ii. **Organization/Agency:** *[Sponsoring entity]*
   iii. **Point of contact:** *[POC name]*
   iv. **Address:** *[POC address]*
   v. **Phone number:** *[POC phone number(s)]*
   vi. **Email:** *[POC email address]*
   vii. **Type(s) of holding structures:** *[Holding structure(s)]*
   viii. **Monitoring schedule:** *[Monitoring schedule]*
   ix. **Additional information:** *[General comments]*

D. **Released species data:**
   i. **Species:** "[Species, Common Name]"
   ii. **Number released:** [Number released]
      a. **Size range:** [Report min-max lengths (mm)]
      b. **Sex:** [*Sex (enter N/A if unknown)*]
      c. **Tag type:** [*Tag type*]
   iii. **Release date:** [Release date]
   iv. **Drainage:** [Drainage]
   v. **Latitude:** [Latitude] **Longitude:** [Longitude]
   vi. **County, State:** [County, State]
   vii. **Specific locality:** [Specific locality]

E. **Origin of released individuals:**
"[wild caught adult, laboratory-transformed juveniles, or glochidia infested fish]"
   i. **If glochidia-infested fish:**
      a. **Fish species released:** [Fish species]
      b. **Number of fish released:** [Number of fish released]
      c. **Number of female mollusks used for glochidia production:** [Number of female mollusks used for glochidia production]
   ii. **If laboratory transformed juveniles:**
      a. **Age of juveniles released:** [Age of juveniles]
      b. **Number of female mollusks used for glochidia production:** [Number of female mollusks used for glochidia production]

iii. **Release of** [enter number of adults] **adults and/or** [enter number of juveniles] **juveniles from wild, non-cultured populations.**

iv. **Additional information:** *[General comments]*

IV. Miscellaneous Reporting Information

A. Will data from this translocation be presented in a thesis, report, or scientific publication? [Yes/No]

B. **If yes, provide citation and state how the publication can be accessed:** [Citation and means of access]

Appendix VII. Genetics guidelines to be considered when developing a long term hatchery based propagation program for freshwater mussels. This is a summary and justification for the 10 genetic guidelines recommended by Jones et al. (2006).

	Summary	Justification
Guideline 1:	Threats to population persistence should be identified and, when feasible, corrected prior to implementing captive propagation for a species.	Increases availability of suitable habitat for population restoration
Guideline 2:	Each mussel species targeted for recovery using propagation technology should have a recovery plan that defines: (1) necessity of genetic characterization of remaining populations, (2) number of populations to be augmented or reintroduced to effectively recover the species, (3) appropriate locations for release of juvenile mussels, (4) number of juveniles to be released per year at a site, (5) number of gravid females to be collected per year for brood stock and (6) field and laboratory protocols to minimize genetic risks incurred by recovery activities.	Promotes implementation of hatchery activities using approved plans designed to protect genetic resources of populations
Guideline 3:	Collection of gravid female mussels for an augmentation ideally should come from the natal river, or from the closest genetically similar viable population and that for restoring species into historical river habitat from the closest adjacent river system.	Maintains within-and among-population genetic variation
Guideline 4:	Establish an appropriate number of gravid females to be collected each year for propagation from a small population, as well as protocols to monitor survival and recruitment of artificially propagated juveniles.	Minimizes over-collection of brood stock from small populations
Guideline 5:	Maintain the largest possible genetically effective population size (N_e) of propagated juvenile mussels by collecting an appropriate number of adult females each year to use as brood stock and when feasible, rotate brood stock periodically.	Maintains within-population genetic variation
Guideline 6:	To avoid declines in population fitness due to outbreeding depression, populations that qualify as evolutionarily significant units (ESUs), subspecies, or closely related species should not be mixed.	Maintains among-population genetic variation

	Summary	Justification
Guideline 7:	Reduce domestication selection during propagation and culture of juvenile mussels by mimicking natural life history processes, such as fish hosts, diet, temperature regimes and habitat of a targeted species as closely as possible in the hatchery.	Increases progeny fitness and survival when released to the wild
Guideline 8:	Protocols are needed to prevent mixing of species or other management units through inadvertent exchanges of juveniles on laboratory equipment.	Maintains among population genetic variation
Guideline 9:	Release an appropriate number of juvenile mussels from an appropriate number of parents at release sites to maximize effective population size (N_e) and at an early life stage to maximize survival in the wild and to minimize the effects of domestication selection.	Maintains within population genetic variation and reduces domestication selection
Guideline 10:	Monitoring, evaluation and database management should be regarded as an integral part of any augmentation or restoration program, followed as appropriate with modification of program goals and operations procedures to promote program effectiveness.	Promotes program effectiveness and adaptive management

Appendix VIII. Summary of various state natural resource agencies requirements conducting mollusk recovery activities within state waters of the Cumberlandian Region.

Alabama

The Alabama Department of Conservation and Natural Resources (ADCNR) requires an approved stocking permit be completed and approved prior to any stocking activity in state waters. An electronic application for a stocking permit can be obtained from the Alabama Division of Wildlife and Freshwater Fisheries, Fisheries Section office, 64 North Union Street, Suite 551, Montgomery, AL 36130-1456 (334/242-3471). A copy of the permit application and reporting form are provided below. A signed letter of authorization from the Chief of Fisheries will be sent to the recovery partner if the stocking is allowed. Restoration of federally threatened and endangered species in state waters is authorized under the current Section 6 agreement between FWS and ADCNR (USDOI & ADCNR 1990). Conservation partners should also contact the Alabama Aquatic Biodiversity Center (AABC, Route 3, Box 86, Marion, AL 36756; 334/683-5000) for informal consultation prior to the submission of any stocking permit for non-game species to the ADCNR Fisheries Chief.

In addition to a valid state scientific collection permit, ADCNR requires special permission to work with any state listed species. Application for state scientific collection permit and the special provision to work with state listed mussels can be obtained by contacting the Director, ADCNR, 64 North Union Street, Suite 567, Montgomery, AL 36746; Phone (334/242-3465). Conservation partners should also contact the AABC, Route 3, Box 86, Marion, AL 36756 (334/683-5000), for informal consultation prior to the initiation of any recovery activity with a state listed species. Be certain to reference the Tennessee or Mobile River Basin plans for the state list of mollusks occurring in each basin. An additional plan and species list for other gulf coastal drainages (i.e., Chipola, Choctawhatchee, Conecuh) will be forthcoming and state listed mollusk species occur in those basins that do not occur in either the Tennessee or Mobile River basin plans. The Alabama state listed mollusks found in the Tennessee River Basin are:

MUSSELS: *Actinonaias ligamentina*, Mucket; *Actinonaias pectorosa*, Pheasantshell; *Alasmidonta marginata,* Elktoe; *Alasmidonta viridis,* Slippershell Mussel; *Cumberlandia monodonta,* Spectaclecase; *Elliptio dilatata,* Spike; *Epioblasma triquetra* Snuffbox; *Fusconaia subrotunda,* Longsolid; *Lasmigona costata,* Flutedshell; *Ligumia recta,* Black Sandshell;

Medionidus conradicus, Cumberland Moccasinshell; *Obovaria olivaria,* Hickorynut, *Obovaria subrotunda,* Round Hickorynut; *Plethobasus cyphyus,* Sheepnose; *Pleurobema oviforme,* Tennessee Clubshell; *Pleurobema rubrum,* Pyramid Pigtoe; *Pleurobema sintoxia*, Round Pigtoe; *Pleuronaia barnesiana,* Tennessee Pigtoe; *Pleuronaia dolabelloides,* Slabside Pearlymussel; *Ptychobranchus fasciolaris*, Kindeyshell; *Ptychobranchus subtentum,* Fluted Kidneyshell; *Quadrula cylindrica cylindrica*, Rabbitsfoot; *Strophitus undulates*, Creeper and *Truncilla truncata,* Deertoe.

SNAILS: *Elimia nassula*, Round-Rib Elimia; *Elimia perstriata*, Engraved Elimia; *Io fluvialis*, Spiny Riversnail; *Leptoxis virgata*, Smooth Mudalia; *Lithasia armigera*, Armored Rocksnail; *Lithasia curta*, Knobby Rocksnail; *Lithasia lima*, Warty Rocksnail; *Lithasia salebrosa*, Muddy Rocksnail; *Marstonia scalariformis*, Moss Pyrg; *Pleurocera alveare*, Rugged Hornsnail; *Pleurocera corpulenta*, Corpulent Hornsnail; and *Pleurocera pyrenella*, Skirted Hornsnail.

Alabama Division of Wildlife and Freshwater Fisheries
Fisheries Section

Application for Public Water Stocking Permit

PERMITTEE INFORMATION		
Applicant's Name	Phone Number	Fax Number
Address	City, State and Zip Code	
Organization		

SOURCE OF FISH		
Hatchery Name	Phone Number	Fax Number
Address	City, State and Zip Code	
Name of Hatchery Owner/Manager		

FISHES, MUSSELS, SNAILS OR CRAYFISHES TO BE STOCKED			
Species	Stock/Strain	Size (inches)	Number
Origin of Parental Stock			

WATERBODY TO BE STOCKED	
Name of Waterbody	Date of Stocking
Specific Stocking Site(s)	
County	GPS Coordinates (approximate)
Purpose of Stocking	
List precautions taken to insure no aquatic nuisance species will be introduced with this stocking	
Explain how you will evaluate the effectiveness of this public water stocking	

DO NOT WRITE IN THE BOX BELOW

Application APPROVED ☐	DENIED ☐ (see attached denial letter)	
Permit Number	Issue Date	Expiration Date

Alabama Division of Wildlife and Freshwater Fisheries
Fisheries Section

Alabama Public Water Stocking Report

REPORT ON THE STOCKING OF FISHES, MUSSELS, SNAILS OR CRAYFISHES INTO ALABAMA PUBLIC WATERS

Submit report within 7 days of stocking.

Permit Information	
Permit Holder	Phone Number
Organization	Permit Number

Waterbody Stocked		
Name of Water Body	County	Date of Stocking
Specific Stocking Site(s)	GPS Coordinates (LAT)	(LON)

Fishes, Mussels, Snails or Crayfishes Stocked				
Species	Stock/Strain	Size (inches)	Wet Weight (lbs)	Number

Total Hauling Time	Time of Stocking	Driver's Name and Phone Number

Submit Report to:
Alabama Division of Wildlife and Freshwater Fisheries
Fisheries Section
64 N. Union Street, Suite 551
Montgomery, AL 36130
Fax: 334/242-2061

Georgia

The Georgia Department of Natural Resources (GDNR) requires prior approval before release of any animal into state waters can take place. Any applicant wishing to complete species restoration work in Georgia must first have a valid GDNR scientific collection permit. If an individual has a valid general permit, they apply and receive an approved Animal Liberation Permit issued by the Nongame Conservation Section in conjunction with the Special Permits Unit (2065 U.S. Highway 278 SE, Social Circle, GA 30025-4714, 770/918-6411). The state malacologist should also be contacted for informal consultation (same address) prior to initiating a formal letter requesting the liberation permit. The Animal Liberation Permit Application is merely a letter requesting release activities within state waters. The letter should include: species of mussel (common and scientific name); release location, including stream, county, locality name and coordinates; brood stock source, including stream, county, locality name and coordinates; number of animals to be released, age of released animals; any markings; and any other pertinent locality information. In the event that animals will be liberated in waters located within the boundaries of Georgia State Park property, the liberator must have scientific collecting permit (see below) issued by the GDNR – State Parks and Historic Sites Division and written permission to liberate animals within the park's waters. Applications for State Park Scientific Collecting Permits may be sent to the above address where they will be reviewed. Furthermore, the State of Georgia Animal Liberation Permit does not alleviate the responsibility to acquire any necessary permits required to release animals within the boundaries of U.S. Forest Service property. In the event that liberations shall be done on private lands, the liberator must include with their application, proof of permission from all applicable landowners where liberations will take place. Proof of permission can be in the form of a signed letter stating that the liberator has informed the landowner of the liberation process, explained any potential legal implications of the release and the landowner permits this activity on his/her property and valid contact information limited to no less than the name, address and phone number of the property owner. Upon receiving the appropriate permits, the Animal Liberation Permit as well as all letters of landowner permission must be in the possession of the person(s) conducting the release at all times. GDNR does have a state list of threatened and endangered species other than those listed by the FWS. However, there are no state listed mollusks identified from the Tennessee River basin.

Georgia STATE PARKS & HISTORIC SITES

Scientific Research & Collection Permit Application

Name of person requesting permit:

_____

Title:

_____

Institution:

_____

Address:

_____

_____ Telephone: ( )_____

Please note: Permits are valid until 12/31 of the current calendar year.

List the species you wish to collect, quantities and methods of capture to be used (e.g., live traps, nets, etc.)

List area (s) and park (s) in which you wish to collect.

Describe briefly what you plan to do, including problem and methods.

What will be the disposition of your specimens? (All specimens must remain part of the public domain and thus be housed in a museum, college, university, school, park or other such institution.)
Justification: Describe briefly the reason for your research or collection.

Note: If additional space is needed, please attach additional sheets.

I certify that the above information is correct and true to the best of my knowledge.

_____ _____

(Date) **(Researcher's Signature)**

Please submit completed permits to:
Nikki Castleberry
State Parks Biologist
Georgia Department of Natural Resources
Nongame Conservation Section
2065 US Hwy. 278 SE
Social Circle, GA 30025-4743
770-761- 3042
FAX 706-557-3033
nikki_castleberry@dnr.state.ga.us

To be completed by Parks & Historic Site Division

I recommend that this application be:

Approved ☐ **Not Approved** ☐

_____ _____

(Date) **(Permit Coordinator)**

Date of Issue: _____
Date of Expiration: _____

Comments or Restrictions:

Kentucky

The Kentucky Department of Fish and Wildlife Resources (KDFWR) requires approval prior to translocating any species within the Commonwealth. Approval may be granted by written permission from authorized agency staff. Conservation partners should contact the Wildlife Diversity Section program coordinator for more information (KDFWR, 1 Sportsman's Lane, Frankfort, KY 40601).

Kentucky does not have a state list of endangered species. The current regulations state that the federal list of threatened and endangered species is adopted as the state's list. However, the state wildlife grants have created a list of species of greatest conservation need that should be considered. If individuals are to be working with federal endangered species, they are required to have an educational or scientific collection permit. They may also need special designation as an Agent of the State. For more information on permits and requirements, you may contact the KDFWR, 1 Sportsman's Lane, Frankfort, KY 40601; 502/564-5448.

Mississippi

The Mississippi Department of Wildlife, Fisheries and Parks (MDWFP) requires that a permit be issued before aquatic species can be released into the public waters of the state (Section 49-7-80, Mississippi Code of 1972), including those propagated for recovery efforts. The permit may be obtained from the MDWFP Fisheries Division, 1505 Eastover Drive, Jackson, MS 39211 (601/432-2205). Recovery of federally listed species in Mississippi is authorized under a Section 6 agreement, in effect since 1985, between MDWFP and the FWS. A Mississippi administrative permit (Section 49-1-41) is required to collect or to possess any freshwater mussel in the state of Mississippi and may be issued for scientific or propagation purposes. Applications are available from the Mississippi Museum of Natural Science, 2148 Riverside Drive, Jackson, MS 39202 (601/354-7303). Permits from the FWS are also required for federally listed species. Mississippi maintains a state list of endangered species (Sections 49-5-101 through 49-5-117) in addition to those listed by the FWS. The Mississippi state listed mollusks found in the Tennessee River system are: *Cyclonaias tuberculata*, Purple Wartyback; *Epioblasma triquetra*, Snuffbox; *Pleuronaia dolabelloides*, Slabside Pearlymussel; *Ptychobranchus fasciolaris*, Kidneyshell and *Quadrula cylindrica cylindrica*, Rabbitsfoot.

North Carolina

The North Carolina Wildlife Resources Commission (NCWRC) has a policy to specifically address R/A activities of federal and state listed aquatic species. Proposals should be developed in cooperation with NCWRC Aquatic Wildlife Diversity (AWD) Regional Coordinator (Steve Fraley, Western Region AWD Coordinator, 50 Trillium Way, Clyde, NC 28721; 828/627-8414; fraleysj@ bellsouth.net) and in accordance with the Wildlife Action Plan (http://www.ncwildlife.org , see link under "Features"). Proposals for R/A activities should be sent to the NCWRC AWD program administrator for review and approval (Todd Ewing, 808 Briggs Street NW, Valdese, NC 28690; 828/874-0494; todd.ewing@ncwildlife.org). Present policy requires that adjacent landowners and local governments be informed of R/A activities and any legal issues involved. Reintroductions require permission from adjacent landowners.

A valid North Carolina Wildlife Collection License is required (http://www.ncwildlife.org; see below). The NCWRC also requires an approved stocking permit prior to any stocking in state waters. If R/A actions are part of a cooperative project with NCWRC, no stocking permit is required. Applications can be obtained from the NCWRC website: (http://www.ncwildlife.org/fs_index_01_license.htm) or contact Diane Renzi, 1721 Mail Service Center, Raleigh, NC 27699; 919/707-0225. A state Endangered Species (NC ES) permit is required for sampling or collecting mollusks from unimpounded waters. Application can be obtained by contacting Todd Ewing (see contact information above). All work conducted under NC ES permits must be reported annually to NCWRC in electronic format (MS Excel™ data form provided). A NC ES permit allows the permit holder to work with federally listed species as an agent of the State without need for a separate federal permit, provided the activities are consistent with the State's Cooperative Agreement with the FWS (signed, 12 January 1977). Specifically, Section 2, Paragraph (b) of the Cooperative Agreement states:

"Any qualified employee or agent of the [North Carolina Wildlife Resources] Commission who is designated by the Commission for such purposes, may, when acting in the course of his official duties, take any resident Federally-listed endangered fish or wildlife for conservation purposes that are consistent with this Cooperative Agreement or any Project Agreement attached thereto, provided that such taking is not reasonably anticipated to result in:

(1) the death or permanent disabling of the specimen;

(2) the removal of the specimen from the State of North Carolina;

(3) the introduction of the specimen or any of its progeny into an area beyond the historical range of the species; or

(4) the holding of the specimen in captivity for a period of more than 45 consecutive days.

NORTH CAROLINA WILDLIFE RESOURCES COMMISSION
DIVISION OF WILDLIFE MANAGEMENT, 1724 MAIL SERVICE CENTER, RALEIGH, NC 27699

WILDLIFE COLLECTION LICENSE APPLICATION

Name of Applicant Institution Represented
Street Address Telephone
City, State, Zip Code County Date of Birth
NOTE: A $5.00 LICENSE FEE IS REQUIRED, UNLESS EXEMPT UNDER CONDITIONS STATED ABOVE.
SEND FEE WITH THIS APPLICATION, CHECK PAYABLE TO: NCWRC.
Species and number of each species you intend to collect:
County or counties where collecting activities will be attempted:
Purpose for which collecting will be attempted:
I have read the terms for issuance of a license listed above and agree to abide by them.
Signature of Applicant
Date
APPROVAL
DATE

NORTH CAROLINA WILDLIFE RESOURCES COMMISSION

DIVISION OF INLAND FISHERIES

Application to Stock Fish in Inland Fishing Waters of North Carolina

Date Received: _____ Permit No: _____

Pursuant with 15NCAC 10C.0209(b), any person, firm, or corporation wanting to stock any fish, mollusk, or crustacean in

Inland Fishing Waters of North Carolina must first obtain a permit from the North Carolina Wildlife Resources Commission.

Name of Applicant

Address

Telephone

Email Address

Species to be stocked

Water body to be stocked

County

Identify specific stocking location(s) Provide as detailed a description as possible. Attach additional pages as necessary.

Purpose for stocking

Will this be a one-time stocking event?

If no, specify the frequency of stocking (monthly, annual, etc.)

Number to be stocked (specify number per stocking event / total per year)

Size of fish to be stocked (check appropriate size)

fry

juvenile

adult

Specify month(s) during which the stocking will occur

Identify the specific source of the fish to be stocked

(name of water body or commercial aquaculture facility)

If the fish will be provided and/or stocked by a third party, provide contact information.

Name

Address

Telephone

Email Address

To the best of my knowledge, the information provided on this application is true and complete. Ialso understand that additional information may be requested in order to fully evaluate my request.

Signed

Date

Tennessee

The Tennessee Wildlife Resources Agency (TWRA) under TCA 70-8-106 is granted authority to establish programs deemed necessary for management of non-game, threatened and endangered wildlife. TWRA requires a scientific collection permit (TCA 70-2-213) and approval from the State Non-Game and Endangered Species Coordinator prior to the release of any non-game species into state waters TCA 70-2-212. A letter of request must be sent to State Non-Game and Endangered Species Coordinator (TWRA, Ellington Agriculture Center, Box 40747, Nashville, TN 37204, 615/781-6500). The letter should include: species of mussel (common and scientific name); release location, including stream, county, locality name and coordinates; brood stock source, including stream, county, locality name and coordinates; age of released mollusks; any markings; and any other pertinent locality information. The state malacologist should also be contacted for informal consultation (TWRA, Fisheries Division, Ellington Agriculture Center, Box 40747, Nashville, TN 37204, 615/781-6575) prior to initiating a formal letter of request.

TENNESSEE WILDLIFE RESOURCES COMMISSION
PROCLAMATION 00-15
ENDANGERED OR THREATENED SPECIES

Pursuant to the authority granted by Tennessee Code Annotated, Sections 70-8-105 and 70-8-107, the Tennessee Wildlife Resources Commission does hereby declare the following species to be endangered or threatened subject to the regulations as herein provided.

SECTION I. ENDANGERED OR THREATENED SPECIES

MOLLUSKS

MUSSELS - Endangered

Common Name	Scientific Name	Federal
Cumberland Elktoe	*Alasmidonta atropurpurea*	E
Appalachian Elktoe	*Alasmidonta raveneliana*	E
Birdwing Pearly Mussel	*Lemiox rimosus*	E
Fanshell Mussel	*Cyprogania stegaria (=irrorata)*	E
Dromedary Pearly Mussel	*Dromus dromas*	E
Cumberlandian Combshell	*Epioblasma brevidens*	E
Oyster Mussel	*Epioblasma capsaeformis*	E
Yellow-Blossom Pearly Mussel	*Epioblasma florentina florentina*	E
Upland Combshell	*E. metastriata*	E
Southern Acornshell	*E. othcaloogensis*	E
Green Blossom	*E. torulosa gubernaculum*	E
Tuberculed Blossom	*E. torulosa torulosa*	E
Turgid Blossom	*E. turgidula*	E
Tan Riffleshell	*E. florentina walkeri*	E
Catspaw	*E. obliquata obliquata*	E
Finerayed Pigtoe	*Fusconaia cuneolus*	E
Shiny Pigtoe	*F. cor*	E
Cracking Pearlymussel	*Hemistena lata*	E
Pink Mucket	*Lampsilis abrupta*	E
Alabama Lampmussel	*L. virescens*	E
Coosa Moccasinshell	*Medionidus parvulus*	E
Ring Pink	*Obovaria retusa*	E
Little Birdwing	*Pegias fabula*	E
White Wartyback	*Plethobasus cicatricosus*	E
Orangefooted Pimpleback	*P. cooperianus*	E
Clubshell	*Pleurobema clava*	E
Southern Clubshell	*P. decisum*	E
Southern Pigtoe	*P. georgianum*	E
Ovate Clubshell	*P. perovatum*	E
Rough Pigtoe	*P. plenum*	E
Cumberland Pigtoe	*Pleuronaia gibberum*	E
Triangular Kidneyshell	*Ptychobranchus greenii*	E

Common Name	Scientific Name	Federal
Rough Rabbitsfoot	*Quadrula cylindrica strigillata*	E
Cumberland Monkeyface	*Quadrula intermedia*	E
Winged Mapleleaf	*Q. fragosa*	E
Appalachian Monkeyface	*Q. sparsa*	E
Pale Lilliput	*Toxolasma cylindrellus*	E
Cumberland Bean	*Villosa trabalis*	E
Purple Bean	*Villosa perpurpurea*	E

MUSSELS – Threatened

Common Name	Scientific Name	Federal
Finelined Pocketbook	*Hamiota altilis*	T
Alabama Moccasinshell	*Medionidus acutissimus*	T

AQUATIC SNAILS – Endangered

Common Name	Scientific Name	Federal
Anthony's Riversnail	*Athearnia anthonyi*	E
Royal Snail	*Marstonia ogmorhaphe*	E

* Federal Status: E = Federally Endangered, T = Federally Threatened, MC = Management Concern, an unofficial indication that this species has been brought to federal attention for review for possible future federal listing

Virginia

The Virginia Department of Game and Inland Fisheries (VDGIF) has a Wildlife Action Plan (http://bewildvirginia.org/wildlifeplan/) which identifies species of greatest conservation need and identifies tasks needed to conserve the species and their habitat on a regional basis. In addition, the VDGIF has Freshwater Mussel Restoration Guidelines for the Upper Tennessee River Basin of Virginia. These restoration guidelines identify species for restoration activities and specify specific stream reaches for which restoration activities can occur for each species. Freshwater mussel restoration activities in Virginia must conform to the guidelines.

In addition to following the Upper Tennessee River Basin guidelines, a valid collection permit is required to conduct freshwater mussel restoration activities in Virginia. A Scientific Collection Permit (http://www.dgif.virginia.gov/permits/permit-applications.asp), valid for two years, is needed for any activities related to non-listed wildlife for scientific or educational purposes. A Threatened and Endangered Species Permit (http://www.dgif.virginia.gov/permits/permit-applications.asp), valid for one year, is needed for any activities related to federal- or state-endangered or threatened species. Either permit can be obtained by contacting Shirl Dressler P.O. Box 11104, Richmond, VA 23230-1104; 804-367-6913 (*CollectionPermits@dgif.virginia.gov*). All permit applications are reviewed by appropriate VDGIF Regional Wildlife Diversity Biologists. An annual report is due 31 January each year, regardless of permit length.

Mussels: *Alasmidonta marginata,* Elktoe; *Alasmidonta viridis,* Slippershell; *Cumberlandia monodonta,* Spectaclecase; *Elliptio crassidens,* Elephantear; *Epioblasma triquetra,* Snuffbox; *Lasmigona holstonia,* Tennessee Heelsplitter; *Leptodea fragilis,* Fragile Papershell; *Ligumia recta,* Black Sandshell; *Plethobasus cyphyus,* Sheepnose; *Pluerobema cordatum,* Ohio Pigtoe; *Pleurobema rubrum,* Pyramid Pigtoe; *Pleuronaia barnesiana,* Tennessee Pigtoe; *Pleuronaia dolabelloides,* Slabside Pearlymussel; *Quadrula pustulosa,* Pimpleback; *Toxolasma lividum,* Purple Lilliput and *Truncilla truncata,* Deertoe.