CRACKING PEARLYMUSSEL

RECOVERY PLAN

RECOVERY PLAN

for

Cracking Pearlymussel (*Hemistena* (=*Lastena*) *lata*)

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for

Southeast Region
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Approved: _____
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Recovery plans delineate reasonable actions that are believed to be required to recover and/or protect the species. Plans are prepared by the U.S. Fish and Wildlife Service, sometimes with the assistance of recovery teams, contractors, State agencies, and others. Objectives will only be attained and funds expended contingent upon appropriations, priorities, and other budgetary constraints. Recovery plans do not necessarily represent the views nor the official positions or approvals of any individuals or agencies, other than the U.S. Fish and Wildlife Service, involved in the plan formulation. They represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Regional Director or Director as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

Literature citations should read as follows:

U.S. Fish and Wildlife Service. 1990. Cracking Pearlymussel (Hemistena (=Lastena) lata) Recovery Plan. Atlanta, GA. 25 pp.

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Fish and Wildlife Reference Service
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EXECUTIVE SUMMARY FOR THE CRACKING PEARLYMUSSEL RECOVERY PLAN

Current Status: The species is listed as endangered. Presently, the cracking pearlymussel is known to survive in only a few shoals in the Clinch and Powell Rivers in Virginia and Tennessee and the Elk River in Tennessee. Populations may possibly still persist in a short reach of the Tennessee River in Tennessee and the Green River in Kentucky. Historically, the species occurred in the Ohio River and its larger tributaries in Ohio, Indiana, Illinois, Kentucky, Tennessee, Alabama, and Virginia.

Habitat Requirements and Limiting Factors: The cracking pearlymussel inhabits cobble, gravel, sand, and sometimes mud substrate in medium to large rivers of the Ohio River basin. The species' distribution and reproductive capacity has been seriously impacted by the construction and operation of reservoirs and by other impacts on water and substrate quality. Unless new populations are found or created and existing populations are maintained, this species will likely become extinct in the foreseeable future.

Recovery Objective: Downlisting. Because of the lack of available habitat for establishment of all needed populations, recovery is unlikely.

Recovery Criteria: To establish eight distinct viable populations.

Actions Needed:
1. Utilize existing legislation/regulations to protect species.
2. Search for new populations and monitor existing populations.
3. Develop and utilize an information/education program.
4. Determine species' life history requirements.
5. Determine threats and alleviate those that threaten species' existence.
6. Through reintroduction and protection, establish eight viable populations.
7. Develop and implement cryopreservation protection of species.

Cost (1,000's):

Year	Need 1	Need 2	Need 3	Need 4	Need 5	Need 6	Need 7	Total
1991	7.0	30.0	25.0	25.0	0.0	40.0	5.0	132.0
1992	7.0	30.0	20.0	25.0	25.0	40.0	5.0	152.0
1993	7.0	8.0	2.0	25.0	25.0	40.0	5.0	112.0
1994	7.0	0.0	2.0	0.0	25.0	20.0	2.0	56.0
1995	7.0	8.0	2.0	0.0	?	15.0	2.0	34.0*
1996	7.0	0.0	2.0	0.0	?	15.0	2.0	26.0*
1997	7.0	8.0	2.0	0.0	?	5.0	2.0	24.0*
1998	7.0	0.0	2.0	0.0	?	0.0	2.0	11.0*
1999	7.0	8.0	2.0	0.0	?	5.0	2.0	24.0*
2000	7.0	0.0	2.0	0.0	?	0.0	2.0	11.0*
2001	7.0	8.0	2.0	0.0	?	5.0	2.0	24.0*
Total:	77.0	100.0	63.0	75.0	75.0*	185.0	31.0	606.0*

*See next page.

*Habitat improvement costs needed for the species' recovery will not be known until the magnitude of specific threats is determined through research.

Date of Recovery: Total recovery is unlikely for this species. The downlisting date cannot be estimated at this time. As mussels do not reproduce until about age 5, more than 10 years will be needed to document reproduction and assess viability.

PART I

INTRODUCTION

The cracking pearlymussel (Hemistena (=Lastena) lata) was listed as an endangered species in the Federal Register (54 FR 39850) on September 28, 1989, under the Endangered Species Act of 1973, as amended. This species, which was once known from the Ohio, Cumberland, and Tennessee River systems, is presently known to survive at only a few shoals in the Clinch and Powell Rivers in Virginia and Tennessee and the Elk River in Tennessee. Populations may possibly still persist in a short reach of the Tennessee River in Tennessee and in the Green River in Kentucky. The species' range has been seriously restricted by the construction of impoundments and by other impacts to its habitat. Due to the species' limited distribution, any factors that adversely modify habitat or water quality in the river reaches it now inhabits could further threaten the species.

Description, Ecology, and Life History

The cracking pearlymussel (Hemistena (=Lastena) lata) was initially described by Rafinesque (1820). This freshwater mussel has a thin, medium-size, elongated, and slightly inflated shell (Bogan and Parmalee 1983). The shell's outer surface (periostracum) is brownish green to brown and often has broken dark green rays. The nacre (inside the shell) is pale bluish to purple. The anterior end of the shell is rounded, while the posterior end is truncated or only bluntly pointed. The species has weak pseudocardinal teeth (a single knob or ridge). The lateral teeth are poorly developed, forming a thickened hinge line. The beak cavity is shallow or sometimes absent. The cracking pearlymussel has a long foot (about the same length as the shell), and the mussel is usually buried deep in the substrate with only its siphons visible (Gordon and Layzer 1989).

Because of its rarity, little is known of the mussel's biology. The species, according to Bates and Dennis (1985), inhabits medium-sized rivers. However, this species has been taken in the Tennessee River downstream of Pickwick Dam (Yokley 1972). The cracking pearlymussel has been reported primarily from riffle habitat with sand, gravel, and cobble substrates (Wilson and Clarke 1914, Ahlstedt 1984), but the species has also been taken from mud and sand substrates in slower flowing water (Call 1900).

Specific food habits of the cracking pearlymussel are unknown, but it likely feeds on food items similar to those consumed by other freshwater mussels. Freshwater mussels are known to feed on detritus, diatoms, phytoplankton, and zooplankton (Churchill and Lewis 1924), which they filter out of the water.

The cracking pearlymussel's reproductive biology is unknown, but it probably reproduces like other freshwater mussels. Males release sperm into the water column. The sperm are taken in by the females

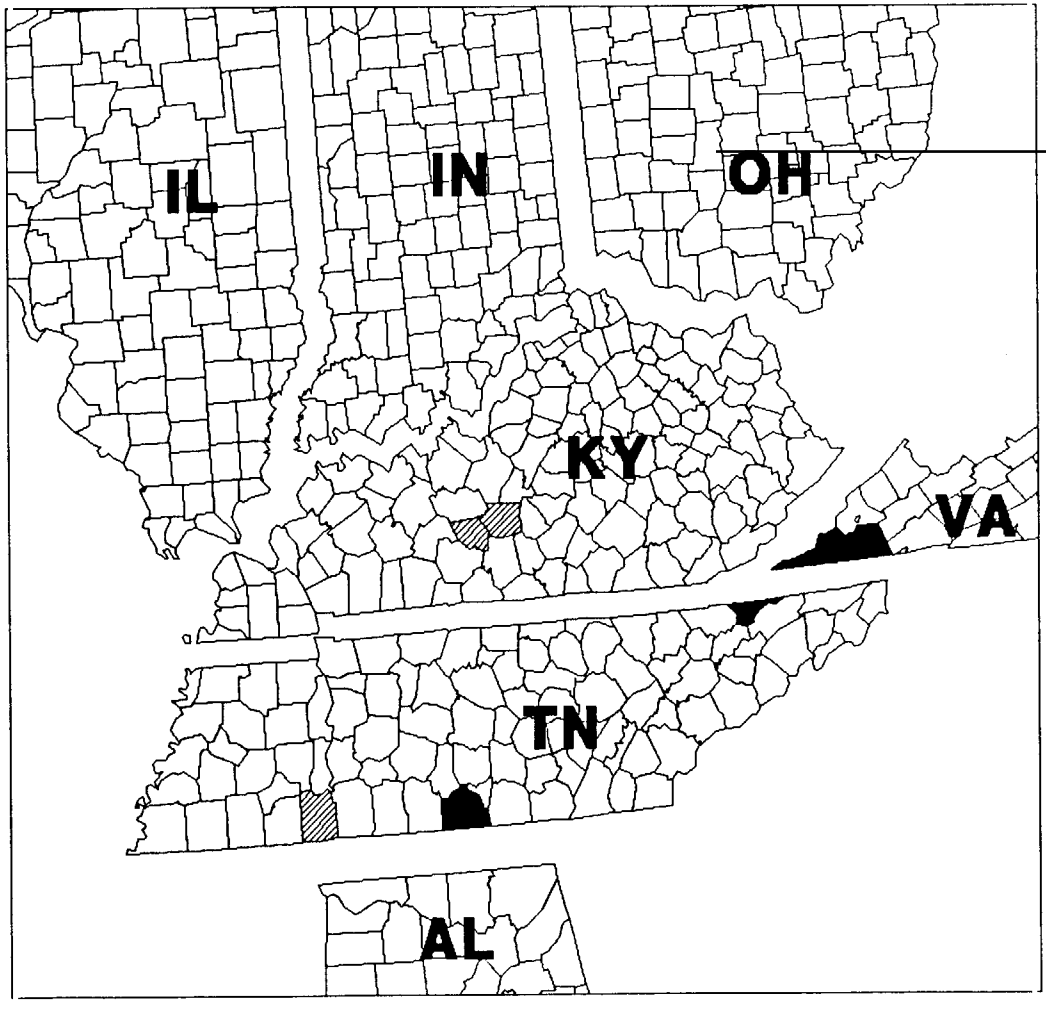
through their siphons during feeding and respiration. The fertilized eggs are retained in the gills until the larvae (glochidia) fully develop. Gravid female cracking pearlymussels have been observed during mid-May (Ortmann 1915). When the glochidia are released into the water, they attach and encyst on the gills or fins of a fish host. When metamorphosis is complete, they drop to the streambed as juvenile mussels. The species of host fish utilized by the cracking pearlymussel and the habitat utilized by the juveniles are unknown.

Distribution, Reasons for Decline, and Threats to Its Continued Existence

The cracking pearlymussel was once widely distributed in the Ohio River basin. The species ranged in the Ohio River from Ohio downstream to Illinois (Bogan and Parmalee 1983). In Indiana and Illinois it was historically known from the White, Wabash, and Tippecanoe Rivers (Kevin Cummings, Illinois State Natural History Survey Division, and Max Henschen, Mollusk Technical Advisory Committee, personal communications, 1988). Kentucky records (Kentucky State Nature Preserves Commission 1980; Richard Hannan, Kentucky State Nature Preserves Commission, personal communication, 1988) show that the species once inhabited the Upper Cumberland, Big South Fork, Green, and Kentucky Rivers. The cracking pearlymussel has historically been taken in Tennessee from the Tennessee, Cumberland, Powell, Clinch, Holston, Elk, Duck, and Buffalo Rivers (Bogan and Parmalee 1983, Ahlstedt 1986, Bates and Dennis 1985). In Alabama, this mussel existed in the Tennessee River (Bogan and Parmalee 1983). Portions of the Powell, Clinch, and Holston Rivers in Virginia are also reported to have supported the species (Bogan and Parmalee 1983; Charles Sledd, Virginia Department of Game and Inland Fisheries, and Michael Lipford, Virginia Department of Conservation and Historic Resources, personal communications, 1988).

Based on a literature review (see above) and personal contacts with knowledgeable Federal, State, and independent biologists, the species is presently known to be surviving (see map) only in the Clinch River, Hancock County, Tennessee, and Scott County, Virginia; the Powell River, Hancock County, Tennessee, and Lee County, Virginia; and the Elk River, Lincoln County, Tennessee. The species may also still survive in the Green River, Hart and Edmonson Counties, Kentucky (Richard Hannan, personal communication, 1988), and in a short reach of the Tennessee River below Pickwick Dam, Hardin County, Tennessee (Paul Yokley, Jr., University of North Alabama, personal communication, 1988).

The Powell River's population was sampled in 1979 by the Tennessee Valley Authority (Ahlstedt 1986). They surveyed 78 sites over about 97 river miles and found the cracking pearlymussel at only three sites. The Powell River watershed is mined extensively for coal, and coal mining impacts to the river are evident. The upper reaches of the Powell River are significantly impacted. The lower river reaches, which still contain a relatively diverse mussel fauna, have



Distribution of the cracking pearlymussel (Hemistena (=Lastena) lata): All States with historic population records, counties with extant populations, and counties with possible extant populations.

PRESENT POPULATIONS

KNOWN EXTANT
POSSIBLE EXTANT

large deposits of coal fines and silt (Ahlstedt 1986). In 1983 the section of the Powell River inhabited by the cracking pearlymussel experienced a mussel kill that may have resulted in a loss of 5 percent of the mussel population (Ahlstedt and Jenkinson 1987).

The Clinch River population of the cracking pearlymussel is the largest and covers the greatest river length. Ahlstedt (1986) reported the species from 16 of the 141 sites sampled in a 1978-83 Tennessee Valley Authority survey that covered about 174 river miles. Although this river and its mussel fauna are apparently healthier than the Powell, the Clinch River has been adversely affected by pollution. Charles Sledd (personal communication, 1988) stated that land use practices along the Clinch have contributed to the decline of water quality and the loss of mussel populations. The Clinch River also experiences some impacts from coal mining, and the river has been subjected to two mussel kills that resulted from toxic substance spills from a riverside coal-fired power plant.

The cracking pearlymussel was taken at only two of 108 sites over the 172 miles of the Elk River surveyed in 1980 by the Tennessee Valley Authority (Ahlstedt 1986). This river, according to Ahlstedt (1986), has a considerable amount of suitable habitat for freshwater mussels, and a large number of relic shells was present. However, Ahlstedt (1986) reported that cold-water releases from Tims Ford Reservoir and pollution from an unknown source in the lower Elk River have impacted the mussel fauna, and mussel density has been reduced.

The cracking pearlymussel has not been taken from the Green River since 1966, and mussel surveys in 1987, 1988, and 1989 did not find the species (Ronald Cicerello, Kentucky State Nature Preserves Commission, personal communication, 1990). However, suitable habitat appears to be available in the Green River, and an isolated population may still exist there (Richard Hannan, personal communication, 1988). In the Tennessee River below Pickwick Dam, live specimens were taken in the 1970s, but only relic shells have been taken in recent years. According to a personal communication from Dr. Paul Yokley, Jr. (1988), this species, which apparently existed only in small numbers in this river reach, could possibly still survive there.

If populations still persist in the Tennessee River below the Pickwick Dam in Tennessee and the Green River in Kentucky, these populations are also at risk. The Green River's mussel fauna has also been seriously depleted. Ortmann (1926) reported finding 66 species of mussels in the Green River. Isom (1974) reported only 27 species present. The Green River has been degraded by oil and gas exploration and production and by alterations of stream flow from an upstream reservoir. Any population below Pickwick Dam in the Tennessee River is potentially threatened by gravel dredging, channel maintenance, and the operation of Pickwick Dam. This river reach also experienced mussel die-offs in 1985 and 1986 (Ahlstedt and Jenkinson 1987).

The Powell and Elk River populations are small, and if the species continues to exist in the Green River and Tennessee River, these populations would likely be very limited. All the populations are geographically isolated from each other. This isolation restricts the natural interchange of genetic material between the populations, and the small population size reduces the reservoir of genetic variability within the populations. It is likely these populations, with the possible exception of the Clinch River, are now below the generally accepted level required to maintain long-term genetic viability (Soulé 1980).

PART II

RECOVERY

A. Recovery Objectives

The ultimate goal of this recovery plan is to restore viable populations of the cracking pearlymussel (Hemistena (=Lastena) lata) to a significant portion of its historic range in the Ohio River system and to remove the species from the Federal List of Endangered and Threatened Wildlife and Plants. However, total recovery of the cracking pearlymussel may not be possible. Much of the habitat within the species' historic range may be unsuitable for reintroductions. **NOTE:** A viable population is defined as a naturally reproducing population that is large enough to maintain sufficient genetic variation to enable it to evolve and respond to natural environmental changes. The number of individuals needed to reach a viable population will be determined as one of the recovery tasks.

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

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

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

3. Biological and ecological studies have been completed, and the recovery measures developed and implemented from these studies are beginning to be successful, as evidenced by an increase in population density and/or an increase in the length of the river reach inhabited by each of the five populations.

The cracking pearlymussel will be considered for removal from Endangered Species Act protection when the likelihood of the

species' becoming threatened in the foreseeable future has been eliminated by the achievement of the following criteria:

1. Through protection of existing populations and successful establishment of reintroduced populations or the discovery of additional populations, a total of eight distinct viable populations exist. These populations must be separated to the extent that it is unlikely that a single event would eliminate or significantly reduce more than one of these populations. The populations shall be distributed throughout the Ohio River basin as follows: two in the upper Tennessee River system, two in the middle to lower Tennessee River system, one in the Cumberland River system, one in a Kentucky tributary to the Ohio River other than the Cumberland River, and two in the Wabash River system.

2. Two distinct naturally reproduced year classes exist within each of the eight populations. Both year classes must have been produced within 10 years, and one year class within 5 years, of the recovery date. Within 1 year of the recovery date, gravid females of the species and its host fish must be present in each river.

3. Studies of the mussel's biological and ecological requirements have been completed, and recovery measures developed and implemented from these studies have been successful, as evidenced by an increase in population density and/or an increase in the length of the river reach inhabited by each of the eight populations.

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

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

B. Narrative Outline

1. Preserve present populations and occupied habitat. Because so few cracking pearlymussel populations exist, it is essential to the survival and eventual recovery of the species that all existing populations and their habitat are protected.

1.1 Continue to utilize existing legislation and regulations (Federal Endangered Species Act, Federal and State surface mining laws, water quality regulations, stream alteration regulations, etc.) to protect the species and its habitats. Prior to and during implementation of this recovery plan, the present cracking pearlymussel populations can be protected only by the full enforcement of existing laws and regulations.

1.2 Solicit help in protecting the species and its essential habitats. Section 7 consultation under the Endangered Species Act, Fish and Wildlife Coordination Act requirements, and other habitat protection programs can assist in protection of the species, but these programs alone cannot recover the cracking pearlymussel. The assistance of Federal and State agencies, conservation groups, and local governments will be essential. Also, support of the local industrial, business, and farming communities, as well as private citizens, will be needed to meet the goal of recovering the species. Without a commitment from the local people who have an influence on habitat quality in the streams inhabited by the species, recovery efforts will be doomed.

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

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

1.2.3 Develop an educational program using such items as slide/tape shows, brochures, etc. Present this material to business groups, civic groups, youth groups, schools, church organizations, etc. Educational material outlining the Service's recovery goals must be presented to the public. However, this material should stress the other benefits of maintaining diverse ecosystems and the use of mussels as indicators of good environmental quality.

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

2. Determine threats to the species, conduct research necessary for the species' management and recovery, and implement management where needed.

2.1 Conduct life history research on the species to include such factors as reproduction, food habits, age and growth, and mortality rates. Only very limited data on the cracking pearlymussel's life history exists. Unless the species's life history (especially its fish host) and environmental requirements are defined, recovery efforts may be inconsequential or misdirected.

2.2 Characterize the species' habitat requirements (relevant physical, biological, and chemical components) for all life history stages. The cracking pearlymussel appears to be sensitive to habitat degradation. The species coexists with other mussel species, but it occurs in much fewer numbers than most of the other species present. Knowledge of the species' habitat needs and ecological associations (especially fish host requirements) is needed to focus management and recovery efforts on the specific problems within the species' habitat.

2.3 Determine present and foreseeable threats to the species. Coal mining and oil and gas well development appear to have been major factors in altering the species' habitat and in reducing its range in the Powell River and eliminating the species from the upper Cumberland River. Siltation from poor land use practices and impoundment have also had an impact. However, other impacts are also probable. The nature of and the mechanisms by which they impact the species and its habitat are not entirely understood. The extent to which the species can withstand these adverse impacts is unknown. To minimize and eliminate these threats where necessary to meet recovery, the information gathered under Tasks 2.1 and 2.2 must be utilized to target specific problem areas and determine the specific causative agent(s).

2.4 Investigate the relationships with nonnative bivalves. Many malacologists believe the Asiatic clam (Corbicula fluminea) poses a threat to the native mussel fauna. Another exotic clam, the zebra clam (Dreissena polymorpha), has recently invaded the Great Lakes, and some adverse impacts to endemic mussels have been noted. The zebra clam has not yet been seen in the Ohio River

basin. However, as the species has spread quickly in the Great Lakes, it is expected to invade other basins in the near future. The relationship between these nonnative mollusks and the native fauna needs to be understood, and (where feasible) measures should be taken to minimize their impact. It has been suggested that Corbicula may adversely impact native mussels by consuming a significant portion of their sperm (Arthur H. Clarke; Ecosearch, Inc; personal communication; 1990). Clarke suggests that, by concentrating endangered mussels, the loss of sperm would decrease, and reproductive success would increase. A study using nonendangered mussels should be used to test this hypothesis.

2.5 Based on the biological data and threat analysis, investigate the need for management, including habitat improvement. Implement management, if needed, to secure viable populations. Specific components of the cracking pearlymussel's habitat may be lacking, and these may limit the species' potential expansion. Habitat improvement programs may be needed to alleviate limiting factors.

2.6 Determine number of individuals required to maintain a viable population. Theoretical considerations by Franklin (1980) and Soulé (1980) indicate that 500 breeding individuals represent a minimum population level (effective population size) that would contain sufficient genetic variation to enable that population to evolve and respond to natural habitat changes. The actual population size in a natural ecosystem necessary to provide 500 breeding individuals can be expected to be larger, possibly by as much as 10 times. The factors that will influence effective population size include sex ratio, length of species' reproductive life, fecundity, and extent of exchange of genetic material within the population, plus other life history aspects. Some of these factors can be addressed under Task 2.1, while others will need to be addressed as part of this task.

3. Search for additional populations and/or habitat suitable for reintroduction efforts. Much of the species' potential available habitat has been surveyed in recent years. An extensive 4-year survey of the Wabash River system in Indiana and Illinois has recently been completed, and the Tennessee River system has also received considerable attention in the last few years. However, it is possible that some relic populations were missed. Further study may yield additional populations; and, more importantly, suitable habitat for transplants could be identified.

4. Determine, through research, the feasibility of augmenting extant populations and reestablishing the cracking pearlymussel into historic habitat and reintroduce where feasible. The historic distribution of the cracking pearlymussel is unknown, but available records indicate that the species was once widespread in the Ohio River system. Streams for possible reintroductions will be selected based on present and expected future habitat and water quality.

   4.1 Determine the need, appropriateness, and feasibility of augmenting and expanding existing populations. Most of the populations are likely below the number needed to maintain long-term viability. These populations may be able to expand naturally if environmental conditions are improved. However, some populations may be too small and may need to be supplemented to reach a viable size. Populations for this task will be selected based on present population size, habitat quality, and the likelihood of long-term benefits from the task.

   4.2 Develop a successful technique for reestablishing and augmenting populations. Sufficient specimens of the mussel are not presently available to allow for translocation of enough adults to establish populations. Propagation and reintroduction techniques should be developed for the species to help ensure success.

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

   4.4 Reintroduce the species into its historic range and evaluate success. Using techniques developed in Task 4.2, introduce and monitor success.

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

5. Develop and implement cryogenic techniques to preserve the species' genetic material until such time as conditions are suitable for reintroduction. The cracking pearlymussel populations that remain, except (possibly) for the Clinch River population, may not be reproducing. Artificial propagation techniques may be able to provide juvenile mussels for transplants. However, present habitat conditions may not be suitable in all rivers at this time for reintroduction to succeed. Cryogenic preservation of the species could maintain genetic material (much like seed banks for endangered plants) from all the extant populations until

such time as the habitat becomes suitable for reestablishment of the species. Additionally, if a population were lost to a catastrophic event, such as a toxic chemical spill, cryogenic preservation could allow for the eventual reestablishment of the population using the genetic material preserved from that population.

6. Develop and implement a program to monitor population levels and habitat conditions of presently established populations as well as newly discovered, introduced, or expanding populations. During and after recovery actions are implemented, the status of the species and its habitat must be monitored to assess any progress toward recovery. This should be conducted on a biennial schedule.

7. Annually assess overall success of the recovery program and recommend action (modify recovery objectives, delist, continue to protect, implement new measures, or other studies, etc.). The recovery plan must be evaluated periodically to determine if it is on track and to recommend future actions. As more is learned about the species, recovery objectives may need to be modified.

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PART III

IMPLEMENTATION SCHEDULE

Priorities in column one of the following implementation schedule are assigned as follows:

1. Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

2. Priority 2 - An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

3. Priority 3 - All other actions necessary to meet the recovery objective.

Key to Acronyms Used in This Implementation Schedule

ADCNR	- Alabama Department of Conservation and Natural Resources
FWE	- Fish and Wildlife Enhancement
FWS	- U.S. Fish and Wildlife Service
ILDOC	- Illinois Department of Conservation
ILSNHSD	- Illinois State Natural History Survey Division
INDNR	- Indiana Department of Natural Resources
KDFWR	- Kentucky Department of Fish and Wildlife Resources
KSNPC	- Kentucky State Nature Preserves Commission
NPS	- National Park Service
ODNR	- Ohio Department of Natural Resources
TDOC	- Tennessee Department of Conservation
TNC	- The Nature Conservancy
TVA	- Tennessee Valley Authority
TWRA	- Tennessee Wildlife Resources Agency
VDGIF	- Virginia Department of Game and Inland Fisheries
VNHP	- Virginia Natural Heritage Program

IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (Years)	RESPONSIBLE PARTY			COST ESTIMATES ($000'S)			COMMENTS
				FWS		Other	FY 1991	FY 1992	FY 1993	
				Region	Division					
1	1.1	Continue to utilize existing legislation and regulations to protect species and its habitat.	Ongoing	3, 4, 5	FWE	See *1.	7.0	7.0	7.0	
2	1.2.1, 1.2.2	Meet with local governmental officials and business interests and elicit their support for recovery.	3	3, 4, 5	FWE	See *1.	---	---	2.0	
1	1.2.3	Develop information and education program and present.	Ongoing	3, 4, 5	FWE	See *1.	25.0	20.0	---	Task duration: 1 year to develop, then continuous.
2	1.3	Consider use of land acquisition to protect the species.	Ongoing	3, 4, 5	FWE	See *1.	---	---	---	
1	2.1, 2.2, 2.3, 2.4	Conduct research necessary for species management and recovery;	4	3, 4, 5	FWE	See *1.	25.0	50.0	50.0	

IMPLEMENTATION SCHEDULE

PRIOR-ITY #	TASK #	TASK DESCRIPTION	TASK DURATION (Years)	RESPONSIBLE PARTY			COST ESTIMATES ($000'S)			COMMENTS
				FWS						
				Region	Division	Other	FY 1991	FY 1992	FY 1993	
		habitat, augment populations, and protect any populations established.								
1	5	Develop and implement cryopreservation.	3 years	3, 4, 5	FWE	See *1.	5.0	5.0	5.0	
2	6	Develop and implement a monitoring program.	Ongoing	3, 4, 5	FWE	See *1.	---	---	8.0	Biennial.
3	7	Annually assess recovery program and modify program and plan where required.	Ongoing	3, 4, 5	FWE	See *1.	0.5	0.5	0.5	

* - ADCNR, ILDOC, ILSNHSD, INDNR, KDFWR, KSNPC, NPS, ODNR, TDOC, TNC, TVA, TWRA, VDGIF, and VNHP

IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (Years)	RESPONSIBLE PARTY			COST ESTIMATES ($000'S)			COMMENTS
				FWS		Other	FY 1991	FY 1992	FY 1993	
				~~Region~~	~~Division~~					
		i.e., habitat requirements, biology, and threat analysis.								
See comments.	2.5	Based on biological and threat analysis, investigate need for management and implement where needed.	1 year	3, 4, 5	FWE	See *1.	---	---	---	Priority 1, 2, or 3 (depending on result of 2.1, 2.2, 2.3, and 2.4).
3	2.6	Determine number of individuals required to maintain viable population.	1 year	3, 4, 5	FWE	See *1.	---	---	?	
1	3	Search for additional populations and suitable habitat.	1 year	3, 4, 5	FWE	See *1.	30.0	30.0	8.0	
1	4	Develop techniques, select sites, reintroduce the species back into historic	Ongoing	3, 4, 5	FWE	See *1.	40.0	40.0	40.0	Task duration: 3 years (protection continues).

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