RING PINK MUSSEL

RECOVERY PLAN

RECOVERY PLAN

for

Ring Pink Mussel (*Obovaria retusa*)

Prepared by

Richard G. Biggins
Asheville Field Office
U.S. Fish and Wildlife Service
Asheville, North Carolina

for

Southeast Region
U.S. Fish and Wildlife Service
Atlanta, Georgia

February 1991

Approved: Harold W. Benson
Acting Regional Director, U.S. Fish and Wildlife Service

Date: 3/25/91

Recovery plans delineate reasonable actions which 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. 1991. Ring Pink Mussel Recovery Plan. Atlanta, Georgia. 24 pp.

Additional copies of this plan may be purchased from:

Fish and Wildlife Reference Service
5430 Grosvenor Lane, Suite 110
Bethesda, Maryland 20814
Phone: 301/492-6403 or
1-800/582-3421

The fee for a plan varies depending on the number of pages in the plan.

EXECUTIVE SUMMARY FOR THE RING PINK MUSSEL RECOVERY PLAN

Current Status: The ring pink mussel is listed as endangered. Presently, the species is known from five relic, possibly nonreproducing, populations--two in Tennessee, two in Kentucky, and one in West Virginia. Historically, the species occurred in the Ohio River and its larger tributaries in Pennsylvania, West Virginia, Ohio, Indiana, Illinois, Kentucky, Tennessee, and Alabama.

Habitat Requirements and Limiting Factors: The ring pink inhabits gravel and sandy substrates in large rivers of the Ohio River basin. The species' distribution and reproductive capacity have been seriously impacted by the construction and operation of reservoirs on these large rivers. Unless reproducing populations are found or created, or existing populations 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 six 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 six viable populations.
7. Develop and implement cryopreservation techniques for the species.

Cost (1,000's):

Year	Need 1	Need 2	Need 3	Need 4	Need 5	Need 6	Need 7	Total
1991	5.0	30.0	25.0	25.0	0.0	25.0	20.0	130.0
1992	5.0	30.0	20.0	25.0	25.0	20.0	20.0	145.0
1993	5.0	8.0	2.0	25.0	25.0	25.0	20.0	110.0
1994	5.0	8.0	2.0	0.0	25.0	10.0	10.0	60.0
1995	5.0	8.0	2.0	0.0	?	10.0	2.0	27.0*
1996	5.0	8.0	2.0	0.0	?	10.0	2.0	27.0*
1997	5.0	8.0	2.0	0.0	?	0.0	2.0	17.0*
1998	5.0	8.0	2.0	0.0	?	0.0	2.0	17.0*
1999	5.0	8.0	2.0	0.0	?	0.0	2.0	17.0*
2000	5.0	8.0	2.0	0.0	?	0.0	2.0	17.0*
2001	5.0	8.0	2.0	0.0	?	0.0	2.0	17.0*
Total:	55.0	132.0	63.0	75.0	75.0*	100.0	84.0	584.0*

*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 not thought to be possible. The downlisting date can not be estimated at this time. Mussels do not reproduce until about age 5, more than 10 years is needed to document reproduction and assess viability.

TABLE OF CONTENTS

PART I

INTRODUCTION

The ring pink mussel (Obovaria retusa) was listed as an endangered species without critical habitat on September 29, 1989 (54 FR 40109) (U.S. Fish and Wildlife Service 1989). This freshwater mussel historically occurred in the Ohio River and its larger tributaries in Pennsylvania, West Virginia, Ohio, Indiana, Illinois, Kentucky, Tennessee, and Alabama. Presently, the ring pink mussel is known from five relic, possibly nonreproducing, populations--two in the Tennessee River (one in the State of Kentucky and one in the State of Tennessee), one in the Green River in Kentucky, one in the Cumberland River in Tennessee, and one in the Kanawha River in West Virginia. The distribution and reproductive capacity of this species has been seriously impacted by the construction of impoundments on the large rivers it once inhabited. Unless reproducing populations are found or methods are developed to maintain existing populations, this species will likely become extinct in the foreseeable future.

Description, Ecology, and Life History

The ring pink mussel, formerly referred to and proposed for listing by the U.S. Fish and Wildlife Service as the golf stick pearly mussel, was described by Lamarck (1819). This mussel has a medium to large shell that is ovate to subquadrate in outline (Bogan and Parmalee 1983). The shell exterior (periostracum) lacks rays and has a yellow-green to brown color. Older individuals are usually darker brown or black. The inside (nacre) of the shell is a salmon to deep purple color surrounded by a white border. For a more detailed description, see Bogan and Parmalee (1983).

As the species is rare, little is known of its life history. The ring pink, which is characterized as a large-river species (Bates and Dennis 1985, Bogan and Parmalee 1983), has been found inhabiting relatively shallow waters (2 feet deep) within gravel and sandy substrates (Neel and Allen 1964, Hickman 1937).

The specific food habits of the ring pink 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).

The species' reproductive biology remains virtually unknown, but it likely reproduces like other freshwater mussels. Males release sperm into the water column, which are taken in by the females through their siphons during feeding and respiration. The fertilized eggs are retained in the females' gills until the larvae (glochidia) fully develop. Gravid ring pink mussels have been observed in late August (Ortmann 1909 and 1912). The glochidia, which were reported by Ortmann (1912) to be rather large and hookless, are released into the water where 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 fish hosts utilized by the ring pink and the habitat of the juvenile mussel are unknown.

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

Historically, the ring pink mussel was widely distributed in the Ohio, Cumberland, and Tennessee River systems in Pennsylvania, West Virginia, Ohio, Illinois, Indiana, Kentucky, Tennessee, and Alabama (Gordon and Layzer 1989, Bogan and Parmalee 1983, Kentucky State Nature Preserves Commission 1980, Parmalee and Klippel 1982, Lauritsen 1987, Stansbery 1970). Based on personal communications with knowledgeable experts (Steven Ahlstedt and John Jenkinson, Tennessee Valley Authority, 1987; Arthur Bogan, Philadelphia Academy of Sciences, 1988; Arthur Clarke, Corpus Christi State University, 1986; Ronald Cicerello, Kentucky State Nature Preserves Commission, 1988; James Sickel, Murray State University, 1987; David Stansbery, Ohio State University, 1987; and William Tolin, U.S. Fish and Wildlife Service, 1990) and a review of current literature (see above, plus Sickel 1985), it is believed that the species has been extirpated from all but five river reaches.

The species was last taken in Pennsylvania in 1908 (Daniel Devlin, Pennsylvania Department of Environmental Resources, personal communication, 1987). According to a personal communication with Robert McCance, Jr. (Ohio Department of Natural Resources, 1987), the last Ohio collection of the ring pink mussel was made in 1938. In Indiana waters, the species has not been collected in decades (Max Henschen, Indiana Mollusk Technical Advisory Committee, personal communication, 1987). The Illinois Department of Energy and Natural Resources (Kevin Cummings, personal communication, 1987) reported that the species has not been collected from Illinois in over 30 years.

The species is presently known from only five river reaches--two in Kentucky, two in Tennessee, and one in West Virginia. In Kentucky waters, the ring pink mussel has been taken in recent years only from the Tennessee River in McCracken, Livingston, and Marshall Counties, and from the Green River in Hart and Edmonson Counties (Linda Andrews, Kentucky Department of Fish and Wildlife Resources, and Ronald Cicerello, personal communications, 1987). Kentucky's Tennessee River population is represented by the collection of only two live individuals in recent years. One was taken in 1985 (Sickel 1985), and the other was collected in 1986 (C. E. Moore, U.S. Army Corps of Engineers, personal communication, 1987). In the Green River, only two fresh-dead individuals have been taken in recent years (Ronald Cicerello, personal communication, 1990). Both specimens (one collected in 1987 and one in 1989) were taken in the river reach between Munfordville and Mammoth Cave National Park, Kentucky. The last live specimen taken from the Green River was collected in the mid-1960s (Mary Helen Miller, Kentucky Natural

Resources and Environmental Protection Cabinet, personal communication, 1987).

Historic records from the State of Tennessee (Ortmann 1918 and 1924, Hickman 1937, van der Schalie 1939, Marsh 1885, Wilson and Clark 1914) indicate that the species once inhabited the lower Holston River, Knox County; Tennessee River, Knox and Humphreys Counties; Clinch River, Anderson County; Cumberland River from Jackson County downstream to Stewart County; and Duck River, Maury County. The ring pink apparently still survives only in the Cumberland River in Wilson, Trousdale, and Smith Counties, and in the Tennessee River in Hardin County. According to personal communications with knowledgeable individuals, the species is taken on rare occasions by commercial mussel fishermen from both these rivers (Paul Parmalee, University of Tennessee, personal communication, 1986; Steven Ahlstedt, personal communication, 1987; Paul Yokley, University of North Alabama, personal communication, 1987).

One live specimen was taken in West Virginia's Kanawha River, Fayette County in 1990 (William Tolin, U.S. Fish and Wildlife Service, personal communication, 1990). Additional surveys are planned and other specimens may be found.

Most of the historically known ring pink populations were apparently lost due to conversion of many sections of these big rivers to a series of large impoundments. This seriously reduced the availability of its preferred riverine gravel and sand habitat and likely affected the distribution and availability of the ring pink mussel's fish host. As a result, the species' distribution has been substantially reduced.

The individuals that still survive in the remaining five populations are threatened by many factors. The Green River in Kentucky has experienced water quality problems related to impacts from oil and gas production in the watershed. The Kanawha River population may be threatened by a barge terminal that is proposed downstream from the area where one specimen was collected. The individuals still surviving in the Tennessee and Cumberland Rivers are potentially threatened by gravel dredging, channel maintenance, and commercial mussel fishing. Although the species is not commercially valuable, incidental take of the species does sometimes occur during commercial mussel fishing for other species.

Additionally, none of the five extant populations are known to be reproducing. Therefore, unless reproducing populations can be found or methods can be developed to maintain these or create new populations, the species will be lost in the foreseeable future. In fact, three of the populations (Cumberland and Tennessee River populations) may contain only old individuals that have passed their reproductive age.

PART II

RECOVERY

A. Recovery Objectives

The ultimate goal of this recovery plan is to restore viable populations of the ring pink mussel (*Obovaria retusa*) to a significant portion of its historic range in the Ohio River basin and remove the species from the Federal List of Endangered and Threatened Wildlife and Plants. However, total recovery for the ring pink may not be possible. The species is presently known from only five, possibly nonreproducing, populations, and suitable habitat for reintroduction is limited. Note: A viable population is defined as a reproducing population that is large enough to maintain sufficient genetic variation to enable it to evolve and respond to natural habitat changes. The number of individuals needed to obtain a viable population will be determined as one of the recovery tasks.

The species 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 successful establishment of reintroduced populations or discovery of additional populations, a total of at least six Ohio River system tributaries contain viable populations. These populations will be distributed within the Ohio River system as follows: two populations in the upper Ohio River basin in Pennsylvania, Ohio, West Virginia, Indiana, or Illinois; two populations in Kentucky; and two populations in Tennessee.

2. 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 population size and length of the river reach inhabited within each of the populations.

The species 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 discovery of additional populations, a total of at least nine Ohio River system tributaries contain viable populations. These populations will be distributed within the Ohio River system

as follows: one population in Pennsylvania, one population in Ohio, one population in West Virginia, one population in Indiana, one population in Illinois, two populations in Kentucky (one in the lower Tennessee or Cumberland River and one in another Ohio River tributary such as the Green River), and two populations in the Tennessee River.

2. Studies of the mussel's biological and ecological requirements have been completed, and the 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 population size and length of the river reach inhabited within each of the nine populations.

3. No foreseeable threats exist that would likely threaten survival of any of these nine populations.

4. 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 populations exist, it is essential that all populations 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 five extant 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 and Fish and Wildlife Coordination Act requirements can assist in protection of the species, but these programs alone cannot recover the ring pink. The assistance of Federal and State agencies, conservation groups, and local governments will be essential. Also, support of the local industrial, business, and farming community, as well as other local individuals and groups, will be needed to meet the goal of recovering the species. Without a commitment from the local people who have the greatest 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 that outlines the recovery goals and emphasizes the other benefits of maintaining and upgrading habitat quality will be extremely useful in informing the public of the recovery objectives.

1.3 Evaluate the use of land acquisition and other land management options as a means of protecting present and reintroduced populations, and use these methods where feasible.

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. Unless the species' life history 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 ring pink mussel appears to be sensitive to habitat degradation. The species coexists with other mussel species, but it occurs in fewer numbers than most other species. Knowledge of the species' habitat needs and ecological associations (especially host fish 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. Reservoir development on the large rivers within the Ohio River basin appears to have been the major cause of the ring pink's decline. However, other factors have and will likely continue to adversely impact the species. The mechanisms by which the species and its habitat are impacted are also not entirely understood. 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; 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 Determine the degree of threat to the species from commercial mussel fishing, and if threats exist, implement measures to minimize or eliminate the threats. In some rivers, commercial mussel fishermen occasionally take the ring pink. The impact of this take to the species should be determined, and steps should be taken to control take, where necessary. Some river reaches may need to be declared mussel sanctuaries by the States to fully protect the species from mussel fishing.

2.6 Based on the biological data and threat analysis, investigate the need for management, including habitat improvement. Implement management, if needed, to secure viable populations. Individual components of the species' habitat may be lacking, and these may limit the species' potential expansion. Specific management and habitat improvement programs may be needed to improve the status of some populations.

2.7 Determine the number of individuals required to maintain a viable population. Theoretical considerations by Franklin (1980) and Soulè (1980) indicate that 500 breeding individuals represents 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 the 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 potential available habitat in the Ohio River system has been surveyed. However, it is possible that some relic populations were missed. Further study may yield additional populations and also help delineate potential habitat for transplants.

4. Determine the feasibility of augmenting extant populations and reestablishing the ring pink mussel in historic habitat. Augment and reintroduce where feasible. The total historic distribution of the ring pink mussel is unknown, but

available records indicate that the species once was widespread in the large rivers of the Ohio River basin. To recover the species, extirpated populations will need to be reestablished, unless substantial additional populations are found. Streams for possible reintroduction 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. The existing 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, most populations are likely too small and will 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 available to allow for the translocation of enough adults to establish populations. Propagation and reintroduction techniques should be developed and evaluated for the species.

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, reintroduce and monitor success.

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

5. Develop and implement cryogenics techniques to preserve the species' genetic material until such time as conditions are suitable for reintroduction. The ring pink populations that remain, except for possibly the Green River population, are apparently not 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 ring pink could maintain genetic material (much like seed banks for endangered plants) from all the extant populations until such time as the habitat is 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 known 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.

C. Literature Cited

Bates, J. M., and S. D. Dennis. 1985. Mussel resource survey, State of Tennessee. Tennessee Wildlife Resources Agency Technical Report No. 85-3. 125 pp.

Bogan, A. E., and P. W. Parmalee. 1983. Tennessee's Rare Wildlife, Volume II: The Mollusks. Tennessee Wildlife Resources Agency and Tennessee Department of Conservation. 123 pp.

Churchill, E. P., Jr., and S. I. Lewis. 1924. Food and feeding in freshwater mussels. Bull. U.S. Bur. Fish. 39:439-471.

Franklin, R. I. 1980. Evolutionary change in small populations. IN: Conservation biology, an evolutionary-ecological perspective. Michael E. Soulè and Bruce A. Wilcox (eds.). Published by Sinauer Assoc., Inc., Sunderland, MA. Pp. 135-149.

Gordon, M. E., and J. B. Layzer. 1989. Mussels (BIVALVIA: UNIONOIDEA) of the Cumberland River: review of life histories and ecological relationships. U.S. Fish and Wildlife Service Biological Report. 89(15). 99 pp.

Hickman, M. E. 1937. A contribution to mollusca of east Tennessee. Unpublished master's thesis, Dept. of Zoology, University of Tennessee, Knoxville. 165 pp., 104 pl.

Kentucky State Nature Preserves Commission. 1980. Kentucky natural area plan - Appendix A. Obovaria retusa (Lamarck).

Lamarck, J. B. P. A. 1815-1822. Histoire naturelle des animaux sans vertebres. Tome V-VII, 8 vol.

Lauritsen, D. 1987. The Nature Conservancy element stewardship abstract: Obovaria retusa. The Nature Conservancy, Midwest Regional Office, Minneapolis, MN. Unpublished report. 4 pp.

Marsh, P. 1885. List of shells collected in central Tennessee by A. A. Hinkley and P. Marsh with notes on species. Aledo, IL.

Neel, J. K., and W. R. Allen. 1964. The fauna of the upper Cumberland basin before impoundment. Malacologia 1:427-459.

Ortmann, A. E. 1909. The breeding season of Unionidae in Pennsylvania. Nautilus, 22(9):91-95; 22(10):99-103.

------. 1912. Notes upon the families and genera of the naiades. Annals Carnegie Mus., 8:222-365.

------. 1918. The naydes (freshwater mussels) of the upper Tennessee drainage, with notes on synonymy and distribution. Proc. Am. Phil. Soc., 57:521-626.

------. 1924. The naiad fauna of the Duck River in Tennessee. Am. Midl. Nat., 9(1):18-62.

Parmalee, P. W., and W. E. Klippel. 1982. A relic population of Obovaria retusa in the middle Cumberland River, Tennessee. The Nautilus, 96(1):30-32.

Sickel, James B. 1985. Biological assessment of the freshwater mussels in the Kentucky Dam tailwaters of the Tennessee River. Submitted to Kentucky Division of Water, Frankfort, KY. 42 pp.

Soulè, M. E. 1980. Thresholds for survival: Maintaining fitness and evolutionary potential. IN: Conservation biology, an evolutionary-ecological perspective. Michael E. Soulè and Bruce A. Wilcox (eds.). Published by Sinauer Assoc., Inc., Sunderland, MA. Chap. 8, pp. 151-169.

Stansbery, David H. 1970. Eastern freshwater mollusks (I) the Mississippi and St. Lawrence River systems. Malacologia, 10(1):9-22.

U.S. Fish and Wildlife Service. 1989. Endangered and threatened wildlife and plants; determination of ring pink mussel (Obovaria retusa) to be an endangered species. Federal Register 54(188):40109-40112.

van der Schalie, H. 1939. Additional notes on the naiades (freshwater mussels) of the lower Tennessee River. Am. Midl. Nat. 22:452-457.

Wilson, C. B., and H. W. Clark. 1914. The mussel fauna of the Cumberland River and its tributaries. Rep. U.S. Comm. Fish. for 1912 Spec. Pap.:1-63.

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

FS - U.S. Forest Service
FWE - Fish and Wildlife Enhancement
FWS - U.S. Fish and Wildlife Service
IDNR - Indiana Department of Natural Resources
IDOC - Illinois Department of Conservation
KDFWR - Kentucky Department of Fish and Wildlife Resources
KDSMRE - Kentucky Department for Surface Mining Reclamation and Enforcement
KSNPC - Kentucky State Nature Preserves Commission
NPS - National Park Service
OSMRE - U.S. Office of Surface Mining Reclamation and Enforcement
TDOC - Tennessee Department of Conservation
TVA - Tennessee Valley Authority
TWRA - Tennessee Wildlife Resources Agency
VDGIF - Virginia Department of Game and Inland Fisheries
WDNR - West Virginia Department of Natural Resources

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.	5.0	5.0	5.0	
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 *2.	1.0	1.0	1.0	
1	1.2.3	Develop information and education program and present.	Ongoing	3,4,5	FWE	See *2.	25.0	20.0	2.0	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 *2.	?	?	?	
1	2.1, 2.2, 2.3, 2.4, 2.5	Conduct research necessary for species management and recovery; i.e., habitat	3	3,4,5	FWE	See *2.	25.0	25.0	25.0	

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~~					
		requirements, biology, and threat analysis.								
See comments.	2.6	Based on biological and threat analysis, investigate need for management and implement where needed.	2 year	3,4,5	FWE	See *2.	---	25.0	25.0	Priority 1, 2, or 3 (depending on result of 1.3.1, 1.3.2, and 1.3.3).
3	2.7	Determine number of individuals required to maintain viable population.	1 year	3,4,5	FWE	See *2.	---	---	?	
2	3	Search for additional populations and suitable habitat.	2 year	3,4,5	FWE	See *2.	30.0	30.0	---	
2	4	Develop techniques, select sites, reintroduce the species back into historic	Ongoing	3,4,5	FWE	See *2.	25.0	20.0	25.0	Task duration: 3 years (protection continues).

IMPLEMENTATION SCHEDULE

PRIOR-ITY #	TASK #	TASK DESCRIPTION	TASK DURATION (Years)	RESPONSIBLE PARTY			COST ESTIMATES ($000'S)			COMMENTS
				FWS		Other	FY 1991	FY 1992	FY 1993	
				Region	Division					
		habitat, and evaluate and protect any populations established.								
1	5	Develop and utilize cryopres-ervation technique	Ongoing	3,4,5	FWE	See *2	12.5	12.5	12.5	
2	6	Develop and implement a monitoring program.	Ongoing	3,4,5	FWE	See *2.	---	---	4.0	Biennial.
3	7	Annually assess recovery program and modify program and plan where required.	Ongoing	3,4,5	FWE	See *2.	0.5	0.5	0.5	

*1 - FS, KDFWR, KDSMRE, KSNPC, IDOC, IDNR, NPS, OSMRE, TDOC, TVA, TWRA, VDGIF, and WVDNR

*2 - FS, KDFWR, KSNPC, IDOC, IDNR, NPS, TDOC, TWRA, TVA, VDGIF, and WVDNR

PART IV

LIST OF REVIEWERS

Mr. Elbert T. Gill, Jr., Commissioner
Tennessee Department of Conservation
701 Broadway
Nashville, Tennessee 37219-5237

Mr. Gary Myers, Executive Director
Tennessee Wildlife Resources Agency
Ellington Agricultural Center
P.O. Box 40747
Nashville, Tennessee 37204

Mr. Jerry Lee
U.S. Soil Conservation Service
U.S. Court House, Room 675
801 Broadway
Nashville, Tennessee 37203

Mr. Edward G. Oakley
Division Administrator
Federal Highway Administration
249 Cumberland Bend Drive
Nashville, Tennessee 37228

Mr. Jack E. Ravan
Regional Administrator
Environmental Protection Agency
345 Courtland Street, NE.
Atlanta, Georgia 30365

Mr. Peter W. Pfeiffer, Director
Kentucky Department of Fish and
Wildlife Resources
Department of Fisheries
Arnold L. Mitchell Building
#1 Game Farm Road
Frankfort, Kentucky 40601

Mr. G. Floyd Hughes, Jr., Director
Kentucky Department of Highways
Division of Environmental Analysis
419 Ann Street
Frankfort, Kentucky 40601

Ms. Charlotte Baldwin, Secretary
Kentucky Natural Resources and
  Environmental Protection Cabinet
Capital Plaza Tower
Frankfort, Kentucky 40601

Colonel James P. King
U.S. Army Corps of Engineers
Nashville District
P. O. Box 1070
Nashville, Tennessee 37202-1070

Mr. William H. Redmond
Regional Natural Heritage Project
Tennessee Valley Authority
Norris, Tennessee 37828

Mr. Richard Hannan, Director
Kentucky State Nature Preserve Commission
407 Broadway
Frankfort, Kentucky 40475

Mr. M. Paul Schmierbach, Manager
Environmental Quality
Tennessee Valley Authority
Room 201, Summer Place Building
Knoxville, Tennessee 37902

Mr. T. Michael Taimi, Commissioner
Department for Environmental Protection
Kentucky Natural Resources and
  Environmental Protection Cabinet
18 Reilly Road
Frankfort, Kentucky 40601

Mr. Donald Harker, Director
Division of Water
Kentucky Natural Resources and
  Environmental Protection Cabinet
5th Floor, Capital Plaza Tower
Frankfort, Kentucky 40601

Mr. Dan Eagar
Program Administrator
Tennessee Department of Conservation
701 Broadway
Nashville, Tennessee 37203

Mr. David A. Mihalic
Superintendent
Mammoth Cave National Park
Mammoth Cave, Kentucky 42259

Colonel Robert L. Oliver
District Engineer
U.S. Army Corps of Engineers
P.O. Box 59
Louisville, Kentucky 40201-0059

Mr. Steven A. Ahlstedt
Field Operations
Division of Water Resources
Tennessee Valley Authority
Forestry Building
Norris, Tennessee 37828

Dr. John Jenkinson
Tennessee Valley Authority
HB 2S 270C-C
311 Broad Street
Chattanooga, Tennessee 37402-2801

Dr. Arthur E. Bogan
Department of Malacology
Academy of Natural Sciences
Nineteenth and the Parkway
Philadelphia, Pennsylvania 19103

Dr. Paul W. Parmalee
Department of Anthropology
The University of Tennessee
Knoxville, Tennessee 37916

Dr. James B. Sickel
Murray State University
Department of Biology
Murray, Kentucky 42071

Dr. David H. Stansbery
Museum of Zoology
Ohio State University
1813 North High Street
Columbus, Ohio 43210

Dr. Guenter A. Schuster, Professor
Department of Biological Sciences
Eastern Kentucky State University
Richmond, Kentucky 40475-0950

Dr. Paul Yokley, Jr.
Department of Biology
University of North Alabama
Florence, Alabama 35630

Mr. Jimmie Patterson
County Executive
Harden County Courthouse
Savannah, Tennessee 38372

Mr. Don Simpson
County Executive
Wilson County Courthouse
Lebanon, Tennessee 37087

Mr. G. W. Oldham
County Executive
Trousdale County Courthouse
Hartsville, Tennessee 37074

Mr. C. E. Hackett
County Executive
Smith County Courthouse
Carthage, Tennessee 37030

Mr. Ralph Smith
County Judge
P. O. Box 68
Smithland, Kentucky 42081

Mr. Mike Miller
County Judge
Marshall County Courthouse
Benton, Kentucky 42025

Mr. John R. Harris
County Judge
McCracken County Courthouse
Paducah, Kentucky 42001

Mr. Vince Lang
County Judge
Box 486
Munfordville, Kentucky 42765

Mr. Mike Turner (PD-R)
U.S. Army Corps of Engineers
Louisville District
P.O. Box 59
Louisville, Kentucky 40201

Dr. Claude Baker
Biology Department
Indiana University Southeast
New Albany, Indiana 47150

Dr. Bill Forsyth
Biology Department
Indiana University Southeast
New Albany, Indiana 47150

Mr. Max Henschen
4307 Greenway Drive
Indianapolis, Indiana 46220

Mr. Kevin Cummings
Illinois Natural History Survey
607 E. Peabody Drive
Champaign, Illinois 61820

Dr. Nicholas Holler
Alabama Cooperative Fish and Wildlife
Research Unit
331 Funchess Hall, Room 302
Auburn University
Auburn, Alabama 36849-5414

Mr. Charles D. Kelley, Director
Division of Game and Fish
Alabama Department of Conservation and
Natural Resources
64 N. Union Street
Montgomery, Alabama 36130

Ms. Sally Van Meter
Deputy Director for Resource Protection
Ohio Department of Natural Resources
Fountain Square
Columbus, Ohio 43224

Mr. Richard E. Moseley, Jr., Chief
Division of Natural Areas and Preserves
Ohio Department of Natural Resources
Fountain Square
Columbus, Ohio 43224

Mr. Warren W. Tyler, Director
Environmental Protection Agency
P.O. Box 1049
361 E. Broad Street
Columbus, Ohio 43216-1049

Dr. Theodore Bookhout, Leader
Ohio Cooperative Fish and Wildlife
Research Unit
Department of Zoology
Ohio State University
1735 Neil Avenue
Columbus, Ohio 43210

Mr. Thomas M. Stockdale
Extension Specialist, Fish and Wildlife
Ohio State University
2021 Coffey Road
Columbus, Ohio 43210

Mr. Ron Potesta
Deputy Director
West Virginia Department of Natural
Resources
1800 Washington Street, East
Charleston, West Virginia 25305

Mr. Nicholas DeBenedictis, Secretary
Pennsylvania Department of
Environmental Resources
Press Office
9th Floor, Fulton Building
Box 2063
Harrisburg, Pennsylvania 17120

Mr. Ralph W. Abele
Executive Director
Pennsylvania Fish Commission
P.O. Box 1673
Harrisburg, Pennsylvania 17105-1673

Mr. Michael B. Witte, Director
Illinois Department of Conservation
Lincoln Tower Plaza
524 S. Second Street
Springfield, Illinois 62706

Mr. Al Mickelson, Chief
Forest Resources and Natural
Heritage Division
Illinois Department of Conservation
Lincoln Tower Plaza
524 S. Second Street
Springfield, Illinois 62706

Chairman
Environmental Protection Agency
2200 Churchill Road
Springfield, Illinois 62706

Mr. James Lahey, Chairman
Natural Resources Commission
Indiana Department of Natural Resources
608 State Office Building
Indianapolis, Indiana 46204

Mr. Edward Hansen, Head
Division of Fish and Wildlife
Indiana Department of Natural Resources
608 State Office Building
Indianapolis, Indiana 46204

Mr. John Bacone, Head
Division of Nature Preserves
Indiana Department of Natural Resources
608 State Office Building
Indianapolis, Indiana 46204

Mr. David S. Beck
Assistant to the Executive Vice President
Kentucky Farm Bureau Federation
120 South Hubbards Lane
P.O. Box 7200
Louisville, Kentucky 40207

Mr. Julius T. Johnson
Director of Public Affairs
Tennessee Farm Bureau Federation
P.O. Box 313
Columbia, Tennessee 38401

Dr. Arthur Clarke
325 E. Bayview
Portland, Texas 78374

Environmental Assessment Section
Kentucky Natural Resources and
Environmental Protection Cabinet
Department for Natural Resources
Division of Abandoned Lands
618 Teton Trail
Frankfort, Kentucky 40601

Environmental Protection Agency
Hazard Evaluation Division - EEB (TS769C)
401 M Street, SW.
Washington, DC 20460

Mr. Ron Escano
U.S. Forest Service
Wildlife, Fisheries, and Range
1720 Peachtree Street
Atlanta, Georgia 30367

Fish and Wildlife Reference Service
5430 Grosvenor Lane, Suite 110
Bethesda, Maryland 20814