Recovery Plan For Anthony's Riversnail *(Athearnia anthonyi)*

US. Fish and Wildlife Service
Southeast Region
Atlanta, Georgia

RECOVERY PLAN

for

Anthony's Riversnail (*Athearnia anthonyi*)

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By approving this recovery plan, the Director or Regional Director certifies that the data used in its development represent the best scientific and commercial information available at the time it was written. Copies of all documents reviewed in the development of the plan are available in the administrative record located at the Asheville Field Office in Asheville, North Carolina.

Literature citations should read as follows:

U.S. Fish and Wildlife Service. 1997. Recovery Plan for Anthony's Riversnail. Atlanta, GA. 21 pp.

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Fish and Wildlife Reference Service
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EXECUTIVE SUMMARY

Current Status: Anthony's riversnail is listed as endangered with no designation of critical habitat. This freshwater snail was once fairly widespread in the Tennessee River system, where it was associated with shoal areas in the main stem of the Tennessee River and the lower reaches of some of its tributaries in eastern Tennessee, northern Alabama, and northwestern Georgia. Many of these populations have been lost as a result of impoundments and the general deterioration of water quality from siltation and other pollutants contributed by past mining activities, poor land-use practices, and waste discharges. Only two populations of Anthony's riversnail are known to survive--one in the Tennessee River in Jackson County, Alabama, and Marion County, Tennessee, extending into the lower Sequatchie River, Marion County, Tennessee; and one restricted to the lower reaches of Limestone Creek, Limestone County, Alabama.

Habitat Requirements and Limiting Factors: Anthony's riversnail has been recorded from both large and relatively small streams; however, the majority of the historic and recent records of the species suggest that it is primarily a big-river species. It is typically found on large submerged objects (e.g., rocks and logs) or gravelly substrata in relatively shallow, moderately to fast-flowing water. The species has been recorded from impounded stream reaches. In the Sequatchie River and the Tennessee River, the species has been found primarily in areas of transition between the swiftly flowing water of runs and riffles and the calmer water of pools. In Limestone Creek the species is generally found in the moderately flowing water of stream runs and riffles. The potential for degradation of the water and substrata quality in the two areas where Anthony's riversnail still survives is the most significant threat to the species' continued survival. Unless new populations are found or reestablished and existing populations are maintained, this species will remain in danger of extinction for the foreseeable future.

Recovery Objective: Delisting.

Recovery Criteria: Downlist from endangered to threatened status when the following criteria are met: (1) through protection of both existing populations and successful reestablishment or discovery of additional populations, a total of four distinct viable populations exist within the species' historic range; (2) each of the four populations must have at least two year classes present and show evidence of successful reproduction (with at least one juvenile age class present); (3) all four populations and their habitats are protected from present and foreseeable threats; and (4) all four populations remain stable or increase over a period of at least 10 years.

Delist when the following criteria are met: (1) through protection of both existing populations and successful establishment or discovery of additional populations, a total of six distinct viable populations exist within the species' historic range; (2) each of the six populations must have at least two year classes present and show evidence of reproduction, with at least one juvenile age class present; (3) all six populations and their habitats are protected from present and foreseeable threats; and (4) all six populations remain stable or increase over a period of at least 10 years.

Actions Needed:

1. Utilize existing legislation/regulations to protect the species.
2. Elicit support for recovery efforts through the development and implementation of an information/education program.
3. Search for new populations and monitor existing populations.
4. Determine the species' life history, habitat requirements, and threats.
5. Implement management and alleviate threats to the species' existence.
6. Through augmentation, reintroduction, and protection, establish six viable populations.
7. Develop and implement cryopreservation of the species.

Cost ($000s):

Year	Need 1	Need 2	Need 3	Need 4	Need 5	Need 6	Need 7	Total
1997	5.5	8.0	6.0	25.0	0.0	30.0	8.5	83.0
1998	5.5	5.5	6.0	25.0	25.0	30.0	8.5	105.5
1999	5.5	3.0	4.0	25.0	25.0	30.0	2.0	94.5
2000	5.5	0.0	0.0	0.0	25.0	10.0	2.0	42.5
2001	5.5	0.0	4.0	0.0	?	10.0	2.0	21.5*
2002	5.5	2.0	0.0	0.0	?	10.0	2.0	19.5*
2003	5.5	0.0	5.5	0.0	?	0.0	2.0	13.0*
2004	5.5	0.0	0.0	0.0	?	0.0	2.0	7.5*
2005	5.5	2.0	5.5	0.0	?	0.0	2.0	15.0*
2006	5.5	0.0	0.0	0.0	?	0.0	2.0	7.5*
2007	5.5	0.0	5.5	0.0	?	0.0	2.0	13.0*
Total	60.5	20.5	36.5	75.0	75.0*	120.0	35.0	422.5*

* 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: The downlisting and delisting dates cannot be estimated at this time. A time period of at least 10 years is needed to document the stability of populations after all other recovery criteria are met.

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PART I

INTRODUCTION

On April 15, 1994, the U.S. Fish and Wildlife Service (Service) listed Anthony's riversnail (*Athearnia anthonyi*) as an endangered species (Service 1994). Critical habitat was not designated. Only two small populations of the species are known to survive--one in the Tennessee River and extreme lower Sequatchie River, Marion County, Tennessee, and Jackson County, Alabama (Tennessee River/Sequatchie River population), and one population restricted to the lower reaches of Limestone Creek, Limestone County, Alabama (Limestone Creek population). The species' continued existence is dependent on maintaining the water and habitat quality of these two sites and reestablishing and protecting additional populations elsewhere within the species' historic range.

Description, Distribution, and Life History

Anthony's riversnail was originally described from specimens collected in the "Holstein" (=Holston) River, near Knoxville, Tennessee ("Budd," in Redfield, 1854). It is a relatively large freshwater snail of the family Pleuroceridae. The species grows to about 2.5 centimeters (1 inch) in shell length (base to top of spire). Its shell is ovate and olive green to yellowish brown in color, with variable purplish or brownish bands that encircle the body whorl (largest whorl). The shell spire is short and has about four whorls, though often those above the body whorl are badly eroded. The body whorl of adults is strongly shouldered (carinate), with a series of large, irregular, obtuse tubercles. The tubercles are often little more than broad undulations of the shoulder. The shell aperture is ovate with a thin outer lip, often with some purple coloration within. The columellar lip is reflected so that it partially or entirely covers a deep umbilical depression (adapted from Gordon 1991). Juvenile Anthony's riversnails are distinct, being as wide (measured across the aperture) as they are long, with pointed spires and bases. This shape, along, with a heavy carina, gives them a saucer-shaped appearance. As an individual grows, the carina gradually disappears, and the shell attains dimensions that are greater in length than width.

Though Anthony's riversnail is a distinctive species, there are two snails within its historic range that are similar in appearance. There has been considerable confusion over the status of one of these snails, *Athearnia crassa* Haldeman 1841, the boulder snail. Literature accounts describe boulder snails as having tubercles on the body whorl that are higher and more prominent than those of Anthony's riversnail (Goodrich 1931) or make no mention of whorls at all (Tryon 1873). In any case, the boulder snail, which was found primarily in the Tennessee River headwaters, appears to be extinct (Gordon 1991).

The other species that may be confused with Anthony's riversnail is *Leptoxis praerosa* Say 1821, the onyx rocksnail. Adult Anthony's riversnails tend to be considerably larger than onyx rocksnails. The onyx rocksnail lacks tubercles on the shoulder of the body

whorl, while the shoulder of adult Anthony's riversnails often has large, obtuse tubercles. Though both have a parietal callus, the callus of the onyx rocksnail differs from that of Anthony's riversnail in that it does not reflect back over the parietal wall. A deep umbilical depression is covered by the callus of Anthony's riversnail, but the umbilicus is usually lacking in shells of the onyx rocksnail. Also, the shells of juvenile onyx rocksnails are not carinate, as are the shells of juvenile Anthony's riversnails (Tryon 1873, Bogan and Parmalee 1983).

Anthony's riversnail is endemic to the Tennessee River system. The snail was historically known from the main stem of the Tennessee River from Knoxville, Knox County, Tennessee, downstream to Muscle Shoals, Colbert and Lauderdale Counties, Alabama (Goodrich 1931, Bogan and Parmalee 1983). In his discussion of the shell characters of this species, Goodrich (1931) also mentioned specimens from the Little Tennessee River (probably from near its mouth, Loudon County, Tennessee); Sequatchie River (Marion County, Tennessee); Little Sequatchie River (Marion County, Tennessee); French Broad River (near its mouth in Knox County, Tennessee); and Battle Creek (Marion County, Tennessee). In a similar paper, Goodrich (1941) described specimens from the Clinch River in Tennessee. To this list, Bogan and Parmalee (1983) added the Nolichucky River (Greene County, Tennessee); Beaver Creek (Knox County, Tennessee); Tellico River (Monroe County, Tennessee); South Chickamauga Creek (Catoosa County, Georgia); Tiger Creek (Catoosa County, Georgia); and an additional site on the Little Tennessee River (Monroe County, Tennessee). Goodrich (1940) added the Elk River to the distribution of *A. anthonyi* but did not give any specific data on the locality or cite any references. Goodrich (1941) also mentioned Piney Creek as the collection locality of some shells that he discussed in his paper on pleurocerid shell sculpture. Though he did not give the location of Piney Creek, it is likely in Limestone County, Alabama. The Piney Creek in Limestone County, Alabama, is part of the Limestone Creek system in which a population of *A. anthonyi* currently exists but is now separated from Limestone Creek by an embayment of Wheeler Reservoir.

Presently only two populations of *A. anthonyi* are known to survive. The largest of these occurs in the Tennessee River, Jackson County, Alabama (Jenkinson 1994), and Marion County, Tennessee (Garner 1994). This population extends a short distance into the lower Sequatchie River, Marion County, Tennessee (M. Gordon, Tennessee Technological University, and S. Ahlstedt, Tennessee Valley Authority, personal communication, 1991). The other surviving population is restricted to a relatively short reach of Limestone Creek in Limestone County, Alabama (F. Thompson, Florida Museum of Natural History, personal communication, 1991; Garner 1992).

The life history and ecological requirements of *A. anthonyi* are generally unknown. Other genera in the family Pleuroceridae are known to be oviparous, and by inference it may be assumed that *A. anthonyi* is as well (Morrison 1954). Though little information on the habitat preferences of *A. anthonyi* is available in the literature, the fact that it was much

more widespread in the preimpounded Tennessee River system suggests that the species preferred the shallow, swiftly flowing water that was prevalent before major dams were built. The remaining Tennessee River population is found a short distance downstream of Nickajack Dam (Garner 1994, Jenkinson 1994). The habitat below most of the Tennessee River dams is riverine, with rocky substrata and moderate to heavy current much of the time (author Garner's personal observation). ERM-Southeast, Inc., (1997) characterized the habitat of *A. anthonyi* at one site on the Tennessee River where the species is found as being "smooth cobble, not covered with sand" and further stated that the species "appeared most common in the 3- to 6-inch cobble and large gravel where they could move and feed between the cobblestones." Goodrich (1931) reported collecting the species from three streams, with the water in each ". . . slow moving at the season, which was late summer . . . ," but he speculated that all were probably subject to high flow at other times of the year. In the Sequatchie River the species was reported to have been found primarily on large submerged objects (e.g., rocks, logs) in areas of transition between the swiftly flowing water of runs and riffles and the calmer water of pools (S. Ahlstedt, U.S. Geological Survey, personal communication, 1995). In Limestone Creek the species was generally found in the moderately flowing water of stream runs on submerged objects and gravelly substrata (Garner 1992).

Threats to the Species' Continued Existence

Many populations of the species were apparently lost when large portions of the Tennessee River and the lower reaches of its tributaries were impounded (Stein 1976). These impoundments also resulted in fragmentation and isolation of the remaining populations, making them more vulnerable to extirpation from other environmental perturbations. Additional population losses and declines are likely attributable to the general deterioration of water and substrata quality that has occurred this century. Factors contributing to population loss include inadequate erosion/sedimentation control during mining, agricultural, timbering, and construction activities; run-off and discharge of organic and inorganic pollutants from industrial, municipal, agricultural, and other point and nonpoint sources; habitat alterations associated with channelization and dredging activities; and other natural and human-related factors that adversely modify the aquatic environment. Many of these factors continue to threaten the two surviving populations.

Because both extant populations of Anthony's riversnail are restricted to short river reaches, each is vulnerable to extirpation from a single catastrophic event, such as a toxic chemical spill, or an activity resulting in a major river channel/habitat modification. Additionally, because these populations are isolated by impoundments, recolonization of additional habitats would be unlikely without human intervention.

Disease, parasites, and predation may also pose threats to the continued existence of Anthony's riversnail. While diseases of pleurocerid snails have not been identified, like most other groups of aquatic mollusks, pleurocerids are often heavily infested with

various parasites. While these infestations are rarely thought to be fatal, they may affect reproduction and function as a controlling factor in population dynamics (Gordon 1991). Also, the species is presumably consumed by various invertebrate and vertebrate predators, such as aquatic fly larvae, crayfish, leeches, salamanders, freshwater drum, muskrats, racoons, etc. While the effects of predation on Anthony's riversnail have not been studied, predation is not thought to be a significant threat to a healthy population but could, as suggested by Neves and Odum (1989), limit the recovery or contribute to the local extirpation of populations already depleted by other factors.

PART II

RECOVERY

A. Recovery Objectives

The immediate goal of this recovery plan is to maintain the only known surviving populations of *Athearnia anthonyi* and to protect its remaining habitat from present and foreseeable threats. There are only two known surviving populations of this species--the Tennessee River/Sequatchie River population in Marion County, Tennessee, and Jackson County, Alabama, and the Limestone Creek population in Limestone County, Alabama. Lack of proper protection and management of these populations will preclude recovery of Anthony's riversnail and may ultimately lead to the species' extinction.

The ultimate goal is to restore and maintain viable populations[1] of *A. anthonyi* within a significant portion of its historic range and remove the species from the Federal List of Endangered and Threatened Wildlife and Plants.

Reclassification to threatened:

Anthony's riversnail 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 the successful establishment of reintroduced populations or the discovery of additional populations, a total of four distinct viable populations exist. These four populations shall be distributed throughout a significant portion of the species' historic range.

2. At least two distinct, naturally reproduced year classes exist within each of the four populations. One of these year classes must have been produced within the 2 years prior to the time the species is reclassified from endangered to threatened.

3. Biological and ecological studies have been completed and any required recovery measures developed and implemented from these studies are beginning to show

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[1]Viable population - 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 and the amount and quality of habitat required to meet this criterion will be determined for the species as one of the recovery tasks.

signs of success, as evidenced by a significant increase in population density and/or an increase in the length of the river reach inhabited by each of the four populations.

4. Where habitat has been degraded, noticeable improvements in water and/or substratum quality have occurred.

5. Each of these four populations and their habitats are protected from any present and foreseeable threats that would jeopardize their continued existence.

6. All four populations remain stable or increase over a period of at least 10 years.

Anthony's riversnail 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 through successful establishment of reintroduced populations or the discovery of additional populations, a total of six distinct viable populations exist. These populations shall be distributed throughout a significant portion the species' historic range.

2. Two distinct, naturally reproduced year classes exist within each of the six populations. One of these year classes must have been produced within the 2 years prior to the recovery date.

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

4. Where habitat has been degraded, noticeable improvements in water and/or substratum quality have occurred.

5. Each of these six populations and their habitats are protected from any present and foreseeable threats that would jeopardize their continued existence.

6. All six of the populations remain stable or increase over a period of at least 10 years.

B. Narrative Outline

1. **Protect existing populations and essential habitat. Presently only two populations of *Athearnia anthonyi* are known to exist.** If the species is to survive and expand its range, protection of the existing populations and remaining areas of suitable habitat is vital. Unless immediate steps are taken to stop the decline of the species and protect and secure these relict populations, the species may become extinct in the very near future.

   1.1 Utilize existing legislation and regulations (e.g., Federal Endangered Species Act, Federal and State water quality regulations, stream alteration regulations, surface mining laws) to protect the species and its habitat. Present populations can be protected only by the full enforcement of existing Federal and State laws and regulations designed to protect water and habitat quality. Unless this objective is met, any recovery activities would be essentially moot. Habitat and water quality degradation have severely reduced the species' range and continue to threaten the only remaining populations. Complete compliance with laws and regulations must be ensured if *A. anthonyi* is to survive.

   1.2 Work with appropriate Federal and State regulatory and review agencies to identify and assess projects and/or activities that could have negative effects on the species and to ensure incorporation of measures for protecting the species and its habitat into such activities. Through Section 7 of the Endangered Species Act, the Fish and Wildlife Coordination Act, Clean Water Act, etc., Federal and State regulatory and review agencies must work together to carefully evaluate and identify actions and activities that could potentially have an adverse effect on the species and its habitat. Once impacts have been identified, regulatory and/or permitting agencies must be encouraged to utilize their authorities to ensure that the species and its habitat are adequately protected from such activities.

   1.3 Solicit help in protecting and enhancing the species and its essential habitat. The assistance and support of conservation groups, local governments, and regional and local planners will be essential in meeting the goal of recovering *A. anthonyi*. Also, the support of local industrial, business, silvicultural, and agricultural communities, as well as local residents, will be needed. Construction, silvicultural, and agricultural "best management practices" should be implemented by all landowners, and National Pollution Discharge Elimination System Permit compliance must be encouraged and enforced. Local land-use planning should be encouraged in order to protect water resources, and individuals need to be informed as to why and how they should protect creeks and rivers. Efforts such as the Service's Partners for

Wildlife Program and programs offered through Federal and State departments of agriculture must be used to encourage and assist landowners with the restoration of degraded areas that are contributing to sedimentation or water pollution problems. 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 difficult.

1.3.1 Meet with local government officials and regional and local planners to inform them of our plans to attempt recovery and solicit their support for protection of the species and its essential habitat.

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

1.3.3 Develop an educational program using such items as slide/tape shows, brochures, etc. Present this material to business and industrial groups, civic groups, schools, church organizations, etc. Educational material outlining the recovery goals and emphasizing the benefits of maintaining and upgrading habitat quality will be extremely useful in informing the public of our actions and in implementing Tasks 1.3.1 and 1.3.2 above.

1.4 Encourage the establishment of protective water quality designations, stream buffer zones, and other protection strategies as a means of protecting present and reintroduced populations. The Service should work with the Environmental Protection Agency and appropriate State agencies in Tennessee and Alabama to have special status assigned to river reaches that would provide increased protection to *A. anthonyi* and the quality of the rivers and streams in which it survives.

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 (e.g., food habits, age and growth, reproduction, mortality rates) and characterize the species' habitat requirements (relevant physical, biological, and chemical components) for all life history stages. Detailed knowledge is needed with regard to the species' life cycle, habitat requirements; community structures of associated flora and fauna; and how these factors affect reproduction, growth, and mortality rates in order to focus management and recovery efforts on specific problems.

2.2 **Identify and eliminate current and future threats to the species' survival.** Water quality and habitat degradation resulting from siltation and other pollutants from numerous point and nonpoint sources appear to be major contributing factors in the reduction of the species' range. The nature of and mechanisms by which these and other factors impact the species 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 in Task 2.1 must be used to target and correct specific problem areas and determine the specific causative agent(s).

2.3 **Investigate relationships with nonnative bivalves and prevent introduction/spread.** Of concern among malacologists is the potential effect of the introduced zebra mussel (*Dreissena polymorpha*) on native freshwater fauna, including snails. Introductions of nonindigenous fish may also pose a significant threat to *A. anthonyi*. The relationship between these nonindigenous species and the native fauna should be thoroughly investigated, and measures should be implemented (where feasible) to prevent and/or minimize their expansion and impact.

2.4 **Based on the biological data and threat analysis, investigate the need for management, including habitat improvement. Implement management where needed to secure viable populations.** Specific components of habitat or biological needs may be lacking, and this may limit the species' potential expansion. Habitat improvement programs may be needed to alleviate limiting factors.

2.5 **Determine the number of individuals required to maintain a viable population and the genetic viability of existing populations.** Long-term management of *A. anthonyi* populations will require knowledge of the genetic composition of each population, the number of individuals necessary to maintain genetic viability, and an understanding of the factors that affect viability. Such studies should develop and use techniques that minimize the sacrifice of individuals from natural populations (e.g., salvage and analysis of individuals killed incidentally; nonlethal analysis of individuals using small excised tissue samples; production of an experimental cultured population, and development of such techniques, using more common surrogate species).

3. **Search for additional populations and/or habitat suitable for reintroduction efforts.** Distribution studies of this species have been completed. However, it is possible that some relic populations were missed, and further study may yield additional populations. Also, surveys are needed to record and monitor any future range reductions or expansions and suitable habitat for reintroductions.

4. **Determine the feasibility of augmenting extant populations and reestablishing populations within the species' historic range and reintroduce where feasible.** There are only two known remaining populations of *A. anthonyi*--the Tennessee River/Sequatchie River population and the Limestone Creek population. For the species to survive it may be necessary at some point in the future for these populations to be supplemented to enable them to reach or maintain a viable size. Also, recovery of *A. anthonyi* cannot be achieved without the reestablishment of the species throughout a significant portion of its historic range. While much of the species' historic habitat has been inundated by impoundments, there may be areas within the species' historic range that could support reestablished populations. Portions of the Tellico River, Holston River, French Broad River, and Elk River, or other streams within the historic range of *A. anthonyi,* may contain suitable habitat and should be evaluated for potential reintroduction of the species. Because the majority of the areas from which the species has been eliminated are isolated from existing populations, natural reestablishment of these areas by the species is impossible and will require human assistance. However, before reintroduction activities can be carried out with any confidence that they can be successful, additional research is necessary to determine the range of environmental requirements of the species and successful techniques for its reintroduction. Further, artificial propagation of the species may be necessary in order to obtain sufficient numbers of the species for successful reintroductions.

   4.1 **Determine the need, appropriateness, and feasibility of augmenting and expanding existing populations.** Implementation of this task will be based on population size, habitat quality, and the likelihood of long-term benefits.

   4.2 **Develop a successful technique for reestablishing and augmenting populations.** It is possible that sufficient specimens of *A. anthonyi* are not currently available to allow for the translocation of enough individuals of the species to reestablish the number of viable populations needed for the downlisting and eventual recovery of the species. There is an immediate need to develop techniques for propagating and holding mollusks for prolonged periods and rearing juveniles to a size and age at which they can be successfully transplanted. Reintroduction techniques must also be developed to ensure success.

   4.3 **Coordinate with appropriate Federal and State agency personnel, local governments, and interested parties to identify habitat suitable for augmentation and reintroduction efforts.**

   4.4 **Augment existing populations where needed, establish new populations within the species' historic range, and evaluate success.** Using the techniques developed in Task 4.2, introduce the species and monitor success.

4.5 Implement the same protective measures for any introduced populations as 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.** Habitat conditions within the species' historic range may not currently be suitable for a reintroduction of *A. anthonyi* to succeed. Cryogenic preservation of *A. anthonyi* could maintain genetic material from all the extant populations (much like seed banks for endangered plants) until successful propagation techniques have been developed and 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, if the techniques can be developed, allow for the eventual reestablishment of the population using genetic material preserved from that population.

6. **Develop and implement a program to monitor population levels and habitat conditions of existing populations as well as newly discovered, introduced, or expanding populations.** During and after the time recovery actions are implemented, the status of the species and its habitat must be monitored to assess any progress toward recovery. Quantitative samples should be taken to determine densities of adults and juveniles. Monitoring should be conducted on a biennial schedule.

7. **Annually assess the overall success of the recovery program and recommend action (e.g., changes in recovery objectives, delist, continue to protect, implement new measures, other studies).** 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 and as conditions change, recovery objectives may need to be modified.

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PART III

IMPLEMENTATION SCHEDULE

Priorities in column 1 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

ES - Ecological Services Division, U.S. Fish and Wildlife Service.
FA - Other Federal Agencies - Includes the Tennessee Valley Authority, U.S. Natural Resources Conservation Service, U.S. Forest Service, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, and Office of Surface Mining.
FWS - U.S. Fish and Wildlife Service.
LE - Law Enforcement Division, U.S. Fish and Wildlife Service.
R4 - Region 4 (Southeast Region), U.S. Fish and Wildlife Service.
SCA - State Conservation Agencies - Includes the Tennessee Department of Environment and Conservation, Tennessee Wildlife Resources Agency, Georgia Department of Natural Resources, Alabama Division of Game and Fish, Alabama Department of Conservation and Natural Resources, Alabama Natural Heritage Program, and Geological Survey of Alabama.
TNC - The Nature Conservancy.

ANTHONY'S RIVERSNAIL IMPLEMENTATION SCHEDULE

Priority	Task Number	Task Description	Task Duration	Responsible Agency		Cost Estimates ($000s)			Comments
				FWS	Other	FY1	FY2	FY3	
1	1.1	Utilize existing legislation and regulations to protect species and its habitat.	Continuous	R4/ES and LE	FA, SCA	2.5	2.5	2.5	
1	1.2	Work with appropriate Federal and State agencies to identify actions that could negatively affect the species and incorporate protective measures into such actions.	Continuous	R4/ES	FA, SCA	3.0	3.0	3.0	
1	1.4	Encourage establishment of outstanding resource water designations and other protective strategies as a means of protecting the species.	Ongoing	R4/ES	FA, SCA, TNC	???	???	???	
1	2.1, 2.2, 2.3	Conduct research necessary for species' management and recovery; i.e., habitat requirements, biology, and threat analyses.	3 years	R4/ES	FA, SCA, TNC	25.0	25.0	25.0	
2	1.3.1, 1.3.2	Meet with local government officials and business interests and elicit their support for recovery.	3 years	R4/ES	FA, SCA, TNC	3.0	2.0	1.0	
2	1.3.3	Develop information and education program and present.	Ongoing	R4/ES	FA, SCA, TNC	5.0	3.5	2.0	Task duration: 1 year to develop, then continuous.

ANTHONY'S RIVERSNAIL IMPLEMENTATION SCHEDULE

Priority	Task Number	Task Description	Task Duration	Responsible Agency		Cost Estimates ($000s)			Comments
				FWS	Other	FY1	FY2	FY3	
See comments.	2.4	Based on biological and threat analyses, investigate need for management and implement where needed.	2 years	R4/ES	FA, SCA, TNC	—	25.0	25.0	Priority 1, 2, or 3, depending on result of 2.1, 2.2, and 2.3.
2	2.5	Determine number of individuals required to maintain viable population.	1 year	R4/ES and LE	Contract	—	—	???	
2	3	Search for additional populations and suitable habitat for reintroduction.	Ongoing	R4/ES	FA, SCA, or Contract	6.0	6.0	—	
2	4	Develop artificial holding and propagation techniques; reintroduce species back into historic habitat; and, if needed, augment existing populations.	Ongoing	R4/ES	Contract	30.0	30.0	30.0	Task duration: 3 years (protection continues).
2	5	Develop and utilize cryopreservation techniques.	Ongoing	R4/ES	Contract	8.5	8.5	2.0	
2	6	Develop and implement a monitoring program.	Ongoing	R4/ES	FA, SCA	—	—	4.0	Biannual.
3	7	Annually assess recovery program and modify program and plan where required.	Ongoing	R4/ES	FA, SCA	—	—	—	

PART IV

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