

AGENCY DRAFT RECOVERY PLAN
for
Royal Snail (*Pyrgulopsis ogmorhappe*)

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Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect listed species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. 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. 1994. Royal Snail Agency Draft Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, GA. 28 pp.

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EXECUTIVE SUMMARY

Current Status: The royal snail is known from only two spring runs flowing out of two caves in the Sequatchie River system in Marion County, Tennessee. It is found in Blue Spring, which is the water supply for the Town of Jasper, and downstream to the State Highway 64 bridge for about 0.5 mile (0.81 kilometer). Downstream of the bridge, water quality deteriorates rapidly. The royal snail is also found in Owen Spring, about 4 miles (6.44 kilometers) northeast, up the Sequatchie River valley. This Tennessee endemic is listed as endangered. No critical habitat has been designated for the species.

Habitat Requirements and Limiting Factors: Potential degradation of the water quality of the two spring runs is the most significant threat to the species' continued survival. Because the royal snail is believed to have a 1-year life cycle, it is subject to sudden extinction should its habitat deteriorate, even for a short term, to the point where a single year's reproduction fails or is significantly reduced. Human-related activities that could prove detrimental to the water quality of the spring runs (by causing/increasing siltation, nutrient or pollutant loading, or by altering water levels, temperature, or pH) include, but are not limited to, increased development, indiscriminate logging and other land use changes, stream alteration (such as channelization or impoundment), excessive water withdrawal from the aquifer that supplies the springs, road and bridge construction, runoff of pesticides and fertilizers, leachate from septic systems and coal mines, and other point and nonpoint pollution discharge. Further, these impacts could possibly come from distant sources because the recharge areas for the springs could extend for several miles.

The introduction or invasion of nonnative species into either spring run inhabited by the royal snail poses another serious threat. Invasion or introduction of nonnative aquatic weeds into the spring runs could eventually result in the elimination of the habitat required by the royal snail and require intensive and potentially harmful control measures. Another concern is the zebra mussel (*Dreissena polymorpha*). There is concern that the tremendous filtering activity exerted by high-density populations of the nonnative species could disrupt the natural food chain and affect entire aquatic communities of infested lakes, streams, and springs.

Recovery Objective: Maintain self-sustaining populations of the royal snail in both of the spring runs it is presently known to inhabit and protect its habitat from present and foreseeable threats. Based on available information concerning the range, biology, and threats to its continued survival, delisting of the royal snail does not appear to be feasible.

Recovery Criteria: The species' biology and restricted distribution make it unlikely that the royal snail can be sufficiently protected from all threats associated with potential degradation and alteration of the water and/or habitat quality of the spring runs they inhabit.

Delisting is unlikely. However, as additional data on the species and threats to its continued existence are obtained, the potential for developing the recovery criteria will be reevaluated.

Actions Needed:

1. Protect the existing population and essential habitat.
2. Isolate threats to the species, conduct research necessary for the species' management, and implement management where needed.
3. Develop artificial holding and propagation techniques and, if feasible, establish captive populations.
4. Develop and implement cryogenic techniques to preserve the species' genetic material.
5. Develop and implement a program to monitor royal snail population levels and water/habitat conditions of each of the spring runs.
6. Annually assess the overall success of the recovery program and recommend action (changes in recovery objectives, continue to protect, implement new measures, other studies, etc.).

Cost (\$000s):

Year	Need 1	Need 2	Need 3	Need 4	Need 5	Need 6	Total
1995	20.0	10.0	12.5	20.0	3.0	1.5	67.0
1996	3.0	17.5	12.5	20.0	3.0	1.5	57.5
1997	3.0	17.5	5.0	1.0	3.0	1.5	31.0
1998	2.0	3.0	1.0	1.0	3.0	1.5	11.5
1999	2.0	3.0	1.0	1.0	3.0	1.5	11.5
2000	2.0	3.0	1.0	1.0	3.0	1.5	11.5
2001	2.0	3.0	1.0	1.0	3.0	1.5	11.5
2002	2.0	3.0	1.0	1.0	3.0	1.5	11.5
2003	2.0	3.0	1.0	1.0	3.0	1.5	11.5
2004	2.0	3.0	1.0	1.0	3.0	1.5	11.5
2005	2.0	3.0	1.0	1.0	3.0	1.5	11.5
TOTAL	42.0	69.0	38.0	49.0	33.0	16.5	247.5

Date of Recovery: Total recovery is unlikely for this species.

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PART I

INTRODUCTION

On April 15, 1994, the U.S. Fish and Wildlife Service (Service) listed the royal snail (*Pyrgulopsis ogmorhapse*) as an endangered species (Service 1994). Critical habitat was not designated. This species has been recorded from only two spring runs (Owen Spring/Town Creek and Blue Spring) in the Sequatchie River valley of Marion County in southeastern Tennessee. Its continued existence is dependent upon maintaining the water and habitat quality of these two sites.

Description, Ecology, and Life History

The royal snail (*Marstonia ogmorhapse*) was described by Thompson (1977) and was later reassigned to the genus *Pyrgulopsis* by Hershler and Thompson (1987). The royal snail is a small, presumably annual species (usually less than 5 millimeters [0.2 inches]), distinguished from other closely related species by: (1) its relatively large size; (2) its large number of whorls (5.2 to 5.8); (3) its deeply incised suture, producing strongly shouldered whorls that are almost flat above; (4) its complete aperture that is broadly ovate in shape with a rounded posterior corner; (5) its outer lip that is slightly arched forward in lateral profile; (6) its thin shell; (7) its

conical-terete shape; and (8) its enlarged bursa copulatrix with a completely exposed duct (Thompson 1977).

The royal snail is known from only two spring runs flowing out of two caves in the Sequatchie River system in Marion County, Tennessee. It is found in Blue Spring, which is the water supply for the Town of Jasper, and is also found downstream, for about 0.5 mile (0.81 kilometer), to the State Highway 64 bridge. Downstream of the bridge, water quality deteriorates rapidly. The royal snail is also found in Owen Spring, about 4 miles (6.44 kilometer) northeast, up the Sequatchie valley. Owen Spring is in a public park owned by the Tennessee Department of Transportation, but the park is in the process of being transferred to county ownership. The snail is found in about a 50-meter (150-foot) stretch of the spring outflow, about 50 meters (150 feet) from where surface flow begins. Royal snails are generally found in the diatomaceous "ooze" and on leaves and twigs in the quieter pools downstream from the spring source. No other life history information is known.

No populations of the royal snail are known to have been lost. However, the general deterioration of water quality resulting from siltation and other pollutants contributed by coal mining, poor land use practices, and waste discharges are likely impacting the species and could result in a serious, irreversible decline. Additionally, because both existing populations inhabit extremely limited areas,

they are very vulnerable to extirpation from accidental toxic chemical spills or vandalism.

Distribution and Threats to Its Continued Existence

The royal snail is found in only two spring runs in Marion County, Tennessee. The species has never been taken from outside these two areas. Specimens have not been reported in the spring runs from more than 0.5 mile (0.81 kilometer) downstream of the surface flow of the springs.

Potential degradation of the water quality of the two spring runs is the most significant threat to the species' continued survival. Because the royal snail is believed to have a 1-year life cycle, it is subject to sudden extinction should its habitat deteriorate, even for a short term, to the point where a single year's reproduction fails or is significantly reduced. Human-related activities that could prove detrimental to the water quality of the spring runs (by causing or increasing siltation, nutrient, or pollutant loading or by altering water levels, temperature, or pH) include, but are not limited to, increased development, indiscriminate logging and other land use changes, stream alteration (such as channelization or impoundment), withdrawal of water, road and bridge construction, runoff of pesticides and fertilizers, leachate from septic systems and coal mines, and other point and nonpoint pollution discharge. Further, these impacts could possibly come from distant sources

because the recharge areas for the springs could extend for several miles. Information received from the U.S. Department of Interior, Office of Surface Mining, states the following:

...information currently available to OSM does not indicate the presence of active or proposed mining in the recharge area [as determined by ground water divides associated with stream valley dissection of overlying caprock of the Southern Cumberland Plateau] for either spring.

However, they also state that "...it is not unlikely that applications for mining within the potential recharge areas may be received in the future...."

The introduction or invasion of nonnative species into either spring run inhabited by the royal snail poses another serious threat. Invasion or introduction of nonnative aquatic weeds (e.g., *Hydrilla*) into the spring runs could result in the elimination of the habitat required by the royal snail and require intensive and potentially harmful control measures. Another concern is the zebra mussel (*Dreissena polymorpha*). There is fear that the tremendous filtering activity exerted by high-density populations of this species could disrupt the natural food chain and affect entire aquatic communities of infested lakes and streams (Weigmann et al. 1991). However, it is not clear whether the zebra mussel will be capable of colonizing headwater streams such as those occupied by the royal snail.

PART II

RECOVERY

A. Recovery Objectives

The Service's goal in developing and implementing recovery plans is to recover a species to the point where Endangered Species Act protection is no longer required. This is often accomplished through the establishment and protection of some specified number of self-sustaining populations throughout a significant portion of the species' historic range. A self-sustaining population is a reproducing population that is large enough to maintain sufficient genetic variation to enable it to survive and respond to natural habitat changes without intensive management. These populations must be sufficiently dispersed or must occur on large enough tracts to ensure their perpetuation. However, based on available information concerning the range, biology, and threats to its continued survival, recovery of the royal snail does not appear to be likely (unless other populations are discovered or established in some presently unknown historic habitat). It is doubtful that the royal snail can be sufficiently protected from all threats associated with potential degradation or alteration of the water and/or habitat quality of the spring runs it inhabits. Therefore, delisting is unlikely. However, as

additional data on the species and threats to its continued existence are obtained, the potential for developing the recovery criteria will be reevaluated.

Accordingly, the objective of this recovery plan is to protect and maintain self-sustaining populations of the royal snail in the two known sites and to protect its habitat from present and foreseeable threats.

B. Narrative Outline

1. Protect the existing populations and essential habitat. The royal snail occurs in only two spring runs in the Sequatchie River valley, Marion County, Tennessee. Although there are many other springs in the Sequatchie River valley and other southeastern Tennessee counties, the royal snail has never been found outside its present range. Because the species is believed to have a 1-year life cycle, it depends upon successful reproduction each year for its survival. Any activity, incident, etc., adversely affecting the water or habitat quality of the springs, even for brief periods during a given year, could result in the extinction of the royal snail. All actions and activities around the springs and their watersheds must be carefully reviewed, planned, and implemented with the protection of the royal snail in mind. Lack of proper protection and management of these populations and the springs will ultimately lead to the species' extinction.

- 1.1 Utilize existing legislation and regulations (Federal Endangered Species Act, Federal and State water quality regulations, stream alteration regulations, surface mining laws, etc.) to protect the species and its habitat. Degradation of the water quality of the springs appears to be the most significant threat to

the survival of the royal snail. Complete compliance with Federal and State laws and regulations designed to protect water and habitat quality must be ensured if the species is to survive. Unless this objective is met, any other recovery activities would be futile.

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 have the potential to adversely affect the species and/or its habitat. Once impacts have been identified, regulatory/permitting agencies must utilize their authorities to ensure that the species and its habitat are adequately protected.

1.3 Solicit help in protecting and enhancing the species and its essential habitat. Assistance and support of conservation groups, local governments, and regional and local planners will be essential in meeting the

goal of maintaining the royal snail. Also, support of local industrial, business, and farming communities, as well as local residents, is vital. Construction, forestry, and agricultural "best management practices" must be implemented by all landowners. Local and county land use planning must be designed and implemented to protect the royal snail and its watersheds. Individuals should be educated regarding the natural processes of the springs, how human activities influence these processes, and measures needed to protect the springs and the royal snail. Without a continuing commitment from the local people who have an influence on the water and habitat quality of the springs, any efforts to maintain the royal snail will meet with little success.

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

1.3.2 Meet with local business, farming, logging, and industry interests and solicit their support; where feasible, provide them assistance 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 groups, civic groups, schools, church organizations, etc.

Educational material outlining the goals and emphasizing the benefits of maintaining and upgrading habitat quality will be extremely useful in informing the public of our actions and implementing Tasks 1.3.1 and 1.3.2.

1.4 Encourage the establishment of high-quality water designations, buffer zones, conservation easements, and other protection strategies as a means of protecting the species. The Service should work with the appropriate State agencies in Tennessee to have special status assigned to the springs and their watersheds, which would provide increased protection to the royal snail.

1.4.1 Determine the recharge areas for both springs.

To most effectively protect the quality of the water in the springs, the surface area recharging the systems must be determined. This will not only benefit the snail, but will also help the City of Jasper better protect its water supply.

1.4.2 Work with landowners to establish conservation management agreements (or similar arrangements) for areas occupied by the royal snail and any adjacent areas that would aid in its protection (buffer zones). To provide the most effective habitat protection for the quality of the water in the spring and the stream habitat, land managers within the recharge area of the spring/stream should be informed as to what they can do to benefit the snail. Using existing financial incentives, such as the Service's Partners for Wildlife program, encourage landowners to manage their land in a way that benefits the snail. Again, this will not only benefit the snail but will also help the City of Jasper better protect its water supply.

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

2.1 Conduct research on the species and characterize the specific habitat requirements (relevant physical, biological, and chemical components) for all life history stages. Detailed knowledge of the habitat requirements of the species; community structures of

associated flora and fauna; and how these biotic and abiotic factors interact and affect reproduction, growth, and mortality rates of the royal snail are needed in order to focus management and recovery efforts on specific problems within the species' habitat. Knowledge of the environmental requirements of all life history stages of the species and an understanding of the nature of the habitat occupied by the species is essential in order to manage for the species' long-term survival.

2.1.1 Determine the number of individuals required to maintain a viable population. Many species are well adapted to inbreeding, including many mollusks (Selander 1983), although their evolutionary longevity may be limited. In general, however, inbreeding depression can be a major obstacle to species recovery, especially if the remaining population sizes are small and/or have gone through some type of genetic bottleneck. The actual number of individuals in a population is not necessarily a good indication of a population's genetic viability; rather, the "effective population" size is needed. The effective population size is the size of an "ideal" population in which

genetic drift takes place at the same rate as in the actual population (Chambers 1983). Franklin (1980) suggested that the inbreeding coefficient (the probability that two alleles present at a locus are identical by descent) should be limited to no more than 1 percent per generation, a figure that implies that the short-term, maintenance effective-population-size should be no fewer than 50 individuals (Frankel and Soulé 1981, Franklin 1980, Soulé 1980). Because the effective population size is typically only one-third to one-fourth the actual population size (being affected by sex ratio, overlapping generations, generally nonrandom distribution of offspring, and nonrandom mating) (Soulé 1980), a population of 150 to 200 individuals is needed for short-term population maintenance. Soulé (1980) further suggests that for long-term viability, an effective population of 500 individuals is necessary, translating into a population size of 1,500 to 2,000 individuals. The mating system of this species needs to be determined as well as a measure of population heterozygosity to determine if inbreeding is in fact a problem.

Some of these factors can be addressed under Task 2.1, while others will need to be addressed as part of this task.

2.2 Isolate and eliminate current and future threats to the species' survival. Water and habitat quality deterioration or alteration (by increasing siltation, nutrient, or pollutant loading or by altering water retention time, temperature, or pH) and the introduction or invasion of nonnative species appear to be the primary threats to the royal snail. All potential sources of these threats (and other potential threats) need to be isolated, and methods and effects of controlling/altering these sources need to be determined. 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 impacts is also unknown. To minimize and eliminate these threats, the information gathered in Task 2.1 must be utilized to target and correct specific problem areas and isolate the specific causative agent(s).

2.3 Based on the biological data and threat analysis, investigate the need for management, including habitat improvement. Implement management, where needed, to

secure the species. Specific components of the royal snail's habitat may be stressed or threatened, and this may limit the species' potential for survival. Habitat improvement programs may be needed to alleviate these threats to the species.

3. Develop artificial holding and propagation techniques and, if feasible, establish captive populations. There is an immediate need to develop techniques for holding and propagating the royal snail to allow for reestablishment or augmentation of the existing populations. Under present conditions, with the species occurring in only two small spring runs, it would be easy to lose one or both populations. This, coupled with the species' biology, makes the royal snail extremely vulnerable to extinction from a single catastrophic event or a combination of events or activities adversely affecting the two spring runs, even for a short period of time. Because the species is found in only two springs, reintroduction into other areas may not be appropriate or feasible. Development of artificial holding/propagation techniques and, if feasible, establishment of captive populations would allow for the reestablishment of a population in the springs, if either or both of the populations were lost, or for population augmentation, if the present populations were significantly reduced in number to a point where their viability and survival was

threatened. The number of individuals necessary to maintain viability will be determined in Task 2.1.1.

4. Develop and implement cryogenic techniques to preserve the species' genetic material. No attempts have been made to transport and hold royal snails or to develop artificial propagation techniques (Task 3 above). This may take a substantial period of time. Also, because of the species' biology, long-term maintenance of captive populations may not be feasible. Cryogenic preservation of the royal snail could indefinitely maintain genetic material (much like seed banks for endangered plants) from the extant populations. Once artificial holding and propagation techniques are developed, cryopreservation could then allow for the eventual creation and reestablishment of royal snail populations (if necessary), using genetic material preserved from that population without requiring the continuous maintenance of a captive population.

5. Develop and implement a program to monitor royal snail population levels and water/habitat conditions of each of the spring runs. The status of the species and its habitat must be continually monitored to assess its condition and identify any potential problems. Quantitative samples should be taken to determine royal snail population densities and the chemical, physical, and biological quality

of each of the spring runs. This monitoring should be conducted at least on an annual schedule.

6. Annually assess the overall success of the recovery program and recommend action (changes in recovery objectives, continue to protect, implement new measures, 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 and as conditions change, recovery objectives may need to be modified.

C. Literature Cited

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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 the species' population and/or 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

- FWS - U.S. Fish and Wildlife Service
- ES - Ecological Services Division of the U.S. Fish and Wildlife Service
- LE - Law Enforcement Division of the U.S. Fish and Wildlife Service
- COE - U.S. Army Corps of Engineers
- EPA - U.S. Environmental Protection Agency
- SCS - U.S. Soil Conservation Service
- TDEC - Tennessee Department of Environment and Conservation
- TNC - The Nature Conservancy
- TWRA - Tennessee Wildlife Resources Agency
- USGS - U.S. Geological Survey

ROYAL SNAIL IMPLEMENTATION SCHEDULE

Priority	Task Number	Task Description	Task Duration	Responsible Agency FWS Other	Cost Estimates (\$000's) FY1 FY2 FY3	Comments
1	1.1	Utilize existing legislation and regulations to protect the species and its habitat.	Continuous	COE, EPA	---	
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	COE, EPA, TDEC, TWRA, SCS	---	
1	1.4	Encourage the establishment of outstanding resource water designations and other protective strategies as a means of protecting the species.	Ongoing	COE, EPA, TDEC, TWRA, SCS, TNC	---	
1	1.4.1	Determine recharge areas for both springs.	2 years	Contract or USGS	15.0	
See comments.	2.3	Based on the biological data and threat analysis, investigate the need for management and implement where needed.	2 years	COE, EPA, TDEC, TWRA, SCS	10.0	Priority 1, 2, or 3, depending on the result of 2.1, 2.2, 1.4.1, and 2.3.
2	1.3.1, 1.3.2	Meet with local government officials and business interests and solicit their support for recovery.	3 years	COE, EPA, TDEC, TWRA, SCS, TNC	---	
2	1.3.3	Develop information and education program and present.	Ongoing	TWRA, TNC	3.0	Task duration: 1 year to develop, then continuous.
2	1.4.2	Work with landowners to establish agreements for areas occupied by the snail and any adjacent areas that would aid in its protection.	Ongoing	TWRA, TNC	2.0	2.0

ROYAL SNAIL IMPLEMENTATION SCHEDULE (continued)

Priority	Task Number	Task Description	Task Duration	Responsible Agency		Cost Estimates (\$000's)			Comments
				FWS	Other	FY1	FY2	FY3	
2	2.1, 2.2	Conduct research necessary for the species' protection and management; i.e., habitat requirements, biology, and threat analysis.	3 years	R4/ES	TWRA	10.0	7.5	7.5	
2	3	Develop artificial holding and propagation techniques and, if feasible, establish captive populations.	Ongoing	R4/ES	Contract	12.5	12.5	5.0	Annual cost should remain relatively constant after techniques established.
2	4	Develop and implement cryogenic techniques.	Ongoing	R4/ES	Contract	20.0	20.0	1.0	Annual cost should remain relatively constant after techniques established.
2	5	Develop and implement a monitoring program.	Ongoing	R4/ES	TWRA	3.0	3.0	3.0	
3	6	Annually assess the overall success of the recovery program and recommend action.	Ongoing	R4/ES	TWRA	1.5	1.5	1.5	

PART IV

LIST OF RECIPIENTS

The following agencies, organizations, and individuals were mailed copies of this recovery plan. This does not imply that they provided comments or endorsed the contents of this plan.

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