Royal Marstonia (Snail)
(*Pyrgulopsis ogmorhaphe*)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Southeast Region
Tennessee Ecological Services Field Office
Cookeville, Tennessee

5-YEAR REVIEW
Royal Marstonia (*Pyrgulopsis ogmorhaphe*)

I. GENERAL INFORMATION

A. Methodology used to complete the review: In conducting this 5-year review, we relied on available information pertaining to historic and current distributions, life history, and habitat of this species. Our sources include the final rule listing this species under the Endangered Species Act; the final recovery plan; unpublished field observations and survey reports from Fish and Wildlife Service (Service), State, and other experienced biologists; and notes and communications from qualified biologists or experts. Public notice of this 5-year review was given in the *Federal Register* on July 28, 2006 (71 FR 42871) and a 60-day comment period was opened. During this comment period, we received two responses, one of which contained information on the status of this species.

We distributed a draft of this document for peer review to individuals with considerable malacological experience including the author of the species' recovery plan and biologists with the Tennessee Division of Natural Areas, Florida Museum of Natural History, National Museum of Natural History, Alabama Department of Conservation and Natural Resources, and the University of Alabama (see Appendix A).

B. Reviewers

Lead Region: Southeast Region: Kelly Bibb, (404) 679-7132

Lead Field Office: Cookeville, Tennessee, Ecological Services Field Office: Stephanie Chance, (931) 525-4981

C. Background

1. Federal Register Notice citation announcing initiation of this review: July 28, 2006; 71 FR 42871

2. Species status: Uncertain, 2011 Recovery Data Call; Surveys and threats analyses are planned for 2012.

3. Recovery achieved: 2 (2=26%-50% recovery objectives achieved)

4. Listing history

Original Listing
FR notice: 59 FR 17994
Date listed: April 15, 1994
Entity listed: species
Classification: endangered

5. Review History:
Final Recovery Plan - 1995
Recovery Data Call - 2011 through 1998

6. Species' Recovery Priority Number at start of review (48 FR 43098):
5 (degree of threat is high, potential for recovery is low, and the taxonomy is at the species level)

7. Recovery Plan
Name of plan: Recovery Plan for Royal Snail (*Pyrgulopsis ogmorhaphe*)
Date issued: August 11, 1995

II. REVIEW ANALYSIS

A. Application of the 1996 Distinct Population Segment (DPS) policy: The royal marstonia is an invertebrate and, therefore, not covered by the DPS policy. The other DPS questions will not be addressed further in this review.

B. Recovery Criteria

1. Does the species have a final, approved recovery plan containing objective, measurable criteria? No

In the section of the recovery plan addressing recovery criteria, the plan indicates: "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 it inhabits. 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."

The plan goes on to identify as a recovery objective "…to protect and maintain self-sustaining populations of the royal snail in the two known sites, to protect its habitat from present and foreseeable threats, and to downlist the species to threatened." The plan then provides a list of actions needed.

2. Adequacy of recovery criteria
The recovery plan did not identify recovery criteria for the species. It shared the potential for developing criteria will be reevaluated as more is learned about the species.

3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information.

There are no criteria for delisting of the species. The objective of the recovery plan is to protect and maintain self-sustaining populations of the royal marstonia at the two known sites, protect its habitat from present and foreseeable threats, and to downlist the species to threatened. Reclassification criteria were not presented but downlisting will be considered with the implementation of the following actions to the point where the species is no longer in danger of extinction:

a. Protect the existing populations and essential habitat. This action addresses listing factors A (present or threatened destruction, modification or curtailment of its habitat or range) and D (inadequacy of existing regulatory mechanisms). It has not been fully met/implemented, although some progress has been made. Tasks identified as necessary to meet this action include (1) utilizing existing legislation and regulations to protect the species and its habitat; (2) working with appropriate Federal and State regulatory review agencies to identify and assess projects and/or activities that could have negative effects on the species and ensure incorporation of measures for protecting the species and its habitat into such activities; (3) soliciting help in protecting the species and its habitat through development of an educational program and through contact with local government officials and planners, as well as local business, farming, logging, and industry interests; and (4) encouraging the establishment of high-quality water designations, buffer zones, conservation easements, and other protection strategies (including determining the recharge area for both springs and working with landowners to establish agreements for the conservation of the royal marstonia).

The royal marstonia has a narrow distribution, known from only two spring runs in the Sequatchie River system. Because the recharge areas for the springs are unknown, it is difficult to evaluate the geographic scope within which threats may be occurring and, therefore, the area within which recovery tasks need to be implemented. The limited effort to date to implement the tasks identified above has been focused in the immediate vicinity of royal marstonia habitat. A broader approach to evaluating and addressing threats needs to be undertaken.

Existing Federal and State laws and regulations are applied to actions conducted within the range of the royal marstonia. Projects requiring State and/or Federal permits are reviewed to determine if impacts to the species are likely and the Service works with those agencies to avoid or minimize impacts to the snail and its habitat.

Although the take prohibitions of section 9 of the Act do apply to activities on private lands and their effects on the royal marstonia, not all projects in or near the royal marstonia habitat result in coordination with the Service. Typically,

only those projects with a federal nexus necessitating compliance with section 7 of the Act are coordinated with the Service, thus making enforcement of the section 9 prohibitions unattainable in some cases. Because the Service is not informed when some activities are being considered, planned, or implemented, we have no opportunity to provide input into the design of the project or the need for a section 10 permit.

No education program has been developed and implemented, nor has widespread contact with local government and businesses been initiated. These types of outreach efforts could possibly have precluded some royal snail habitat destruction that has occurred, such as the removal of extensive riparian vegetation from a portion of Town Creek. The headwaters of Town Creek are surrounded by the Town of Jasper's water treatment plant. In late 2002, the water treatment plant elected to remove extensive riparian vegetation from a portion of Town Creek, as well as to remove a series of trout runs that were part of a former hatchery. The royal marstonia occurred in the trout runs, as well as in the portion of Town Creek used as a crossing for heavy equipment. Adverse effects to the royal snail were not considered while the project was undertaken and no permits were obtained, emphasizing the need for better education regarding the conservation needs of the snail.

A cooperative management agreement between the Tennessee Department of Environment and Conservation's Division of Natural Areas (TDNA) and Marion County Government defines, and assigns responsibility for implementation of, actions required to provide for a reasonable level of oversight and management of the Sequatchie Cave State Natural Area. However, the agreement is somewhat limited in its scope and funding is not committed for its implementation. Additionally, a management plan for the Sequatchie Area State Natural Area (Management Plan) has been developed and is being implemented by TDNA staff as funding allows. One of the goals of the Management Plan is to "restore and maintain the water quality of Owen Spring Branch and the ecological integrity of the natural area within the Sequatchie River watershed in order to sustain the Federally-endangered royal snail population and other rare elements inhabiting the cave and spring waters."

During 2001, a 10-year agreement was entered into by the Fish and Wildlife Service and a landowner to restore and protect habitat for the royal marstonia in Town Creek. Approximately 5,000 feet of electrified high-tensile fencing was installed to limit livestock access to the stream and its associated riparian zone. Alternate watering sources were also installed for livestock. On a nearby upland ridge, a heavy-use feeding area was created and an existing feeding area located adjacent to Town Creek was abandoned. This change in the livestock feeding strategy greatly reduced localized erosion associated with winter feedings. Natural regeneration and native tree plantings were used to stabilize eroded areas within the protected riparian zone. All of these practices improved water quality and benefit the royal marstonia which was found on-site. However, the

agreement is not being renewed at this time and additional maintenance of the site is needed to address problems potentially caused by beaver activity resulting in inundation of a portion of the project site.

b. Identify threats to the species, conduct research necessary for the species' management, and implement management where needed. This action has not been met/implemented. Tasks identified to meet it include (1) conducting research on the species and characterizing the specific habitat requirements for all life history stages, (2) determining the number of individuals required to maintain a viable population, (3) isolating and eliminating/reducing threats to the species' survival, and (4) investigating the need for management (including habitat improvement) and implementing management to secure the species. To date, little research has occurred. Most investigation into the royal snail has been limited to surveys of potentially suitable habitat to better delineate the snail's distribution within its range. No work has been conducted to determine the viability of the existing populations or to estimate a minimum viable population size.

Some attention has been focused on identifying and eliminating current threats, as well as investigating the need for and implementing management actions. As discussed previously, the royal marstonia occupies only two spring runs and the recharge areas for the springs are unknown. It is difficult to evaluate the geographic scope within which threats may be occurring and, therefore, the area within which management actions should be taken. The limited effort to date to implement the tasks identified above has been focused in the immediate vicinity of royal marstonia habitat.

For example, in Town Creek the royal marstonia population does not appear to extend downstream of the US 64/72 bridge in Jasper, because of the influence of beaver damming in the system. Although the stream was cleared of beaver in 2000, beaver returned by 2002 and their activity currently continues unchecked with associated adverse impacts to the snail's habitat. Continual attention needs to be paid to the stream to prevent further beaver activity. Similarly, restoration work in the riparian zone of Owen Spring (Sequatchie Cave) occurred in 2000 in response to significant direct human impacts to the habitat from activities including littering, dumping, and off road vehicle (ORV) use in the stream. ORV traffic in the stream became virtually non-existent and snails reoccupied the areas that had been most impacted prior to the restoration work. However, maintenance of barriers near the stream is needed and evidence of limited ORV use in the stream has become apparent again (Withers 2007). Additional effort is needed to address these types of issues before they become significant and imminent.

In 2011, the Alabama Aquatic Biodiversity Center (AABC) agreed to assist TDNA staff with the evaluation of possible threat assessments and provide suggestions for mitigation options at both the Town Creek and Owen Spring sites. This plan is expected to be written in 2012 and would include, but is not limited

to threat assessment from: water withdrawal, accidental discharge, beaver impacts, surface drainage, and vehicular traffic.

c. Develop holding and propagation techniques and, if feasible, establish captive populations. This has not been implemented. In the recovery plan, this was identified as an immediate need given the limited distribution of the royal marstonia, as well as aspects of its biology, making it extremely vulnerable to extinction.

In 2011-12, the AABC will complete sampling and surveys for the snail during the winter months, and simultaneously development of culture systems. It is likely two system designs will be utilized. The first design would be a partial-recirculation system attached to a chiller unit holding culture temperatures stable. The second would be a flow-through that will use the natural temperature variation in AABC well water during the culture season. Well water temperatures at the AABC vary seasonally (17º – 23º C). Both systems will also be designed to provide constant aeration and current. Some snails require flows to initiate oviposition, although this may not be required for royal marstonia. For this initial trial, 20 snails would be required for each system. Notes on life history observations and oviposition dates will be recorded within each culture system. Initiation of the propagation efforts will follow initial genetics evaluation of the two populations. If initial analyses determine the Owen Spring and Town Creek populations are substantially different/divergent, the number of culture systems would be doubled.

Previous culture efforts with Hydrobiidae (*Fontigens* spp.), or Lithoglyphidae (*Somatogyrus* spp. *Lyperium showalteri*) have demonstrated nearly complete mortality as part of the culture process. At this point, it appears the mortality is a normal part of the life cycle as continued Alabama Department of Conservation and Natural Resources (ADCNR) monitoring of listed Alabama hydrobiids has demonstrated (*Lyperium showalteri, Marstonia pachyta,* etc.). These snails have a 1-year life-span and the majority of individuals (> 90%) die soon after the reproduction.

d. Develop and implement cryogenic techniques to preserve the species' genetic material. This has not been implemented.

e. Develop and implement a program to monitor royal marstonia population levels and water and/or habitat conditions of each of the spring runs. This has not been implemented. Although no monitoring program has been developed or implemented for the royal marstonia or the water and/or habitat it inhabits, qualitative monitoring of the populations and their habitat has occurred sporadically. Monitoring by personnel from the Tennessee Division of Natural Heritage has occurred intermittently since 1999. For example, during 2003, the two extant populations were visited periodically during the course of a survey of many sites in the vicinity. The population at Owens Spring was visited during

2005 and found to be doing well, with the snail abundant in portions of the creek (Withers 2005). During this same trip, Withers also evaluated the habitat and noted some issues regarding habitat management. During 2007, staff from the Service accompanied the Natural Heritage Division staff to both sites and found the snails to be plentiful in the headwaters, but noted some impacts to habitat including sedimentation from nearby hiking trails and the adjacent gravel road leading to the spring.

The ADCNR has previously implemented sampling protocols for *Marstonia pachyta*, Armored Marstonia a federally endangered snail endemic to the Limestone Creek drainage in Limestone County, Alabama. *Marstonia pachyta* utilizes root mats and other structures along the channel margin, where royal marstonia is often found in open spring pools as well as in vegetation associated with the channel margins. During the winter of 2011-12, ADCNR biologists will modify the current *M. pachyta* sampling protocol to complete density estimates for royal marstonia at both Owen Spring and Town Creek sites. However, this program will be limited (about 30 samples each) since sample collection will involve moving in the stream, which could cause some limited mortality. Sampling protocol involves small samplers (10 cm^2). The sampling program should be carried out between September – December, as the snails will be larger and easier to enumerate (Johnson, pers. comm., 2010).

The ADCNR will also examine 20 additional localities for the presence of royal marstonia in the Sequatchie River drainage. It is likely that additional populations will be restricted to the lower portions of the basin below the Cumberland Escarpment. There are numerous springs at the base of the escarpment, where other populations of royal marstonia might be located.

f. 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.). This has not been fully implemented with the limited information on the species.

C. Updated Information and Current Species Status

1. Biology and Habitat

a. Abundance, population trends, demographic features, or demographic trends: No new information has become available regarding abundance, demography, or trends since the recovery plan was developed in 1995. Since 1995, one systematic survey of potentially suitable habitat has occurred, as well as a few opportunistic qualitative evaluations of the two known populations. ADCNR biologists are scheduled to complete density estimates for royal marstonia at both Owen Spring and Town Creek sites during the winter of 2011-12 using methodology developed for a similar snail species. During the 2003 systematic survey (discussed further in section II.C.1.d.), no additional

populations of the royal marstonia were documented. The two extant occurrences of the royal marstonia were visited repeatedly during the 2003 survey and appeared to be stable. The population at Owens Spring was visited during 2005 and it was found to be doing well, with the snail abundant in portions of the creek (Withers 2005). In 2007, both populations were observed to be plentiful in the headwaters of the two drainages, although both populations were constrained by beaver activity in downstream areas (Withers 2007).

b. Genetics, genetic variation, or trends in genetic variation: There has been no new definitive genetic information since the recovery plan was developed, although there is some speculation on the part of several researchers that the Jasper/Town Creek population could be a separate species rather than the same species as found at the type locality in Sequatchie (based on preliminary morphological comparisons of individuals of the two populations).

The two populations of royal marstonia have not been evaluated to determine whether there are two or a single species with a disjunct distribution, or to determine the magnitude of intraspecific differentiation if they do indeed comprise a single species. Since 2000, the mitochondrial cytochrome oxidase I (COI) gene has been recognized as providing a measure of genetic differentiation that can be used, along with other information on morphology, life history, etc., to infer species limits and to explore the level of gene flow between distinct populations. Moreover, the CO1 gene is in routine use to examine species and population relationships among many different groups of hydrobiid snails. Beginning in 2012, the genetic diversity between the Owen Spring and Town Creek populations will be evaluated with mitochondrial DNA sequencing, to examine the relationship between the two populations. If the COI gene is found to be insufficiently sensitive for this purpose, the first internally transcribed spacer region (ITS-1) between the 5.8S and 18S ribosomal DNA genes will be sequenced as well. These two markers, either singly or in combination, should provide a suitable measure of the levels of genetic differentiation between the two populations, and if they represent separate species. Even if levels of sequence divergence (and other evidence) are consistent with the interpretation that they represent a single species, genetic differentiation between the two populations may be high enough to warrant consideration as separate management entities. Molecular genotyping will require a minimum of 5 individuals from each site. With these small snails, the entire specimen is typically consumed to provide enough DNA for amplification; non-invasive methods have not been explored for such small species, and may not be effective. In addition, other *Marstonia* spp. within and outside the Tennessee River basin (TRB) will be evaluated simultaneously (including *M. pachyta*) to examine diversity patterns within the genus. Specifically, additional Tennessee River basin species include *M. arga*, and *M. scalariformis* as well as 2 Mobile Basin occurrences *Marstonia* sp. (Cahaba Basin – possibly undescribed) and *M. hershleri* (lower Coosa). This will allow us to place the genetic data for *M. ogmorhaphe* within the appropriate

taxonomic context. CO1 sequences for numerous species of Hydrobiidae are available on GenBank.

c. Taxonomic classification or changes in nomenclature: Thompson (1977) noted the close morphological similarity between *Marstonia* and eastern species of *Pyrgulopsis*, but continued to recognize them as separate genera. Herschler and Thompson (1987) synonymized *Marstonia* with *Pyrgulopsis* largely based on morphological characteristics of *P. nevadensis* (the poorly known type species of *Pyrgulopsis*). However, based on strongly differentiated morphological characteristics between eastern and western congeners of *Pyrgulopsis*, Thompson and Herschler (2002) re-evaluated eastern North American species assigned to *Pyrgulopsis* and recognized them as distinct species of the genus *Marstonia*. Since it is published, peer-reviewed, and uncontested, this assignment to *Pyrgulopsis* stands as taxonomically valid and should be reflected in the next American Fisheries Society publication of common and scientific names of aquatic invertebrates from the United States and Canada (expected to be published in a year or two). The Integrated Taxonomic Information System (ITIS 2011) lists both *M. ogmorhaphe* and *P. ogmorhaphe* as valid, although only *P. ogmorhaphe* shows a record credibility rating of "verified," meaning all standards have been met.

d. Spatial distribution, trends in spatial distribution, or historic range (e.g., corrections to the historical range, change in distribution of the species' within its historic range, etc.): A resurvey for the royal marstonia was completed during 2003 by the Tennessee Division of Natural Heritage (2003). The survey focused on habitat potentially suitable for use by royal marstonia within and proximal to the Sequatchie Valley in Cumberland, Bledsoe, Sequatchie, and Marion counties. Fifty-one sites of potentially suitable habitat were surveyed, but no additional populations of the royal marstonia were found. The report concluded that the likelihood that this species occurs naturally elsewhere in the Sequatchie Valley is minimal.

e. Habitat: Since the Recovery Plan was developed in 1995, the significance of adverse effects to royal snail habitat as a result of beaver activity has become more apparent. Both populations are constrained by downstream beaver activity that results in formerly free-flowing cold water sections of stream becoming inundated and inaccessible to the royal snail. Although this is most notable in Town Creek, beavers are also active in Owen Spring Branch and a dam was found on the creek in Sequatchie Cave State Natural Area. There are no long term commitments in place to control beaver populations in either spring.

The Town Creek population of royal marstonia does not appear to extend downstream of the US 64/72 bridge in Jasper, likely due to the continuing influence of beaver damming in the system. The headwaters of Town Creek (Blue Hole Spring) are owned by the Town of Jasper and are surrounded by the town water treatment plant. In late 2002, the water plant removed extensive

riparian vegetation from a portion of Town Creek immediately downstream of Blue Hole Spring. The area around the water treatment plant currently remains devoid of most riparian vegetation. Additionally, in 2002 the water treatment plant removed a series of trout runs that were a part of a former hatchery and had been occupied by the royal marstonia.

There has been some improvement in habitat conditions at localized areas as a result of conservation actions taken by state and local governments since 1995. For example, the riparian zone of Owen Spring Branch near Sequatchie Cave appears to have stabilized since completion of the restoration work in 2000. The snails reoccupied those portions of the littoral zone that were most impacted prior to 1999-2000. However, evidence of ORV use in the stream was noted during 2007 (Withers 2007). The current downstream limit of the species in Owen Spring is uncertain, although the species had expanded just downstream of the old SR 28 Bridge shortly after the conclusion of the restoration project in 2000. The snail has not expanded past this point (Withers pers. comm., 2011).

More subtle aspects of habitat quality, such as various water quality parameters, have not been monitored routinely. In 2005, staff of the Tennessee Department of Environment and Conservation (TDEC) collected water samples to compare water quality among Blue Hole, Owen Spring Branch, and 2 other local springs (Call 2006). It was hoped that this comparison would assist with understanding the source of turbidity. The Service has not reviewed the results of the water quality comparison. Additionally, there appears to be some impact to water temperature and flow regime in the downstream portion of Owen Spring Branch as a result of beaver activity and the influence of a man-made canal (known as "The Lagoon"). In 2011, TDEC measured water temperature, dissolved oxygen, pH, and specific conductivity at the Owen Spring, in the lagoon, and below the SR 28 Bridge. While there are differences in these water quality parameters at the three sampled points, it is not clear whether or not these water quality parameters and/or the lagoon are limiting royal marstonia distribution.

2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

a. Present or threatened destruction, modification or curtailment of its habitat or range: As indicated at the time of listing and in the recovery plan, degradation of habitat and water quality remain the biggest threats to the royal marstonia. Because the royal marstonia is known from only two spring runs in the Sequatchie River system and the recharge areas for the springs are unknown, it is difficult to evaluate the geographic scope within which activities may be occurring with the potential to result in adverse effects to the species' habitat. However, since the recovery plan was prepared, several specific threats to habitat have become apparent.

Beaver activity in both the Town Creek and Owen Spring Branch drainages has

impacted royal marstonia habitat and likely will continue to threaten habitat. Formerly free-flowing cold water sections of Town Creek are now wholly inundated and inaccessible to the royal marstonia. In Town Creek, the snail population does not appear to extend downstream of the US 64/72 bridge in Jasper because of beaver activity. Although the stream was cleared of beaver in 2000, beaver returned by 2002 and their activity currently continues unchecked, with associated adverse impacts to the snail's habitat. Downstream portions of the Owen Spring Branch are being impacted by beaver activity. A beaver dam occurred on the Sequatchie Cave State Natural Area during 2007. The dam was removed in 2008, but beaver activity continues with no long term plans for control.

Human activities have impacted royal marstonia habitat and will likely do so in the future. For example, the headwaters of Town Creek have been adversely impacted by activities at the Town of Jasper's water treatment plant. In late 2002, the water treatment plant elected to remove extensive riparian vegetation from a portion of Town Creek, as well as to remove a series of trout runs that were part of a former hatchery. Town Creek currently remains devoid of normal riparian vegetation in the vicinity of the water treatment plant (Withers pers. comm., 2011). The royal marstonia occurred in the trout runs, as well as in the portion of Town Creek used as a crossing for heavy equipment. No permits were obtained. TDNH continues to meet with Jasper water treatment plant staff to discuss plant operations and potential measures that could be taken to improve habitat for the snail at the site (Withers pers. comm., 2011).

Owen Spring Branch was significantly impacted by human activities near Sequatchie Cave prior to 1999. Littering, dumping, and ORV use significantly damaged the riparian area and caused a direct loss of snail habitat. Restoration work occurred in 2000 and included installation of barriers to keep ORV's out of the stream, as well as vegetation planting and recontouring of the riparian zone. ORV traffic in the stream became virtually non-existent and snails reoccupied the areas that had been most impacted prior to the restoration work. However, maintenance of barriers near the stream is needed and evidence of limited ORV use in the stream has become evident again (Withers 2007). While there is currently no ORV use in the stream; water withdrawal, passive recreation, social gatherings, and wildlife viewing activities are still considered to threaten royal snail habitat at Sequatchie Cave State Natural Area (Withers pers. comm., 2011).

In August 1998, a portion of the stream bottom of Owens Spring Branch downstream of SR 27 was covered by a layer of sawdust and silt as a result of dumping of wood waste by a local factory (TDNH 2000). The sawdust was removed and the bank re-seeded. Additional attention is still needed to restore portions of the stream and address other pollution issues. The handle factory continues to threaten potential habitat in Owens Spring Branch (Withers pers. comm., 2011).

Subtle changes in water quality parameters may result from activities taking place elsewhere within the springs' recharge zones and may occur without prompt detection. For example, there are anecdotal reports of turbidity of water at Blue Hole and in Town Creek with some speculation that the turbidity could be associated with activities at the water treatment plant or activities at a quarry in the drainage, although monitoring has not been in place to determine the source of the turbidity or whether water quality has been impaired during these episodes.

b. Overutilization for commercial, recreational, scientific, or educational purposes: Overutilization for commercial, recreational, scientific or educational purposes was not considered to be a limiting factor at the time of listing or in the recovery plan. We have no new information to indicate that this has changed.

c. Disease or predation: At the time of listing, there was no evidence that predation or disease were serious threats to the species. The recovery plan made no mention of disease or predation as threats to the species. We have no new information on disease or predation of the royal marstonia. We continue to believe that neither disease nor predation is a limiting factor for this species.

d. Inadequacy of existing regulatory mechanisms: We have little new information regarding the inadequacy of existing regulatory mechanisms for protecting the royal marstonia and its habitat. The royal marstonia and its habitats are afforded limited protection from water quality degradation under the Clean Water Act of 1977 (33 U.S.C. 1251 et seq.) and the Tennessee Water Quality Control Act of 1977. These laws focus on point-source discharges, and many water quality problems are the result of non-point source discharges. Therefore, these laws and corresponding regulations have been inadequate to halt population declines and degradation of habitat for the snail.

In addition to the federal listing, the royal marstonia is listed as Endangered by the State of Tennessee. Under the Tennessee Nongame and Endangered or Threatened Wildlife Species Conservation Act of 1974 (Tennessee Code Annotated §§ 70-8-101-112), "…it is unlawful for any person to take, attempt to take, possess, transport, export, process, sell or offer for sale or ship nongame wildlife, or for any common or contract carrier knowingly to transport or receive for shipment nongame wildlife." Further, regulations included in the Tennessee Wildlife Resources Commission Proclamation 00-15 Endangered Or Threatened Species state the following: except as provided for in Tennessee Code Annotated, Section 70-8-106 (d) and (e), it shall be unlawful for any person to take, harass, or destroy wildlife listed as threatened or endangered or otherwise to violate terms of Section 70-8-105 (c) or to destroy knowingly the habitat of such species without due consideration of alternatives for the welfare of the species listed in (1) of this proclamation, or (2) the United States list of Endangered fauna. Potential collectors of this species would be required to have a state collection permit.

Since listing, section 7 of the Act has required Federal agencies to consult with the Service when projects they fund, authorize, or carry out may affect the species. However, the lack of Federal authority over the many actions likely impacting royal marstonia habitat has become apparent. Many of the threats (including those identified at the time of listing, during recovery planning, and since development of the Recovery Plan) involve activities that likely do not have a Federal nexus (such as water quality changes resulting from development or indiscriminate logging) and, thus, may not result in section 7 consultation. Although the take prohibitions of section 9 of the Act do apply to these types of activities and their effects on the royal marstonia, enforcement of the section 9 prohibitions is difficult, at best. The Service is not informed when many activities are being considered, planned, or implemented; therefore, we have no opportunity to provide input into the design of the project or to inform project proponents of the need for a section 10 permit.

e. Other natural or manmade factors affecting its continued existence: The recovery plan identified the introduction or invasion of nonnative species into either spring run inhabited by the royal marstonia as a serious threat. The invasion or introduction of nonnative aquatic weeds into the spring runs could eventually result in the elimination of the habitat required by the royal marstonia and require intensive and potentially harmful control measures. Additionally, terrestrial nonnative weeds, or their control, may be a threat to the habitat of the royal marstonia. As part of the riparian restoration project along Owens Spring Branch near Sequatchie Cave in 2000, the Tennessee Division of Natural Heritage (TDNH), along with the Marion County Highway Department, made a concerted effort to remove invasive exotic plants (primarily Chinese privet and multiflora rose) that were excluding native riparian vegetation from the project area (TDNH 2000). The exotics were cut and removed, followed by herbicide treatment of stumps and sprouts. Kudzu has been problematic at the Sequatchie Cave State Natural Area, advancing to within approximately 450 feet of the snail's habitat in Owen Spring during 2005. In coordination with the Service, the Tennessee Division of Natural Areas developed a management prescription for treatment of kudzu at the natural area, with treatment measures including mechanical removal as well as herbicide application.

A concern identified in the recovery plan is the possible invasion by the zebra mussel (*Dressena polymorpha*). The filtering activity exerted by high-density populations of this nonnative species could disrupt the natural food chain and affect entire aquatic communities. The USGS Nonindigenous Aquatic Species database (USGS 2007) shows no records of zebra mussels from the Sequatchie watershed (HUC 06020004), although zebra mussels are known to have established in the Tennessee River, in the vicinity of the confluence with the Sequatchie River. Zebra mussel distribution and densities have remained at low levels within the mainstem Tennessee River only since their invasion of the Tennessee River watershed and the species is not likely to threaten the royal marstonia.

Because the royal marstonia is restricted to two small spring runs, it is vulnerable to extinction from stochastic events. This vulnerability is exacerbated by its presumed 1-year life cycle, making it susceptible to extinction even when stochastic events are short-term in duration. Because the populations are physically isolated from each other, recolonization of an extirpated population would not be possible without human intervention. Given the potential for genetic differences between the two populations, human-assisted repopulation or augmentation may be inappropriate. Additionally, because natural gene flow among populations is not possible, the long-term genetic viability of these isolated populations is questionable.

D. Synthesis

The royal marstonia has a narrow distribution, known from only two spring runs in the Sequatchie River system. Habitat and water quality degradation are the greatest threats to the species. The recharge areas for the springs are unknown, so it is difficult to evaluate the geographic scope within which threats may be occurring. However, habitat has been impacted by several types of human activities including direct habitat destruction at the Town of Jasper's water treatment plant and habitat destruction from ORV use in the Owen Spring Branch. Additionally, beaver activity constrains royal snail use of downstream habitat in both Town Creek and Owen Spring Branch. The limited and disjunct distribution of the royal marstonia populations, as well as the snail's presumed annual life cycle, makes it vulnerable to extinction from stochastic events, even when of short duration.

Because of the royal marstonia's limited distribution and continued threats to the two populations, it remains in danger of extinction throughout all or a significant portion of its range. Therefore, the status of the royal marstonia should remain as endangered.

At the time of listing (USFWS 1994), this species had a high degree of threat and a low recovery potential, which results in a recovery priority number of 5 for the taxonomic level of species. We continue to believe that the threats to this species remain high and that the recovery potential likely remains low. Therefore, a change to the existing recovery priority number is not warranted.

III. RESULTS

A. Recommended Classification:

_X_ **No change is needed**.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

The primary actions for the royal marstonia include:

1. Restore degraded habitat in both the Town Creek and Owen Spring Branch drainages, with priority given to those areas closest to occupied habitat. Implement a long-term beaver control program where needed and investigate the need for and potential to regulate flow from "The Lagoon" into the Owen Spring Branch.
2. Delineate the recharge zone for both springs.
3. Within the recharge zone, protect habitat on public lands through formal agreements and management plans. Work with the Town of Jasper to develop and implement a plan to provide for conservation of the royal marstonia in the vicinity of, and downstream of, the Jasper Water Plant.
4. Within the recharge zone, protect habitat on private land through acquisitions and easements where possible.
5. Investigate approaches to estimating population abundance. Develop a protocol for and implement a program to monitor important royal marstonia population parameters.
6. Develop a program for monitoring water quality and habitat conditions in occupied habitat.
7. Develop artificial holding and propagation technology.
8. Investigate genetic differences between the two populations of royal marstonia.
9. Form an informal recovery group comprised of a broad array of stakeholders to better facilitate periodic discussion of and implementation of recovery activities.

V. REFERENCES

Peer reviewed original research based on data

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Personal communications

Notes from Geoff Call, U.S. Fish and Wildlife Service, Cookeville, Tennessee, Field Office, regarding royal snail conservation issues (April 24, 2006)

E-mail from David Ian Withers, Ph.D., Tennessee Department of Environment and Conservation, Division of Natural Areas (August 24, 2005; March 10, 2011; September 2, 2011)

Notes from David Ian Withers, Ph.D., Tennessee Department of Environment and Conservation, Division of Natural Areas, regarding Town Creek/Blue Hole and Owen Spring/Sequatchie Cave State Natural Area Trip Summary (August 24, 2007)

U.S. FISH AND WILDLIFE SERVICE
5-year review of the royal marstonia (snail) (*Pyrgulopsis ogmorhaphe*)

Current Classification Endangered
Recommendation resulting from the 5-Year Review

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist**
_X_ **No change is needed**

Review Conducted By Stephanie Chance, Tennessee Ecological Services Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve Mary E Jennings Date 11/1/11

REGIONAL OFFICE APPROVAL:

Lead Regional Director, Fish and Wildlife Service

Approve Date 12/1/11

APPENDIX A: Summary of peer review for the 5-year review of royal marstonia (snail) (*Pyrgulopsis ogmorhaphe*)

A. Peer Review Method: We distributed a draft of this document for peer review to individuals with considerable malacological experience including the author of the species' recovery plan and biologists with the Tennessee Division of Natural Areas, Notebaert Nature Museum, Florida Museum of Natural History, and the Alabama Department of Conservation and Natural Resources.

B. Peer Review Charge: Reviewers were charged with providing a review of the document including any other comments and/or additions appropriate to include. Reviewers were not asked to comment on the legal status of the species.

C. Summary of Peer Review Comments/Report: We received comments from the Tennessee Division of Natural Areas and Notebaert Nature Museum. The reviewers provided comment on the need for genetic analyses, species monitoring, status of the species, and current threats.

D. Response to Peer Review: We incorporated new threats information into the Five-Factor Analysis and included thoughts on genetic analyses and species monitoring into the Recommendations for Future Actions section.