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THE RARE AND ENDEMIC SNAILS OF SELECTED SPRINGS WITHIN THE ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

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Prepared for the St. Johns River Water Management District

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EXECUTIVE SUMMARY

Within the St. Johns River Water Management District (SJRWMD), a series of springs and spring runs supply water to much of the St. Johns River basin. These karst springs and runs are unique from a geological standpoint as they are high calcium bicarbonate systems. This chemical composition enables the springs to support numerous freshwater mollusk species.

Demands for groundwater may reduce flows in springs and their runs. These small reductions may impact spring biota including rare and endemic aquatic snails. As a result, the SJRWMD contracted with the Alabama Malacological Research Center to produce a literature-based inventory of rare and endemic snail species and their degree of imperilment for Alexander, Apopka, Bugg, DeLeon, Gemini, Green, Rock, Silver, Silver Glen and Wekiwa spring boils and spring runs. Additionally, (1) the unique nature of these springs and their role in the evolution of endemic snail species and (2) the potential ecological effects on these species of small reductions in water flow and habitat alteration were discussed. This report provides support to the Minimum Flows and Levels (MFLs) Program because the existence of rare and endemic snail species within the springs' boils and their runs will be considered in setting MFLs for the protection of springs.

Ten species of rare and endemic snails were identified. *Aphaostracon monas, Floridobia alexander*, *Floridobia petrifons* and *Floridobia wekiwae* were found only in a single spring and are extremely rare and critically imperiled. *Aphaostracon pycnum* was found at two springs and is critically imperiled. *Spilochlamys gravis* and *Tryonia aequicostata* are considered vulnerable to extinction. An *Aphaostracon species* was only identified to genus. Its global ranking status is

unknown. *Elimia vanhyningiana* and *Floridobia floridana* are apparently secure in their range but are endemic to Florida. Table 1 describes the rare and endemic snails found at each spring.

Table 1. Explanation of Global Ranking System

REGIONAL RANKING		DEGREE OF IMPERILMENT	
G	Global	1	Critically imperiled
N	National	2	Imperiled
S	Subnational	3	Vulnerable to extirpation or extinction
		4	Apparently secure
		5	Demonstrably widespread, abundant, secure

About 9% of the nation's freshwater snails are extinct. Another 48% are considered imperiled. The extinction and imperilment of most of these species may be correlated to habitat alteration. This is especially true of naturally rare or endemic species with limited ranges.

Because of the highly restrictive occurrence range of these species, conservation efforts are needed to insure their future survival. Any anticipated spring flow reduction should be accompanied by a baseline chemical flow monitoring effort designed to protect rare and endemic snails.

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INTRODUCTION

Demands for groundwater may reduce flows in springs and their runs within St. Johns River Water Management District (SJRWMD). These small reductions may impact spring biota including rare and endemic aquatic snails. Section 62-40.473, *Florida Administravive Code.*, specifies that a Minimum Flows and Levels (MFLs) determination should be evaluated to protect nonconsumptive uses of water such as fish and wildlife habitats and other natural resources values. Preservation of wildlife resources by the MFLs Program also involves protection of rare species.

This report produced a literature-based inventory of rare and endemic snail species and their degree of imperilment for Alexander, Apopka, Bugg, DeLeon, Gemini, Green, Rock, Silver, Silver Glen and Wekiwa spring boils and spring runs. Additionally, (1) the unique nature of these springs and their role in the evolution of endemic snail species and (2) the potential ecological effects on these species of small reductions in water flow and habitat alteration were discussed. This report provides support to the MFLs Program because the existence of rare and endemic snail species within the springs' boils and their runs will be considered in setting MFLs for the protection of springs.

METHODS

The Alabama Malacological Research Center (AMRC) in Mobile, Alabama, was contracted by the SJRWMD to produce a literature based report on the rare and endemic snails of

.Alexander, Apopka, Bugg, DeLeon, Gemini, Green, Rock, Silver, Silver Glen and Wekiwa springs all within the SJRWMD in northeast Florida.

AMRC was founded in 1996 for research and education on worldwide marine, freshwater, terrestrial and fossil mollusks and is nationally recognized for work with federally protected species of freshwater mollusks. The majority of AMRC work is monitoring or mitigation consultation projects relating to federal and state regulatory agencies within the southeastern United States. Numerous projects have been completed for clients including federal and state agencies, universities, engineering firms and environmental organizations.

The literature search reviewed the holdings of the libraries of the AMRC; the University of South Alabama, Mobile, Alabama; and the Gulf Coast Research Center, Ocean Springs, Mississippi. Additional literature was obtained via an internet search using the subjects of "Florida Spring Snails," "St. Johns River Water Management District," "Flow Regime," "Floridobia" and the springs names associated with this project. Most of the species records came from the online database of the Florida Museum of Natural History (FLMNH) (Thompson 2004).

FLMNH houses the largest malacological collection in the Southeast. Many of the records associated with the aforementioned springs were from the collections of Dr. Fred G. Thompson, Curator of Mollusks at Florida Museum of Natural History (FLMNH), who has done extensive research on Florida freshwater mollusks (Thompson 1968 and 1984). His ongoing research has led to the discovery of several endemic species associated with various Florida springs (Thompson 2000). He and Robert Hershler have helped establish the currently recognized genera of this malacofauna (Thompson and Hershler 2002; Hershler et al. 2002). These works comprise the main literature body associated with the ecology, collection and

identification of the rare and endemic snails of the springs included in this study. Probably the single most valuable resource to this project was Dr. Thompson's online book, which is the evolving documentation of his ongoing research on the Florida freshwater snails (Thompson 2004).

Each species identified in this report was assigned its locality as per the FLMNH database and existing literature. The degree of imperilment assigned follows the NatureServe Explorer Species Index: Phylum Mollusca (NatureServe 2005) at the NatureServe Explorer Website.

NatureServe is a nonprofit conservation organization that provides scientific information and tools to assist conservation action. NatureServe and its network of natural heritage programs are the leading information source for rare and endangered species and threatened ecosystems. It is an international network of biological inventories operating in all 50 states, Canada, Latin America and the Caribbean. NatureServe assigns a global ranking to each species to demonstrate its degree of imperilment. This global ranking follows the standard of the Natural Heritage Methodology developed by The Nature Conservancy. This ranking system is in widespread use by the state-level Natural Heritage Programs throughout the United States. State and federal regulatory agencies use this ranking system to aid their conservation efforts. Interpretation of their ranking system is shown in Table 1. For example, a species with a global ranking of G1 would be considered critically imperiled in its entire range. Species with such a ranking are often found in a very limited area.

Table 1. Explanation of Global Ranking System

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General information on freshwater snails of North America was found in Burch (1980 and 1989). Information more specific to Florida's snails is found in field guides (Shelton 1996; Thompson 1984 and 2004).

The taxonomy used in this report generally agrees with the commonly accepted standardized list published by the American Fisheries Society (Turgeon et al. 1998). Deviation from the standardized list is based on the latest available research (Thompson 2004; Thompson and Hershler 2002).

RESULTS

Ten species of rare and endemic snails were identified in this study. *Aphaostracon monas, Floridobia alexander, Floridobia petrifons* and *Floridobia wekiwae* were found only in a single spring and are extremely rare and critically imperiled. *Aphaostracon pycnum* is found at two springs and is also critically imperiled. *Spilochlamys gravis* and *Tryonia aequicostata* are considered vulnerable to extinction. One species (*Aphaostracon species*) was only identified to genus. It's global ranking status is unknown. *Elimia vanhyningiana* and *Floridobia floridana* are apparently secure in their range but are endemic to Florida.

The rare and endemic snails found at each spring included in this study are summarized below and in Table 2. Figures 1-8 (Appendix A) illustrate the shell forms of most of the species included in this study.

Alexander Springs

Five species are reported from Alexander Springs: four hydrobiids and one pleurocerid. *Floridobia alexander* is endemic to this spring. *Aphaostracon pycnum* is endemic to Alexander Springs and Silver Glen Springs. *Elimia vanhyningiana, Spilochlamys gravis* and *Tryonia aequicostata* are endemic to the St. Johns River basin.

Apopka Springs

No rare or endemic snails were identified from this spring system.

Bugg Springs

One hydrobiid species of note is found at Bugg Springs. As in DeLeon and Green Springs, this snail is identified as *Aphaostracon species* but may or may not be the same species as the snail at DeLeon and Green. The designation of the genus and just "species" simply means the snail has not been identified to the species level. If further research proves the *Aphaostracon species* to be an undescribed species, it may be unique to Bugg Springs.

DeLeon Springs

Two species of note are found at DeLeon Springs: *Aphaostracon species* (exact identity undetermined) and *Tryonia aequicostata*, which is endemic to the St. Johns River basin. Both

species are members of the family Hydrobiidae, which is known for its high degree of endemism. Many members of this family are endemic to single springs. If further research proves the *Aphaostracon species* to be undescribed, it may be unique to DeLeon Springs.

Gemini Springs

No rare or endemic snails were identified from this spring system.

Green Springs

One hydrobiid species of note is found at Green Springs. As in Bugg and DeLeon Springs, this snail is identified as *Aphaostracon species* but may or may not be the same species as the snail at Bugg and DeLeon. The designation of the genus and just "species" simply means the snail has not been identified to the species level. If further research proves this to be an undescribed species, it may be unique to Green Springs.

Rock Springs

Four rare or endemic snails have been identified from Rock Springs: *Elimia vanhyningiana, Floridobia floridana, F. petrifons* and *Spilochlamys gravis*. *E. vanhyningiana* is a member of the family Pleuroceridae and is endemic to the St. Johns River basin. The latter three species are members of the family Hydrobiidae. *F. floridana* is endemic to the St. Johns River basin while its close relative *F. petrifons* is endemic to Rock Springs. *S. gravis* is endemic to the St. Johns River basin (Thompson 2004).

Silver Springs

No rare or endemic snails are reported from Silver Springs.

Silver Glen Springs

Two rare snails are reported from Silver Glen Springs. *Aphaostracon pycnum* is endemic to Silver Glen Springs and Alexander Springs. *Floridobia floridana* also occurs in Sliver Glen Springs and is endemic to the St. Johns River basin.

Wekiwa Springs (also known as Wekiva Springs)

Four rare or endemic snails have been identified from Wekiwa Springs: *Aphaostracon monas, Floridobia wekiwae, Spilochlamys gravis* and *Tryonia aequicostata.* All are members of the family Hydrobiidae. *A. monas and F. wekiwae* are endemic to Wekiwa Springs. *S. gravis* and *T. aequicostata* are endemic to the St. Johns River basin (Thompson 2004).

Table 2: Rare and Endemic Snails of Selected Springs

SPECIES	SPRINGS										IMPERIL-MENT	ENDEM-ISM
	ALEXANDER	APOPKA	BUGG	DELEON	GEMINI	GREEN	ROCK	SILVER	SILVER GLEN	WEKIWA		
Aphaostracon monas										X	G1	Wekiwa Springs
Aphaostracon pycnum	X								X		G1	Alexander Springs
Aphaostracon species			X	X		X					?	?
Elimia vanhyningiana	X						X				G5	St. Johns River Drain.
Floridobia alexander	X										G1G2	Alexander Springs
Floridobia floridana							X		X		G5	St. Johns River Drain.
Floridobia petrifons							X				G1	Rock Springs
Floridobia wekiwae										X	G1	Wekiwa Springs
Spilochlamys gravis	X						X			X	G3G4	St. Johns River Drain.
Tryonia aequicostata	X			X						X	G3	St. Johns River Drain.

DISCUSSION

The springs in the St. Johns River basin are high calcium bicarbonate karst springs that support the high biological diversity of aquatic invertebrates. Springs in the St. Johns and Suwannee River basin support a large number of endemic taxa, including a unique malacofauna. Many are minute snails in the family Hydrobiidae with highly restricted ranges, sometimes occurring in single springs and/or spring runs (Walsh 2001). These restricted hydrobiid snails are obligate spring dwelling species that over the millennia have adapted to the unique habitats where they now occur (Id.).

Hydrobiid snails are found around the world, however, historically, this group was more widespread. It is believed that during glacial upheaval, various populations were fragmented and separated. Over the millennia, these populations became isolated and began to dissociate genetically. Some populations became isolated from related groups to the extent that they became restricted (or endemic) to localized areas (Burch 1989). Florida's hydrobiid snails are excellent examples of this endemism.

Freshwater snails are found in various environments but most generally prefer clean, clear water (Dillon 2002). The hydrobiid snails, which dominate this report's species list, are obligate spring species (Walsh 2001) that live in cold water environments and do not tolerate warming or deoxygenation of their surroundings (Frest and Johannes 1995). They require permanent, clear, cold, unpolluted waters (USFWS 1992). Hydrobiid snails are grazers, eating the algae on the rocks and other available substrate. This foraging process helps to keep the water clear and clean (Frest and Johannes 1995). These minute snails generally breed only once

per year (Thompson 1968). Hydrobiid snails generally are dormant during the winter months and are most active during the summer (Thompson 1968; Frest and Johannes 1995).

Nonmarine mollusks are among the most imperiled groups of animals (Lydeard et al. 2004). About 9% of the nation's freshwater snails are extinct. Another 48% are considered imperiled (Johnson 2003). The extinction and imperilment of most of these species may be correlated to habitat alteration. This is especially true of naturally rare or endemic species with limited ranges. Habitat alteration resulting from channel modifications, siltation, pollution, and other habitat quality degradation are the primary causes for this extinction and imperilment. Habitat protection and restoration are considered the most important functions for the preservation of these rare and imperiled species (Id.).

The karst springs of SJRWMD have a high level of calcium bicarbonate as part of their chemical composition. Altered water chemistry may change the snail's ability to reproduce, therefore adversely affecting a given population (Gutierrez et al. 2001). Chemical changes that detrimentally impact phytoplankton or other vegetation may also affect a snail's ability to feed, ultimately starving the population.

Greater demands are being placed on our water resources as various municipalities and counties tap into groundwater sources, thereby decreasing natural flows in these systems. As municipalities grow, so grows their demand for water. Springs and spring runs can be adversely impacted as flow reductions increase. Competition between municipalities and even competition with the environment for water resources is becoming commonplace (Dyson et al. 2003).

Reduced water levels decrease available habitat. Minimal flow reductions may fall within the realm of natural flow variations and have negligible effects on snail populations. However, lower water levels that significantly shrink available habitat have impacted the

reproductive ability of applesnails, *Pomacea paludosa* (Darby et al. 1997). Hydrobiid snails are much smaller than applesnails but, where present, usually occur in abundance and are colonial in their distribution (Thompson 1968). Reduced flows that significantly decrease available habitat may adversely effect hydrobiid populations by hindering their ability to reproduce, forage and occupy needed habitat.

In the field, this author has noticed that reduced flows, which significantly decrease available habitat by a drop of ten centimeters or more in depth, periodically stranded freshwater mollusks including hydrobiid snails. These strandings often proved fatal to those mollusks unable to crawl to the deeper water. Decreases in available habitat may reduce population size by limiting the numbers of reproducing adults.

Pollution from overdevelopment and unwise land use practices also threaten the ecology of Florida's spring malacofauna. Chemicals from runoff in developed areas seep into the nearby aquifers and pollute the ecosystem. Chemical spills in Tennessee and Virginia have resulted in massive kills of rare and endangered mollusks in the Clinch River. One such spill occurred in a Clinch River tributary and subsequently destroyed one of only two reproducing populations of the endangered tan riffleshell mussel in about a seven-mile area of available habitat (Bennett 2004). This accident demonstrates the susceptibility of certain mollusk species to the sudden alteration of the chemical composition of their ecosystem. Such events are uncommon but can occur anywhere development and rare and endemic species overlap.

Common household chemicals, petroleum products and agricultural chemicals can also threaten rare mollusk species (Johnson 2003). Herbicide and pesticide use and encroaching nonnative species are known to threaten mollusk species (Bowler 2004). Adverse impacts from these improperly disposed chemicals may occur suddenly or over a period of time (Gibson and

Meyer 2002). The result may be the loss of unique species occurring in only one area. Hydrobiid snails are sensitive to pollution regardless of the source (Burch 1989; Frest and Johannes 1995). Of recent extinctions, mollusks comprise 42% of the total. Approximately 99% of these are freshwater mollusks with hydrobiid snails being among the most vulnerable (Bowler 2004).

Should a small flow reduction be anticipated at any spring that supports rare and endemic snail species, it is suggested that baseline chemical flow regime data be gathered if not currently collected. Baseline data are needed to establish the chemical composition and flow regime of the spring and its spring run for comparison with post-flow reduction monitoring. Any alteration of the chemical composition or flow regime that affects the snails' ability to feed, reproduce or endure could adversely impact the continued survival of the species. Similar data appear to be available for Blue Spring (Wetland Solutions, Inc. 2003; Rouhani et al. 2004), located within the SJRWMD and having an endemic hydrobiid snail, *Aphaostracon asthenes* (Thompson 2004). The baseline chemical data collected and the occurrence of this endemic snail make Blue Spring an excellent example for conservation efforts at the springs included in this study. Rosenau et al. (1977) studied the springs of Florida with particular detail given to water chemistry and physical features.

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Appendix A:

Figures

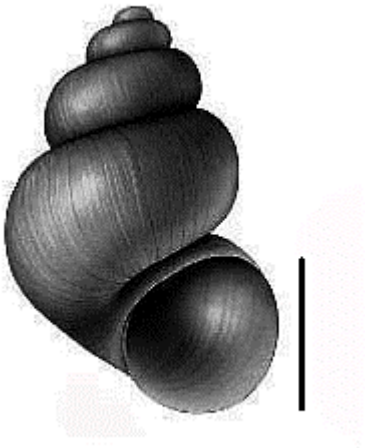

Figure 1: ***Aphaostracon monas***
After Thompson (2004) with permission
Scale bar = 1 mm

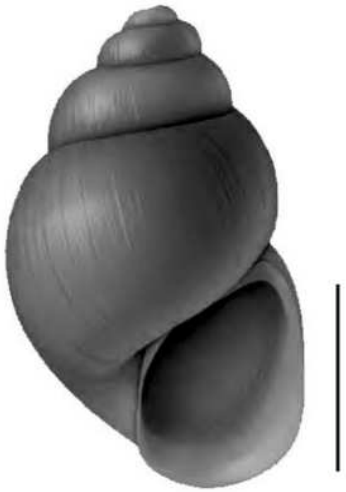

Figure 2: ***Aphaostracon pycnum***
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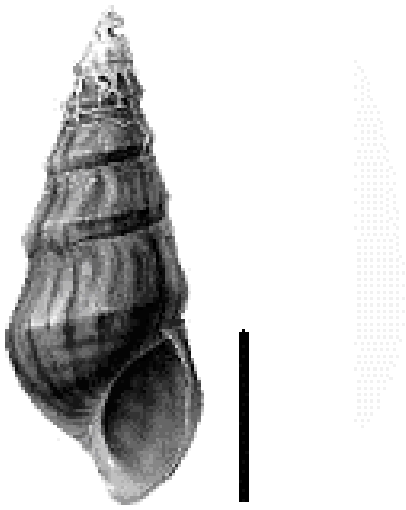

Figure 3: ***Elimia vanhyningiana***
After Thompson (2004) with permission
Scale bar = 5 mm

Figure 4: ***Floridobia alexander***
After Thompson (2004) with permission
Scale bar = 1 mm

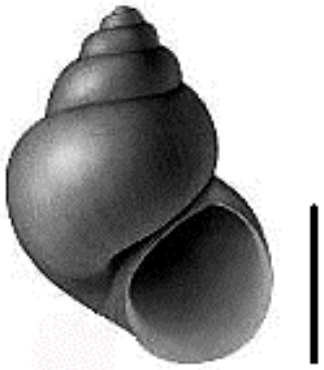

Figure 5: ***Floridobia floridana***
After Thompson (2004) with permission
Scale bar = 1 mm

Figure 6: *Floridobia petrifons*
After Thompson (2004) with permission
Scale bar = 1 mm

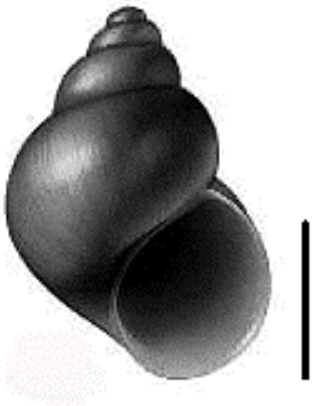

Figure 7: *Floridobia wekiwae*
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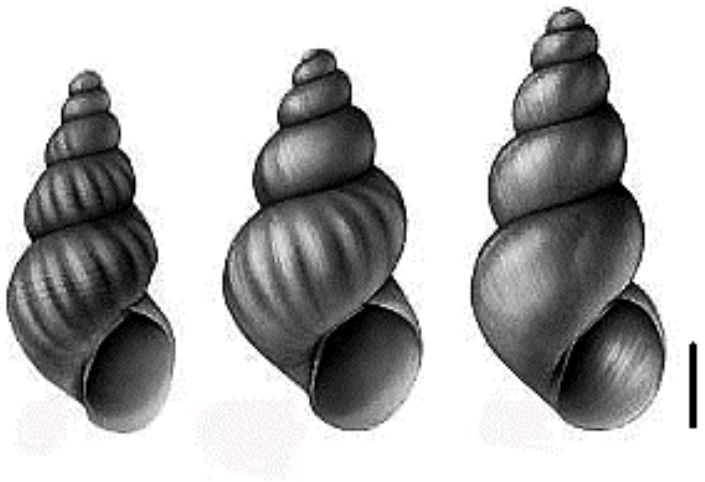

Figure 8: ***Tryonia aequicostata*** **(three forms of species)**
After Thompson (2004) with permission
Scale bar = 1 mm