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A Qualitative Freshwater Mussel Survey of the South Fork Spring River, Missouri and Arkansas

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Abstract

A qualitative freshwater mussel survey was performed in the South Fork Spring River, Arkansas between May 13 and June 20, 2006 to assess community composition, density, and the presence of endangered mussel species (Family Unionidae). Twenty-one species from 460 individuals of mussels were collected using qualitative methods. Of those 21 species, 11 were ranked as S1, S2, or S3 using rankings established by the Arkansas Natural Heritage Commission Heritage Program. Three species, *Amblema plicata* (Say 1817), *Lampsilis reeveiana* (Call 1887), and *Ptychobranchus occidentalis* (Conrad 1836), comprised 48% of all mussels collected with 12%, 15%, and 21%, respectively. Mussel abundance within beds ranged between 2 to 33 individuals/site with an overall mean of 13 individuals/site. Selecting mussel beds for long-term monitoring in streams is necessary to assess population status and recruitment and to document success of future stream restoration projects.

Introduction

Freshwater mussels (Unionidae and Margaritiferidae) are widely distributed throughout North America with nearly 300 taxa (Williams et al. 1993). Unfortunately, many are imperiled species. Currently there are 70 species of freshwater mussels in North America that are considered federally threatened or endangered (U.S. Fish and Wildlife Service 2007). In Arkansas, 52 of 77 extant mussel species are considered to be of special concern and in Missouri, there are approximately 52 species with 28 of those considered species of special concern (Missouri Department of Conservation 2003, Arkansas Game and Fish Commission 2007).

No doubt, freshwater mussels have suffered significant population declines and range restrictions in Ozarks region during the last century (Utterback 1915, Oesch 1995, Roberts and Bruenderman 2000, Bruenderman et al. 2001). Williams et al. (1993) suggested that the declines are primarily the result of habitat destruction and degradation associated with adverse anthropogenic activities. The abundance and diversity of unionid mussels in Missouri are greatest in the larger rivers that drain the Ozarks region (Utterback 1915, Oesch 1995). Surveys have documented the mussel fauna in streams of this region such as the Spring River (Trauth et al. 2007), and selected streams in southeast Missouri (Buchanan 1996). The regions of greatest concern within Arkansas are found in the Ouachita and Ozark Highlands, with several endemic species occurring within these ecoregions (The Nature Conservancy 2007).

Documenting the mussel resources of a river is important for establishing a monitoring system or a management plan. The primary goal of this study was to conduct a baseline qualitative survey of freshwater mussel populations in the South Fork Spring River (SFSR), which can then be used to track changes and develop a conservation plan. To do so, we used timed qualitative visual survey methods along the entire length of the South Fork Spring River in southeastern Missouri and northeastern Arkansas. Through this process, we documented mussel species distributions, relative abundance, catch per unit of effort (CPUE) data, and locations of mussel assemblages.

Materials and Methods

Study Area

The South Fork Spring River (SFSR) originates in southeastern Missouri and flows through the Ozark and Salem Plateaus (Figure 1). The SFSR is approximately 120 km in length, of which 45 km flows through Missouri, and drains approximately 243 km^2 (Arkansas Natural Resources Commission 1995). The SFSR begins in Howell County, Missouri, flows through

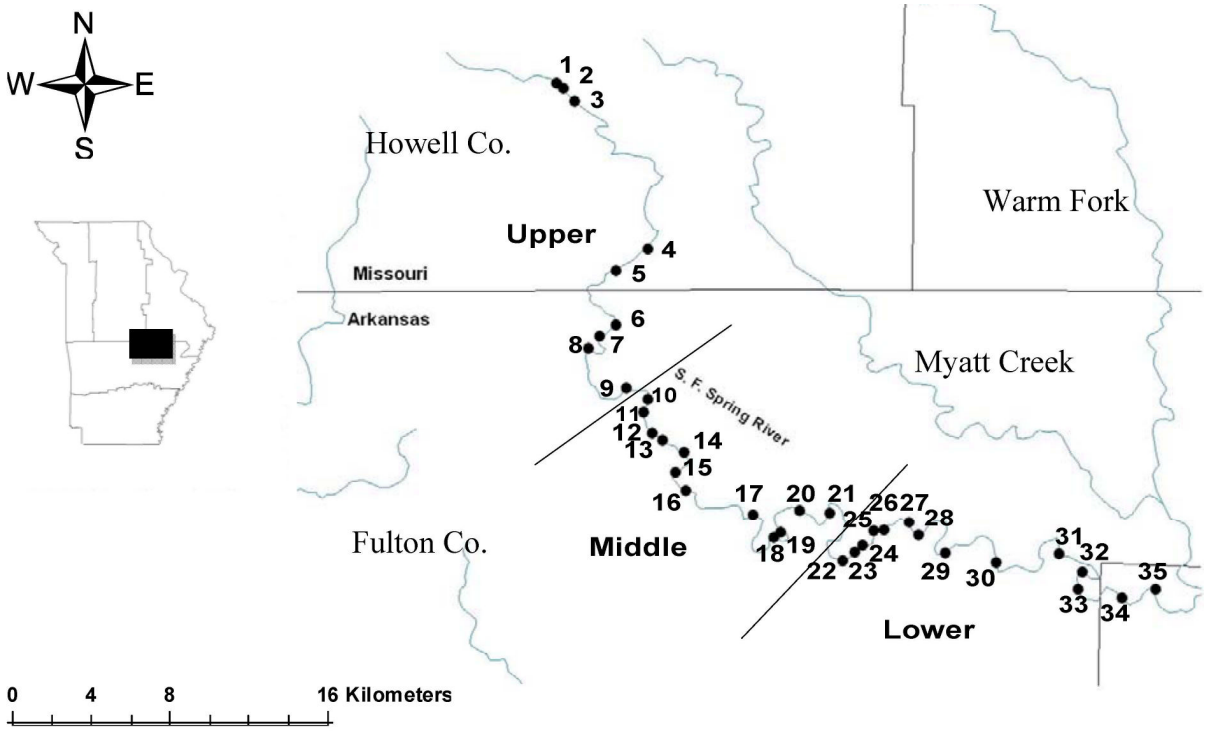

Figure 1. Map of the South Fork Spring River showing the 2006 freshwater mussel qualitative survey sampling locations and the arbitrary upper, middle, and lower river divisions.

Fulton and Sharp counties, Arkansas until its confluence with the Spring River northeast of the city of Hardy in Sharp County, Arkansas. Major tributaries to the SFSR include Myatt Creek, Spring Creek, West Fork, Horton Branch, Camp Creek, and Lick Creek.

The SFSR is designated as an Extraordinary Resource Water by the Arkansas Department of Environmental Quality (2006), with the land surrounding the SFSR consists of predominantly pastureland and forestland (Arkansas Natural Resources Commission 1995). The SFSR is located within the Ozark Highlands, which consists of dissected plateaus and narrow valleys with steep gradients (Arkansas Natural Resources Commission 1995). The soils of the Ozark Highlands developed mainly from limestone and dolomite and range from very deep to shallow in depth. The annual precipitation ranges from 1,025 to 1,225 mm and maximum rainfall occurs in the spring and early summer, while minimum rainfall occurs in midsummer. The average annual air temperature is between 13 ^{o}C and 16 ^{o}C.

Qualitative Survey Methods

Specific sampling sites were chosen in the field based on the apparent quality of mussel habitat (e.g., suitable depth and flow, stable substrate with some fines that allows the mussel to burrow), signs of mussel assemblages such as shells in muskrat middens, and accessibility by land or water. Qualitative sampling was conducted by searching for live specimens in the stream and along the shore. During the sampling period, May and June 2006, the water was very low and clear, and the wetted width ranged from 3 m to 27 m.

Qualitative surveys consisted of timed visual searches by a ≥2-person team via snorkeling or SCUBA methods for a minimum of 60 person minutes (e.g., 2 searchers for 30 minutes, 3 searchers for 20 minutes, etc.). The river bottom was searched for mussels by continually sweeping side to side in a zigzag pattern. Occasionally, rocks were lifted to look for mussels underneath. Species were identified, counted, and returned to the stream in life position. Species identification was made using primarily external shell morphology following Oesch (1995)

with nomenclature following Turgeon et al. (1998). Locations were recorded using USGS 7.5 minute maps and latitudes and longitudes obtained by a Garmin GPS 72 Global Positioning System (GPS) unit (NAD83 datum). Catch per unit of effort (CPUE; individuals/minute) was calculated for each species and for all mussels per site. Each species also was identified by state rankings S1 to S5 (S1=extremely rare, S2=very rare, S3=rare to uncommon, S4=common, apparently secure, and S5=common and secure) established by the Arkansas Natural Heritage Commission Heritage Program (2004).

Results

A total of 35 sites were surveyed in the SFSR between May 13 and June 20, 2006 (Table 1; Figure 1) resulting in a total of 21 species being identified from 460 live specimens (Table 2). Of those 21 species, 11 are ranked as S1 to S3 (extremely rare to uncommon)(Table 2). Three species, *Amblema plicata* (Say 1817), *Lampsilis reeveiana* (Call 1887), and *Ptychobranchus occidentalis* (Conrad 1836), comprised 48% of all mussels collected, with 12.0%, 15.2%, and 21.1%, respectively. Mussel abundance in the SFSR ranged between 2 to 33 live mussels at sites 35 and 29, respectively, with an overall mean of 13 individuals/site. The greatest number of individuals collected and the highest CPUE occurred at Site 29 (33 and 0.55 individuals/min, respectively)(Table 2). Species richness ranged from 2 to 10 species/site, with the greatest richness occurring at Site 23 (Table 2). In the upper portion of the SFSR, *Ligumia. subrostrata* (Say 1831) and *Utterbackia. imbecillis* (Say 1829) were the dominant species, while downstream (Sites SF 06-35) *A. plicata*, *L. reeveiana*, and *P. occidentalis* were the dominant species (Table 2; Figure 1).

Table 1. South Fork Spring River qualitative mussel survey site locations by coordinates (latitude and longitude (NAD 83), county and state [Arkansas (AR) and Missouri (MO)].

Site	Coordinates	County	State
01	N 36.62163, W 91.87279	Howell	MO
02	N 36.61949, W 91.87083	Howell	MO
03	N 36.61333, W 91.86985	Howell	MO
04	N 36.52219, W 91.82793	Howell	MO
05	N 36.50990, W 91.84682	Howell	MO
06	N 36.47792, W 91.84689	Fulton	AR
07	N 36.46267, W 91.85246	Fulton	AR
08	N 36.46272, W 91.85815	Fulton	AR
09	N 36.44091,W 91.82872	Fulton	AR
10	N 36.42740, W 91.82987	Fulton	AR
11	N 36.42642, W 91.83039	Fulton	AR
12	N 36.41824, W 91.82830	Fulton	AR
13	N 36.41013, W 91.81932	Fulton	AR
14	N 36.40326, W 91.80689	Fulton	AR
15	N 36.39128, W 91.81204	Fulton	AR
16	N 36.38095, W 91.80581	Fulton	AR
17	N 36.36553, W 91.75885	Fulton	AR
18	N 36.35263, W 91.75418	Fulton	AR
19	N 36.35599, W 91.75010	Fulton	AR
20	N 36.36903, W 91.73871	Fulton	AR
21	N 36.36769, W 91.72079	Fulton	AR
22	N 36.33932, W 91.71330	Fulton	AR
23	N 36.34434, W 91.70600	Fulton	AR
24	N 36.34848, W 91.70190	Fulton	AR
25	N 36.35258, W 91.69688	Fulton	AR
26	N 36.35730, W 91.68898	Fulton	AR
27	N 36.34967, W 91.68440	Fulton	AR
28	N 36.35443, W 91.66881	Fulton	AR
29	N 36.34363, W 91.65281	Fulton	AR
30	N 36.33803, W 91.62307	Fulton	AR
31	N 36.34323, W 91.58601	Fulton	AR
32	N 36.33271, W 91.57234	Fulton	AR
33	N 36.32215, W 91.57452	Fulton	AR
34	N 36.36271, W 91.55367	Sharp	AR
35	N 36.32254, W 91.52893	Sharp	AR

Discussion

Considering the relative size of the SFSR drainage area to other streams, the SFSR (drainage area ~ 243 km^2) exhibits relatively high taxa richness (n= 21) compared to other Ozark streams. For example, the Spring River, Arkansas (drainage area ~ 3186 km^2) has a taxa richness of 28 (Trauth et al. 2007), while the Buffalo River, Arkansas (drainage area ~ 3427 km^2) has a species richness of 23 (Matthews 2007). Conversely, the SFSR has lower relative mussel abundance compared to other Ozark rivers. For example, the SFSR had an overall CPUE of 0.22 individuals / minute, while the Buffalo River had a CPUE of 1.1 individuals/minute (Matthews 2007). However, compared to the Tyronza River (CPUE of 0.45 individuals/minute), a Mississippi Delta stream of similar drainage area, the SFSR has similar to CPUE (Christian et al. 2007).

The high taxa richness and low relative abundances is expected for a headwater stream like the SFSR as most headwater mussel species have a relatively small geographic range. Meyer et al. (2007) cited two primary reasons for these small ranges: their

Table 2. Results of South Fork Spring River qualitative mussel survey conducted in 2006. S Rank = the Arkansas Natural Heritage Commission Heritage Program (2004) (S1=extremely rare, S2=very rare, S3=rare to uncommon, S4=common, apparently secure, and S5=common and secure). CPUE = Catch per unit effort (individuals/minute).

Site		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
Species	S Rank																			
Actinonaias ligamentina	S5	0	0	0	0	0	0	0	0	1	0	0	0	3	1	1	0	0	0	3
Alasmidonta marginata	S3	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Amblema plicata	S5	0	0	0	0	0	5	7	1	3	15	0	2	5	0	0	1	0	0	0
Cyclonaias tuberculata	S3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyprogenia aberti	S2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Elliptio dilatata	S4	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0
Fusconaia ozarkensis	S3	0	0	0	0	2	9	6	2	0	2	4	0	0	0	2	0	2	0	0
Lampsilis cardium	S4	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	2	0	0	0
Lampsilis reeveiana	S3	0	1	2	2	2	4	1	0	2	0	6	2	2	3	1	2	1	2	0
Lampsilis siliquoidea	S3	0	0	3	1	0	1	1	1	0	0	0	0	0	1	2	1	0	0	1
Lasmigona costata	S3	0	0	0	0	0	6	1	0	1	2	0	1	0	1	1	0	1	1	0
Ligumia subrostrata	S4	2	1	2	0	0	1	0	0	1	0	0	1	0	0	1	1	2	0	0
Pleurobema sintoxia	S3	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0
Potamilus purpuratus	S4	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	1	0	0
Ptychobranchus occidentalis	S3	0	2	1	0	2	4	4	3	3	3	1	0	1	0	0	2	1	1	0
Quadrula metanevra	S3/4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toxolasma lividus	S2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tritogonia verrucosa	S4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Utterbackia imbecillis	S3/4	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Venustaconcha pleasii	S3	0	1	0	3	2	2	0	0	0	0	2	3	0	0	0	0	0	0	1
Villosa iris	S2/S3	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
Total abundance		14	5	10	6	8	32	22	7	13	23	14	12	12	7	11	10	9	4	7
Species Richness		3	4	5	3	4	8	7	4	6	5	5	7	5	5	8	7	5	3	5
CPUE (#./min)		0.23	0.08	0.17	0.10	0.13	0.53	0.37	0.12	0.22	0.38	0.23	0.20	0.20	0.12	0.18	0.17	0.15	0.07	0.12

Table 2. (cont.)

Site Species	S Rank	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	Total	% Total
Actinonaias ligamentina	S5	2	0	2	2	0	2	0	0	1	0	0	0	0	0	0	0	18	3.9
Alasmidonta marginata	S3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	<0.1
Amblema plicata	S5	1	0	0	1	0	0	1	1	5	5	1	0	1	0	0	0	55	12.0
Cyclonaias tuberculata	S3	0	0	0	0	0	0	1	0	0	10	0	0	0	0	0	0	11	2.4
Cyprogenia aberti	S2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	<0.1
Elliptio dilatata	S4	0	0	0	2	1	0	6	4	4	1	0	0	0	0	0	0	23	5.0
Fusconaia ozarkensis	S3	0	3	0	3	1	0	0	3	0	0	0	4	1	0	1	0	45	9.8
Lampsilis cardium	S4	0	1	3	0	0	1	0	0	0	0	0	0	2	0	0	0	12	2.6
Lampsilis reeveiana	S3	1	0	2	2	1	1	1	7	1	0	11	2	1	2	4	1	70	15.2
Lampsilis siliquoidea	S3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	2.6
Lasmigona costata	S3	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	18	3.9
Ligumia subrostrata	S4	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	15	3.3
Pleurobema sintoxia	S3	0	2	0	0	0	0	0	0	0	3	0	0	0	0	2	0	10	2.2
Potamilus purpuratus	S4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	1.1
Ptychobranchus occidentalis	S3	2	0	5	2	7	1	9	10	1	12	2	0	0	6	12	0	97	21.1
Quadrula metanevra	S3/4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	3	<0.1
Toxolasma lividus	S2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	3	<0.1
Tritogonia verrucosa	S4	0	0	0	0	0	0	2	1	5	2	0	0	0	0	0	0	11	2.4
Utterbackia imbecillis	S3/4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	2.2
Venustaconcha pleasii	S3	0	0	6	2	3	0	0	0	1	0	1	0	0	0	0	0	27	5.9
Villosa iris	S2/S3	0	0	0	0	2	0	1	1	0	0	0	0	1	1	0	0	10	2.2
Total Abundance		6	8	20	17	15	5	21	31	18	33	16	6	6	9	21	2	460	
Species Richness		4	4	7	10	6	4	7	9	7	6	5	2	4	3	6	2	21	
CPUE (#./min)		0.10	0.13	0.33	0.28	0.25	0.08	0.35	0.52	0.30	0.55	0.27	0.10	0.10	0.15	0.35	0.03	0.22	

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limited ability to move and the high diversity of headwater habitats. Other explanations for the restricted range may be 1) the limited range of the fish hosts and/or 2) seasonal reductions in available habitat (e.g. during the summer months, entire reaches of the Missouri portion of the SFSR are dry with only residual pools). Mussels also vary considerably with respect to their habitat preferences. Some are restricted to a specific habitat type (e.g. small creeks), whereas others can be found in almost any permanent body of water. For instance, at Sites 1 through 4, the habitat reach ranged from about 3 to 6 meters wide and consisted of a series of shallow pools. *Ligumia subrostrata* and *U. imbecillis* were the two dominant species found at these sites; not surprising because these two species are usually found in sluggish mud-bottomed pools of creeks and rivers (Cummings and Mayer 1992).

Overall, the relative abundance and taxa richness at sites were variable in SFSR, which may be a result of differences in the distribution and quality of microhabitats within a particular segment of the stream. Habitat characteristics (physical and chemical) and impacts from land use discharges could be affecting the range of variation in the mussel communities of the SFSR. For example, excessive sedimentation has been suspected as a cause of mussel declines since the late 1800s (Kunz 1898, Box and Mossa 1999) and studies suggest that the composition and abundance of mussel faunas are directly linked to bed sediment distributions (Neves and Widlak 1987, Leff et al. 1990, Box and Mossa 1999). Land-use, topographic relief, and geologic history also have been shown to influence mussel distributions (Arbuckle and Downing 2002). Some examples of land use changes that influence mussel richness and abundance are urbanization, logging, and the conversion of land cover to agricultural crops (Arbuckle and Downing 2002). Poor land-use practices, in part, provide excessive sedimentation, one of the most ubiquitous factors that may adversely affect mussel populations (Box and Mossa 1999). Thus, due to their restricted ranges and declining population levels, it is important to keep impacts to mussel habitat at a minimum for the continued existence of these species.

Conclusions

We documented 21 species, of which 11 species had a state ranking of S1, S2, or S3. The first action in conserving the freshwater mussel resources of the South Fork Spring River, as in most river systems today, is to protect existing mussel populations and habitat. Efforts to increase populations include habitat improvement, artificial propagation, reintroduction, and development of captive populations in hatcheries. Selecting mussel beds for long-term monitoring in streams is necessary to assess population status and recruitment and to document success of future restoration projects. Management strategies for conserving mussel diversity differ depending on watershed characteristics. Based on this qualitative survey the SFSR should be divided morphologically into the upper, middle, and lower sections for a complete inventory.

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