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Mussel Inventory and Population Status of the Federally Endangered *Potamilus capax* (Green 1832) in the Tyronza River, Arkansas

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Abstract

Currently, few data exist for the mussel assemblages of the Tyronza River, Arkansas. The goal of this project was to inventory the freshwater mussel assemblages of the Tyronza River and determine the status of the federally endangered *Potamilus capax*. We qualitatively and quantitatively sampled mussel assemblages and documented the occurrence of S1 (extremely rare), S2 (very rare), and S3 (rare to uncommon) species. A total of 70.4 river kilometers were sampled in 2006 and 2007 resulting in 363 sampling sites, 4030 live individuals, and 25 species. We observed a total of 1 S1, 2 S2, and 9 S3 species. Mean catch-per-unit-of-effort was 0.9 (1.2 SD) individuals / min. and mean species richness and individual abundance were 3.4 (2.7 SD) species / site and 11.1 (15.1 SD) individuals / site, respectively. Thirteen *Potamilus capax* were collected during this survey, with only 1 gravid female and 2 juveniles. Quantitative survey mean densities per site ranged from 1.0 to 1.9 mussels / m^2 with an overall mean of 1.4 individuals / m^2 (0.3 SD). A total of 7 *Potamilus capax* were observed during quantitative sampling. Community Numerical Standing Crop estimates ranged from 70 ± 30 to 22,986 ± 7,905 individuals. The data collected from this survey provide a valuable baseline on the mussel assemblages of an altered-alluvial river and the location and status of all S1, S2 and S3 species. This information is essential to the management of this imperiled fauna in the Tyronza River.

Keywords: Freshwater mussels, Tyronza River, *Potamilus capax*

Introduction

Freshwater mussels of the families Unionidae and Margaritiferidae (Mollusca: Bivalvia), are among the most imperiled species in North America. Williams et al. (1993), Bogan (1993), and Neves (1999) estimate that 70% of the species found in North America are listed as threatened, endangered, or of special concern. Of approximately 85 species of freshwater mussels occurring in Arkansas, 8 are federally endangered, 1 threatened, and 2 candidate species (Harris et al. 1997, Harris et al. 2009). One of the 8 endangered species is *Potamilus capax*, which was listed on June 14, 1976 and a recovery plan was developed in 1989 by the US Fish and Wildlife Service. This study addresses Objective 1 of the 1989 *Potamilus capax* recovery plan (USFWS 1989).

Little data exists on the distribution and abundance of mussel assemblages for the Tyronza River, Arkansas. Bates and Dennis (1983) and Ahlstedt and Jenkinson (1987, 1991) qualitatively surveyed portions of the 80 km long Tyronza River with only 13 and 15 sites sampled, respectively. Bates and Dennis (1983) found relatively low species richness and abundance with only 9 live species collected at 3 of the 13 sites surveyed, with the remainder of the sites having no live individuals present. Ahlstedt and Jenkinson (1987, 1991) reported higher species richness within the Tyronza River during their surveys, with 23 species from their 15 survey sites compared to a total of 28 species identified in the St. Francis River proper.

The goal of this project was to inventory the freshwater mussel resources for ~70 river km (RKM) of the Tyronza River, Arkansas. To meet this goal, we had 3 objectives: 1) to systematically survey the Tyronza River at 200 – 300 m intervals from the mouth near Parkin, Arkansas upstream ~ 70 RKM to near Dyess, Arkansas, 2) to document the occurrence of S1 (extremely rare), S2 (very rare), and S3 (rare to uncommon) freshwater mussel species for this study area, based on the Arkansas Natural Heritage Commission state rankings (ANHC 2006), and 3) to quantitatively survey mussel assemblages.

Study Area

The Tyronza River is located in the Mississippi River Alluvial Plain ecoregion of Arkansas and its watershed is approximately 3,000 km^2, containing a high number of agricultural drainage ditches (Figure

1). The watershed begins as Ditch #31 approximately 10 km (6.5 miles) southeast of Blytheville, Arkansas. Ditch #31 is a shallow, channelized drainage ditch lacking a forested riparian corridor and consists of partially vegetated riffles. The unchannelized portion of the Tyronza River begins approximately 5 km (3 miles) north of Dyess, Arkansas and continues southwest to its confluence with the St. Francis River north of Parkin, Arkansas (Figure 1). The headwaters of the Tyronza River begin at an elevation of 86 m above sea level, subsequently dropping to 75 and 70 m above sea level at Dyess and Parkin, respectively. Major soil types consist of poorly to moderately drained clay and sand, with western portions of the watershed ranging from poorly drained loamy soils to excessively drained sandy soils (USDA 1971, EPA 2005).

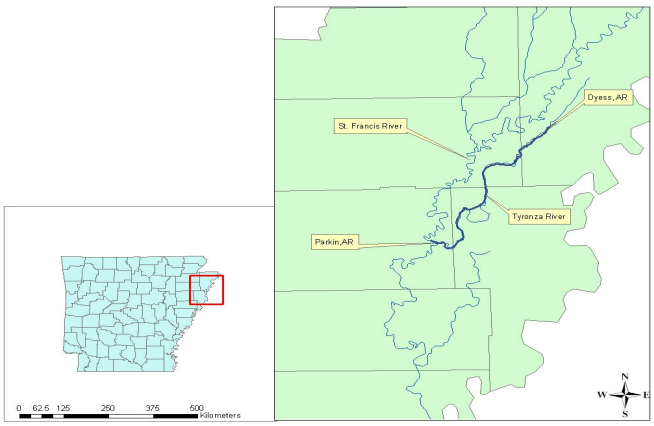

Figure 1. Map of naturalized channel of the Tyronza River, Arkansas from Dyess, Arkansas to Parkin, Arkansas.

Primary land-use in the Tyronza River watershed is agriculture. An estimated 93.5% of the watershed is in row crops (soybeans 58.9%, cotton 20.8%, rice 9.6%, and sorghum/corn 4.2%) and the remaining 6.5% is classified as a mixture of urban, water, and forest (EPA 2005). Road densities are moderate, with approximately 17 paved or graveled crossings between Dyess and Parkin (AGFC 1989).

Methods

Qualitative Survey

A qualitative survey was conducted for the entire Tyronza River in autumn 2006 and spring 2007. The survey entailed searching the entire natural channel using, depending on stream depths, tactile wading, snorkeling, and surface supplied air system collection methods. Searches involved feeling through the substrate using both hands. These systematic searches for live or dead mussels within the wetted width of the channel were conducted from 10 m above to 10 m below transects placed every 200-300 m of stream length. Mussels were identified to species and returned to the transect area in which they were removed; however, selected voucher specimens were deposited in the Arkansas State University Museum of Zoology – Unionoida Collection. Nomenclature followed Turgeon et al. (1998). When *Potamilus capax* was encountered, each individual was uniquely marked with an etching via a Dremel tool, measured [length (mm), width (mm), and height (mm)], examined for gravidity, and returned to the transect search area. Each sampling transect was identified with a unique code and latitude/longitude coordinates, habitat type (e.g. pool, riffle, and run), and substrate types (e.g. sand, clay, topsoil) were recorded on field data sheets. Species distributions, species richness, relative abundance, and catch-per-unit-of-effort (CPUE) estimates (individuals / min) were calculated for each transect search area.

Quantitative Survey

Nine sites from among the 363 qualitative sites were selected for quantitative sampling. The 9 sites were distributed in upper and lower sections with 4 and 5 sites, respectively. The upper and lower section division and site selection were based on a metric developed to include species richness, abundance, and presence/absence of *Potamilus capa*x and was calculated as:

$$X=Z_1 * Z_2 * Z_3$$

where Z_1 is the species richness of a qualitative site, Z_2 is the abundance of the site, and Z_3 is the presence or absence of *Potamilus capax*. If *Potamilus capax* was absent, a value of 1 was used in the metric; however, if present, a value of 2 was used in the metric, doubling the metric score.

At each of the quantitative sites mussel assemblages were delineated through tactile searches to determine the length and width of the assemblage. A mussel assemblage was defined as an area of mussel densities ≥ 1 m^2 with an area ≥ 100 m^2. Assemblages were quantitatively assessed by using a systematic transect sampling design (Brower and Zar 1977) and a 1m^2 quadrat sample size. For each transect, quadrats

were placed 2 m intervals across the wetted width of the stream. A new transect was placed downstream at 5 m intervals from the previous transect for the length of the assemblage. Mussels occurring within the $1m^2$ quadrat were removed from the substrate, placed in mesh bags and brought to the surface to be identified to species, weighed to the nearest gram, measured to the nearest 0.1 mm (length, width, and height) and returned to the area of collection.

Table 1. Total number of individuals collected and Catch Per Unit Effort (CPUE) per species (individuals / min.), Arkansas Natural Heritage Commission (ANHC) Rank, Global Rank, % Relative Abundance for species collected from the Tyronza River qualitative survey, and '+' indicates occurrence of live individuals only in quantitative surveys.

Species	ANHC Rank	Nature Serve 2009	Total Collected		Overall CUPE	% Relative Abundance
			Live	Dead		
Amblema plicata	S5	G5	2226	763	0.544	55.2
Arcidens confragosus	S3	G4	103	63	0.025	2.6
Fusconaia ebena	S3/S4	G4/G5	0	3	0.000	0.0
Fusconaia flava	S4	G5	83	132	0.020	2.1
Lampsilis cardium	S4	G5	15	11	0.004	0.4
Lampsilis hydiana	S3	G4Q	0	6	0.000	0.0
Lampsilis teres	S4	G5	119	144	0.029	3.0
Lasmigona complanata	S3/S4	G5	88	22	0.022	2.2
Leptodea fragilis	S4	G5	97	174	0.024	2.4
Ligumia subrostrata	S4	G4/G5	0	1	0.000	0.0
Megalonaias nervosa	S3/S4	G5	4	15	0.001	0.1
Obliquaria reflexa	S4	G5	79	70	0.019	2.0
Plectomerus dombeyanus	S4	G5	22	103	0.005	0.5
Pleurobema rubrum	S2	G2/G3	4	22	0.001	0.1
Pleurobema sintoxia	S3	G4/G5	9	25	0.002	0.2
Potamilus capax	S1	G1/G2	13	19	0.003	0.3
Potamilus ohiensis	S3/S4	G5	38	14	0.009	0.9
Potamilus purpuratus	S4	G5	310	247	0.076	7.7
Pyganodon grandis	S5	G5	21	15	0.005	0.5
Quadrula apiculata	S2	G5	0	10	0.000	0.0
Quadrula metanevra	S3/S4	G4	2	1	0.001	0.0
Quadrula nodulata	S4	G4	209	328	0.051	5.2
Quadrula pustulosa	S5	G5	333	288	0.081	8.3
Quadrula quadrula	S5	G5	143	155	0.035	3.5
Strophitus undulatus	S3	G5	29	10	0.007	0.7
Toxolasma lividus	S2	G2	+	+	+	+
Toxolasma parvus	S4	G5	0+	1+	0.000+	0.0+
Toxolasma texasiensis	S3	G4	0	1	0.000	0.0
Tritogonia verrucosa	S4	G4/G5	58	51	0.014	1.4
Truncilla donaciformis	S3	G5	15	8	0.004	0.4
Truncilla truncata	S4	G5	8	18	0.002	0.2
Uniomerus declivus	S1	G5	0	1	0.000	0.0
Uniomerus tetralasmus	S2	G5	0	1	0.000	0.0
Total			**4030**	**2722**	**0.985**	

Statistical analyses for mussel assemblages include assemblage area, density, species richness, and sample variance and standard deviation for individual species. Community numerical standing crop (CNSC) and population estimates were calculated using the equation described by Sampford (1962):

$$X = \sum_{0}^{i} y_i * g_i$$

where x is the total number of mussels found in the assemblage, *i* is the number of strata, y_i is the total individuals collected from the sample, and g_i is the raising factor. The raising factor can be defined by n_i/N_i, with n_i as the number of sample units in the *i*th stratum, and N_i as the total potential number of sampling units in the *i*th stratum. Ninety-five percent confidence intervals were calculated using the following formula:

$$X = \left[t * \sqrt{\sum_{o}^{i} N_i^2 * S^2 y_i * \frac{1 - f_i}{n_i}} \right]$$

In the equation, S^2y_i is the variance from counts in the n_i sampling units in the *i*th stratum and *t* is the student's *t* for effective degrees of freedom.

Results

Qualitative Survey

A total of 70.4 RKM of the Tyronza River was surveyed resulting in a total of 363 sites. A total of 33 species were observed, 8 of which were only collected dead, either in middens or within the river proper. One S1 (extremely rare), 1 S2 (very rare), and 9 S3 (rare to uncommon) species observed (Table 1). The second S2 species observed during the quantitative survey. *Amblema plicata* was the most abundant species observed during the qualitative survey with 2,226 individuals, comprising 55.2% of the total specimens found. *Quadrula pustulosa* and *Potamilus purpuratus* were the second and third most abundant species with 333 and 310 individuals, comprising 8.3 and 7.7% of the total individuals, respectively (Table 1).

Overall, CPUE per site was rather low for the upper 30 RKM, with a mean of 0.5 individuals / min.; however, at RKM 30-31, CPUE increased to a mean of 1.9 individuals / min. (Fig. 2). The survey wide CPUE was 0.9 individuals / min. (Table 2). Approximately

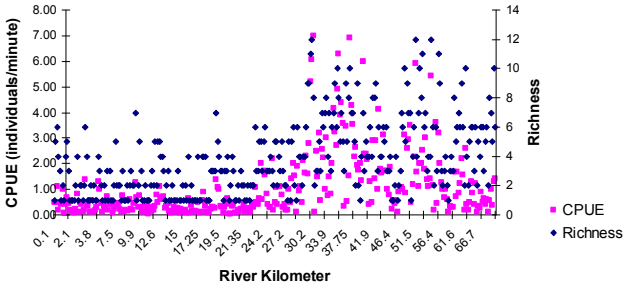

Figure 2. CPUE (individuals / min) and species richness of the qualitative survey of the Tyronza River, Arkansas, plotted by river kilometer. The survey began at river km 0, upstream, and ended at river km 70.4 at Parkin, Arkansas.

70% of the 363 sites sampled had a CPUE of ≤1 individual / min. (Fig. 3). The mean sample time per site was 11.7 (3.6 SD) min. (Table 2). Mean species richness and abundance increased from sites upstream of RKM 30 – 31 (2.5 (1.5 SD) species / site and 5.3 (5.7 SD) individuals / site, respectively) to sites downstream of RKM 30 – 31 (5.5 (2.7 SD) species / site and 22.2 (18.8 SD) individuals / site, respectively) (Fig. 2, Table 2). The survey wide mean species richness and individual abundance were 3.4 (2.7 SD) species / site and 11.1 (15.1 SD) individuals / site, respectively (Table 2). A Mann-Whitney test showed that increases in CPUE, species richness, and abundance were significantly higher (p <0.0001) downstream of RKM 30 – 31 compared to upstream of RKM 30 – 31.

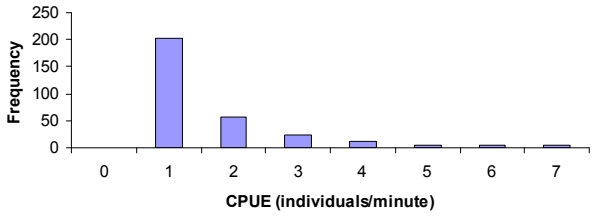

Figure 3. Frequency distribution of the number of Tyronza River qualitative sites with CPUE ranging from 0 to 7 individuals / min.

Quantitative Survey

Twenty-five species and 914 individuals were observed from the 9 quantitative sites. A total of 1, 501 quadrats were sampled over 37,025 m^2 with a range of assemblage size ranging from 75 m^2 to 29,900 m^2 (Table 4). Species composition at each assemblage ranged from 5 to 21 species with mean densities from

Table 2. Sample effort, CPUE, number of individuals, and richness per site with standard deviation and sample variance in parentheses.

	Sample Effort	CPUE	No. of individuals	Richness/Site
Overall Mean	11.7 (3.6;13.5)	0.9 (1.2; 1.5)	11.1(15.1; 228.2)	3.4 (2.7; 7.3)
RKM 0 to 30-31		0.5 (0.4; 0.2)	5.3 (5.7; 32.9)	2.5 (1.5; 2.4)
RKM 30-31 to 70.4		1.9 (1.5; 2.4)	22.2 (18.8; 355.0)	5.5 (2.7; 7.1)
Minimum	0	0	0	0
Maximum	28	7	79	12

Table 3. Length (mm), height (mm), and width (mm), overall means (SD), and gravidity status for all *Potamilus capax* observed during the qualitative survey of the Tyronza River, Arkansas.

Potamilus capax ID	Site Location	Length	Height	Width	Maturity	Gravid
TW1	N35.46665;W090.39989	118.0	86.5	75.2	Adult	
TW2	N35.38880;W090.41620	101.2	69.8	69.5	Adult	YES
TW3	N35.37712;W090.46560	129.4	84.0	67.7	Adult	
TW4	N35.37468;W090.46883	88.3	67.7	57.7	Adult	NO
TW5	N35.37225;W090.47082	97.6	72.1	65.2	Adult	
TW6	N35.36812;W090.47579	89.1	64.0	58.5	Adult	NO
TW7	N35.30293;W090.47034	79.2	58.4	52.3	Adult	
TW8	N35.28674;W090.47939	48.7	32.5	37.1	Juvenile	
TW9	N35.28253;W090.52901	92.0	69.2	58.6	Adult	
TW10	N35.28253;W090.52901	41.6	31.4	26.0	Juvenile	
TW11	N35.28169;W090.53540	55.1	45.2	36.9	Adult	
TW12	N35.28734;W090.56240	106.8	80.2	67.1	Adult	NO
TW13	N35.28734;W090.56240	123.6	99.3	73.5	Adult	
Mean Adult		90.0 (27.9)	66.2(20.3)	57.3(15.4)		
Mean Juvenile		45.2(5.0)	32.0(0.8)	31.6(7.9)		

adult length, height, and width of 90.0 (27.9) mm 66.2 (20.3) mm, 57.3 and (15.4) mm, respectively and juvenile mean length, height, and width was 45.2 (5.0 SD) mm, 32.0 (0.8 SD) mm, and 31.6 (SD) mm respectively (Table 3). Densities and population estimates for *Potamilus capax* ranged from 0.005 to 0.05 mussels / m^2 and 10 ± 25 to 33 ± 50 individuals, 1.0 (0.2 SD) to 1.9 (2.7 SD) mussels / m^2, respectively (Table 4). Community Numerical Standing Crop (CNSC) estimates ranged from 70 ± 30 to 22,986 ± 7, 905 individuals (Table 4). *Amblema plicata* was the most abundant species during the quantitative sampling, followed by *Q. pustulosa*, *Q. nodulata*, *Potamilus purpuratus*, and *Q. quadrula*. *Potamilus capax* was observed at 3 of the 9 sites with 7 individuals collected. Mean *Potamilus capax*, respectively, with an overall mean of 0.03 mussels / m^2 (0.02 SD).

Discussion

CPUE and Species Richness

Amblema plicata was the most common mussel collected during the survey comprising over half of all total live individuals. The remaining top 4 species, in order of abundance and number of site occurrences, were *Q. pustulosa*, *Potamilus purpuratus*, *Q. nodulata*, and *Q. quadrula*, respectively. Other species, *M. nervosa*, *Q. metanevra*, and *Utterbackia imbecillis*, were far less abundant; however due to the qualitative nature of the survey, we believe that these species are under represented and may have larger populations than observed. The results of this survey were similar to those of Ahlstedt and Jenkinson (1987) and Posey (1997), in regards to *Amblema plicata* and *Q. nodulata, Q. pustulosa*, and *Q. quadrula* abundances, which were often the top 4 species within the St. Francis and Cache

River basins. Ahlstedt and Jenkinson (1987) only observed 6 individuals of *Q. metanevra* and no live *Utterbackia imbecillis* across 192 sites in the St. Francis and Cache River watersheds. Christian (1995) also did not observe any *Utterbackia imbecillis* in the White and Cache Rivers, while dominant species in that study included: *Amblema plicata, M. nervosa, Plectomerus dombeyanus, Q. pustulosa, and Q. quadrula*.

The presence of 6 species solely as dead or relic shells indicates extremely low populations of these species within the river. Three of the species, *Ligumia subrostrata*, *Uniomerus declivus*, and *Uniomerus tetralasmus*, were collected downstream of the Ditch 40 confluence, in locations where the 3 species were previously documented (Ahlstedt and Jenkinson 1987, pers. obs.). The remaining species were previously documented within the St. Francis River basin, but with low population numbers or only as relics (Bates and Dennis 1983, Ahlstedt and Jenkinson 1987, 1991).

Table 4. Location (latitude/longitude), total number of samples, total area, mean density (mussels/ m^2) with (SD), minimum-maximum mussels / m^2, and community numerical standing crop (CNSC ± 95% CI**)** for the 9 assemblages quantitatively sampled in the Tyronza River.

	Latitude/Longitude)		Total Samples	Total Area (m^2)	Total Individuals	Min.-Max.	Mean Density (mussels/ m^2)	CNSC ± 95% CI
SITE 1	N35.62787	W-90.17840	15	75	13	0-3	1.2 (0.4)	70 ± 30
SITE 2	N35.56228	W-90.26754	15	150	16	0-3	1.5 (0.8)	160 ± 58
SITE 3	N35.52293	W-90.29912	93	780	13	0-3	1.0 (0.2)	109 ± 116
SITE 4	N35.50674	W-90.33860	126	1050	27	0-4	1.1 (0.3)	225 ± 151
SITE 5	N35.49865	W-90.39312	640	29900	492	0-37	1.9 (2.7)	22986 ± 7905
SITE 6	N35.38933	W-90.41628	267	2730	146	0-6	1.3 (0.7)	1524 ± 298
SITE 7	N35.37458	W-90.46915	161	800	108	0-6	1.5 (1.0)	537 ±164
SITE 8	N35.28736	W-90.47861	83	700	45	0-6	1.4 (0.9)	396 ±189
SITE 9	N35.28526	W-90.55440	101	840	54	0-7	1.3 (1.0)	450 ± 228

Individual Species Accounts

Species distribution in the Tyronza River varied from isolated individuals, *Q. metanevra* and *U. imbecillis*, to widespread aggregates, *Amblema plicata* and *Potamilus purpuratus*. Several interesting patterns were observed when species distributions were spatially plotted using Geographic Information Systems (GIS). Specifically, 80% of *S. undulatus'* observations occurred between RKM 30 – 40. Similar trends were observed for *Truncilla donaciformis*, *Truncilla truncata*, and *M. nervosa*. *Arcidens confragosus* was sparsely distributed throughout the river; however, an increase was observed near RKM 50. *Lampsilis cardium* showed an opposite trend, with no individuals in the downstream 20 RKMs.

Potamilus capax, previously undocumented in the Tyronza River by Bates and Dennis (1983) and Ahlstedt and Jenkinson (1987), was first observed live near RKM 30; which is downstream of US Highway 63 between Marked Tree and Tyronza. Thirteen live *Potamilus capax* individuals were collected and released during the survey, 1 of which was a gravid female collected in September 2006. Cummings and Mayer (1993) and Barnhart and Roberts (1997) reported populations of *Potamilus capax* in Illinois, Indiana, and Missouri as being gravid during June. Wisconsin females have been reported as being gravid from June to October (Baker 1928). Gravid females were observed in Ditch 10 of the St. Francis River, near Truman, Arkansas, during April and May 2005. Anecdotally, *Potamilus capax* were collected in all major substrate types (i.e. sand, clay, and silt) and in all major habitat types (i.e. lateral scour pools, riffles, and runs). The presence of juvenile *Potamilus capax* at 2 sites indicated that some recruitment has occurred in the Tyronza River.

Quantitative Survey

Results of the quantitative survey were similar to those of the qualitative survey, with 25 species present for both types of surveys. However, *M. nervosa* and *Pluerobema sintoxia* were not found alive in the quantitative survey and *Toxolasma lividus* and *Toxolasma parvus* were not found alive in the qualitative survey. The top 5 most abundant species were the same for each survey, but in the qualitative survey *Potamilus purpuratus* was the third most abundant versus the fourth most abundant in the

quantitative survey. Community estimates for the Tyronza River were well below those of larger Arkansas Delta rivers, specifically the Cache River, which had CNSC estimates ranging from 3,705 ± 1,908 to 122,115 ± 24,192 individuals, and the St. Francis River, which had CNSC ranging from 5,400 ± 2,646 to 53,198 ± 17,145 individuals (Christian 1995, Posey 1997, Christian et al. 2005). Lower CNSC could possibly be explained through any number of hypotheses, such as lack of suitable mussel habitat and/or hydrological variability (Strayer 1981, 1983, Oesch 1984, DiMaio and Corkum 1995, Strayer 1999, Downing et al. 2000). *Potamilus capax* densities were not as high as that reported by Ahlstedt and Jenkinson (1987), 0.01 mussels / m^2 in ditches and 0.02 mussels / m^2 mainstream St. Francis River, with an overall mean density of 0.004 individuals / m^2 in the entire Tyronza River, but were similar to the results of Harris (1986). However, when densities of only the downstream portion of the Tyronza River were calculated, *Potamilus capax* densities increase to 0.01 mussels / m^2, similar that reported by Ahlstedt and Jenkinson (1987) within ditches.

Conclusions

The qualitative and quantitative surveys completed on the Tyronza River, Arkansas documented the distribution, relative abundance, and population estimates of mussel assemblages, including *Potamilus capax*, a federally endangered species. A total of 27 live species were observed and an additional 6 species were observed as relics between the 2 surveys. The surveys documented that *Potamilus capax* is present and reproducing in the Tyronza River. Reproduction was confirmed by the presence of a single gravid female and recruitment was documented through the collection of 2 juvenile individuals. The small population of *Potamilus capax* in the Tyronza River may be attributed to habitat and/or flow selectivity of *Potamilus capax* which has been previously undocumented, or an extremely low interaction rate with the host fish, freshwater drum (*Aplodinotus grunniens*). Freshwater drum also serve as a host fish for the bleufer (*Potamilus purpuratus*), which is prevalent throughout the river and was third and fourth most abundant species in the qualitative and quantitative surveys, respectively. This suggests that other driving factors are influencing the distribution and abundance of *Potamilus capax* in the Tyronza River. This survey provides valuable baseline data on the mussel assemblages of an altered alluvial river and reports on the location and status of S1, S2, and S3 species. Such data is critical for the effective management of freshwater mussel in the Tyronza River and of communities in channel altered alluvial rivers.

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