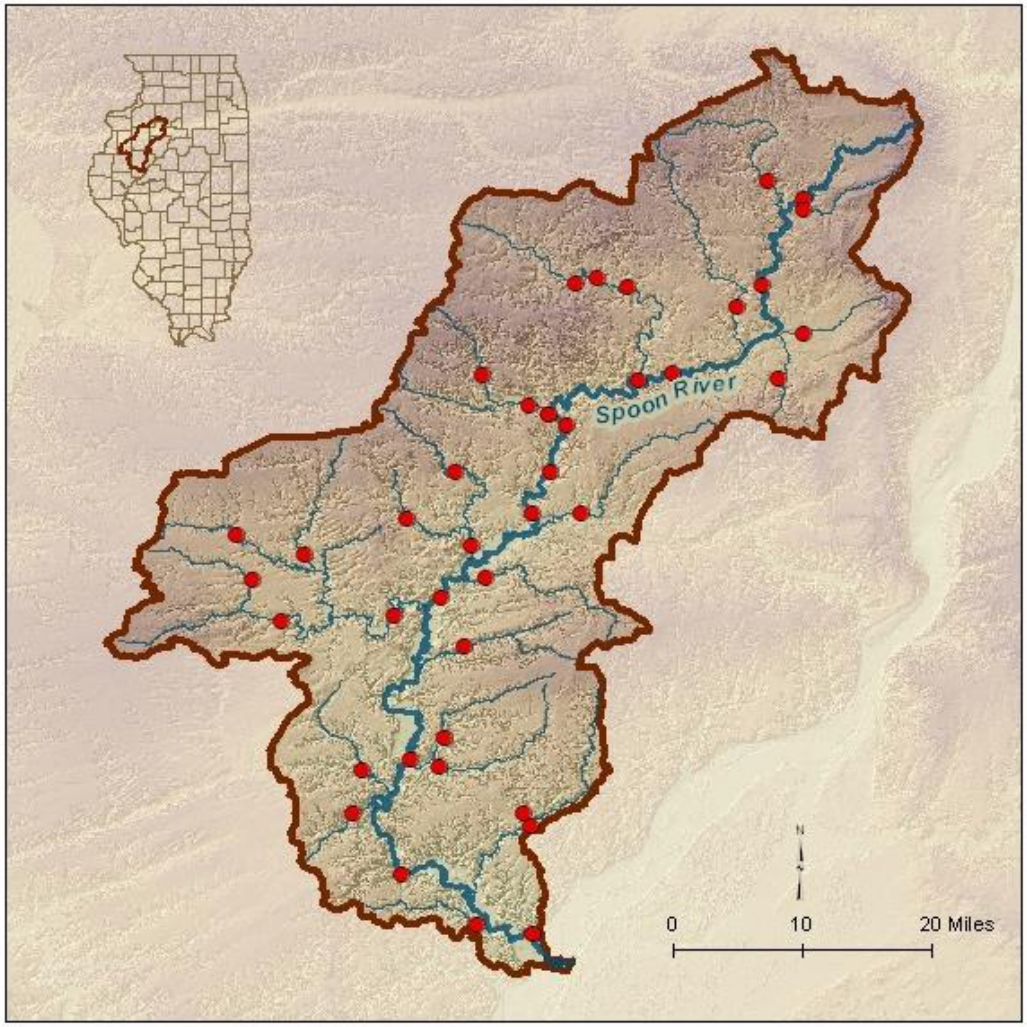
Freshwater Mussels of the Spoon River Basin



2014

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Preface

While broad geographic information is available on the distribution and abundance of mussels in Illinois, systematically collected mussel-community data sets required to integrate mussels into aquatic community assessments do not exist. In 2009, a project funded by a US Fish and Wildlife Service State Wildlife Grant was undertaken to survey and assess the freshwater mussel populations at wadeable sites from 33 stream basins in conjunction with the Illinois Department of Natural Resources (IDNR)/Illinois Environmental Protection Agency (IEPA) basin surveys. Inclusion of mussels into these basin surveys contributes to the comprehensive basin monitoring programs that include water and sediment chemistry, instream habitat, macroinvertebrate, and fish, which reflect a broad spectrum of abiotic and biotic stream resources. These mussel surveys will provide reliable and repeatable techniques for assessing the freshwater mussel community in sampled streams. These surveys also provide data for future monitoring of freshwater mussel populations on a local, regional, and watershed basis.

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Suggested Citation
Douglass, S.A., D.K. Shasteen, and A.P. Stodola. Freshwater Mussels of the Spoon River Basin. Illinois Natural History Survey Technical Report 2014 (10). Champaign, Illinois. 18 pp. + appendix.

Acknowledgements
This study was supported by funding from the US Fish and Wildlife Service, State Wildlife Grant (T-53-D-1, Investigating Mussel Communities in Illinois Streams), IDNR and INHS. Our extreme gratitude goes to the primary investigators for the project: Ann Holtrop, Kevin Cummings, Robert Szafoni, and Dr. Yong Cao, who served as our mentors and made this project possible. We would like to thank all people involved in our surveys, especially our field assistants (A.J. Berger, Brandon Cheek, Brittanie Dabney, Jeff Gersch, Kacie Jonasen, Drew Negangard, A.J. Repp, Jen Schwab, Amy Stultz, and Corrina Wendel), Jeremy Tiemann, Josh Sherwood, IDNR fisheries biologists, IEPA water monitoring biologists, and volunteers from other agencies. We would like to extend gratitude to all the landowners, both public and private, who allowed us access to their properties. We would like to thank Andrew Hulin for the creation of maps for this report and Christine Mayer for INHS Mollusk Collection Database support.

Introduction

Freshwater mussel populations have been declining for decades and are among the most seriously impacted aquatic animals worldwide (Bogan 1993, Williams et al. 1993). It is estimated that nearly 70% of the approximately 300 North American mussel taxa are either federally-listed as endangered or threatened, extinct, or in need of conservation status (Williams et al. 1993, Strayer et al. 2004). In Illinois, 25 of the 62 extant species (44%) are listed as threatened or endangered (Illinois Endangered Species Protection Board, 2011) and an additional 5 species are species in greatest need of conservation (SGNC; IDNR 2005a). This report summarizes the mussel survey conducted in the Spoon River basin from 2010 to 2012 at IEPA/IDNR basin survey sites and previously ranked disturbance sites.

The Spoon River flows for 161 miles southwesterly through Bureau, Fulton, Henry, Knox, Marshall, McDonough, Peoria, Stark, and Warren Counties where it empties into the Illinois River at Havana, Illinois (Figure 1). It drains approximately 2,985 km^2 (1,855 mi^2) and is characterized by gently rolling uplands, ravines, and a level floodplain (Page et al. 1992). The Spoon River basin resides in three natural divisions— primarily in the Western Forest-Prairie, Galesburg Section, Upper Mississippi and Illinois River Bottomlands, and the Grand Prairie (Schwegman 1973).

Land use and Instream Habitat

Historically, the Spoon River basin was comprised of mesic and wet prairies with forested portions interspersed throughout much of the region, but land use today is predominately row crop agriculture due to the fertile prairie soils (Schwegman 1973, Page et al. 1992). The Spoon River is primarily rural; it flows through London Mills (pop. 392) and a few small municipalities like Bernadotte and Duncan Mills, populations of approximately 100 or less and therefore not sectioned out in the US Census (US Census Bureau 2010). The mainstem has an old milldam at Bernadotte, built in the early 1800s (Strode 1896), but is otherwise unmodified. The Spoon River basin is one of the least channelized regions of the state, however, channelization has occurred on several small tributaries to a minimal degree (IDNR 1998).

Substrates in the Spoon River are predominately gravel and sand with suspended silt in the water column. In 1892, Strode mentioned the Spoon River as “a clear-running spring-fed stream,” however today the Spoon River is highly turbid with algal blooms caused by fertilizer runoff and suspended silt moving through the system (Page et al. 1992). The tributaries have varied substrate compositions, from predominantly gravel/sand mixture to some cobble and claypan with silt banks. Tributaries and most mainstem sites were wadeable and had average depths less than a meter at base flow. However, sampling sites on the lower portion of the Spoon River mainstem were limited due to non-wadeable water depths (e.g., depth >1m).

Methods

During the 2010 - 2012 survey, freshwater mussel data were collected at 41 sites: 11 mainstem and 30 tributary sites in the Spoon River basin (Figure 1; Table 1). Locations of sampling sites are listed in Table 1 along with IDNR/IEPA sampling type information for the site. In most cases, mussel survey locations were the same as IDNR/IEPA basin survey sites. At one site on the Spoon River (site 11), mussel data were collected on more than one occasion to fulfill sampling objectives for other analyses (Table 1).

Live mussels and shells were collected at each sample station to assess past and current freshwater mussel occurrences. Live mussels were surveyed by hand grabbing and visual detection (e.g., trails, siphons, exposed shell) when water conditions permitted. Efforts were made to cover all available habitat types present at a site including riffles, pools, slack water, and areas of differing substrates. A four-hour timed search method was implemented at each station. Live mussels were held in the stream until processing.

Following the timed search, all live mussels and shells were identified to species and recorded (Table 2). For each live individual, shell length (mm), gender (if applicable), and an estimate of the number of growth rings were recorded. Shell material was classified as recent dead or relict based on condition of the best shell found. A species was considered extant at a station if it was represented by live or recently dead shell material (Szafoni 2001). The nomenclature employed in this report follows Turgeon et al. (1998) except for recent taxonomic changes to the gender ending of lilliput (*Toxolasma parvum*), which follows Williams et al. (2008; Appendix 1). Voucher specimens were retained and deposited in the Illinois Natural History Survey Mollusk Collection. All non-vouchered live mussels were returned to the stream reach where they were collected.

Other parameters recorded were comprised of extant and total species richness, presence of rare or listed species, and individuals collected, expressed as catch-per-unit-effort (CPUE; Table 2). A population was considered to indicate recent recruitment if individuals less than 30mm in length or with three or fewer growth rings were observed. Finally, mussel resources were classified as Unique, Highly Valued, Moderate, Limited, or Restricted (Table 2) based on the above parameters (Table 3) and following criteria outlined in Table 4 (Szafoni 2001).

Results

Species Richness

In this survey, 21 live, 23 extant, and 31 total species were observed (Table 2). Across all sites, the number of live species collected ranged from 0 to 11, extant species collected (live + dead)

ranged from 1 to 15, and total number of species collected (live + dead + relict) ranged from 2 to 19. Mainstem species richness ranged from 2 to 11 live species, 4 to 15 extant species, and 6 to 19 total species. Across tributary sites, species richness ranged from 0 to 10 live, 1 to 11 extant species, and 2 to 15 total species. In mainstem sites, the mapleleaf (*Quadrula quadrula*), pimpleback (*Quadrula pustulosa*), and plain pocketbook (*Lampsilis cardium*) were each encountered at 9 of 11 sites (82%; Figure 3a). In tributary sites, the plain pocketbook and creeper (*Strophitus undulatus*) were the most widespread species, collected at 16 of 30 sites (53%, Figure 3b).

Abundance and Recruitment

A total of 1762 live individuals were collected across 41 sites. Live individuals collected in tributary sites ranged from 1 to 176 and in mainstem sites ranged from 2 to 240. A total of 168 collector-hours were spent sampling, with an average of 9 mussels collected per hour at tributary sites and 16 mussels per hour at mainstem sites. The plain pocketbook was the most collected species in the mainstem (n=207, 27.8%) and tributaries (n=258, 25.4%), comprising 26.4% of total collections (n=465, Table 2). The next most collected species in the mainstem was monkeyface (SGNC, *Quadrula metanevra*, n=150, 20.1%), with over 60% of individuals found at site 6 (Figure 2, Table 2). The white heelsplitter (*Lasmigona complanata*, n=177) and Wabash pigtoe (*Fusconaia flava*, n=176) each represented approximately 17% of the individuals collected in the tributaries (Table 2).

Recruitment for each species was determined by the presence of individuals less than 30mm or with 3 or fewer growth rings. Smaller (i.e., younger) mussels are harder to locate by hand grab methods and large sample sizes can be needed to accurately assess population reproduction. However, a small sample size can provide evidence of recruitment if it includes individuals that are small or possess few growth rings. Alternatively, a sample consisting of very large (for the species) individuals with numerous growth rings suggests a senescent population.

Recruitment, referred to as Reproduction Factor in Table 3, at individual sites ranged from none (1) to high (4) across the basin. Three mainstem sites (5, 7, 11b) and ten tributary sites exhibited high (> 30-50%) recruitment. In the first sample at site 11 on the Spoon River we did not observe recruitment, however in our second sample we did observed high recruitment. Three Spoon River sites (3, 4, 6) and five tributary sites (16, 18, 20, 33, 40) exhibited moderate (>1-30%) recruitment. Five remaining mainstem sites (1-2, 8-10) and eleven tributary sites (12-13, 21, 23, 25-26, 29-30, 36, 37, 39) had no recruitment observed (Figure 4a-b).

Mussel Community Classification

Based on data collected in the 2010 – 2012 basin survey, 71% (29 of 41) of sites in the Spoon River basin were classified as Highly Valued or Moderate mussel resources, according to the

current MCI classification system (Table 4; Figure 4a-b). The mainstem sites, 2-7, rank as a Highly Valued mussel resources due to high species richness, presence of intolerant species and recruitment observed. Sites 1, 8-9, and 11 on the mainstem were classified as Moderate mussel resources since moderate species richness, lack of intolerant species, and minimal recruitment (except site 11) were observed. Among tributaries, seven sites (17-18, 20, 24, 27, 32-33) were identified as Highly Valued mussel resource and twelve sites were Moderate mussel resources, due to high and moderate species richness and recruitment observed. Seven tributary sites were Limited mussel resources, and, four sites were Restricted mussel resources due to no live individuals observed (Table 2).

Noteworthy Finds

One species of greatest need of conservation (SGNC), monkeyface, was found alive at seven mainstem sites (1-6, 8) and three tributary sites (18, 20, 33, Table 2). In addition, dead shells were found at two other mainstem sites (7, 9, Table 2). Other SGNC or state-listed species such as black sandshell (*Ligumia recta*, state-threatened), flutedshell (*Lasmigona costata*, SGNC), and spike (*Elliptio dilatata*, state-threatened) were documented only by relict shell. Ellipse (*Venustaconcha ellipsiformis,* SGNC) and slippershell mussel (*Alasmidonta viridis*, state-threatened) were two new shell (relict) records in the tributaries. Our survey documented the first live records for the round pigtoe (*Pleurobema sintoxia*) in Spoon River tributaries. The rainbow (*Villosa iris*, state-threatened) and snuffbox (*Epioblasma triquetra*, state-endangered) were also new shell (relict) records for the basin (Table 2).

Discussion

W.S. Strode (1891, 1892, 1896) sampled primarily in the Spoon River, particularly around Bernadotte, and recorded approximately 38 species including the earliest accounts of the current rare and listed species. In addition, M.R. Matteson of the University of Illinois and W.C. Starrett of the Illinois Natural History Survey conducted unpublished surveys of the Spoon River in 1957 and 1971 respectively. Matteson and Starrett had comparable species lists (20 and 19 live species, respectively), with a noticeable loss of species already occurring. Until our survey efforts and concurrently by Sherwood (2011), a Masters student from Western Illinois University who completed a basin wide survey of the mussel fauna for his M.S. thesis, only sporadic sampling of this basin had occurred in the drainage. Prior to our survey, 43 species were known historically from the Spoon River and 19 species have been documented in its tributaries (INHS Mollusk Collection). During our survey, mainstem species consisted of 21 extant and 29 total species and 17 extant and 21 total species were collected in the tributaries.

Our (including Sherwood 2011) findings are similar to Starrett's (19 live species), with the exception of an obvious decline of yellow sandshell (*Lampsilis teres*) in the basin. One species

documented within the last decade and also found alive in our survey was the pondhorn (*Uniomerus tetralasmus*). Two other species reappearing alive since Strode's surveys are the deertoe (*Truncilla truncata*) and threehorn wartyback (*Obliquaria reflexa*). Both live deertoe and threehorn wartyback were similarly recent finds in the La Moine basin (Sherwood 2011, Price et al. 2012). These species have common fish hosts, such as the golden shiner (pondhorn), freshwater drum (deertoe), and common shiner, silverjaw minnow, and longnose dace (threehorn wartyback). It can be hypothesized that the success of the golden shiner in the tributaries and freshwater drum from the Illinois River into the Spoon River, for instance, are leading to an increased presence of these mussel species. Another explanation could simply be more intensive and extensive sampling has occurred the last few years resulting in more occurrences of these species.

Species not collected in our current surveys that Strode recorded in the late 1800s and early 1900s were the yellow sandshell, flat floater (*Anodonta suborbiculata*), washboard (*Megalonaias nervosa*), wartyback (*Quadrula nodulata*), rock pocketbook (*Arcidens confragosus*, SGNC), purple wartyback (*Cyclonaias tuberculata*, state-threatened), elephantear (*Elliptio crassidens*, state-threatened), sheepnose (*Plethobasus cyphyus*, federally endangered), Higgins eye (*Lampsilis higginsii*, federally endangered), ring pink (*Obovaria retusa*, federally endangered), winged mapleleaf (*Quadrula fragosa*-federally endangered) and fat pocketbook (*Potamilus capax*, federally endangered). All these species, except for yellow sandshell, have only one or a few collection records (INHS Mollusk Collection). Species such as wartyback, sheepnose, elephantear, Higgins eye, winged mapleleaf, fat pocketbook, and rock pocketbook are large river species with occasional presence in the large tributaries to these rivers; hence, rare in the Spoon River (Cummings and Mayer 1992, Cummings and Mayer 1997, Tiemann et al. 2007). In addition, Strode (1892) consulted with other experts' to distinguish fat and plain pocketbook specimens from the Spoon River, but did not concur with their specimen identification of fat pocketbook. There are two records of this species and, although rare, it is not improbable it was historically present since its range extends into the Illinois River (Cummings and Mayer 1992). The ring pink is found only in the Wabash and Ohio River drainages, and, thus, can be considered a spurious record (Cummings and Mayer 1992). Flat floater is often found in backwater, sluggish regions of a river, or in lakes, and therefore rare in the mainstem (Cummings and Mayer 1997); it is likely present in these habitats in the Spoon River basin. Yellow sandshell and purple wartyback were present throughout the state and have since declined in their ranges (Cummings and Mayer 1997). Strode (1892) noted that yellow sandshell and purple wartyback were "common; found everywhere associated in small groups or singly" and "very common and fine," respectively.

The monkeyface (SGNC) has been present in the Spoon River with live records (usually one to a few individuals) since the earliest collections (INHS Mollusk Collection). Our surveys found high

densities of monkeyface, with recruitment observed, in a few locations along the Spoon River (Table 2). Low, receding waters around gravel islands aided our collection of the numerous monkeyface, for example, at site 6 (n=91, Figure 2, Table 2). Monkeyface occurs in large rivers and their major tributaries throughout the state; however, only noticeably healthy and comparably dense populations have been observed in the Kankakee and Mississippi Rivers (Cummings and Mayer 1997; INHS Mollusk Collection). The local densities and recruitment observed in the Spoon River indicate a viable and stable population of monkeyface at this time.

Two additional species collected by relict shell, the rainbow and snuffbox, are state and federally endangered, respectively. The rainbow is generally found in the northeast to east-central part of the state, and the Spoon basin represents the westernmost edge of its range (Cummings and Mayer 1992). The snuffbox historically was widespread in larger streams across Illinois but is now restricted to a short section of the Embarras River (Tiemann et al. 2007). All listed species with the exception of two SGNC species, monkeyface and creek heelsplitter, could be considered extirpated from this basin (Appendix 1). Live individuals of these species have not been found since the late 1800s-early 1900s (INHS Mollusk Collection).

Mussel Communities in the Spoon River Basin

The most recent IEPA assessments for the Spoon River list it as fully supporting aquatic life although water quality issues still exist that may impact aquatic organisms (IEPA 2012). We observed ten of eleven sites on the Spoon River to be Highly Valued and Moderate mussel resources while the remaining site was a Limited mussel resource, according to current MCI classification. The first sample on site 11 yielded a Limited mussel resource; however, in the subsequent sample with lower water levels we found more individuals and added a live species which increased its rating to a Moderate mussel resource. Current water quality issues in the Spoon River include elevated levels of fecal coliform throughout the mainstem and high mercury levels at one site (DJ-09; IEPA 2012). Page et al. (1992) cited silt, strip mine and industrial waste, agricultural chemicals, and domestic and animal waste as major sources of pollution in the Spoon River. An obvious decline of species richness occurred between Strode and Starrett's survey in 1971 after which time tolerant and one intolerant mussel species (i.e., the monkeyface) continued to persist. It was during the late 1800s-early 1900s that immigration to the area occurred and land use shifted into predominately row crop agriculture throughout the Spoon basin (McManis 1968).

Twenty-two tributary sites are listed as fully supporting aquatic life, and nineteen streams were listed as either having a Highly Valued mussel resource (seven sites) or a Moderate mussel resource (twelve sites). Other tributaries including West Fork Spoon River, Slug Run, Negro Creek, Prince Run and Barker Creek are listed as not fully supporting aquatic life due to sedimentation, stream bank and instream alterations, dissolved oxygen issues, and excessive

concentrations of fluoride and fecal coliform resulting from channelization, intensive agricultural practices, previous strip mining, and municipal discharge, respectively (IEPA 2012). Several of these streams at one time hosted live mussels but, today, have minimal or no mussel presence hence listed as a Limited or Restricted mussel resources with the exception of Slug Run and Prince Run, which were classified as Moderate mussel resources (Table 2; Figure 4b). Although many of these tributaries are listed as fully supporting aquatic life and reflect healthy mussel populations, continued disturbances exist in other streams that may negatively impact their mussel communities.

Summary

Mussel sampling and collection efforts have occurred since the 1800s, and 43 species were known historically from the Spoon River basin (INHS Mollusk Collection). In this recent systematic survey, 21 species were found alive, 23 species extant, and 31 total species were observed. An approximately 53% species decline with a noticeable loss of rare, intolerant species is evident while the common, widespread, tolerant species remain. Our survey findings were consistent to Starrett's survey in 1971 and thereby the mussel species composition appears stable at this time. Multiple factors could have affected the species loss in this basin such as increased sedimentation, instream alterations, the milldam at Bernadotte, and historical clamming. Strode (1891) wrote of a 'pearl craze' that hit Bernadotte in which wagon loads of mussels were opened in the hopes of finding pearls; the mussel beds around Bernadotte were "almost annihilated." Our survey below the Bernadotte dam (site 10) yielded little live mussel presence compared to historical finds. Effects of the dam above and below can make sampling conditions difficult (deep pools), modify instream habitat making less suitable habitat for mussel beds, and blockage of fish passage thereby limiting host fish interaction and mussel recruitment efforts (Watters 2000). The Spoon River basin historically contained a rich diversity of mussel species and an obvious decline in its species richness is evident. The tolerant mussel communities continue to persist throughout this basin and should be protected from further disturbance.

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Table 1. 2010-2012 Spoon River survey sites. Sites are listed from upstream to downstream, mainstem (1-11) and tributaries (12-41). Types of samples include MU-mussel sampling, W-water chemistry, S-sediment, T-fish tissue, F-fish sample, H-habitat, and M-macroinvertebrate. *denotes site sampled twice

Site Number	IEPA Code	Stream	Types of Samples	County	Location	Watershed Area (km^2)
1	DJ-06	Spoon River	MU,W,T,F,H,M	Stark	2 mi W Wyoming; Rt 17 bridge	507.64
2	DJ-05	Spoon River	MU	Peoria	2.5 mi N Laura; Rt 78 bridge	1092.98
3	DJ-38	Spoon River	MU	Peoria	Elmore; Co Hwy 6 bridge	1582.95
4	DJ-11	Spoon River	MU	Knox	Dahinda; downstream confluence with Court Creek	1702.11
5	DJ-02	Spoon River	MU,W	Knox	2.5 mi SE Dahinda; Rt 150 bridge	1956.82
6	DJ-34	Spoon River	MU	Knox	5 mi NE Maquon; Co Hwy 17 at Wolf Covered Bridge	1996.81
7	DJ-39	Spoon River	MU	Knox	2 mi ENE Maquon; Co Rd 650 N bridge	2284.13
8	DJ-09	Spoon River	MU,W,T,F,H,M	Fulton	N Edge London Mills; 2nd Street bridge	2722.15
9	DJ-14	Spoon River	MU,W,T,F,H,M	Fulton	3.5 mi NW Smithfield; Co Rd 2350 N, Buckeye bridge	3783.54
10	DJ-13	Spoon River	MU,W	Fulton	Bernadotte; downstream of dam	4355.87
11*	DJ-12	Spoon River	MU,W	Fulton	3 mi S Lewistown; N Waterford Road	4721.11
12	DJO-01	W Fk Spoon River	MU,W,F,H,M	Stark	2 mi E Elmira; Rt 93 bridge	140.65
13	DJN-02	E Fk Spoon River	MU,W,F,H,M	Stark	4 mi SW Bradford; Co Rd 1300 E bridge	172.07
14	DJNA-01	Coopers Defeat Creek	MU,W,F,H,M	Stark	1.8 mii NE Modena; Co Rd 1300 E bridge	56.61
15	DJM-01	Camp Run	MU,W,F,H,M	Stark	4 mi SSE Wyoming; Co Rd 1300 E bridge	126.99
16	DJMAA-01	Prince Run	MU	Peoria	2 mi N Princeville; Streitmatter Road bridge	49.21
17	DJL-02	Indian Creek	MU,W,F,H,M	Stark	3.5 mi SW Wyoming; Co Rd 450 N bridge	157.05
18	DJK-03	Walnut Creek	MU	Knox	2 mi NE Victoria; Co Rd 2000 E road at old bridge	225.79
19	DJK-02	Walnut Creek	MU	Knox	3.5 mi NE Victoria; Rt 180 bridge	261.03
20	DJK-04	Walnut Creek	MU,W,S,F,H,M	Knox	3.5 mi SW La Fayette; Co Rd 1450 E bridge	291.44
21	DJJB-03	North Creek	MU,W,F,H,M	Knox	5 mi ENE East Galesburg; Co Rd 1700 N bridge	75.43
22	DJJ-04	Court Creek	MU,W,F,H,M	Knox	1.5 mi W Dahinda; Co Rd 1600 E bridge	190.35
23	DJJ-10	Court Creek	MU	Knox	South edge of Dahinda; at confluence with Spoon River	190.35
24	DJI-01	French Creek	MU,W,F,H,M	Knox	4 mi NW Yates City; Co Rd 2000 E bridge	138.47
25	DJH-02	Haw Creek	MU,W	Knox	2.5 mi WSW Gilson; Co Rd 950 N/ 1025 E bridge	53.76
26	DJHD-01	Brush Creek	MU,W,F,H,M	Knox	4 mi E Abingdon; Co Rd 600 N bridge	80.46
27	DJH-01	Haw Creek	MU,W,F,H,M	Knox	3.5 mi SW Maquon; Co Rd 400 N bridge	284.64
28	DJG-01	Littlers Creek	MU,W,F,H,M	Knox	2 mi NW Rapatee; Co Rd 1300 E bridge	94.78
29	DJF-04	Cedar Creek	MU	Warren	3.5 mi SSE Berwick; Co Rd 1475 E bridge	87.36
30	DJFD-01	Cedar Fork	MU,W,F,H,M	Warren	4 mi SE Berwick; Co Rd 900 N bridge	171.01
31	DJFBB-03	Negro Creek	MU	Warren	6 mi W of Roseville; Hwy 16 bridge	78.77
32	DJFB-01	Swan Creek	MU,W,F,H,M	Warren	2.5 mi SE Greenbush; Co Rd 1500 E bridge	207.80
33	DJF-02	Cedar Creek	MU,W,T,F,H,M	Fulton	3.5 mi SW London Mills; Co Rd 3400 N bridge	724.87
34	DJE-02	Coal Creek	MU,W,F,H,M	Fulton	4 mi SE London Mills; Co Rd 1100 E bridge	74.96
35	DJDB-03	Turkey Creek	MU,W,F,H,M	Fulton	1 mi SE Blyton; Co Rd 900 N bridge	92.24
36	DJD-02	Put Creek	MU,W,F,H,M	Fulton	3 mi S Blyton; Co Rd 2300 N bridge	91.96
37	DJC-01	Shaw Creek	MU,W	Fulton	1.5 mi NW Marietta; Co Rd 325 E bridge	77.24
38	DJZF-01	Barker Creek	MU,W,F,H,M	Fulton	1.8 mi S Marietta; Co Rd 250 E bridge	49.88
39	DJB-18	Big Creek	MU,W,F,H,M	Fulton	2 mi SW Bryant; Co Rd 1650 E bridge	104.90
40	DJBZ-01	Slug Run	MU	Fulton	2.5 mi NW Bryant; Girard Road bridge	14.52
41	DJZA-01	Tater Creek	MU,W,F,H,M	Fulton	1.5 mi NW Duncan Mills; Mile Load Rd bridge	49.79

Table 2. Mussel data for the Spoon River basin sampled during 2010-2012 surveys (Table 1). Numbers in columns are live individuals collected, "D" and "R" indicates only dead or relict shells collected. Shaded boxes indicate historic collections at the specific site location obtained from the INHS Mollusk Collection database. Extant species is live + dead shell and total species is live + dead + relict shell. Proportion of total is number of individuals of a species divided by total number of individuals at all sites. MCI scores and Resource Classification are based on values in Tables 3 and 4 (R=Restricted, L=Limited, M=Moderate, HV=Highly Valued, and U=Unique). NDA = no data available. Species in bold are federally or state-listed species or species in Greatest Need of Conservation by IL DNR. Sites with one or more samples are denoted by a and b. **Arcidens confragosus, Anodonta suborbiculata, Cyclonaias tuberculata, Elliptio crassidens, Megalonaias nervosa, Plethobasus cyphyus, Quadrula nodulata, Lampsilis higginsii, Potamilus capax, Obovaria retusa, Utterbackia imbecillus, Quadrula fragosa* are included in historical total but not represented in the table.

	Spoon River Site Number												Tributary Site Number								
Species	1	2	3	4	5	6	7	8	9	10	11a	11b	12	13	14	15	16	17	18	19	20
Subfamily Anodontinae																					
Alasmidonta marginata		R																			
Alasmidonta viridis		**R**																**R**			**R**
Anodontoides ferussacianus			D				1						D	R	10	6	25	D	2		4
Lasmigona complanata	3	D	1			2	D		2	D			7	2		R	133		11	D	D
Lasmigona compressa	**D**		**D**											**1**			**6**		**5**		
Lasmigona costata		**R**	**D**			**R**															
Pyganodon grandis														D							R
Strophitus undulatus	D	1	2	3	D	4	D	D	R	R			2	1			1	1	9	1	7
Subfamily Ambleminae																					
Amblema plicata	1	R	R	R	D	R	R		R		R			R		R	R	R			
Elliptio dilatata	**R**	**R**	**R**		**R**	**R**				**R**					**R**	**R**			**R**		**R**
Fusconaia flava	D	3	19	3	6	28	14		D					19		R		11	26	D	33
Pleurobema sintoxia	1	1	27	4	7	13	3	2	R							R		2	6	1	10
Quadrula metanevra	2	2	34	4	14	91	D	3	D										**6**		**1**
Quadrula pustulosa	1	28	31	3	2	19	16		2		R	1		2				4	18	1	23
Quadrula quadrula		3	3	2	3	19	8	1	2	1	D	D									
Tritogonia verrucosa	R	2	4											7							
Uniomerus tetralasmus																					
Subfamily Lampsilinae																					
Actinonaias ligamentina		R				R	R		R	R											
Epioblasma triquetra						**R**															
Lampsilis cardium	6	17	59	31	34	53	1	3	3	R				45	D	D		42	71	1	8
Lampsilis siliquoidea	R	R	59	R	R	1			R					9		R		2	22	R	6
Lampsilis teres																					
Leptodea fragilis	D	R	D	2	D	1	D	D	D	D	1	6	D	D						R	D
Ligumia recta	**R**		**R**																		
Obliquaria reflexa											1										
Obovaria olivaria																					
Potamilus alatus											D										
Potamilus ohiensis										1	4	1									
Toxolasma parvum		1															R	R			1
Truncilla donaciformis						1			D			6									
Truncilla truncata			1																		
Venustaconcha ellipsiformis	**R**		**R**		**R**					**R**						**R**		**R**			**R**
Villosa iris		**R**																			
Individuals collected	14	58	240	52	66	232	43	9	9	2	6	14	9	86	10	6	165	62	176	4	93
Live Species	6	9	11	8	6	11	6	4	4	2	3	4	2	8	1	1	4	6	10	4	9
Extant Species	10	10	15	8	9	11	10	6	8	4	5	5	4	10	2	2	4	7	10	6	11
Total Species Collected	15	19	19	10	12	16	12	6	13	9	7	5	4	12	3	9	6	11	11	8	15
Historical Species Richness	8	8	16	NDA	NDA	7	2	NDA	5	19	NDA	NDA	NDA	NDA	NDA	NDA	NDA	5	7	1	NDA
CPUE	3.5	14.5	46.4	13.0	16.5	59	10.7	4	2.24	0.5	1.43	3.59	2.31	22.3	2.56	1.54	42.3	15.3	44	1	23.3
MCI	11	12	15	13	14	15	15	9	9	5	7	10	7	10	10	10	11	12	15	10	14
Resource Classification	M	HV	HV	HV	HV	HV	HV	M	M	L	L	M	L	M	M	M	M	HV	HV	M	HV

Table 2. continued

Species	Tributary Site Number																					Proportion of total	Proportion of tributaries	Proportion of mainstem
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41			
Subfamily Anodontinae																								
Alasmidonta marginata																						-	-	-
Alasmidonta viridis																						-	-	-
Anodontoides ferussacianus	1		D	16										D								3.7%	6.3%	0.1%
Lasmigona complanata	D	R	D	2	2	D	D	7	1	2	4	2	1	R			1		1	1	R	10.5%	17.4%	1.1%
Lasmigona compressa	**R**			**9**		**R**		**D**	**3**		**4**	**2**	**1**									1.8%	3.0%	-
Lasmigona costata																						-	-	-
Pyganodon grandis					D			6											D	1		0.4%	0.7%	-
Strophitus undulatus	D	1	D	12	2		1	3		1	5	1	11	R	D		D		R	D		3.9%	5.8%	1.3%
Subfamily Ambleminae																						-	-	-
Amblema plicata		R		R									R				R					0.1%	-	0.1%
Elliptio dilatata				**R**									**R**									-	-	-
Fusconaia flava			2	8			12			30	5	7	23		R							14.1%	17.3%	9.8%
Pleurobema sintoxia		R					3															4.5%	2.2%	7.8%
Quadrula metanevra													**3**									9.1%	1.0%	20.1%
Quadrula pustulosa			1	4			14	D				4	17				R		D	D		10.8%	8.7%	13.8%
Quadrula quadrula			1				7						2			5	1		D	D		3.3%	1.6%	5.6%
Tritogonia verrucosa										2		1	12			1			1	1		1.8%	2.5%	0.8%
Uniomerus tetralasmus					1				D		1				D			D		D	D	0.1%	0.2%	-
Subfamily Lampsilinae																						-	-	-
Actinonaias ligamentina																						-	-	-
Epioblasma triquetra																						-	-	-
Lampsilis cardium	3	15	5	12	R	D	1	3		11		22	13			D	2		D	4		26.4%	25.4%	27.8%
Lampsilis siliquoidea		2	D		1	1		1		15	1	14	R		R	D						7.6%	7.3%	8.1%
Lampsilis teres																						-	-	-
Leptodea fragilis			D				R			D			2			D			R	D		0.7%	0.2%	1.3%
Ligumia recta																						-	-	-
Obliquaria reflexa																						0.1%	-	0.1%
Obovaria olivaria																						-	-	-
Potamilus alatus																						-	-	-
Potamilus ohiensis																			1			0.4%	0.1%	0.8%
Toxolasma parvum				1	R		1	1	1					R	D		D	D		D	D	0.3%	0.5%	0.1%
Truncilla donaciformis																						0.4%	-	0.9%
Truncilla truncata																						0.1%	-	0.1%
Venustaconcha ellipsiformis															**R**							-	-	-
Villosa iris																						-	-	-
																						Totals	**Tributaries**	**Mainstem**
Individuals collected	4	18	9	64	6	1	39	21	5	61	20	53	85	0	0	6	4	0	3	7	0	1762	1017	745
Live Species	2	3	4	8	4	1	7	6	3	6	6	8	10	0	0	2	3	0	3	4	0	21	17	18
Extant Species	4	3	9	8	5	3	8	8	4	7	6	8	10	1	3	5	5	2	6	9	2	23	17	21
Total Species Collected	5	6	9	10	7	4	9	8	4	7	6	8	13	4	6	5	7	2	8	9	3	31	21	29
Historical Species Richness	3	6	6	8	5	1	8	3	NDA	8	NDA	3	6	3	NDA	NDA	3	NDA	1	2	NDA	43*		
CPUE	1	4.5	2.25	16.3	1.5	0.25	9.5	5.25	1.25	15.3	5.13	13.9	21.3	0.0	0.0	1.5	1	0.0	0.75	1.75	0.0			
MCI	7	9	8	13	8	5	12	11	6	9	10	12	14	0	0	7	7	0	5	10	0			
Resource Classification	L	M	M	HV	M	L	HV	M	L	M	M	HV	HV	R	R	L	L	R	L	M	R			

Table 3. Mussel Community Index parameters and scores.

Extant species in sample	Species Richness		Catch per Unit Effort (CPUE)	Abundance (AB) Factor
0	1		0	0
1-3	2		1-10	2
4-6	3		>10-30	3
7-9	4		>30-60	4
10+	5		>60	5
% live species with recent recruitment	Reproduction Factor		# of Intolerant species	Intolerant species Factor
0	1		0	1
1-30	3		1	3
>30-50	4		2+	5
>50	5			

Table 4. Freshwater mussel resource categories based on species richness, abundance, and population structure. MCI = Mussel Community Index Score

Unique Resource MCI ≥ 16	Very high species richness (10 + species) &/or abundance (CPUE > 80); intolerant species typically present; recruitment noted for most species
Highly Valued Resource MCI = 12 - 15	High species richness (7-9 species) &/or abundance (CPUE 51-80); intolerant species likely present; recruitment noted for several species
Moderate Resource MCI = 8 - 11	Moderate species richness (4-6 species) &/or abundance (CPUE 11-50) typical for stream of given location and order; intolerant species likely not present; recruitment noted for a few species
Limited Resource MCI = 5 - 7	Low species richness (1-3 species) &/or abundance (CPUE 1-10); lack of intolerant species; no evidence of recent recruitment (all individuals old or large for the species)
Restricted Resource MCI = 0 - 4	No live mussels present; only weathered dead, sub-fossil, or no shell material found.

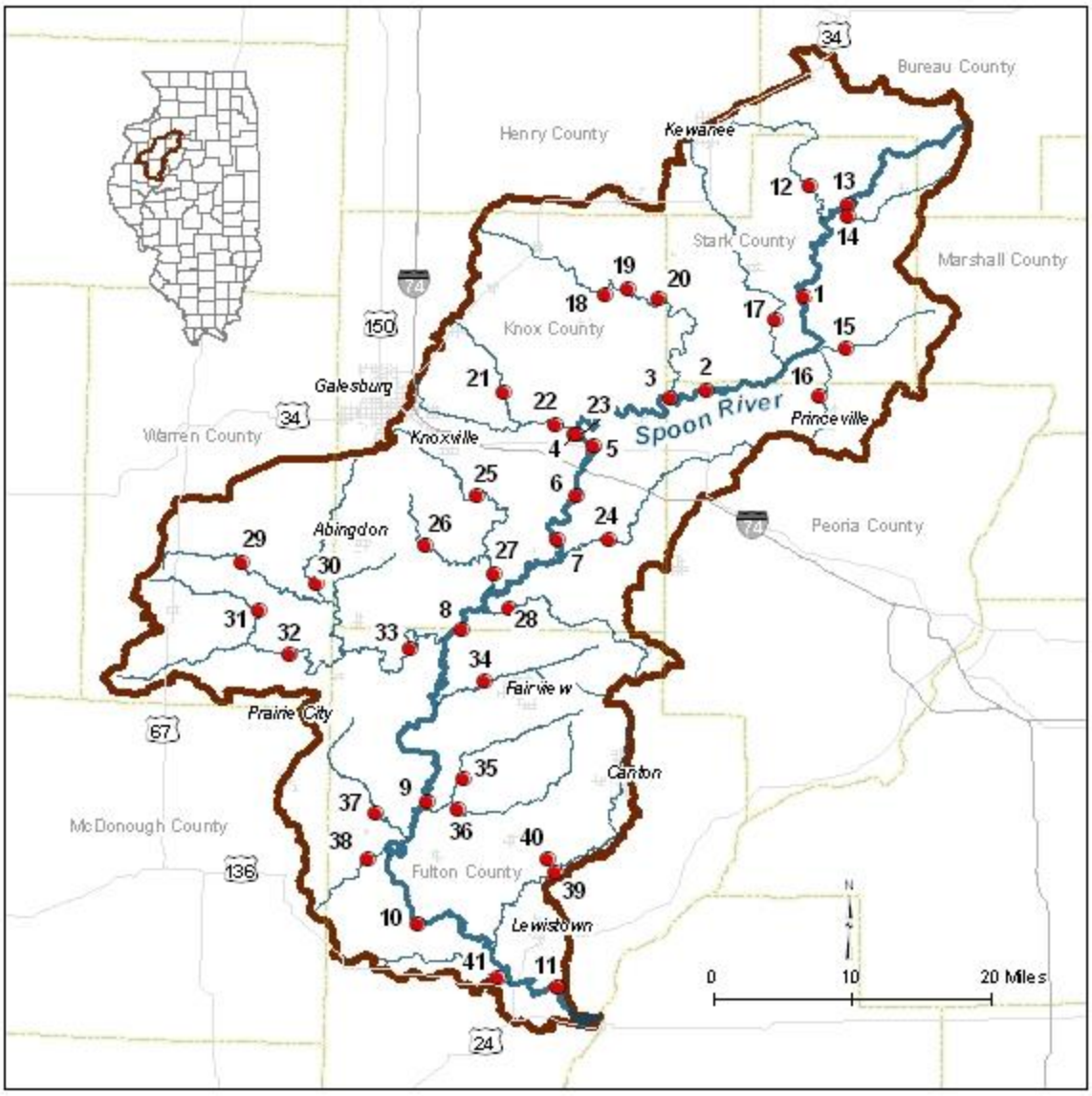
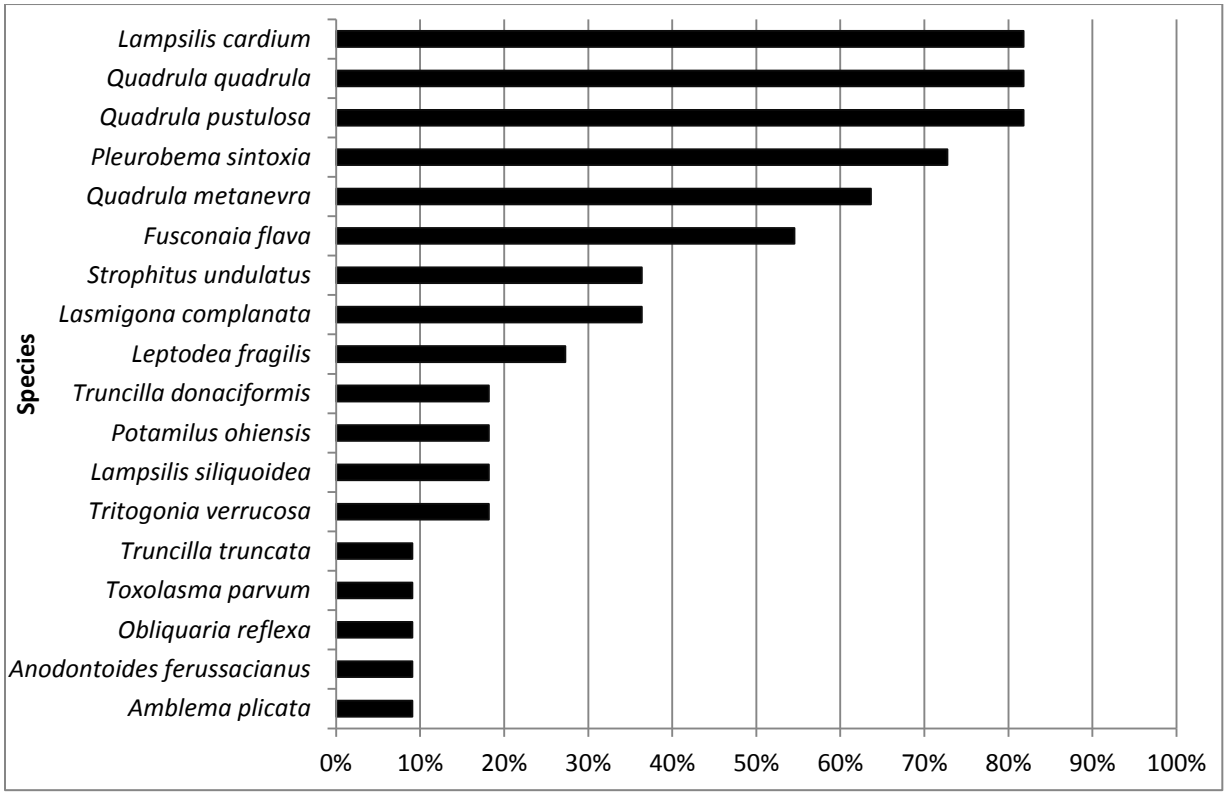


Figure 1. Sites sampled in the Spoon River basin during 2010-2012. Site codes referenced in Table 1.

Figure 2. Monkeyface (*Quadrula metanevra*, SGNC); site 6 (above).

a) Spoon River



b) Tributaries

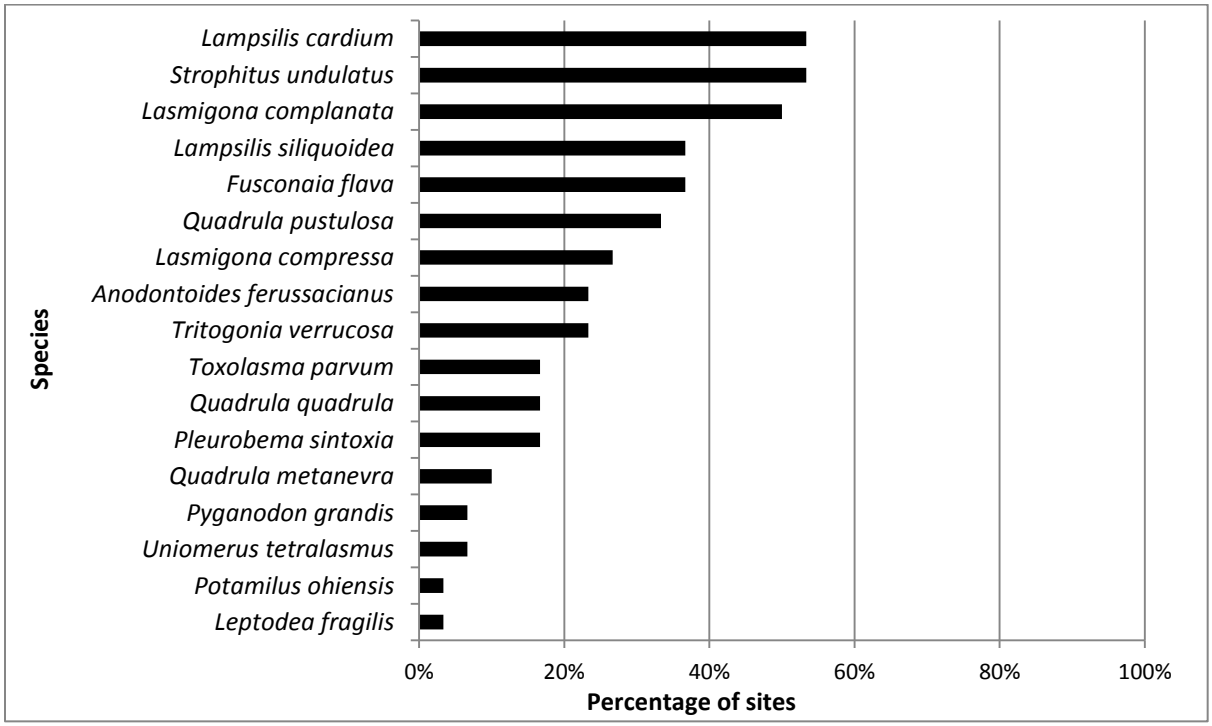
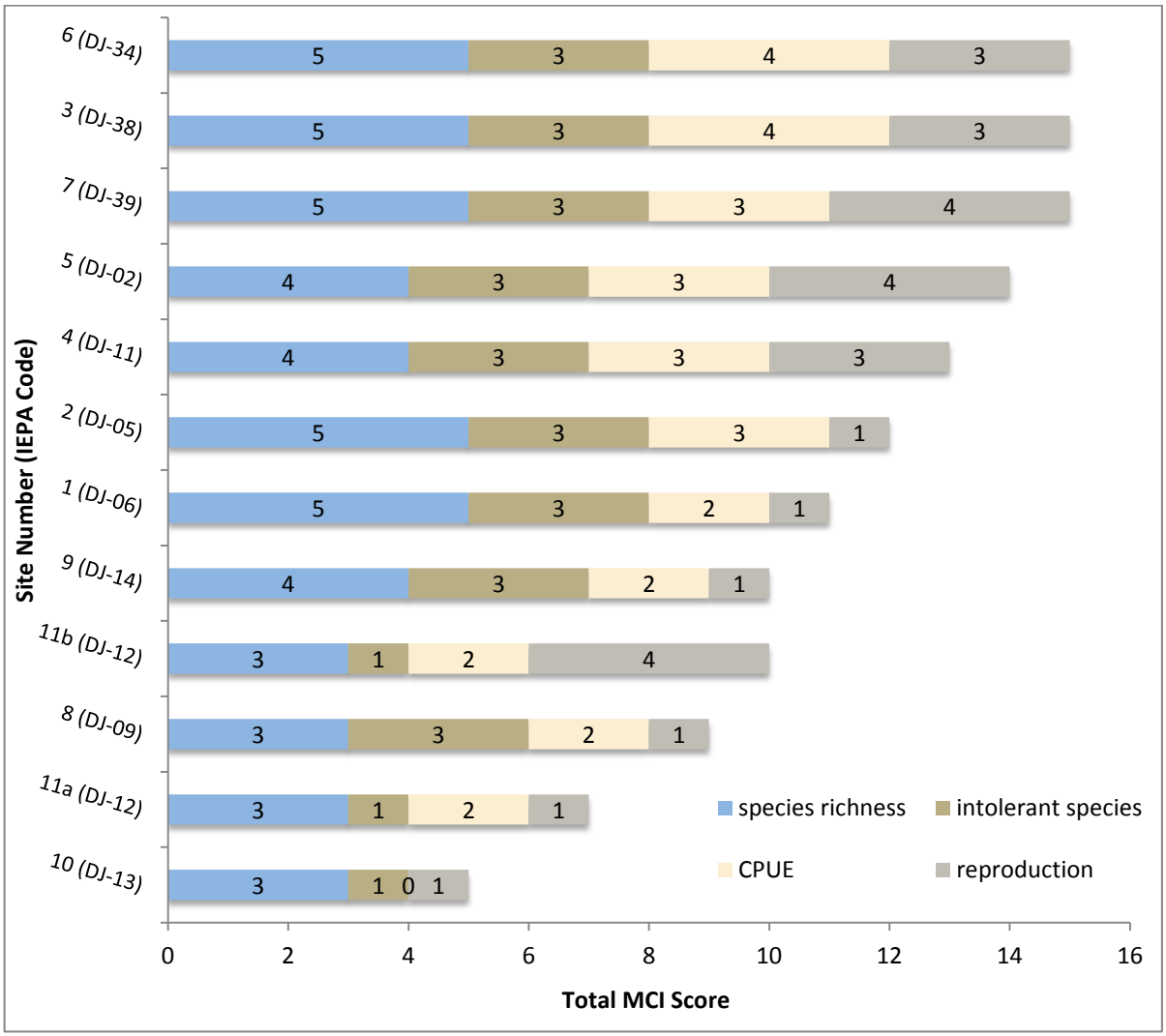


Figure 3. Spoon River basin species occurrence by percentage: number of sites with live species collected compared to the number of total sites sampled (11 mainstem, 30 tributary).

a) Spoon River



b) Tributaries

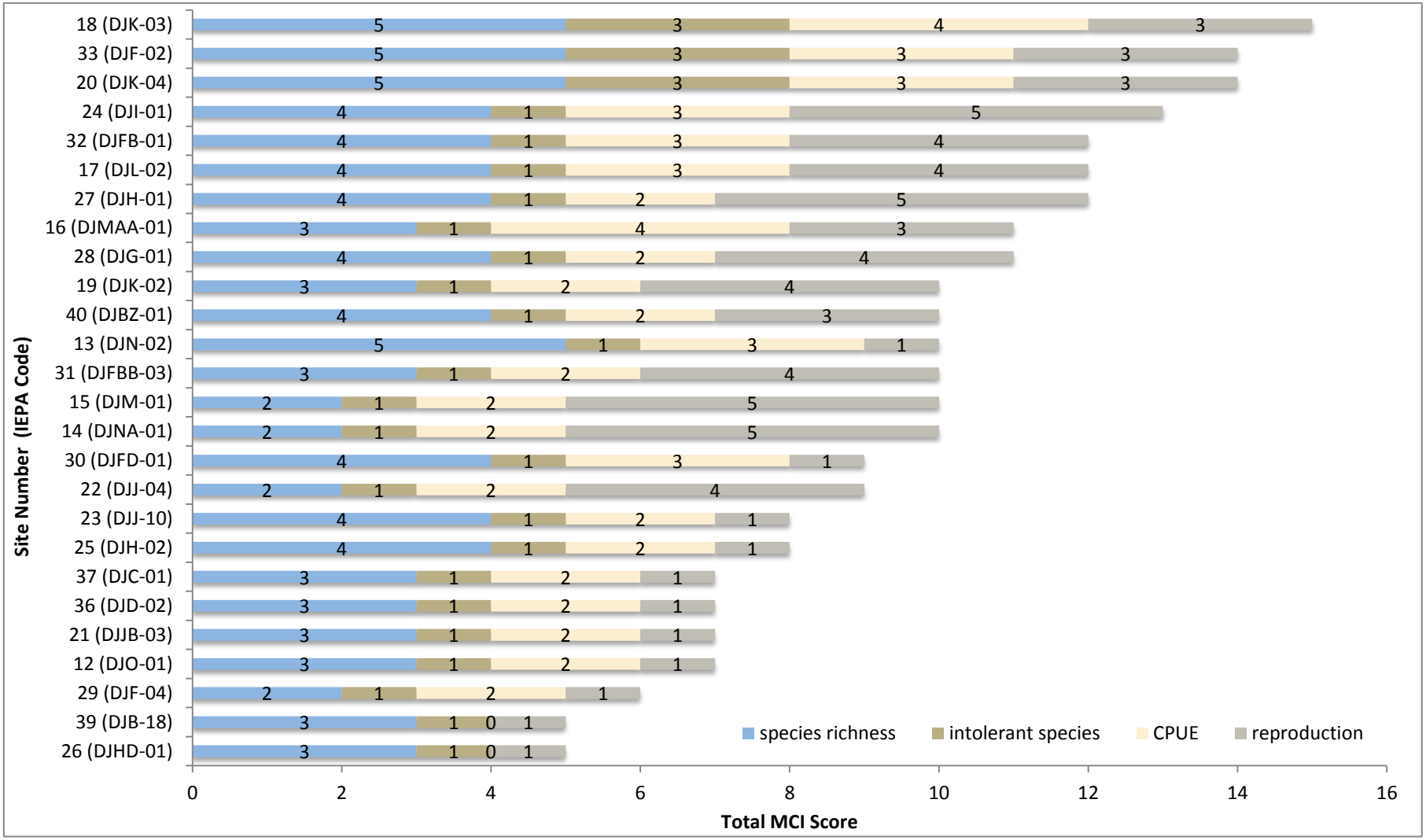


Figure 4a-b. Comparison of Mussel Community Index (MCI) and its parameter scores for the Spoon River basin based on factor values from Table 3.

Appendix 1. Scientific and common names of species. Status refers to conservation status in Illinois in 2012; SGNC- Illinois' species in greatest need of conservation, ST-state threatened, FE- federally endangered, X- extirpated.

Scientific name	Common name	Status
Subfamily Anodontinae		
Alasmidonta marginata	elktoe	
Alasmidonta viridis	slippershell mussel	ST
Anodontoides ferussacianus	cylindrical papershell	
Arcidens confragosus	rock pocketbook	SGNC
Lasmigona complanata	white heelsplitter	
Lasmigona compressa	creek heelsplitter	SGNC
Lasmigona costata	flutedshell	SGNC
Pyganodon grandis	giant floater	
Strophitus undulatus	creeper	
Anodonta suborbiculata	flat floater	
Subfamily Ambleminae		
Amblema plicata	threeridge	
Cyclonaias tuberculata	purple wartyback	ST
Elliptio crassidens	elephantear	ST
Elliptio dilatata	spike	ST
Fusconaia flava	Wabash pigtoe	
Megalonaias nervosa	washboard	
Plethobasus cyphyus	sheepnose	FE
Pleurobema sintoxia	round pigtoe	
Quadrula fragosa	winged mapleleaf	FE, X
Quadrula metanevra	monkeyface	SGNC
Quadrula nodulata	wartyback	
Quadrula pustulosa	pimpleback	
Quadrula quadrula	mapleleaf	
Tritogonia verrucosa	pistolgrip	
Uniomerus tetralasmus	pondhorn	
Subfamily Lampsilinae		
Actinonaias ligamentina	mucket	
Epioblasma triquetra	snuffbox	FE
Lampsilis cardium	plain pocketbook	
Lampsilis higginsii	Higgins eye	FE
Lampsilis siliquoidea	fatmucket	
Lampsilis teres	yellow sandshell	
Leptodea fragilis	fragile papershell	
Ligumia recta	black sandshell	ST
Obliquaria reflexa	threehorn wartyback	
Obovaria olivaria	hickorynut	
Obovaria retusa	ring pink	FE, X
Potamilus alatus	pink heelsplitter	
Potamilus ohiensis	pink papershell	
Toxolasma parvum	lilliput	
Truncilla donaciformis	fawnsfoot	
Truncilla truncata	deertoe	
Venustaconcha ellipsiformis	ellipse	SGNC
Villosa iris	rainbow	ST