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Freshwater mussels of the upper Illinois River basin: Mazon River, Aux Sable Creek, and Vermilion River

Alison P. Stodola, Sarah A. Bales, Diane K. Shasteen

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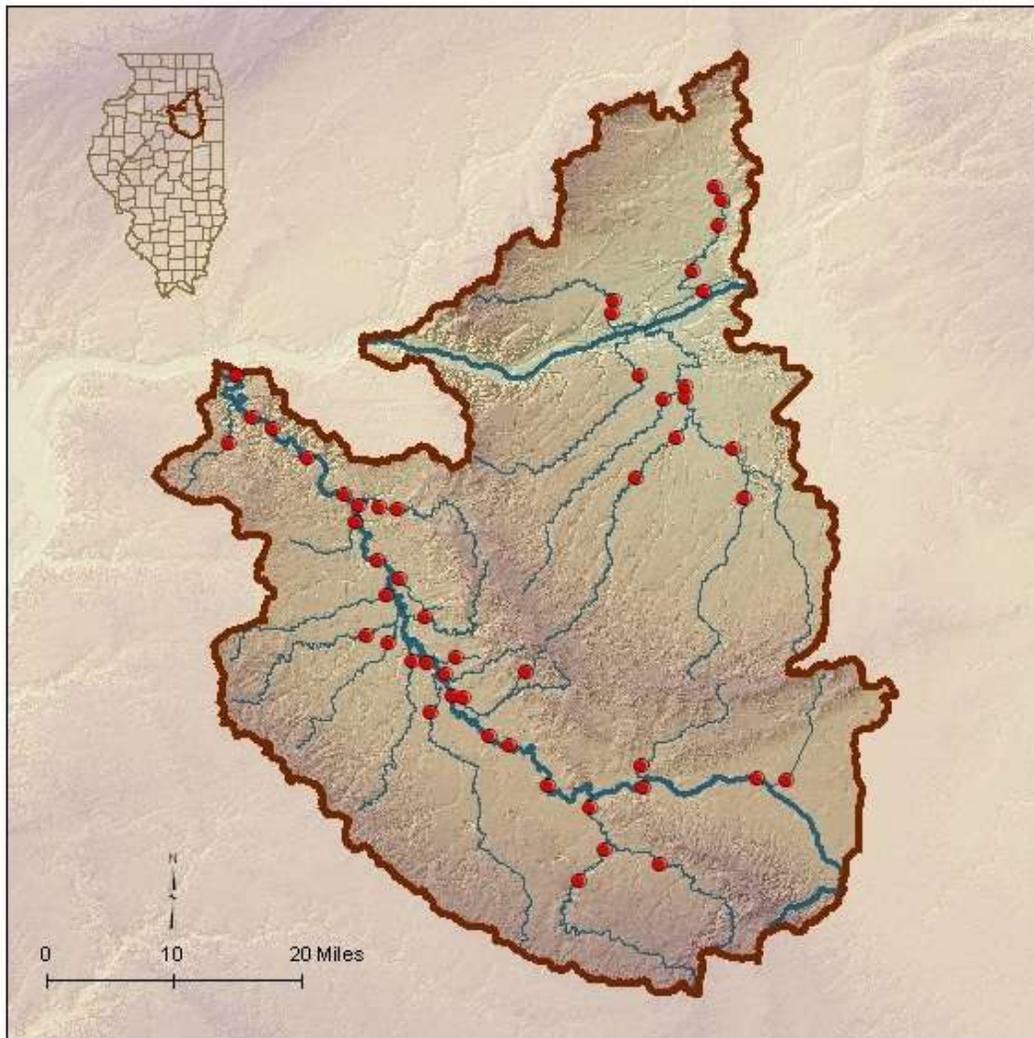
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Prairie Research Institute, University of Illinois at Urbana Champaign
William Shilts, Executive Director

Illinois Natural History Survey
Brian D. Anderson, Director
1816 South Oak Street
Champaign, IL 61820
217-333-6830



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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.

Agency Contacts

Kevin S. Cummings, INHS, ksc@inhs.illinois.edu, (217) 333-1623

Bob Szafoni, IDNR, Robert.szafoni@Illinois.gov, (217)348-0175

Ann Marie Holtrop, IDNR, ann.holtrop@Illinois.gov, (217)785-4325

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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 extinct, federally-listed as endangered or threatened, 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 covers the Mazon River basin; Aux Sable, Nettle, and Waupecan Creeks; and the Vermilion River in the upper Illinois River basin (henceforth referred to as the Vermilion River). We summarize the mussel surveys conducted in these basins from 2009 to 2012 at IEPA/IDNR basin survey sites and other targeted survey sites.

Location and Habitat

The Illinois River tributaries are located in north-central Illinois. The major tributaries in this region are the Mazon and Vermilion Rivers, and minor tributaries include Aux Sable, Nettle, and Waupecan Creeks. The Mazon River and tributaries, as well as Waupecan Creek, flow through portions of Livingston and Grundy Counties, and drain an area of approximately 1420 km² (550 mi²). The Vermilion River rises in Ford and Livingston Counties and flows northwest through LaSalle County into the Illinois River. The Vermilion River drains an area of 3447 km² (1331 mi²). Aux Sable and Nettle Creeks, located north of the Illinois River, flow through portions of Kendall and Grundy Counties and drain approximately 1165 km² (450 mi²) and 310 km² (120 mi²), respectively. The tributaries in this region flow primarily through the Grand Prairie Natural Division, although a small portion of the Vermilion River flows through the Illinois River Bottomlands (Schwegman 1973).

Land use in this region is 90% agriculture, and forested corridors persist along streams (Page et al. 1992; IDNR 2004). Many of the streams in this region have highly varying topography as the streams make their way to the Illinois River, thus steep banks and v-shaped valleys are common. The upper Vermilion River is characterized by slow-moving sections and finer substrates, such as sand and gravel with minimal cobble. Some dredging has occurred in the upper reaches of the river (Page et al. 1992). Exposed rock cliffs and bedrock are present along the lower portions of the Vermilion River (Figure 1). Substrates are coarse and rocky, with a mix of gravel, cobble, boulder, and areas of bedrock. The Mazon River is fairly shallow and bedrock outcroppings exist throughout the lower watershed (Page et al. 1992). Urban areas are few, although Pontiac and Streator (pop. ~12,000 and ~14,000, respectively; US Census Bureau 2010) both use the Vermilion River as a municipal water source and for treated discharge; several smaller municipalities also discharge municipal wastes into tributaries in the region

(IDNR 2004). Other threats to aquatic habitats include active and previous strip mining operations, row crop agriculture, and pasturing of stream banks (Page et al. 1992).

Methods

Freshwater mussel data were collected at 50 sites between June and September of 2009-2012: 15 sites in Mazon River and Aux Sable Creek watershed, and 35 sites in the Vermilion River basin (Figure 2, Table 1). Locations of sampling sites are listed in Table 1 along with information regarding IDNR/IEPA sampling at the site. Site locations for mussel surveys matched those of IDNR/IEPA basin survey sites when applicable.

Live mussels and shells were collected at each sample site 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 site.

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, and an estimate of the number of growth rings were recorded. Shell material was classified as recent dead (periostracum present, nacre pearly, and soft tissue may be present) or relict (periostracum eroded, nacre faded, shell chalky) based on condition of the best shell found. A species was considered extant at a site 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.

Parameters recorded included 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 indicated recent recruitment if individuals with lengths less than 30 mm or with 3 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

A total of 27 species of freshwater mussels were observed in the Illinois River tributaries, 25 of

which were live (Table 2). Across all sites, the number of species collected ranged from 0 to 15 live species, 1 to 15 extant species (live + dead), and 2 to 17 total species (live + dead + relict). Across all sites, the fatmucket (*Lampsilis siliquoidea*) was the most widespread species, collected at 23 of 50 sites (46%). The fatmucket was also the most widespread species in the Mazon River and Aux Sable Creek watersheds, collected alive at nearly every site (13 of 15 sites, or 87%; Figure 3). In the Vermilion River basin, the white heelsplitter was the most widespread species and was collected at 18 of 35 sites (51%); other widespread species were the plain pocketbook (*Lampsilis cardium*) and threeridge (*Amblema plicata*), collected at 17 of 35 sites (49%; Figure 4).

Abundance and Recruitment

Live mussels were collected at 46 of 50 sites, and a total of 2934 individuals were collected during 200 collector hours. In the Mazon River and Aux Sable Creek drainage, the range of live individuals collected at a site was 2 to 239. In the Vermilion River basin, the range of live individuals collected at a site was 1 to 348. The most commonly collected species across all drainages was the threeridge (n=631), which comprised 21% of all individuals collected (Table 2). Other common mussels were the pimpleback (*Quadrula pustulosa*, n=283), mapleleaf (*Quadrula quadrula*, n=258), plain pocketbook (n=255), and white heelsplitter (*Lasmigona complanata*, n=240).

Recruitment for each species was determined by the presence of individuals less than 30 mm 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 may suggest a senescent population.

Recruitment observed at individual sites ranged from none to high across the basin; 50% of sites where live mussels were collected had observed recruitment in at least one species (Figures 5 and 6). In the Mazon River and Aux Sable Creek drainage, we observed recruitment in 1-30% of species collected in 7 of 14 sites, and we observed no recruitment in the remaining sites with live mussels (7 of 14). In the Vermilion River basin, we observed recruitment in over 50% of species collected at several sites, including Kelly Creek (site 16), Mud Creek (site 35), Prairie Creek (site 38) and Murray Creek (site 39). Six other sites had recruitment in 30-50% of species collected (sites 19, 21, 29, 32, 37, and 43) and 13 sites had recruitment in at least one species (reproduction values of "3", Figure 5). Only 9 of 32 sites in the Vermilion River basin had no observed recruitment.

Mussel Community Classification

Based on our survey data, over 70% of the sites where mussels were collected (33 of 46 sites with mussels) in the Illinois River tributaries are classified as Moderate, Highly Valued, or Unique mussel resources under the current MCI classification system (Table 2, Figures 5 and 6). Four sites in the Mazon River and Aux Sable Creek drainage were classified as Highly Valued mussel resources, and these include Aux Sable Creek (site 4), the Mazon River (sites 7 and 12), and the West Fork Mazon River (site 9). Two sites on the Vermilion River, sites 26 and 33, stand out as Unique mussel resources due to high species richness, number of intolerant species, and observed recruitment. Highly Valued mussel resources in the Vermilion River basin include Fivemile Creek (site 18), Indian Creek (sites 21 and 22), Kelly Creek (site 16), Mud Creek (site 35), Otter Creek (sites 42 and 43), Prairie Creek (site 38), Rooks Creek (site 30), the North Fork Vermilion River (sites 17 and 19), and the Vermilion River (sites 25, 45, and 47). Six sites in the Mazon Creek and Aux Sable Creek drainage (sites 2, 3, 5, 8, 10, and 13) and six sites in the Vermilion River basin (sites 20, 29, 32, 39, 40, and 50) were Moderate mussel resources (Figures 5 and 6).

Noteworthy Finds

This survey collected 25 live species and 27 total species and 27 species were known historically from the Illinois River tributaries covered in this report. Although we did not collect the historically known rainbow mussel (*Villosa iris*), we collected new records for the fawnsfoot (*Truncilla donaciformis*; n=4 from 3 sites). All species collected in our survey could be considered extant (e.g., still present), since dead shell represented any species not collected alive. The two species represented only by shell in our survey were the slippershell mussel (*Alasmidonta viridis*; state-threatened) and pink papershell (*Potamilus ohioensis*). Our survey also found few live occurrences for state-threatened spike (*Elliptio dilatata*; n=1) and creek heelsplitter (*Lasmigona compressa*; n=2), which is a species in greatest conservation need. Other species in greatest conservation need collected were flutedshell (*Lasmigona costata*; n=10 across 2 sites), and ellipse (*Venustaconcha ellipsiformis*; n=36 across 8 sites).

Discussion

Mussel Community

The Vermilion and Mazon River basins have several sites that are classified as Highly Valued or Unique mussel resources, including nearly half of all sites sampled in the Vermilion basin (17 of 35 sites) and four of 15 sites in the Mazon River. These streams were highly ranked due to species richness, presence of intolerant species, the number of individuals collected, and reproduction. Of particular note is that among sites with >100 individuals collected (sites 7, 10,

12, 18, 19, 25, 26, 27, 33, and 35), a fairly even species distribution existed. This is in contrast to other basins near this region; the Kankakee and Iroquois species distribution was skewed toward one species, mucket (*Actinonaias ligamentina*) and pimpleback (*Quadrula pustulosa*), respectively, in sites with >100 individuals collected. This indicates that many sites throughout these drainages maintain mussel populations that are diverse, even, and intact. Furthermore, we found extant records of freshwater mussels at every site sampled within this survey, a rare occurrence in most Illinois basins (per previous INHS freshwater mussel reports). These findings coincide with previous stream classifications based on aquatic organisms, as much of the Vermilion and Mazon River basins were classified as “A” or “B” streams (e.g., Unique or Highly Valued Aquatic Resources; Bertrand et al. 1993).

No studies have been published regarding the freshwater mussel fauna of these drainages, and systematic historical collections do not exist. Hence, it is difficult to determine the true intactness and/or historical fauna of these drainages. Nevertheless, we can partially infer the historical species richness from shell records and current shell condition. Twenty-seven species were known in these Illinois tributaries prior to our surveys, and we collected 26 of the known species. The only species we did not collect is the rainbow, which was considered extirpated by Page et al. (1992) and our surveys corroborate this assertion. We found fawnsfoot (n=4 across 3 sites), which was previously undocumented in this drainage. Fawnsfoot is widespread throughout much of Illinois, although it is considered rare in portions of northeastern Illinois (Cummings and Mayer 1992). We speculate that this species may have been present historically (i.e., prior to any documentation) and has since re-colonized this drainage.

We collected few individuals of state-listed freshwater mussels in our survey. The state-threatened slippershell mussel was not collected alive, although dead (site 21, Indian Creek) and relict shell (site 15, Waupecan Creek) were collected. Similarly, we found one live spike, one dead, and three relicts (sites 26, 25, 27, 33, 46, respectively). Historical records do not indicate that either of these species was ever widespread within these drainages, although our surveys were well within the known range of slippershell and spike in Illinois. The loss or rareness of these species should be noted for future conservation efforts.

Summary

On the whole, the tributaries of the Illinois River covered in this report contain relatively diverse and abundant freshwater mussel resources. Nearly all the sites sampled (i.e., 46 of 50 sites) in our survey had live unionids present, and several sites contained more than 10 live species (9 sites; Table 2). While these tributaries did not contain unique or rare species assemblages (i.e., listed species), balanced, reproducing, abundant mussel populations exist throughout the entire drainage. Streams in these watersheds should be recognized as highly valued mussel resources and may serve as a valuable focal point for future research or conservation.

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Table 1. 2009-2012 Upper Illinois River tributary sites. Types of samples include MU-mussel sampling, W-water chemistry, H-habitat, M-macroinvertebrate, F-fish sampling, S-sediment, D-discharge, CM- continuous monitoring.

Site number	IEPA Code	Stream	Types of Samples	County	Location
Mazon River and Upper Illinois watershed					
1	DW-07	Aux Sable Creek	MU,W,H,M,F,D,CM	Kendall	9.5 mi W Shorewood, Rt 52
2	DW-08	Aux Sable Creek	MU	Kendall	6 mi NW Channahon, at Bell Rd.
3	DW-03	Aux Sable Creek	MU,W,H,M,F,S,D,CM	Kendall	2.5 mi WNW Minooka, Holt Rd.
4	DW-01	Aux Sable Creek	MU,M,F,D,CM	Grundy	5.6 mi NE Morris, Rt 6
5	DW-99	Aux Sable Creek	MU, W,H,M,F,D,CM	Grundy	5.4 mi ENE Morris, at I & M Canal
6	DVF-01	East Fork Mazon River	MU,W,H,M,F,D,CM	Grundy	4.3 mi NNW Reddick, Goodfarm Rd.
7	DV-02	Mazon River	MU,W,H,M,F,D,CM	Grundy	5.1 mi S Coal City, at I-55
8	DVE-02	West Fork Mazon River	MU,W,H,M,F,D,CM	Grundy	4.2 mi SSW Mazon, Dwight Rd.
9	DVE-03	West Fork Mazon River	MU,W,H,M,F,D,CM	Grundy	2.6 mi ESE Mazon, Braceville Rd.
10	DV-08	Mazon River	MU,W,H,M,F,D,CM	Grundy	4.0 mi WSW Coal City, 1000S
11	DVD-01	Johnny Run	MU,W,H,M,F,D,CM	Grundy	2.5 mi NE Mazon, Spring Rd.
12	DV-04	Mazon River	MU,H,M	Grundy	3.5 mi W Coal City, Hwy 113
13	DU-03	Nettle Creek	MU	Grundy	3.1 mi NW Morris, Gore Rd.
14	DU-02	Nettle Creek	MU,W,H,M,F,D,CM	Grundy	2.8 mi WNW Morris, Rt 6
15	DZX-01	Waupecan Creek	MU,W,H,M,F,D,CM	Grundy	4 mi N Mazon, Dwight Rd.
Vermilion-Illinois watershed					
16	DSQC-01	Kelly Creek	MU,W,S,F,M,H	Ford	4 mi SE Cullom, 1300E
17	DSQ-03	North Fork Vermilion	MU,W,S,F,M,H	Livingston	3 mi S Cullom, 3500E
18	DSQB-01	Fivemile Creek	MU,W,S,F,M,H	Livingston	3 mi SW Saunemin, 2600E
19	DSQ-02	North Fork Vermilion River	MU	Livingston	4.5 mi SSW Saunemin, 2600E
20	DSP-03	South Fork Vermilion	MU,W,S,F,M,H	Livingston	0.5 mi SE Forrest, Rt 47
21	DSPA-01	Indian Creek	MU,W,S,F,M,H	Livingston	1.5 mi SW Fairbury, 2050E
22	DSPA-FB-C2	Indian Creek	MU,W,M	Livingston	1.5 mi ENE Fairbury, 900N
23	DSP-01	South Fork Vermilion River	MU	Livingston	3.5 mi N Fairbury, 1225N
24	DS-06	Vermilion River	MU,W	Livingston	0.5 mi E McDowell, Rt 24
25	DS-18	Vermilion River	MU	Livingston	Pontiac, Humiston Riverside Park
26	DS-15	Vermilion River	MU	Livingston	2 mi NW Pontiac, 1875N
27	DS-14	Vermilion River	MU,W,S,F,M,H	Livingston	5 mi NW Pontiac, Humiston Nature Center
28	DSL-01	Deer Creek	MU,W,S,F,M,H	Livingston	5.1 mi SW Odell, between 1700E and 2300N
29	DSL-01	Wolf Creek	MU,W,S,F,M,H	Livingston	5 mi NW Pontiac, 1200E
30	DSJ-01	Rooks Creek	MU,W,S,F,M,H	Livingston	5.2 mi SSW Cornell, 2000N
31	DSK-01	Baker Run	MU,W,S,F,M,H	Livingston	2 mi S Cornell, 2300N
32	DSI-01	Ida Creek	MU,W,S,F,M,H	Livingston	1.3 mi SW Cornell, 2425N
33	DS-13	Vermilion River	MU	Livingston	1.5 mi SW Cornell, 2400N
34	DSH-02	Scattering Point	MU,W,S,F,M,H	Livingston	2 mi SW Cornell, 2400N
35	DSG-01	Mud Creek	MU,W,S,F,M,H	Livingston	3 mi NNW Cornell, 900E
36	DSF-01	Long Point Creek	MU,W,S,F,M,H	Livingston	2.5 mi E Long Point, 450E
37	DSFA-01	Mole Creek	MU,W,S,F,M,H	Livingston	4 mi W Cornell, Rt 23
38	DSE-01	Prairie Creek	MU,W,S,F,M,H	Livingston	4 mi S Streator, 600E
39	DST-01	Murray Creek	MU,W,S,F,M,H	Livingston	2.5 mi S Streator, 700E
40	DS-10	Vermilion River	MU,W	Livingston	Streator, Old Rt 23
41	DSC-01	Eagle Creek	MU	Lasalle	0.5 mi W Streator, Spring Lake Rd.
42	DSB-02	Otter Creek	MU	Lasalle	3 mi NE Streator, E 19th Rd.
43	DSB-03	Otter Creek	MU,W,S,F,M,H	Lasalle	2 mi N of Streator, Marilla Park
44	DSB-01	Otter Creek	MU	Lasalle	2.4 mi NW Streator, E 16th St.
45	DS-05	Vermilion River	MU	Lasalle	1 mi N Kangley; E 15th St.
46	DS-07	Vermilion River	MU,W,S,F,M,H	Lasalle	3 mi ENE Leonore, Sandy Ford
47	DS-09	Vermilion River	MU	Lasalle	1.5 mi SE Lowell, Scout Camp
48	DS-08	Vermilion River	MU	Lasalle	Lowell, Rt 178
49	DSA-02	Bailey Creek	MU,W,S,F,M,H	Lasalle	1 mi NE Tonica, Tonica Rd.
50	DS-04	Vermilion River	MU	Lasalle	Oglesby, Hwy 23

Table 2. Mussel data for sites sampled during 2009-2012 surveys (Table 1) in the Illinois tributaries. Numbers in columns are live individuals collected, “D” and “R” indicates that only dead or relict shells were collected. Shaded boxes indicate historic collections at the specific site location obtained from the INHS Mollusk Collection records. 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. *historic count includes *Villosa iris*, not represented in the table, and does not include *Truncilla donaciformis*, newly collected in our survey.

Species	Mazon River and Upper Illinois															Vermilion-Illinois									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Subfamily Anodontinae																									
<i>Alasmidonta marginata</i>				R			1					1								1	R		1		1
<i>Alasmidonta viridis</i>															R						D				
<i>Anodontoides ferussacianus</i>						1	1		R		1	R	3			D	D	D				1	R		
<i>Lasmigona complanata</i>	4	1	R	3	R	R	8	4	1	10	D	10	1	R	R	9	3	21	34	1	D	R	D	13	12
<i>Lasmigona compressa</i>													1					1							
<i>Lasmigona costata</i>			1	R																					R
<i>Pyganodon grandis</i>	5	6	2	1	R	R	1	5	D		1	D	D	R		1	D	19			D	1		3	D
<i>Strophitus undulatus</i>	1	1		R	R	R	3	2	D	D	D	1	2			D	1	R	R	1	R	4	R	R	R
<i>Utterbackia imbecillis</i>		D												R											
Subfamily Amblesinae																									
<i>Amblesina plicata</i>		1	3	34	23		100		3	22		31				5	7	66	52	3	3	25	3	5	74
<i>Elliptio dilatata</i>																									D
<i>Fusconaia flava</i>			R	11		1	11	14	20	13		16				10	20	16	25	28	D	R	2	1	5
<i>Pleurobema sintoxia</i>				17	1												1		8	2					2
<i>Quadrula pustulosa</i>							5		D	7		2							18						36
<i>Quadrula quadrula</i>				3	5		1	1	2	1		1				14	10	1	97			1	1	14	26
<i>Tritogonia verrucosa</i>							56			28		72													
<i>Unio merus tetralasmus</i>																D	R								
Subfamily Lampsilinae																									
<i>Actinonaias ligamentina</i>												8													
<i>Lampsilis cardium</i>			R	2	R	1	3	1	4	5		25	1			D	1	1	1	3	D	11	R		18
<i>Lampsilis siliquoidea</i>	3	7	1	1	R	1	1	2	7	3	10	36	9	2	R			3		1	D		R		1
<i>Leptodea fragilis</i>			1	D	2		6	2	3	1		4				3	D		5					1	10
<i>Potamilus alatus</i>			D	6	1		1		1	5		38		D											
<i>Potamilus ohioensis</i>			R									R					D								
<i>Toxolasma parvum</i>	2	1	R			R		D					1				D		1						1
<i>Truncilla donaciformis</i>					1																				
<i>Truncilla truncata</i>			R	5	D		43			7		2													3
<i>Venustaconcha ellipsiformis</i>			R	D	1										D					1	3	1			R
Individuals collected	15	17	8	83	34	4	241	31	41	102	12	247	18	2	0	42	43	129	240	41	6	44	7	37	189
Live species collected	5	6	5	10	7	4	15	8	8	11	3	14	7	1	0	6	7	9	8	9	2	7	4	6	12
Extant species	5	7	6	12	8	4	15	9	11	12	5	15	8	2	1	12	10	10	8	9	8	7	5	6	14
Total species collected	5	7	13	15	13	8	15	9	12	12	5	17	8	5	4	12	11	11	9	9	10	9	9	7	17
Historical species richness	3	NDA	12	NDA	7	NDA	NDA	NDA	NDA	3	NDA	13	NDA	NDA	NDA	12	NDA	10	10	10	9	NDA	11	9	15
Catch per unit effort (CPUE)	3.75	4.25	2	20.75	8.5	1	60.25	7.75	10.25	25.5	3	61.75	4.5	0.5	0	10.5	10.75	32.25	60	10.25	1.5	11	1.75	9.25	47.25
Mussel Community Index (MCI)	7	10	11	14	10	5	14	8	12	10	7	14	10	4	0	14	12	13	13	11	15	13	7	7	15
Resource Classification	L	M	M	HV	M	L	HV	M	HV	M	L	HV	M	R	R	HV	HV	HV	HV	M	HV	HV	L	L	HV

Table 3. Mussel Community Index (MCI) parameters and scores.

Extant species in sample	Species Richness	Catch per Unit Effort (CPUE)	Abundance (AB) Factor
0	1	0-0.99	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 \geq 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. Variation of habitats in the upper (site 24; channelization) and lower reaches (site 48; exposed bedrock and boulder) of the Vermilion River.

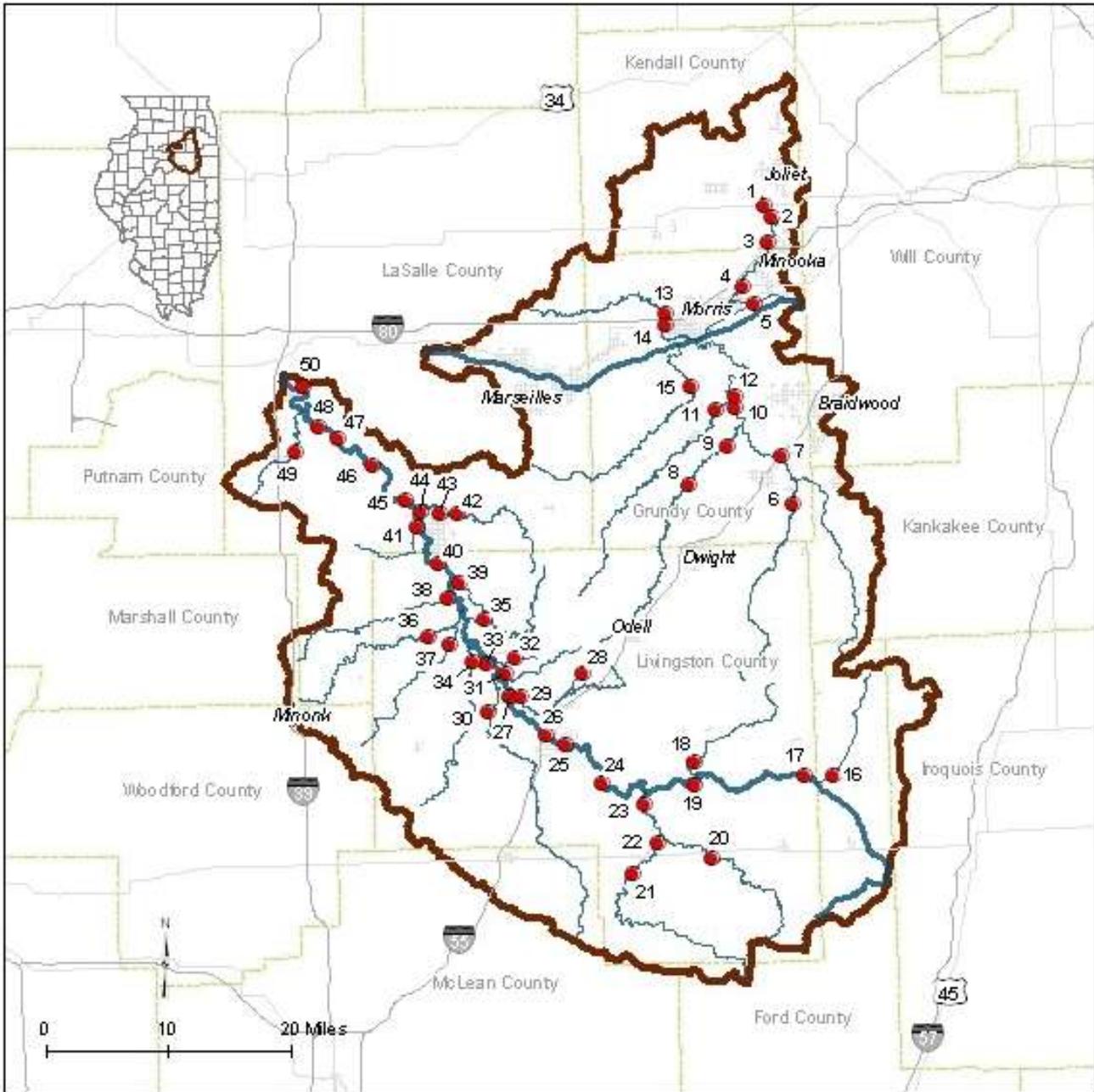


Figure 2. Sites sampled in the Illinois River tributaries in 2009 - 2012. Site codes referenced in Table 1.

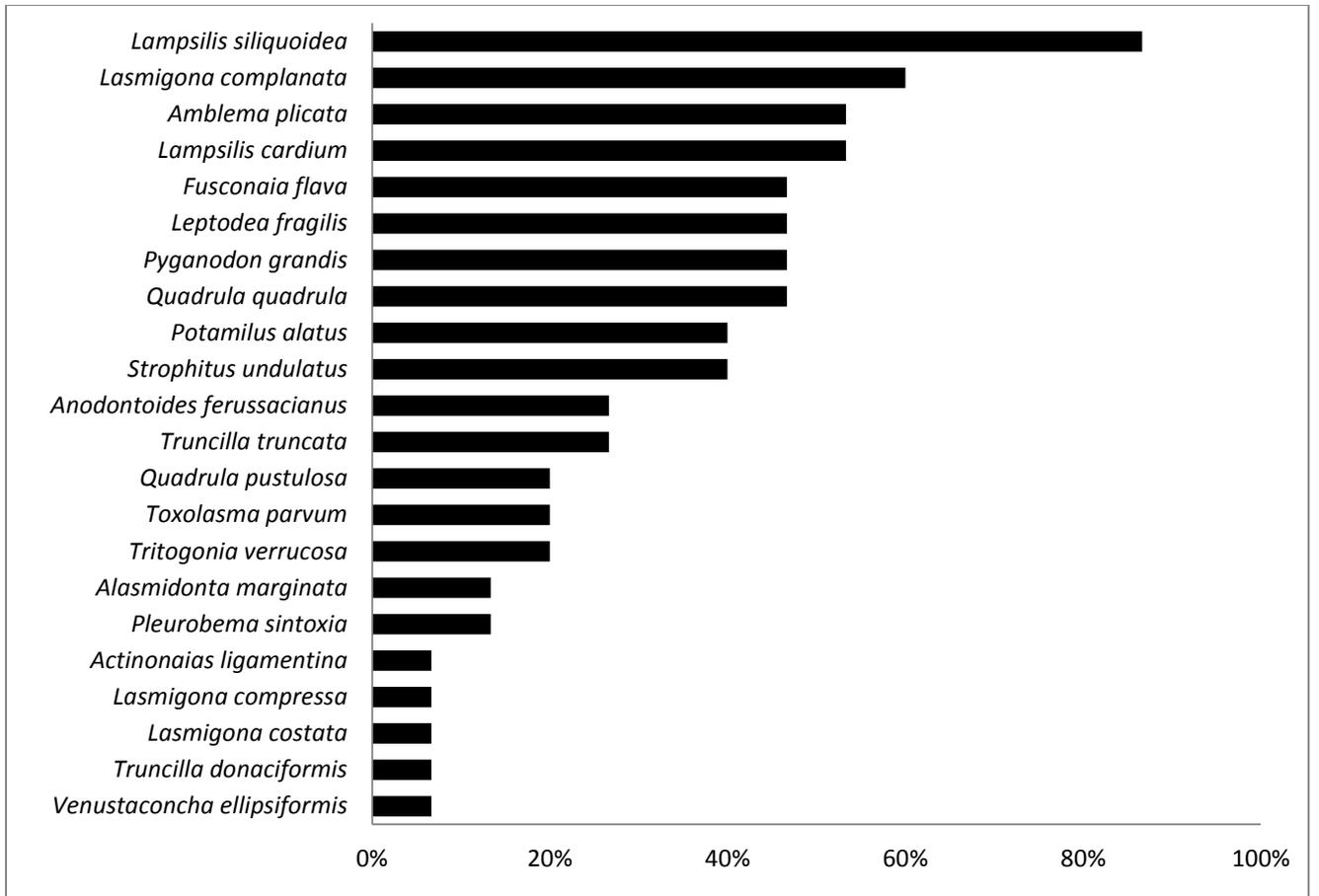


Figure 3. Number of sites where a species was collected live compared to the total number of sites sampled in the Mazon River and Aux Sable Creek tributaries (15 sites).

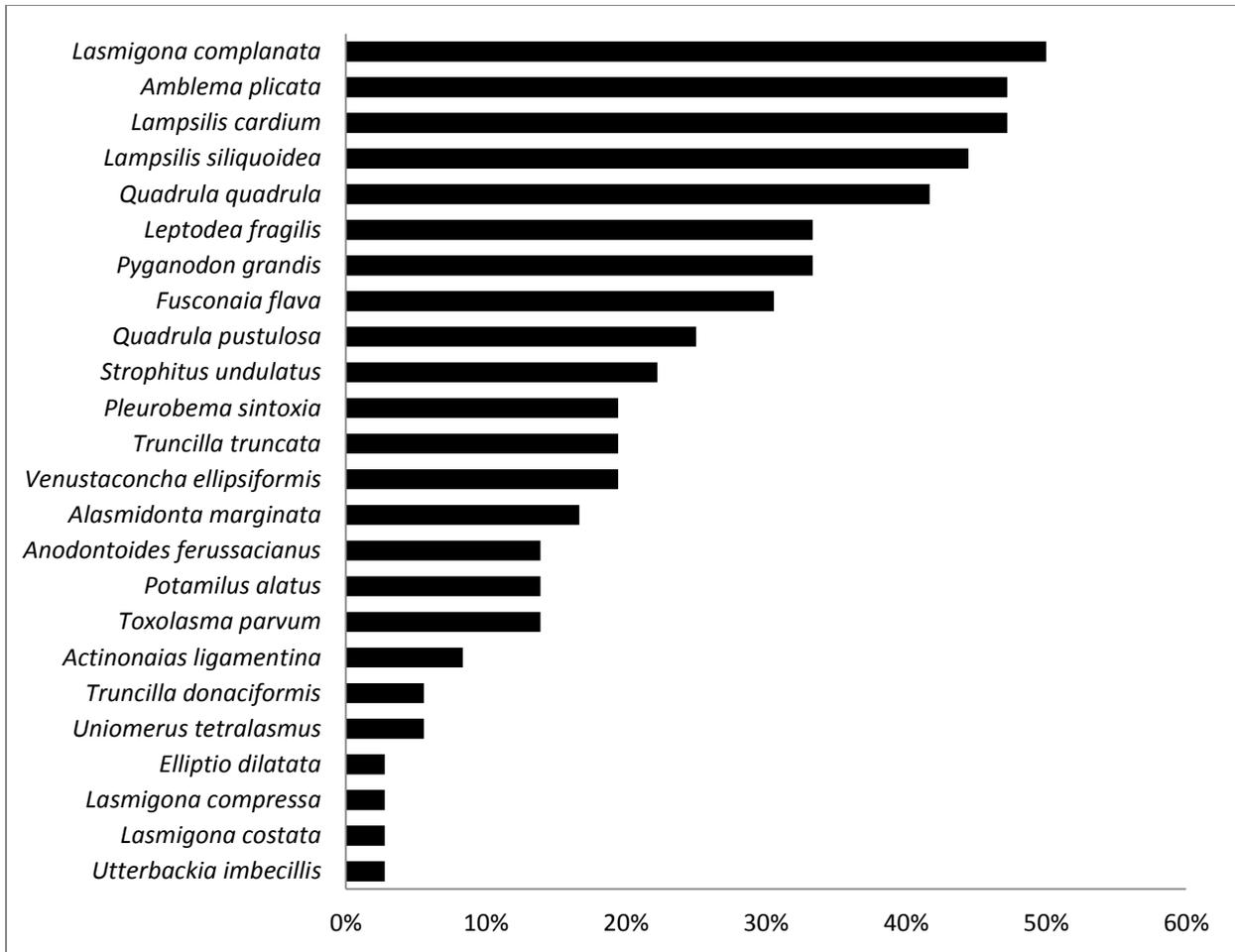


Figure 4. Number of sites where a species was collected live compared to the total number of sites sampled in the Vermilion-Illinois basin (35 sites).

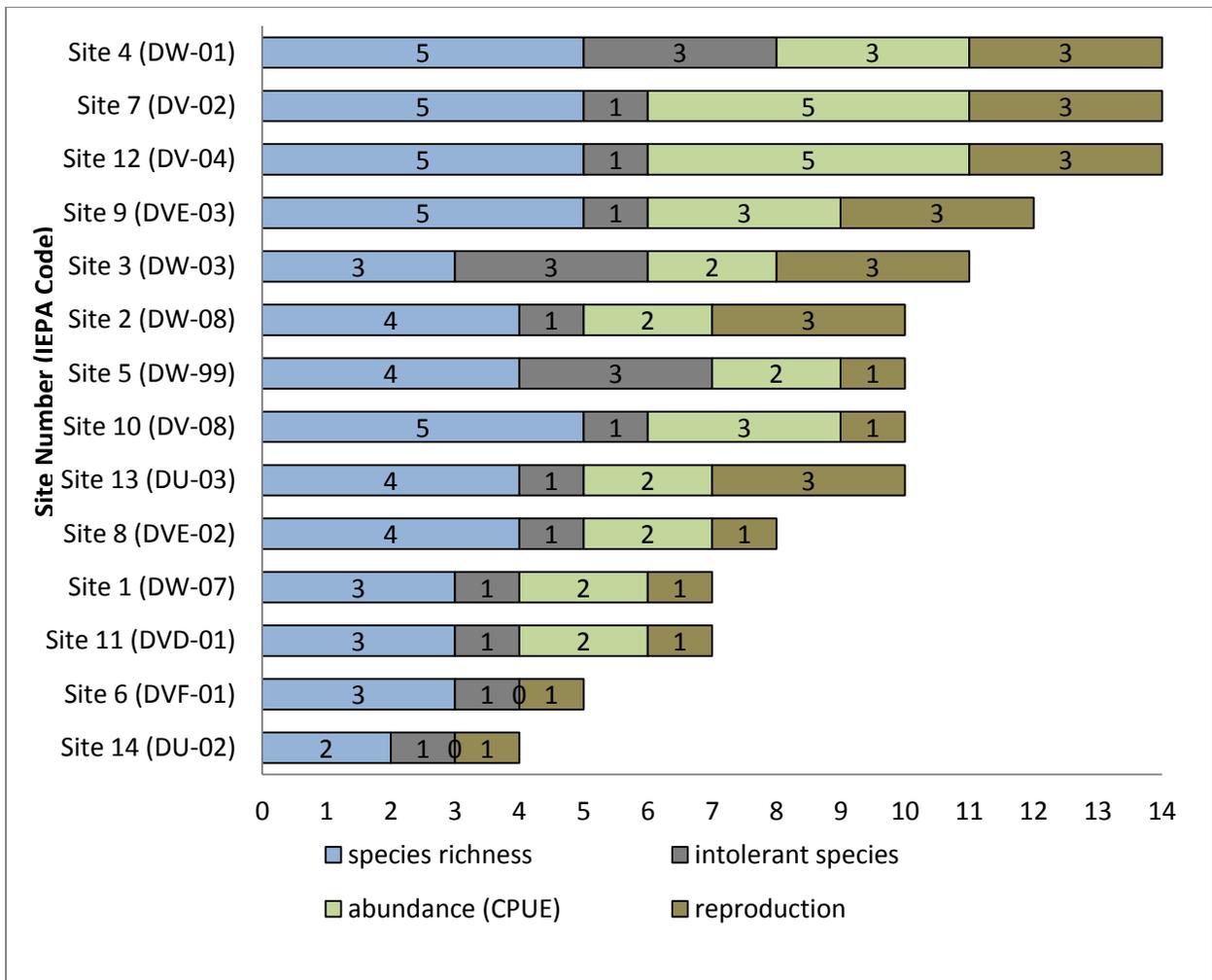


Figure 5. Comparison of Mussel Community Index (MCI) and MCI component scores for Mazon River and Aux Sable Creek sites based on factor values from Table 3.

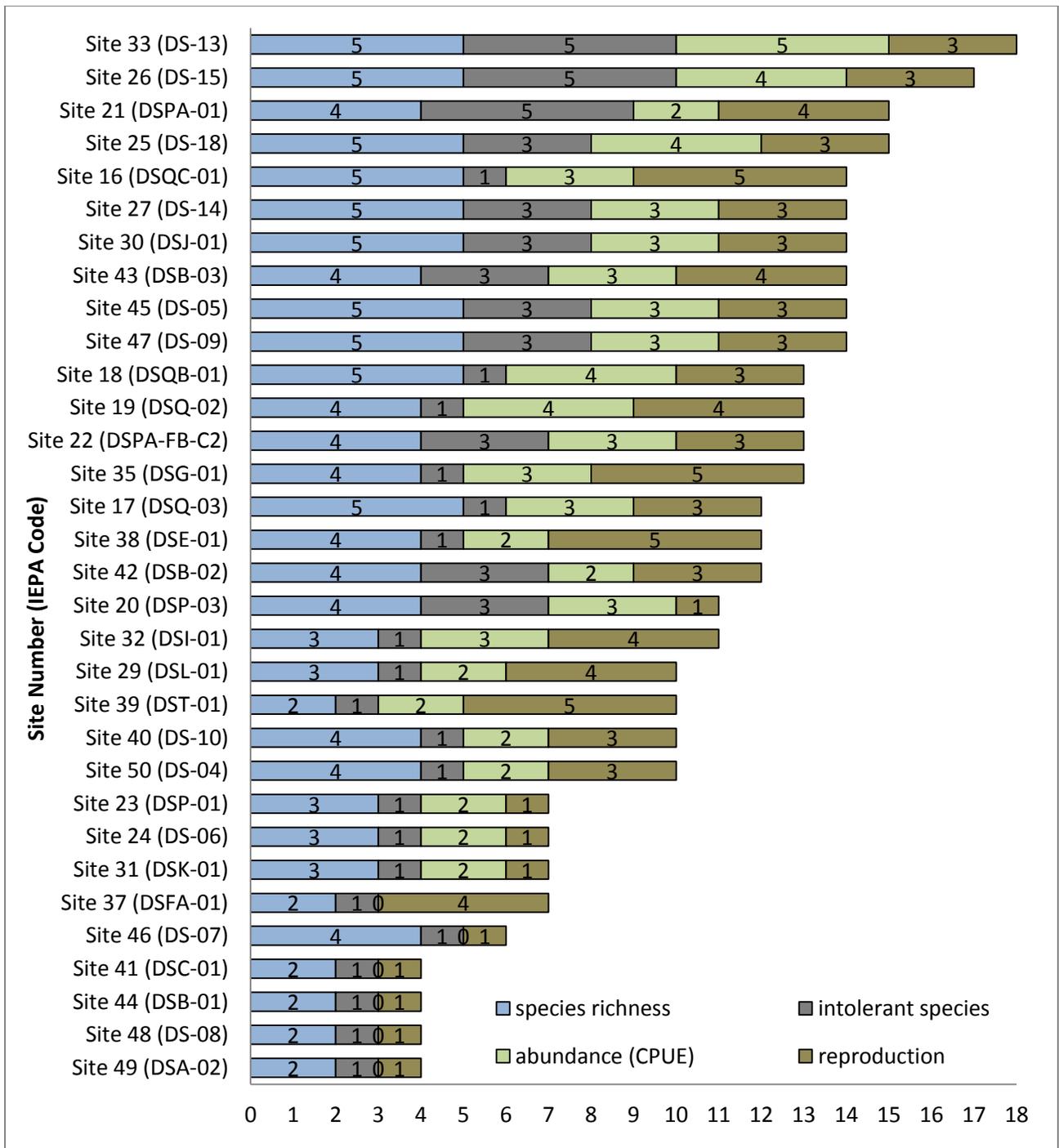


Figure 6. Comparison of Mussel Community Index (MCI) and MCI component scores for Vermilion River tributary sites based on factor values from Table 3.

Appendix 1. Scientific and common names of species. Status (in 2013): SGNC-Illinois' species in greatest need of conservation, ST-state threatened and SE-state endangered.

Scientific name	Common name	Status
Subfamily Anodontinae		
<i>Alasmidonta marginata</i>	elktoe	
<i>Alasmidonta viridis</i>	slippershell mussel	ST
<i>Anodontoides ferussacianus</i>	cylindrical papershell	
<i>Lasmigona complanata</i>	white heelsplitter	
<i>Lasmigona compressa</i>	creek heelsplitter	SGNC
<i>Lasmigona costata</i>	flutedshell	SGNC
<i>Pyganodon grandis</i>	giant floater	
<i>Strophitus undulatus</i>	creeper	
<i>Utterbackia imbecillis</i>	paper pondshell	
Subfamily Ambleminae		
<i>Amblema plicata</i>	threeridge	
<i>Elliptio dilatata</i>	spike	ST
<i>Fusconaia flava</i>	Wabash pigtoe	
<i>Megalonaias nervosa</i>	washboard	
<i>Pleurobema sintoxia</i>	round pigtoe	
<i>Quadrula quadrula</i>	mapleleaf	
<i>Tritogonia verrucosa</i>	pistolgrip	
<i>Uniomerus tetralasmus</i>	pondhorn	
Subfamily Lampsilinae		
<i>Actinonaias ligamentina</i>	mucket	
<i>Lampsilis cardium</i>	plain pocketbook	
<i>Lampsilis siliquoidea</i>	fatmucket	
<i>Leptodea fragilis</i>	fragile papershell	
<i>Potamilus alatus</i>	pink heelsplitter	
<i>Potamilus ohioensis</i>	pink papershell	
<i>Toxolasma parvum</i>	lilliput	
<i>Truncilla donaciformis</i>	fawnsfoot	
<i>Truncilla truncata</i>	deertoe	
<i>Venustaconcha ellipsiformis</i>	ellipse	SGNC
<i>Villosa iris</i>	rainbow	SE