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Freshwater Mussels of the Mackinaw River

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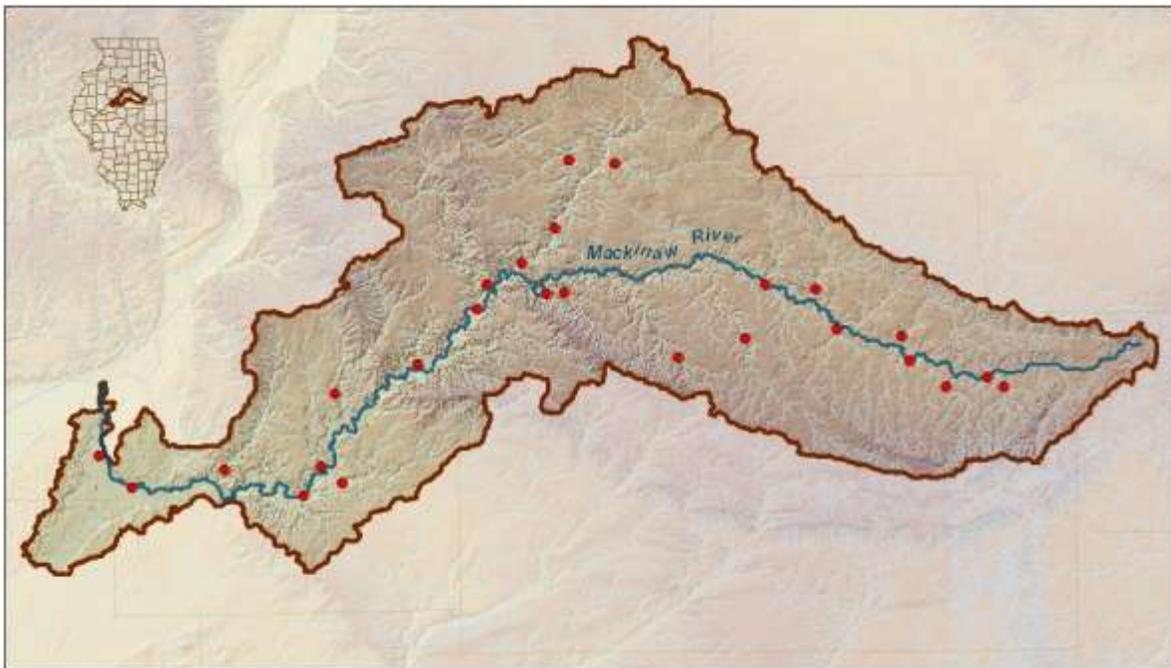
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Preface

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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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 2005). The Mackinaw River basin has been the source of several mussel surveys over the past few decades (Cummings et al. 1988, Retzer 1997, Cummings and Mayer 2001), and this report focuses solely on sites sampled in 2010 in conjunction with IDNR and IEPA basin surveys. Much of the Mackinaw River basin has been recognized as a Biologically Significant Stream in previously published reports (Page et al. 1992) and surveys by Cummings and Mayer (2001) found that the upper Mackinaw watershed had particularly diverse, dense, and intact mussel populations.

The Mackinaw River basin drains nearly 3000 km² (1136 mi²) in north-central Illinois and contains principal tributaries of Panther, Walnut and Money creeks (Cummings and Mayer 2001). It flows from east to west through Ford, McLean, Woodford, Tazewell, and Mason Counties, rising near Sibley in Ford County and emptying into the Illinois River south of Pekin in Tazewell County (Figure 1). The Mackinaw River basin flows through three natural divisions, including the Grand Prairie, Upper Mississippi River and Illinois Bottomlands, and Illinois and Mississippi Sand Areas (Schwegman 1973). The river flows through the El Paso, Eureka, Bloomington, and Shelbyville moraines, and these geologic features have influenced structure of the riverbed (Illinois Department of Natural Resources 1997). The river upstream of the Bloomington and Shelbyville moraines is a series of pools and fast-flowing riffles and lacks significant headwater marshes or impoundments (subsequently referred to as “upper section of watershed”; Page et al. 1992, Cummings and Mayer 2001). The character of the river downstream of the moraines is markedly different, with a relatively wide floodplain, large meanders and erosion-prone sandy banks (subsequently referred to as “lower section of watershed”; Illinois Department of Natural Resources 1997).

Land-use and Instream Habitat

The primary land use of the Mackinaw River basin is row-crop agriculture, which contributes to significant sedimentation in some areas (Illinois Department of Natural Resources 1997). The primary municipality in the region is the city of Bloomington-Normal, with a current population of approximately 130,000 people and located just south of the Mackinaw River basin (US Census Bureau 2010). Two man-made impoundments, Evergreen Lake (Six Mile Creek) and Lake Bloomington (Money Creek), serve as water supplies for the city. Effluent is discharged

downstream of Lake Bloomington, and several other smaller municipalities discharge into tributaries within the basin.

Substrates throughout the Mackinaw River basin are variable, but are primarily comprised of sand and gravel with lesser amounts of cobble and silt. Boulder and clay are less common, and bedrock is nearly absent in these streams. Due to the extensive agricultural practices, most streams are channelized and lack natural vegetation in the riparian zone (Figure 2). Instream habitat of sites in the upper section of the watershed consist of a mix consolidated sand, gravel, silt, and cobble, with riffles, runs, and shallow pools and occasional patches of emergent aquatic vegetation (e.g. water willow; *Justicia americana*). Much of the Panther Creek system and the Mackinaw River between Colfax in McLean County and the confluence with Panther Creek (Woodford County) is forested, naturally meandering, and supports fairly diverse mussel communities. Instream habitat is sand, gravel, silt, and cobble, with areas of large woody debris. The Mackinaw River mainstem and tributaries downstream of the confluence with Panther Creek (e.g., Mud Creek, Dillon Creek, Little Mackinaw River) are higher gradient streams with varying substrates. Unconsolidated sand, sloughing banks, and woody debris are more common here, although some tributaries (e.g., site 24; Dillon Creek) had substrate that was primarily boulder, cobble, and gravel. Features that may limit mussel occupancy in the lower section of the watershed include large areas of unconsolidated sand (Figure 3), sloughing banks with treefalls, as well as accumulated runoff from several municipalities upstream. During summer and fall months, most of the tributary streams and the Mackinaw River are wadeable, with average depths less than three feet.

Methods

During the 2010 survey, freshwater mussel data were collected at 26 sites: eight mainstem and 18 tributary sites in the Mackinaw River basin (Figure 1) from June to September. Locations of sampling sites are listed in Table 1 along with information regarding IDNR/IEPA sampling at the site. In most cases, mussel survey locations were the same as IDNR/IEPA sites.

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 most sites, and a 16-hour survey was completed at two sites to fulfill the sampling objectives for a separate project (Table 1). 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, 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 30mm 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 30 species of freshwater mussels were observed in the Mackinaw River basin, 25 of which were live (Table 2). Across all sites, the number of live species collected ranged from 0 to 13, the number of extant species collected (live + dead) ranged from 0 to 15, and the total number of species collected (live + dead + relict) ranged from 1 to 19. The plain pocketbook (*Lampsilis cardium*) had the most occurrences across sites sampled and was collected at 17 of 26 sites (68%; Figure 4). The fatmucket (*Lampsilis siliquoidea*), white heelsplitter (*Lasmigona complanata*), cylindrical papershell (*Anodontoides ferussacianus*), creeper (*Strophitus undulatus*), and Wabash pigtoe (*Fusconaia flava*) were other commonly occurring species (Figure 4), occupying between 58% and 42% of sites.

Abundance and Recruitment

A total of 2471 individuals were collected across 26 sites. The number of live specimens collected at a given site ranged from 0 to 678, with an average of 103 mussels per site where live mussels were collected (median=73). A total of 128 collector-hours were spent sampling with an average of 20 mussels collected per hour at sites where mussels were present. Live mussels were collected at nearly every site in the basin (24 of 26 sites; Table 2), and 20 sites, or 77% of sites, yielded more than 10 individuals. Of those 20 sites, nine sites yielded more than 100 live individuals. Three of the most upstream sites in the basin (sites 1, 2, and 4) had very

dense mussel populations and had catch per unit effort values of over 50 mussels per hour. A total of 1104 fatmuckets (*Lampsilis siliquoidea*), were collected at 15 sites (44.7% of the total; Table 2), and fatmuckets were the most common species collected across all sites. Other common species included the plain pocketbook (*Lampsilis cardium*; n=248), threeridge (*Amblema plicata*; n=171), white heelsplitter (*Lasmigona complanata*; n=153), cylindrical papershell (*Anodontooides ferussacianus*; n=116) and giant floater (*Pyganodon grandis*; n=115).

Recruitment for each species was determined by the presence of individuals less than 30 mm or with three 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 at individual sites ranged from none observed to moderate across the basin. Recruitment levels, referred to in Table 3 as Reproduction Factor, varied from 1 to 4, and 70% of sites had no reproduction observed. One site, Frog Alley, had a Reproduction Factor of 4 (indicating 30-50% of species exhibiting reproduction) and all other sites where live mussels were observed had less than 30% of species exhibiting reproduction.

Mussel Community Classification

Based on the data collected in the 2010 basin survey, 70% of the sites in the Mackinaw River basin are classified as Moderate, Highly Valued, or Unique mussel resources under the current MCI classification system (Table 4, Figure 5). Three sites, the Mackinaw River (site 2; southeast of Colfax), Henline Creek, and Frog Alley stand out as Unique Resources due to the presence of intolerant species, the number of mussels collected, and the species richness of the site. The sites classified as Highly Valued mussel resources were the Mackinaw River (sites 4 and 8) and three sites within the Panther Creek drainage (East and West Branch, and Panther Creek, site 15). Eight sites (sites 11 and 20-26) were considered Limited or Restricted mussel resources, and all but Denman Creek (site 11) are located in the lower half of the watershed.

Noteworthy Finds

This survey collected 25 live species and 30 total species, and 31 species were known historically from the Mackinaw River basin. Of the 30 species recorded during this survey, two species, the threehorn wartyback (*Obliquaria reflexa*) and the pondmussel (*Ligumia subrostrata*), have never been recorded in the Mackinaw River basin previously. *Obliquaria reflexa* was represented by one live specimen found in the Mackinaw River at site 19, while one relict shell of *Ligumia subrostrata* was recorded from the Mackinaw River at site 8. This survey

found no occurrences (live, dead, or relict) for three species that are included in the historical species count of 31: rock pocketbook (*Arcidens confragosus*), pistolgrip (*Tritogonia verrucosa*), and rainbow (*Villosa iris*). According to Cummings and Mayer (2001), these species were considered to have always been relatively rare in the basin; the rainbow is state-endangered and extremely rare statewide.

Five species, spike (*Elliptio dilatata*), flutedshell (*Lasmigona costata*), mucket (*Actinonaias ligamentina*), black sandshell (*Ligumia recta*), and pondmussel (*Ligumia subrostrata*) were only represented in these surveys by relict shell. Another species, the elktoe (*Alasmidonta marginata*), was represented by few records during our surveys. Live elktoe or elktoe shells have been collected historically from 10 of the sites sampled in this survey, yet our survey located only one live individual, one dead individual, and three relict shells at a total of five sites.

The slippershell (*Alasmidonta viridis*) was located alive at three sites in the upper section of the Mackinaw River basin: Frog Alley, Henline Creek and the most upstream Mackinaw River mainstem site. The slippershell is state-threatened and was considered in decline or absent in the Mackinaw River as of 1987 (Page et al. 1992). Several subsequent surveys located live slippershell in the Mackinaw River basin (Retzer 1997, Cummings and Mayer 2001) and our findings reinforce these records. The ellipse (*Venustaconcha ellipsiformis*), considered an intolerant species (Table 4), was represented by fairly large populations at seven sites in the upper section of the drainage (Table 2). These occurrences also support findings by Cummings and Mayer (2001), who located several large populations of ellipse in the upper section of the Mackinaw watershed.

Discussion

Two species of mussels, the pondmussel and the threehorn wartyback, were found during our survey that had previously been undetected in the Mackinaw River basin. The pondmussel is fairly common throughout its range and uses Centrarchid fish hosts, such as Green Sunfish, Bluegill, or Largemouth Bass (Williams et al. 2008). The threehorn wartyback is another fairly common species in larger rivers throughout its range, and several minnow species have been documented as host fish for this mussel (Williams et al. 2008). Several theories could explain the occurrence of new species in the Mackinaw River, including colonization from a fish introduction, movement from other water bodies (e.g., farm ponds during a flood event, or failure to detect a population in previous surveys).

Based on this survey and recent surveys by Cummings and Mayer (2001), we have identified several species that may be extirpated in the Mackinaw River basin. Extant records for the black sandshell, flutedshell, pistolgrip, mucket, rainbow, rock pocketbook, and spike were not

located during this survey or recent past surveys. Black sandshell, rainbow, and spike are all state-listed species and are rare throughout their range in Illinois. Flutedshell, mucket, pistolgrip, and rock pocketbook seem to have always been relatively rare in the Mackinaw River basin (Cummings and Mayer 2001), and it is possible that large river specialists like the mucket do not have suitable habitat in this basin.

Recruitment

While the data collected during this survey indicates that very recent recruitment may not be occurring at most sites, most mussels collected during these basin surveys were less than 10 years old (i.e., counted rings were less than 10 and shells had little or no erosion present). The populations observed in most streams appeared to be viable and within the age range thought to be reproductively active (Haag and Staton 2003). We observed gravid females at several locations, including sites where no juveniles were collected (e.g., Mackinaw River, site 23). Sampling methods to target juvenile mussels are necessary to better assess the reproductive status of populations in the Mackinaw River.

Mussel community of the Mackinaw River basin

Our surveys documented the existence of 28 of the 31 species known historically from the Mackinaw River basin. Additionally, our surveys found that 24 of these species were represented by live individuals. The mussel communities collected at many sites suggest relatively intact freshwater mussel communities, since the number of extant species was nearly the same as historic species records or relict shell collected. At many sites (numbers 1-7, 9, 10, and 13-16, 19), the number of extant species comprised at least 75% of the total number of species collected. Furthermore, at over half of the sites with historic data available (10 sites, 19 total), the 2010 survey turned up as many or more species than were historically known.

While the streams in the upper section of the watershed appear heavily impacted by agriculture, our survey found that the upper Mackinaw drainage is capable of supporting biologically significant mussel communities. The eight sites sampled that are considered Highly Valued or Unique Mussel Resources were all located in the upper section of the Mackinaw drainage. Cummings and Mayer (2001) described what they considered atypical mussel populations in the upper drainage; the greatest diversity of mussels was found where agriculture has been most intensive. In contrast to these apparent intact mussel communities, three sites on the Mackinaw are showing signs of species decline. At three sites on the Mackinaw River (sites 18, 23, and 25), over half of the species collected were represented only by relict shells. These findings are consistent with those of Cummings and Mayer (2001), who noted an uncharacteristic decline in mussel diversity and abundance in sites located downstream of the town of Mackinaw (near site 19; Figure 1). As mentioned in the

introduction, the river changes markedly downstream of Mackinaw due to the river having passed through several moraines. The structural change of the river is likely influencing the richness of the mussel community.

Literature Cited

Bogan, A.E. 1993. Freshwater bivalve extinctions (Mollusca: Unionoida): a search for causes. *American Zoologist* 33(6):599-609.

Cummings, K.S., and C.A. Mayer. 2001. The freshwater mussels (Mollusca: Bivalvia: Unionidae) of the Mackinaw River drainage, Illinois. Prepared for The Nature Conservancy, Central Illinois Field Office, Peoria, Illinois. Center for Biodiversity Technical Report 2001(17):1-25.

Haag, W. R. and J.L. Staton. 2003. Variation in fecundity and other reproductive traits in freshwater mussels. *Freshwater Biology* 48:2118-2130.

Illinois Department of Natural Resources. 1997. Critical Trends Assessment Program: Mackinaw River Area Assessment. Published by the State of Illinois.

Illinois Department of Natural Resources. 2005. The Illinois Comprehensive Wildlife Conservation Plan and Strategy, Version 1.0. Illinois Department of Natural Resources, Springfield, Illinois.

Illinois Endangered Species Protection Board. 2011. Checklist of Endangered and Threatened Animals and Plants of Illinois. Illinois Endangered Species Protection Board, Springfield, Illinois. 18 pp.

Page, L.M., K.S. Cummings, C.A. Mayer, S.L. Post, and M.E. Retzer. 1992. Biologically significant Illinois streams, an evaluation of the streams of Illinois based on aquatic biodiversity. Technical Report. Illinois Department of Conservation and Illinois Department of Energy and Natural Resources, Springfield, Illinois. 498 pp.

Retzer, M.E. 1997. Assessment of the water quality, fish, mussel communities of the Mackinaw River, Illinois. Final report under USEPA grant # X995714-01-0, The Nature Conservancy, Central Field Office, Peoria, Illinois.

Schwegman, J.E. 1973. Comprehensive plan for the Illinois nature preserves system. Part 2. The natural divisions of Illinois. Illinois Nature Preserves Commission, Springfield, Illinois.

Strayer, D.L., J.A. Downing, W.R. Haag, T.L. King, J.B. Layzer, T.J. Newton, and S.J. Nichols. 2004. Changing perspective on pearlymussels, North America's most imperiled animals. *BioScience* 54(5):429-439.

Szafoni, R. E. 2001. Protocol for integrating freshwater mussel surveys into IDNR / IEPA stream basin surveys. Version 2.0. IDNR/ORC/Natural Heritage, Charleston, IL. 5pp.

Turgeon, D.D., A.E. Bogan, E.V. Coan, F.G. Hochberg, W.G. Lyons, P.M. Mikkelsen, J.F. Quinn, Jr.,

C.F.E. Roper, G. Rosenberg, B. Roth, A. Scheltema, M.J. Sweeney, F.G. Thompson, M. Vecchione, and J.D. Williams. 1998. Common and scientific names of aquatic invertebrates from the United States and Canada: Mollusks. 2nd Edition. American Fisheries Society, Special Publication 26:ix-526.

U.S. Census Bureau; 2010 Census National Summary File of Redistricting Data; generated by Alison Price; using Quick Facts; <[http:// quickfacts.census.gov](http://quickfacts.census.gov) >; (1 November 2011)

Williams, J.D., A. E. Bogan, J. T. Garner. 2008. Freshwater mussels of Alabama and the Mobile Basin in Georgia, Mississippi, and Tennessee. University of Alabama Press, Tuscaloosa.

Williams, J.D., M.L. Warren, Jr., K.S. Cummings, J.L. Harris, and R.J. Neves. 1993. Conservation status of freshwater mussels of the United States and Canada. *Fisheries* 18(9):6-22.

Table 1. 2010 Mackinaw River Intensive Basin Survey. Types of samples include MU-mussel sampling, F-fish sampling (electric seine or boat electrofishing), FF-fish flesh contaminate, H-habitat, M-macroinvertebrate, S-sediment, W-water chemistry. Sites where a 16-hour sample was completed are noted with an asterisk (*).

Site Number	IEPA Code	Stream	Types of Samples	County	Location	Watershed Area (km ²)
1	DKZE-01	Frog Alley	MU, W,F,H,M	McLean	2 mi SW Anchor, Co. Rd. 1800N bridge	33.5
2	DK-29	Mackinaw River	MU, W,F,H,M	McLean	1.5 mi SE Colfax, Co. Rd. 3600E bridge	174.3
3	DKZD-01	Bray Creek	MU, W,F,H,M	McLean	1.5 mi S Colfax, Co. Rd. 1800N	41.5
4	DK-21	Mackinaw River	MU, W,F,H,M	McLean	3 mi W Colfax, Co. Rd. 3075E	267.3
5	DKV-01	Henline Creek	MU, W,F,H,M	McLean	4 mi NW Colfax, Co. Rd. 2150N	106.7
6	DKT-01	Crooked Creek	MU, W,F,H,M	McLean	2.5 mi SSE Lexington, Co. Rd. 2200N bridge	76.0
7	DKS-01	Turkey Creek	MU, W,S,F,H,M	McLean	0.5 mi W Lexington, P.J. Kellar Hwy. bridge	85.6
8*	DK-20	Mackinaw River	MU, W,F,H,M	McLean	4 mi W Lexington, abandoned bridge off PJ Kellar Highway	695.7
9	DKP-02	Money Creek	MU, W,F,H,M	McLean	2.5 mi N Towanda, Co. Rd. 1975E bridge	112.1
10	DKN-02	Six Mile Creek	MU, W,F,H,M	McLean	1.5 mi S Hudson, Co. Rd. 2000N bridge	56.3
11	DKM-01	Denman Creek	MU, W,F,H,M	Woodford	4.1 mi N Carlock, Co. Rd. 355N bridge	30.0
12	DK-17	Mackinaw River	MU, W,F,H,M	Woodford	2.5 mi NE Congerville, Parklands Foundation canoe launch	1248.6
13	DKKC-02	East Branch Panther Creek	MU, W,F,H,M	Woodford	3.1 mi NW El Paso, Co. Rd. 2525E bridge	99.7
14	DKKB-01	West Branch Panther Creek	MU, W,F,H,M	Woodford	2 mi NNE Secor, Co. Rd. 1250N bridge	132.0
15	DKK-02	Panther Creek	MU	Woodford	2 mi S Secor, Co. Rd. 800N bridge	443.8
16*	DKK-01	Panther Creek	MU, W,F,H,M	Woodford	4 mi NNE Congerville, Schumm Rd./Co. Rd. 5545N	494.0
17	DKJ-01	Walnut Creek	MU, W,F,H,M	Woodford	2 mi E Goodfield, co. Rd. 1625 bridge	181.7
18	DK-16	Mackinaw River	MU, W,FF,F,H,M	Woodford	2 mi WNW Congerville, Rt. 150 bridge	1961.7
19	DK-15	Mackinaw River	MU, W,FF,F,H,M	Tazewell	3 mi NE Mackinaw, Mackinaw River State Fish & Wildlife Area, canoe launch	2115.7
20	DKG-02	Mud Creek	MU, W,F,H,M	Tazewell	3.6 mi W Mackinaw, Co. Rd. 1500N	21.2
21	DKE-03	Little Mackinaw River	MU, W,F,H,M	Tazewell	2 mi N Hopedale, Valley Rd. bridge	132.8
22	DKF-11	Prairie Creek	MU, W,F,H,M	Tazewell	3.6 mi NNW Hopedale, Co. Rd. 1000N bridge	58.4
23	DK-19	Mackinaw River	MU, W,FF,F,H,M	Tazewell	3 mi NW Hopedale, old Rt. 121 bridge	2539.4
24	DKC-01	Dillon Creek	MU, W,F,H,M	Tazewell	4.7 mi ESE Pekin, Co. Rd. 1000N/Straub Rd. bridge	91.0
25	DK-12	Mackinaw River	MU, W,F,H,M	Tazewell	3 mi NW Green Valley, Wagonseller Bridge/Co. Rd. 1250E	2820.4
26	DKB-01	Hickory Grove Ditch	MU, W,F,H,M	Tazewell	4.3 mi NNE Manito, Townline Rd. bridge	30.0

Table 2. Mussel data for sites sampled during 2010 surveys (Table 1). 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. Species in bold are federally or state-listed species or species in Greatest Need of Conservation by IL DNR. *16-hour survey. **includes *Arcidens confragosus*, *Tritogonia verrucosa*, and *Villosa iris*, which are not represented in the table.

Species	Site Number																										Proportion of Total
	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	26	
Subfamily Anodontinae																											
<i>Alasmidonta marginata</i>		D										R				1	R								R		
<i>Alasmidonta viridis</i>	1	4			10			R				R															
<i>Anodontoides ferussacianus</i>	41	1	5	2	1	2	4	R	1		R	15	41	2	R	1				R							
<i>Lasmigona complanata</i>				2			3	4		35	1	36	31	19	14	2	D	5				R	D		1	R	
<i>Lasmigona compressa</i>						R	2					1														D	
<i>Lasmigona costata</i>											R														R		
<i>Pyganodon grandis</i>		18			D		51	D		45			1		D	R	R								D	R	
<i>Strophitus undulatus</i>	1	9	D	2			2	R	2			5	4	2	1	3	D	D	2	R		R	R				
<i>Utterbackia imbecillis</i>										R		1	3	1													
Subfamily Ambleminae																											
<i>Amblema plicata</i>		76		20	2		7	R				R	51	12	1	1	R	1	R					R		R	
<i>Elliptio dilatata</i>												R							R								
<i>Fusconaia flava</i>		24		26	2		D	13	13			R	6	1	14	3	1	R	1					R	R		
<i>Pleurobema sintoxia</i>		6		8				24				15			1	2		3						R	R		
<i>Quadrula pustulosa</i>				6				10				16			3	9		10	3						R		
<i>Quadrula quadrula</i>							D					5	1		4	2		R									
<i>Unio merus tetralasmus</i>							R			5			1									R	R				
Subfamily Lampsilinae																											
<i>Actinonaias ligamentina</i>																				R				R	R		
<i>Lampsilis cardium</i>	4	51	4	13	2	1		39				24	D		4	41	17	14	16	2	R	1	14	1	R		
<i>Lampsilis siliquioidea</i>	197	467	87	125	82	7	6	46				3	36	17	5	15	9	2	D				R	R	R		
<i>Lampsilis teres</i>		1		2				10				1		8	13	21	7	6	R		5	R	R	R	D		
<i>Leptodea fragilis</i>		1		D				1	D			4		1	D	5	R	D	9	R	R	D	2	1	R		
<i>Ligumia recta</i>																							R	R			
<i>Ligumia subrostrata</i>								R																			
<i>Obliquaria reflexa</i>																			1								
<i>Potamilus alatus</i>		1		1				11				1			4	11	1	R	2				D		R		
<i>Potamilus ohioensis</i>												R											D		2		
<i>Toxasma parvum</i>		D					D				10	R	17	2	D						1	2	R		R		
<i>Truncilla donaciformis</i>								R				1							R	1				R			
<i>Truncilla truncata</i>												1							R	2				R			
<i>Venustaconcha ellipsiformis</i>	1	19	27	18	23	2	R	9	D							R		R							R		
Totals																											
Individuals collected	202	646	118	219	111	10	13	163	13	5	10	71	112	41	49	110	35	36	35	3	7	1	16	0	4	0	
Live Species	3	8	3	9	5	3	2	9	1	1	1	10	6	6	9	10	5	6	8	2	2	1	2	0	3	0	
Extant Species	3	9	3	10	5	3	4	10	3	1	1	10	7	6	11	10	5	7	9	2	2	2	4	0	3	1	
Total Species	3	9	3	10	5	3	6	13	3	1	1	15	7	6	11	11	7	14	12	3	5	5	14	1	14	3	
Historical Species	7	14	6	16	13	9	NDA	14	11	4	NDA	17	NDA	11	14	20	8	20	NDA	NDA	5	4	15	NDA	14	NDA	
Catch per unit effort (CPUE)	50.5	161.5	29.5	54.8	27.8	2.5	3.3	10.2	3.3	1.3	2.5	17.8	28.0	10.3	12.3	6.9	8.8	9.0	8.8	0.8	1.8	0.3	4.0	0.0	1.0	0.0	
Mussel Community Index (MCI)	17	16	11	13	16	11	11	12	9	8	6	10	13	12	12	9	8	8	10	4	6	4	7	0	7	0	
Resource Classification	U	U	M	HV	U	M	M	HV	M	M	L	M	HV	HV	HV	M	M	M	M	R	L	R	L	R	L	R	

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
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

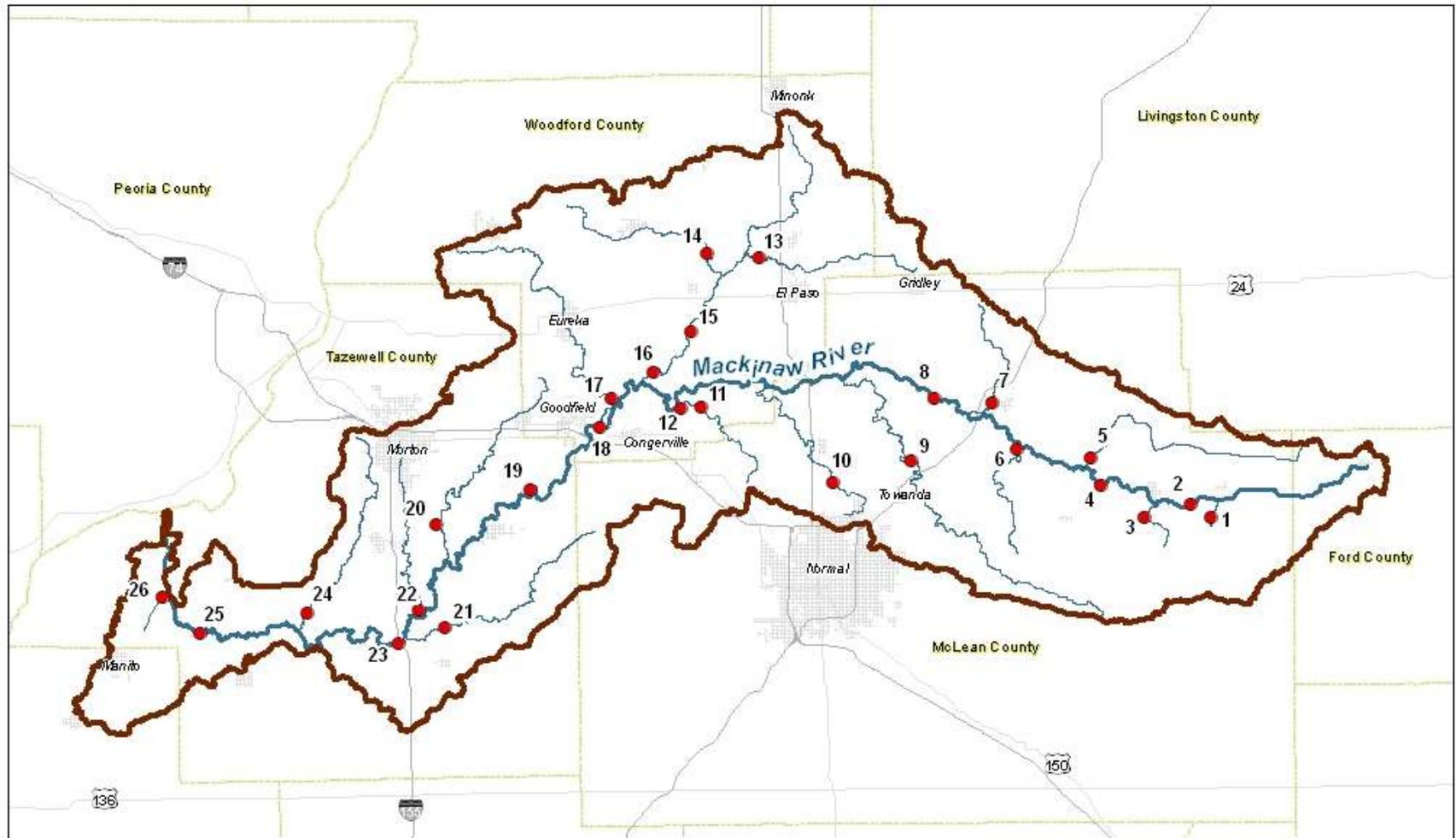


Figure 1. Sites sampled in the Mackinaw River basin in 2010. Site codes referenced in Table 1.



Figure 2. Mackinaw River mainstem at most upstream site sampled (Site 2). Note sand/gravel substrate, channelized structure, and lack of riparian zone. During the survey, 678 individuals were collected.



Figure 3. Mackinaw River mainstem at furthest downstream site sampled (Site 25). Note prominent sand bars and shifting sand. During the survey, 5 individuals were collected.

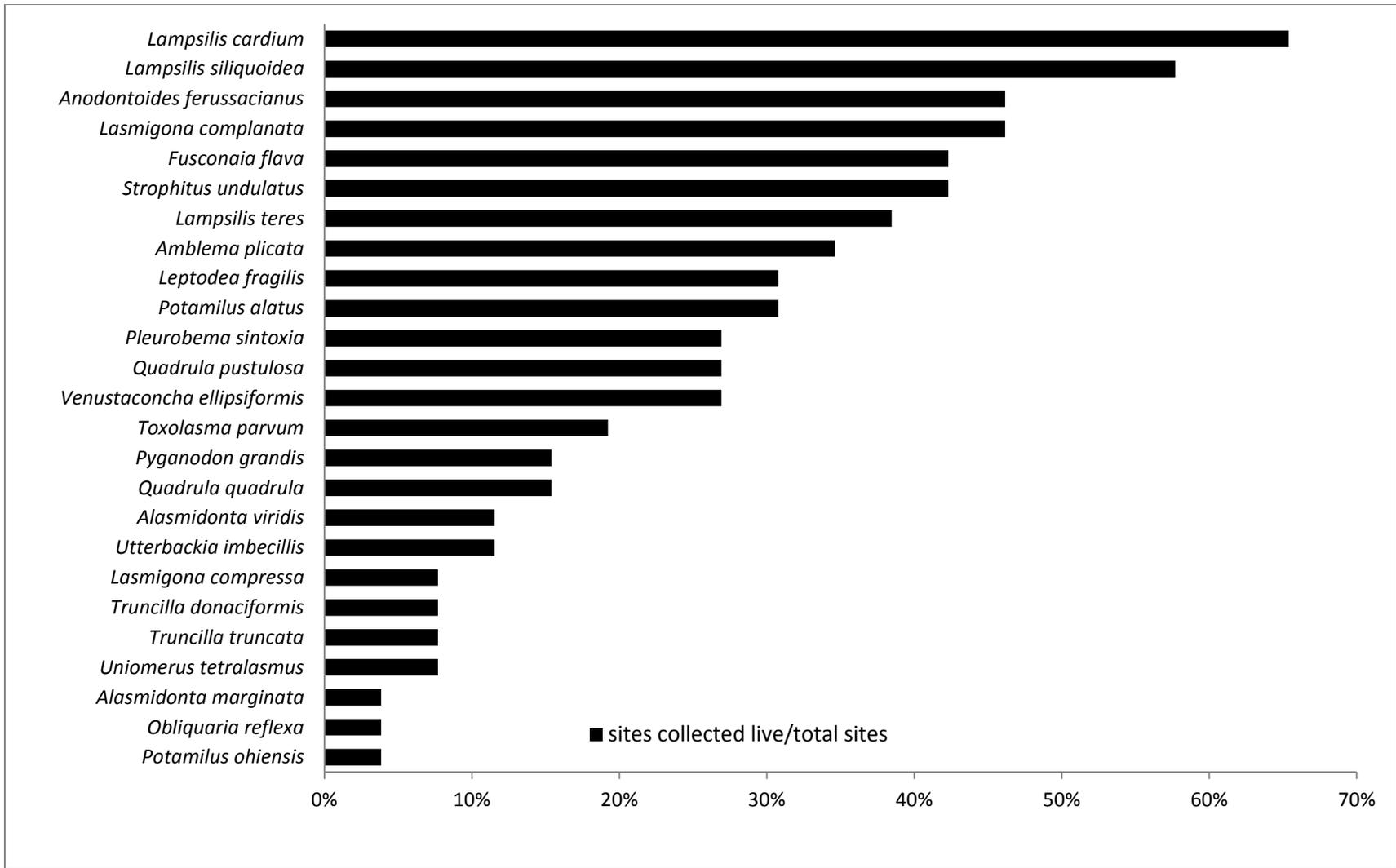


Figure 4. Number of sites where a species was collected live compared to the number of total sites sampled (26 total sites).

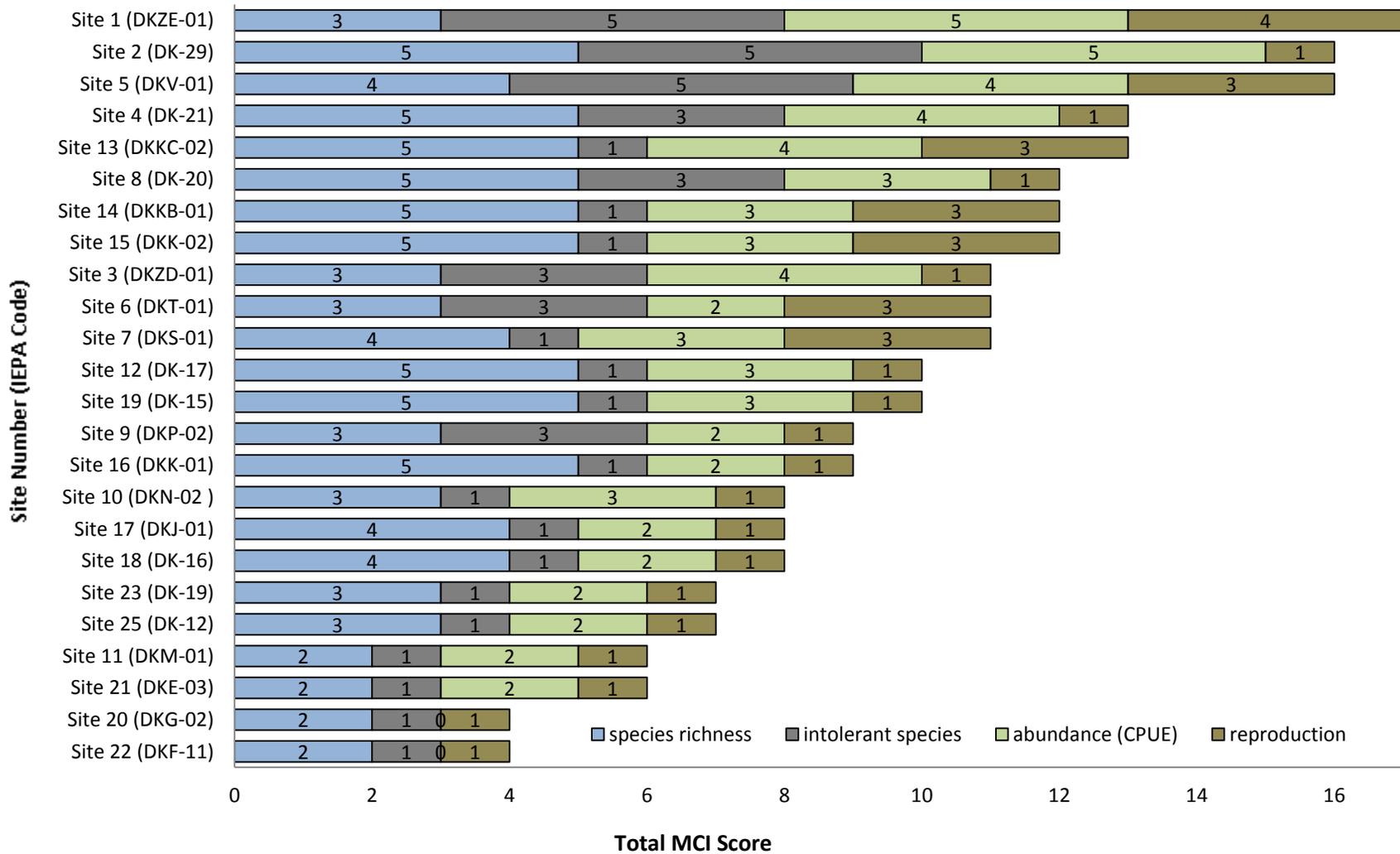


Figure 5. Comparison of Mussel Community Index (MCI) and MCI component scores for Mackinaw River basin sites based factor values from Table 3.

Appendix 1. Scientific and common names of species. Status refers to conservation status in Illinois at time of printing (December 2011); ST-state threatened, SE-state endangered, SGNC-Species in Greatest Need of Conservation.

Scientific name	Common name	Status
Subfamily Anodontinae		
<i>Alasmidonta marginata</i>	elktoe	
<i>Alasmidonta viridis</i>	slippershell	ST
<i>Anodontoides ferussacianus</i>	cylindrical papershell	
<i>Arcidens confragosus</i>	rock pocketbook	SGNC
<i>Lasmigona complanata</i>	white heelsplitter	
<i>Lasmigona compressa</i>	creek heelsplitter	SGNC
<i>Lasmigona costata</i>	flutedshell	
<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>Pleurobema sintoxia</i>	round pigtoe	
<i>Quadrula pustulosa</i>	pimpleback	
<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>Lampsilis teres</i>	yellow sandshell	
<i>Leptodea fragilis</i>	fragile papershell	
<i>Ligumia recta</i>	black sandshell	ST
<i>Ligumia subrostrata</i>	pondmussel	
<i>Obliquaria reflexa</i>	threehorn wartyback	
<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