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Freshwater Mussels of the Big Muddy River

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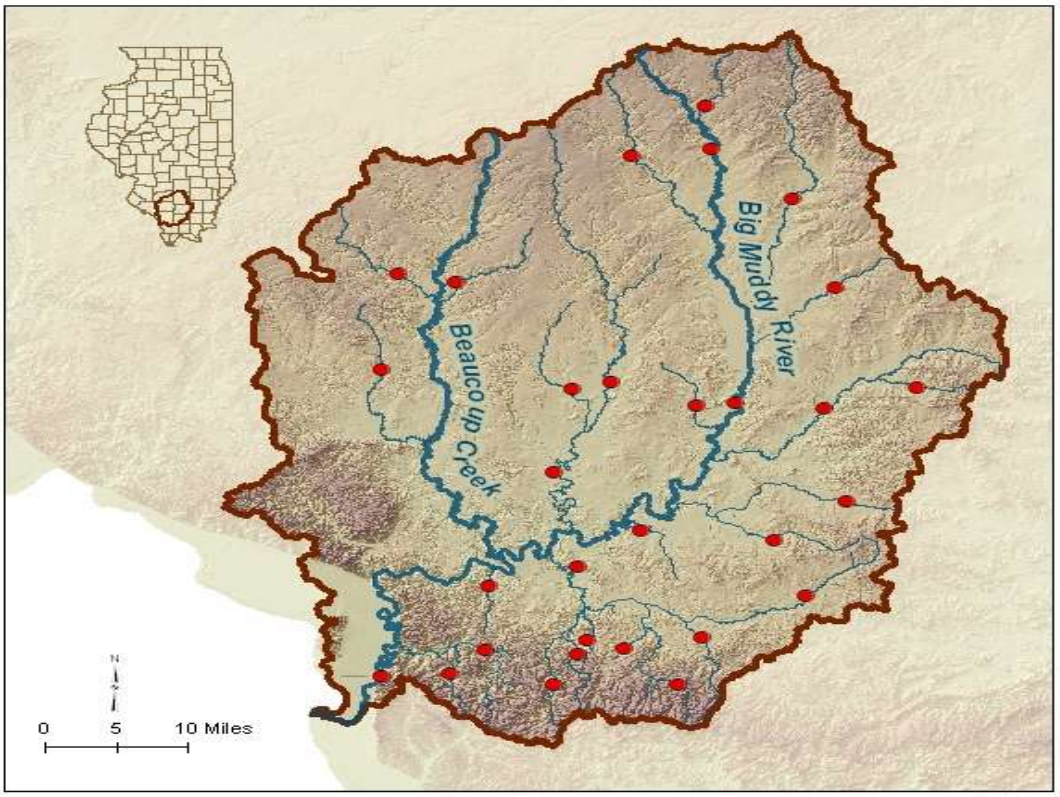

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Preface

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). 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. Sampling of mussels has been very sporadic and limited in the Big Muddy River basin and no known reports pertaining to mussel communities of the basin have been published. This report summarizes the mussel survey conducted in the Big Muddy River basin in 2009-2010 in conjunction with IDNR and IEPA basin surveys.

The Big Muddy River basin drains 3798 km^2 (2360 mi^2) in the southern part of Illinois and contains principal tributaries of Casey Fork, Middle Fork Big Muddy, Beaucoup Creek, Little Muddy River, and Crab Orchard Creek (Page et al. 1992). Originating near Cravat in Jefferson County, the Big Muddy River basin drains through the counties of Jefferson, Washington, Perry, Franklin, Williamson, and Jackson. The river mainstem forms the Jackson /Union county line and joins the Mississippi River south of Grand Tower (Figure 1). The Big Muddy River basin flows through four natural divisions, including the Lower Mississippi River Bottomlands, Ozark, Shawnee Hills, and Southern Till Plain (Schwegman 1973). The Southern Till Plain comprises the majority of the basin which is characterized by hilly upland topography and a broad flood plain (Forbes and Richardson 1908).

Land-use and Instream Habitat

In the Big Muddy River basin, land use varies slightly by county with approximately 50 to 75% of the area in agriculture. Forested lands account for 8 to nearly 25% of the landscape with the larger forested areas being located in Jackson and Williamson counties (IDA 2000). Three of the largest cities in southern Illinois with populations between 15,000 and 28,000 (Marion, Mt. Vernon, and Carbondale) are also located in this basin (IEPA 1996, US Census Bureau 2010). In 1965, the Big Muddy River was dammed near Benton and thus Rend Lake, the second largest inland impoundment in the state, was created (Page et al. 1992, USACE 2005). This reservoir provides over 15 million gallons of water per day to approximately 300,000 people in over 60 communities throughout the basin. It is also used extensively for recreational activities including boating, fishing, waterfowl hunting and camping (USACE 2005). These recreational activities are also popular in the Shawnee National Forest, Giant City State Park, Lake Kinkaid and Murphysboro, Crab Orchard National Wildlife Refuge, and LaRue Pine Hills Ecological Area,

which are all located within the Big Muddy River basin. In the southwestern part of this basin, especially near the Murphysboro area, strip mining for coal was prevalent during the early 20th century and pollution from the remaining spoil banks continues to be a problem in the basin (Page et al. 1992).

During glacial activity in the region, the Mississippi River exceeded its sediment transporting capacity thus closing off the mouths of its tributary streams, including the Big Muddy River. The Big Muddy River temporarily formed a lake; once the natural process of removing sediment returned to the Mississippi River a deeper channel emerged. As the Big Muddy River drained, soils typical of a lake bed were left behind (LeTellier 1971). Today, the soils of the Big Muddy basin consist of impervious clays, silt and fine sand. The substrates in all of the streams of this basin were dominated by some combination of sand, silt, and clay. Excessive siltation along with large woody debris was common at many sites within the basin (Figure 2 and 3). Most of the sites in the basin had wadeable water depths; however sampling sites were limited on the mainstem of the Big Muddy and on Beaucoup Creek due to non-wadeable water depths (e.g., depth>1m).

Methods

During the 2009/2010 surveys, freshwater mussel data were collected at 30 sites: 3 mainstem and 27 tributary sites in the Big Muddy River basin (Figure 1, Table 1). 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 each site. 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 (Appendix 1) follows Turgeon et al. (1998) except for recent taxonomic changes to the gender ending of lilliput (*Toxolasma parvum*), which follows Williams et al. (2008). 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 was considered to indicate recent recruitment if individuals less than 30 mm in length or with 3 or fewer growth rings were recorded. 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 19 species of freshwater mussels were observed in the Big Muddy River basin, all of which were collected live (Table 2). Across all sites, the number of live species collected, the number of extant species collected (live + dead), and the total number of species collected (live + dead + relict) ranged from 0 to 13. The giant floater (*Pyganodon grandis*) had the most occurrences across sites sampled with live mussels present (11 of 30 sites; 37%; Figure 4). The lilliput (*Toxolasma parvum*), paper pondshell (*Utterbackia imbecillis*), pondhorn (*Uniomerus tetralasmus*) and white heelsplitter (*Lasmigona complanata*) were other commonly occurring species (Figure 4), occupying 17% of these sites. Site 6, the Big Muddy River near Benton, had the greatest species richness with 12 live species.

Abundance and Recruitment

A total of 358 individuals were collected across 30 sites. The number of live specimens collected at a given site ranged from 0 to 133, with an average of 16 mussels per site where live mussels were collected (22 of 30 sites; Table 2). A total of 120 collector-hours were spent sampling with an average of three mussels collected per hour. Nine sites yielded more than 10 live individuals and 2 of the 9 sites (sites 6 and 15) yielded more than 45 live individuals. The most common species collected in the Big Muddy basin were giant floater (*n*=131), mapleleaf (*Quadrula quadrula*; n=37), white heelsplitter (n=34), lilliput (n=24), and pink papershell (*Potamilus ohiensis;* n=20), which together comprised approximately 70% of the individuals collected.

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 at individual sites ranged from none observed to high across the basin. Recruitment levels, referred to in Table 3 as Reproduction Factor, varied from one to five, and three of the sites in the Big Muddy River basin exhibited high to very high recruitment. Recruitment was over 50% at site 7, Andy Creek, and 30 to 50% at sites 1 and 9, Snow Creek and Middle Fork Big Muddy (Figure 5). Sites 2 and 29, Big Muddy River and Cedar Creek, exhibited recruitment from 1 to 30% of species collected. Recruitment may be occurring at site 30, Big Muddy mainstem, where dead shells of nearly all species collected were less than 3 years of age. All other sites in the Big Muddy River basin (24 of 30) exhibited no observed recruitment during this survey.

Mussel Community Classification

Based on the data collected in the 2009/2010 basin surveys, nearly 75% of the sites in the Big Muddy River basin have Restricted or Limited mussel communities using the current MCI classification system (Table 4, Figure 5). No sites are ranked as Unique or Highly Valued in the basin. Eight sites (sites 1, 2, 6, 7, 9, 15, 23, and 29) in the Big Muddy River basin were ranked as Moderate mussel resources.

Noteworthy Finds

According to historical records, 25 species are known from the Big Muddy River basin (Tiemann et al. 2007). All 19 species found during this survey had been recorded in the basin historically. However, three of these species had not been recorded live since 1969; these species included Wabash pigtoe (*Fusconaia flava*), pondmussel (*Ligumia subrostrata*), and deertoe (*Truncilla truncata*). Historic species not detected during this survey include creeper (*Strophitus undulatus*), spike (*Elliptio dilatata*), pimpleback (*Quadrula pustulosa*), plain pocketbook (*Lampsilis cardium*), pink heelsplitter (*Potamilus alatus*), and fawnsfoot (*Truncilla donaciformis*).

A possible range expansion may be occurring with the Louisiana fatmucket (*Lampsilis hydiana)* which occurs in the upper Arkansas, White and St. Francis rivers and in Louisiana and East Texas (NatureServe 2011). Specimens collected during this survey were classified as *Lampsilis siliquoidea* (*hydiana*) due to morphological features that resemble the Louisiana fatmucket (pers. comm. Kevin Cummings). Additional genetic testing would need to be conducted to correctly determine which species, *Lampsilis siliquoidea* or *Lampsilis hydiana*, exists in the Big Muddy basin.

Discussion

Our survey documented 19 species from the Big Muddy River basin, all were recorded live. No new species were found that had previously been undetected and six species previously detected were not found during our survey. Of these six species, only the plain pocketbook has

been documented as live in the basin. This species was found at three tributaries in the late 1990's to early 2000's; however these streams were not sampled during our survey. These sites would need to be surveyed to determine if this species is still present in the basin. Of the remaining five species not collected, deertoe and creeper have been documented only by relict shell, and the pink heelsplitter, pimpleback, and spike have not been documented since the late 1800's, early 1900's. All of these species were collected from the Big Muddy mainstem. These particular species, except for spike, are widespread and common throughout most of Illinois (Cummings and Mayer 1992) and all of these species are known from other major Mississippi River tributaries including the Rock, Illinois, and Kaskaskia Rivers (INHS Mollusk Collection Database). Sampling the mainstem of the Big Muddy was hindered by non-wadeable water depths; therefore additional sampling by alternative means would need to be conducted to determine if these species have indeed been extirpated from the basin.

Recruitment

Data collected during this survey indicate that very recent recruitment may not be occurring at most (25 of 30) sites in the Big Muddy basin. Only 3 of the 30 sites exhibited high to very high recruitment and 2 other sites had moderate recruitment noted. This finding suggests that most mussel communities of the Big Muddy may not be viable and self-maintaining. Although very few mussels collected during this basin survey fell into the category of 3 age rings or younger, many of them ranged from 4 to 10 years of age. This would indicate that the populations observed in most streams are within the age range thought to be reproductively active (Haag and Staton 2003). Therefore, we cannot conclusively state that the mussel communities of this system are void of recruitment. Recruitment may also be occurring on the Big Muddy mainstem near the Mississippi as nearly all of the dead shells found at site 30 were less than 3 years of age. Sampling methods to target juvenile mussels would be necessary to better assess the reproductive status of these populations.

Mussel community of the Big Muddy River basin

There is limited mussel community information relating to this basin from past surveys and reports. Nearly 90% of the sites sampled had no historical data available (Table 2), and there is no known intensive survey for mussels in this basin. Our surveys documented the existence of 19 species in the Big Muddy River basin from which 25 species were known historically. Additionally, our surveys found that all 19 species were represented by live individuals. Five of the six species not collected during this survey are represented by either relict shell or pre-1930 collections.

Other major Mississippi tributaries such as the Kaskaskia, Rock, and Illinois Rivers have a larger mussel fauna base according to historical records and recent surveys. Historically, these basins

contained 43, 47, and 49 species, respectively, while the Big Muddy has only 25 recorded species (Tiemann et al. 2007). Several theories could be offered on the disparity of species in this basin including the inability to conduct wadeable surveys, challenging diving conditions, lack of river access by vehicle, or the lack of suitable substrate composition for varying species. Substrates such as gravel, cobble, and boulder are practically nonexistent in the Big Muddy basin. As mentioned in the introduction, the substrate of the Big Muddy is predominately impervious clay, silt, and sand. The Big Muddy basin provides suitable substrates for many mussel species such as the giant floater, white heelsplitter, and other Anodontines. However, many species that occur in the other major Mississippi tributaries such as mucket (*Actinonaias ligamentina*), black sandshell (*Ligumia recta*), and threehorn wartyback (*Obliquaria reflexa*) prefer a mixture of substrate types including gravel, sand, and cobble (Cummings and Mayer 1992). Sedimentation and siltation of the streams in this basin may be another factor influencing the lack of these species. These factors are listed as impairments for aquatic life for many mainstem sites on the Big Muddy and several tributaries within the basin (IEPA 2010). With the lack of coarser substrates from the basin both today and historically, it may be safe to assume that many of these species have never existed in the basin. However, this statement cannot be made conclusively, due to a lack in historical information.

Living up to its name, sampling in the Big Muddy basin is challenging at best due to water depths (Big) and high turbidity (Muddy). The Big Muddy mainstem and many of its larger tributaries, such as Beaucoup and Drury Creeks, are not easily surveyed for freshwater mussels, thus it is difficult to accurately determine species richness of the basin. It is possible that the Big Muddy River provides a haven for the recruitment of many mussel species, based on the dead shells less than 3 years of age found at site 30, the nature of its substrates, and the river's connection with the Mississippi River. We are unable to conclusively state that the Big Muddy is serving as a source population for mussel species because of the lack of historical data and difficulty in sampling the basin. Additional sampling, either diving or boating to shallow areas on the lower portion of the mainstem and larger tributaries, would be needed to adequately determine the mussel fauna of this basin.

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Table1. 2009/2010 Big Muddy River Intensive Basin Survey. Types of samples include MU-mussel sampling, BE-boat electrofishing, ES-electric fish seine, SH-fish seine hauls, FF-fish flesh contaminate, H-habitat, M-macroinvertebrate, S-sediment, W-water chemistry. *Drury Creek Survey not completed due to water depth >3m.

Site Number	IEPA Code	Stream	Types of Samples	County	Location	Watershed Area (km^2)
1	NL-01	Snow Creek	MU, ES,H,M,S,W	Jefferson	6 mi NW Mt Vernon; Rd 1850N	49.60
2	N-05	Big Muddy River	MU, ES,H,M,S	Jefferson	1.5 mi NE Woodlawn Co Rd; 1450N	154.04
3	NK-02	Rayse Creek	MU	Jefferson	3.7 mi W Woodlawn; Rd 1400N	119.89
4	NJ-26	Casey Fork	MU	Jefferson	SE Mt Vernon; DNS Rt 142	196.87
5	NI-01	Gun Creek	MU, ES,H,M,S,W	Jefferson	3.3 mi E Ina	35.62
6	N-06	Big Muddy River	MU, BE,H,M,S,W	Franklin	Rt 14 Br; 3 mi W Benton	1287.86
7	NZN-15	Andy Creek	MU, ES,H,M,S,W	Franklin	Satch Road; 1.6 mi NE of Christopher	33.54
8	NHG-01	Akin Creek	MU, ES,H,M,S,W	Franklin	N Botail Road; 8.8 mi E of Benton	21.98
9	NH-23	Middle Fork	MU, BE,H,M,S	Franklin	2.2 mi SE Bent; Us Rt 34	329.47
10	NG-05	Pond Creek	MU, SH,H,M,S,W	Williamson	Liberty School Rd; 4.7 mi SE of West Frankfort	31.84
11	NGA-02	Lake Creek	MU, ES,H,M,S,W	Williamson	Co Rd 1200E; 0.3 mi S Johnston City	40.90
12	NF-01	Hurricane Creek	MU, ES,H,M,S,W	Williamson	4 mi WNW Herrin	60.67
13	NE-04	Little Muddy River	MU	Perry	Rt 14 Br; 2 mi E Old Duquoin	426.62
14	NEB-02	Reese Creek	MU, ES,H,M,S,W	Perry	2 mi E Duquoin on Park St	60.79
15	NE-05	Little Muddy River	MU, BE,H,M,S,W	Jackson	1.3 mi E of Elkville	684.39
16	ND-04	Crab Orchard Creek	MU, ES,H,M,S,W	Williamson	Rt 13 Br; E edge of Marion	82.52
17	NDJ-01	Wolf Creek	MU, ES,H,M,S,W	Williamson	E Rt 148; old railroad	44.74
18	NDD-03	Grassy Creek	MU, ES,H,M,S,W	Williamson	At Wolf Creek Rd	14.84
19	NDDA-01	Little Grassy	MU, ES,H,M,S,W	Williamson	6 mi SSW Carterville	47.11
20	NDC-99*	Drury Creek	ES,H,M,S,W	Jackson	0.2 mi US Makanda business dist	47.29
21	NDCB-01	Indian Creek	MU, ES,H,M,S,W	Jackson	2.5 mi NE Makanda	14.01
22	NDCA-01	Sycamore Creek	MU, ES,H,M,S,W	Jackson	2 mi E of Boskydell	5.27
23	ND-01	Crab Orchard Creek	MU, BE,H,M,S,W	Jackson	4 mi NE Carbondale	693.93
24	NCK-02	Swanwick Creek	MU, ES,H,M,S,W	Perry	Misty Road; 5.8 mi NW of Pinckneyville	117.41
25	NCI-01	Little Beaucoup Creek	MU, ES,H,M,S,W	Perry	6 mi NNE Pinckneyville	46.96
26	NCDB-01	Little Galum Creek	MU, SH,H,M,S,W	Perry	Galum Cr Rd; 0.5 mi N Pyramid St	30.47
27	NZL-01	Mud Creek	MU, ES,H,M,S,W	Jackson	West Lake Road; 2.1 mi SE of Muphysboro	25.54
28	NAC-02	Cave Creek	MU, ES,H,M,S,W	Jackson	Jerusalem Hill Road; 0.2 mi W of Ponoma	15.24
29	NA-03	Cedar Creek	MU, ES,H,M,S	Jackson	1 mi S Brewer School on Dutch Ridge	80.38
30	N-99	Big Muddy River	MU, BE,H,M,S	Jackson	5 mi E Grandtower at Rattlesnake Ferry	6064.97

Table 2. Mussel data for sites sampled during 2009/2010 surveys (Table 1). Numbers in columns are live individuals collected; "D" and "R" indicates dead or relict shells collected. Shaded boxes are historic collections at the specific site location obtained from the INHS Mollusk Collection records. Species in bold are federally or state-listed species or species in Greatest Need of Conservation by IL DNR. Proportion of total is number of individuals of a species divided by total number of individuals at all sites. Extant species is live + dead shell and total species is live + dead + relict shell. NDA represents no historical data available. 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). *Includes *Strophitus undulatus*, *Elliptio dilatata*, *Quadrula pustulosa*, *Lampsilis cardium*, *Potamilus alatus*, and *Truncilla donaciformis*, historical species not collected during this survey.

	Site Number																						Proportion of Total
	1	2	3	5	6	7	9	11	13	14	15	16	17	19	23	24	25	26	27	28	29	30	
Anodontinae																							
Anodonta suborbiculata					1		2				D												1%
Arcidens confragosus											4				D							D	1%
Lasmigona complanata					19					1	9				1						4		9%
Pyganodon grandis		12	1	R	30		23	2	2	21	19	R	D	12	D	D			1		8	D	37%
Strophitus undulatus																							0%
Utterbackia imbecillis	1	1			D		3				1										2	D	2%
Ambleminae																							
Amblema plicata		1			4				1		3												3%
Elliptio dilatata																							0%
Fusconaia flava					1																		0%
Megalonaias nervosa					16										1								5%
Quadrula pustulosa																							0%
Quadrula quadrula					26				2		6				3								10%
Tritogonia verrucosa					1																		0%
Uniomerus tetralasmus	1	R				2				1							2	D	R	1			2%
Lampsilinae																							
Lampsilis cardium																							0%
Lampsilis siliquoidea (hydiana)		3														D							1%
Lampsilis teres					4						4				1						5		4%
Leptodea fragilis					8				1	1	D				1							D	3%
Ligumia subrostrata	4	4	2									R		4									4%
Potamilus alatus																							0%
Potamilus ohiensis					19						1											D	6%
Toxolasma parvum	16	3	3											1							1		7%
Toxolasma texasiensis	1	5	D			4	D			D													3%
Truncilla donaciformis																							0%
Truncilla truncata					4										6								3%
																							Total
Individuals	23	29	6	0	133	6	28	2	6	24	47	0	0	17	13	0	2	0	1	1	20	0	358
Live Species	5	7	3	0	12	2	3	1	4	4	8	0	0	3	6	0	1	0	1	1	5	0	19
Extant Species	5	7	4	0	13	2	4	1	4	5	10	0	1	3	8	2	1	1	1	1	5	5	19
Total Species	5	9	4	1	13	2	4	1	4	5	10	2	1	3	8	2	1	1	2	1	5	5	19
Historical Species	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	2	NDA	NDA	NDA	1	NDA	NDA	1	6	25*
Catch per unit effort (CPUE)	5.76	7.02	1.50	0.00	33.33	1.50	6.97	0.50	1.50	6.00	11.78	0.00	0.00	4.25	3.25	0.00	0.50	0.00	0.25	0.25	5.00	0.00	
Mussel Community Index (MCI)	10	10	7	0	11	10	10	4	7	7	10	0	0	6	8	0	4	0	4	4	9	0	
Resource Classification	M	M	L	R	M	M	M	R	L	L	M	R	R	L	M	R	R	R	R	R	M	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 ≥ 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

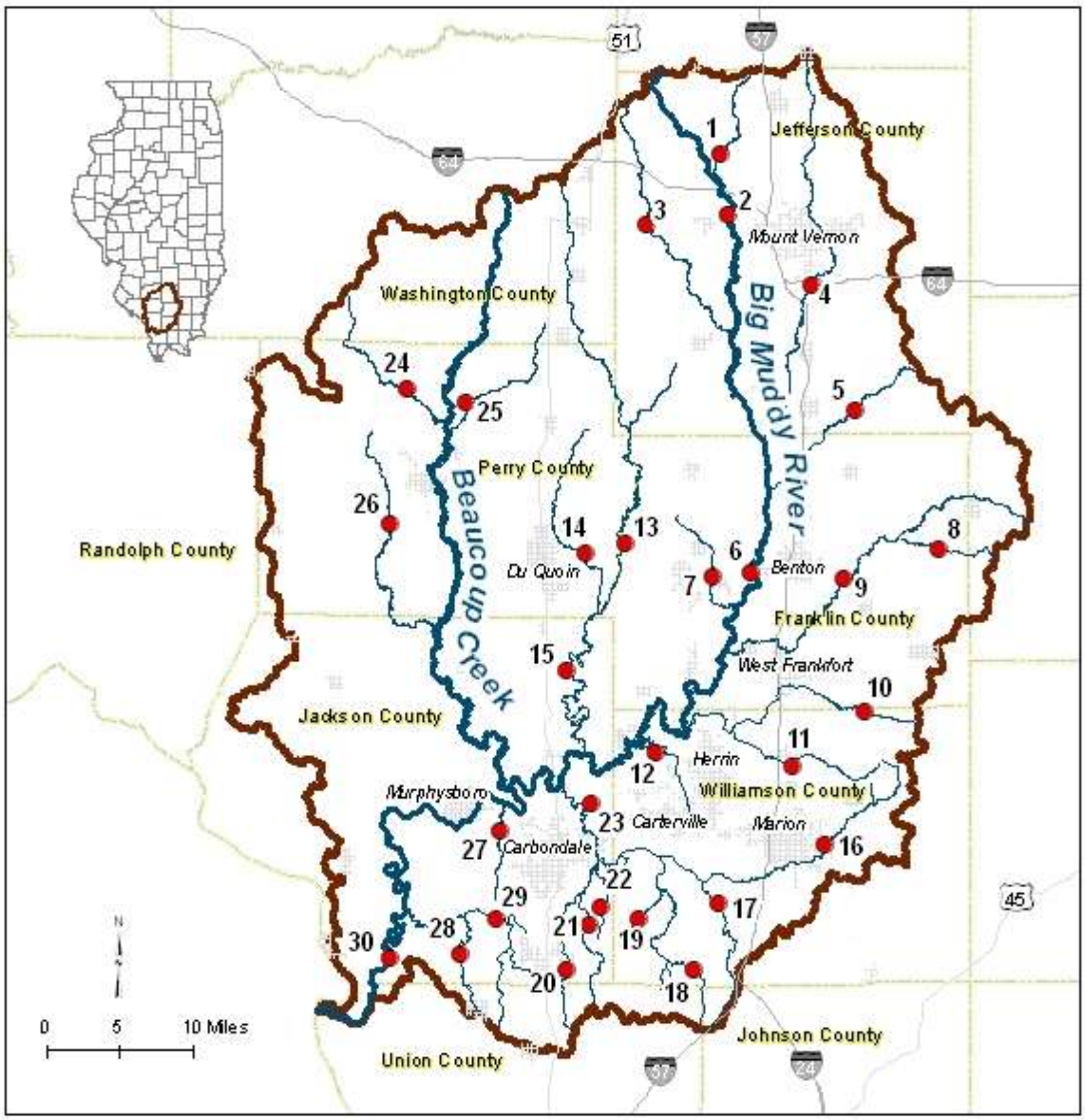

Figure 1. Sites sampled in the Upper and Lower Big Muddy River basin during 2009. Site codes referenced in Table 1.

Figure 2. Big Muddy near Benton, Illinois (Site 6). Note excessive sedimentation and turbidity of river. Alison Price and A. J. Berger measuring mussels sunk up to thighs and waist in silt.

Figure 3. Casey Fork near Mt. Vernon, Illinois (Site 4). Note large woody debris in stream, silt/clay banks, and turbidity of river.

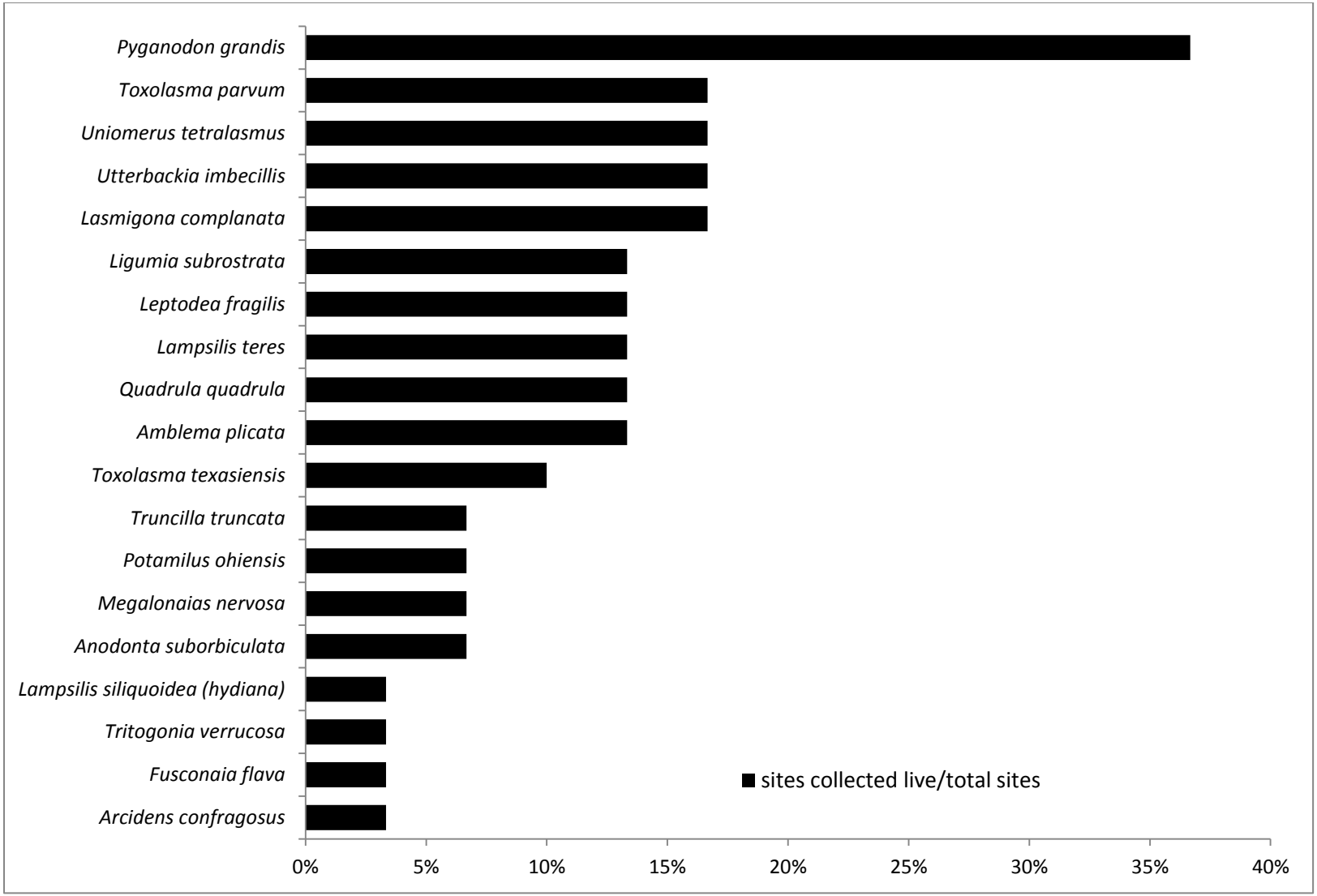

Figure 4. Number of sites where a species was collected live compared to the number of total sites sampled (30 total sites).

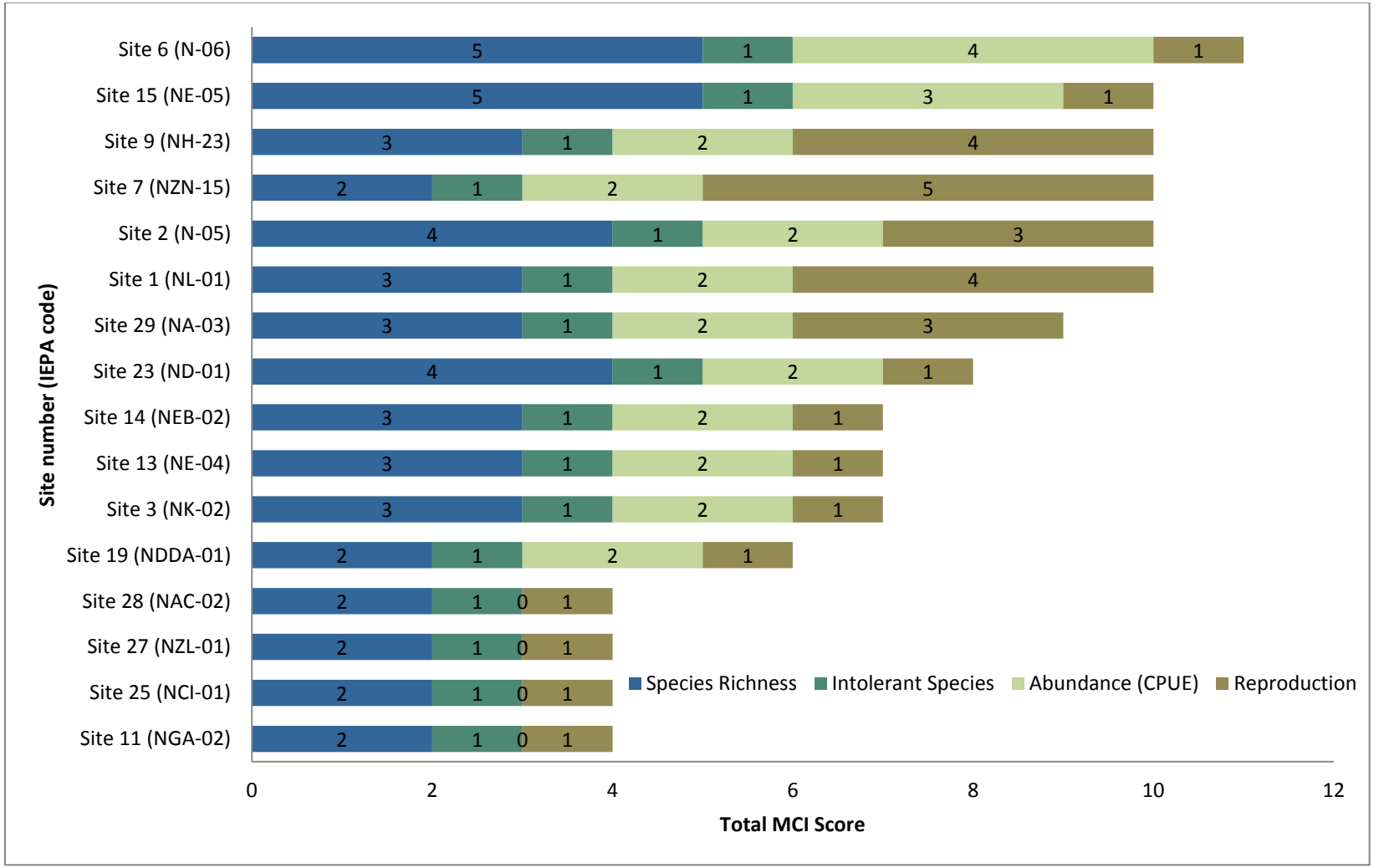

Figure 5. Comparison of Mussel Community Index (MCI) and MCI component scores for Big Muddy River basin sites based on factor values from Table 3.

Appendix 1. Scientific and common names of species. ST= state threatened.

Scientific Name	Common Name	Status
	Subfamily Anodontinae	
Anodonta suborbiculata	flat floater	
Arcidens confragosus	rock pocketbook	
Lasmigona complanata	white heelsplitter	
Pyganodon grandis	giant floater	
Strophitus undulatus	creeper	
Utterbackia imbecillis	paper pondshell	
	Subfamily Ambleminae	
Amblema plicata	threeridge	
Elliptio dilatata	spike	ST
Fusconaia flava	Wabash pigtoe	
Megalonaias nervosa	washboard	
Quadrula pustulosa	pimpleback	
Quadrula quadrula	mapleleaf	
Tritogonia verrucosa	pistolgrip	
Uniomerus tetralasmus	pondhorn	
	Subfamily Lampsilinae	
Lampsilis cardium	plain pocketbook	
Lampsilis siliquoidea hydiana	Louisiana fatmucket	
Lampsilis teres	yellow sandshell	
Leptodea fragilis	fragile papershell	
Ligumia subrostrata	pondmussel	
Potamilus alatus	pink heelsplitter	
Potamilus ohiensis	pink papershell	
Toxolasma parvum	lilliput	
Toxolasma texasiensis	Texas lilliput	
Truncilla donaciformis	fawnsfoot	
Truncilla truncata	deertoe	