

Survey of Freshwater Mussel Beds in Pools 20, 22, 24, and 25 of the Upper Mississippi River, 2003.

**(With expanded or resurvey results from Fox Island, Fabius Island, Fool's Creek Sanctuary,
Blackbird Island, Hickory Chute, Louisiana Riverfront, and Cash Island.)**

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Executive Summary

During the summer of 2003, the Missouri Department of Conservation, Illinois Department of Natural Resources, US Fish and Wildlife Service, and the US Army Corps of Engineers combined efforts to survey a total of 27 beds within pools 20, 22, 24, and 25 of the Upper Mississippi River. The purpose of these surveys was to provide baseline data for previously unsurveyed beds, provide updated information for comparison of previously surveyed beds, to document where current species of conservation concern are found, and to determine which sites hold the most promise for species reintroduction.

Of the 36 species of unionids historically documented in the Missouri/Illinois boundary of the Upper Mississippi River, 27 were collected. A total of 12,549 animals were collected. The six most commonly encountered species, in order, were the threehorn wartyback, threeridge, mapleleaf, hickorynut, butterfly, and pimpleback. They comprised 74% of the total sample.

Pool 24 exhibited the most diverse species assemblage. The Orton/Fabius Island (Pool 22), Louisiana Riverfront (Pool 24), and Quiller (Pool 25) beds were the most diverse with 19 species each.

Seven species of conservation concern in Missouri or Illinois were collected. All seven were found in Pool 22, six in Pool 24, and five each in pools 20 and 25. The Orton/Fabius bed contained all but one of the seven species of concern and held the largest populations of butterfly, ebonyshell, black sandshell, and hickorynut. Seven beds were home to five of the species of concern and six more hosted four species.

There are eight beds where there is historical survey information. Overall, most of the mussel beds appear to be stable. However, there were several substantial differences for a number of species.

On the positive side, mapleleaves, threehorn wartybacks, butterflies, hickorynuts, and pimplebacks showed gains at most sites. On the negative side, both *Truncilla* species (deertoe and fawnsfoot) have almost completely disappeared. Deertoos were once common in many mussel beds. In previous surveys, they ranged from 1.9 - 7.2/m². In 2003, only 17 deertoos and only 11 fawnsfoot mussels were collected from all 27 beds.

Also of significant concern is that very few juveniles of most species were observed. Recruitment remains low.

Of the three commercially important mussel species (washboard, threeridge, and mapleleaf) only the washboard continues its decline. They were common at only one site, the Louisiana riverfront, where they increased from 8% of the sample in 1990 to 32% in 2003. The threeridge and mapleleaf are rebounding and increasing in numbers at many sites.

The bed with the most historical information, Fool's Creek, is experiencing drastic changes in habitat as large quantities of rock continue to flow from the creek and migrate downstream, covering much of the bed. In 1994, mussels upstream of the rock bar were confined to sand-filled cracks in bedrock. In 2003, divers reported mussels "lying on the surface of the bedrock" with densities exceeding 70/m².

While these surveys have been important in determining species status and population trends, it is time to take a more active role in mussel population recovery. Research into host identification, artificial propagation, and projects that aim to identify barriers to recovery should be pursued. Without taking a more active role, it is likely that additional mussel species may be extirpated from our waters.

INTRODUCTION

The purpose of this report is to document and compare the results of freshwater mussel surveys that were conducted in pools 20, 22, 24, and 25 of the Upper Mississippi River during 2003 and to compare these results to past surveys completed in these reaches. Surveys were conducted by the Missouri Department of Conservation (MDC), the Illinois Department of Natural Resources (ILDNR), and the US Army Corps of Engineers (USACE). Funding for the surveys was provided by these agencies and the US Fish and Wildlife Service (USFWS).

The purpose of the surveys was varied depending on the funding source but included: determining the status of state and federally listed rare, threatened, or endangered (RTE) species, identifying potential reintroduction sites for RTE species, locate parent stocks of RTE species, and for general inventory and monitoring efforts.

Background

The Missouri/Illinois boundary waters of the Upper Mississippi River once supported large mussel beds with diverse assemblages. The number of beds, and mussel diversity in general, have steadily declined over the last 100 years due primarily to overharvest and habitat degradation.

Thirty-six species have historically been found within the Missouri portion of the Upper Mississippi River (Table 1). Of these, six are believed extirpated from this reach and fifteen are listed as species of concern, threatened, or endangered either in Missouri or Illinois.

The Missouri Department of Conservation and Illinois Department of Natural Resources have combined forces over the last decade to survey and monitor known mussel beds and explore for undocumented beds. In 2003, each state provided funding for one full week's worth of dive survey work. ILDNR also petitioned the USFWS for funds to survey sites where shells from the federally listed fat pocketbook mussel had been found (Potamilus capax) and were granted funding for three days worth of surveys.

The St. Louis District of the USACE provided additional funding for one day's worth of work downstream of the Clarksville Riverfront site where they planned to place mooring bouys for barge use. The St. Paul District of USACE also requested survey work from their Waterways Experiment Station (WES). WES staff focused on mussel beds which were being considered for Higgin's eye pearl mussel (Lampsilis higginsi) reintroduction.

Dive services for the Missouri, Illinois, USFWS, and St. Louis District of USACE were conducted by Ecological Services, Inc., St. Peters, Missouri. The ESI dive/work crew included up to three of the following people each day: Richard Hayward (diver), Kendall Cranney (diver),

Charles Howard (malacologist), and Heidi Dunn (malacologist). MDC and/or ILDNR provided at least one person each day to assist with sample processing.

SITE DESCRIPTION

Sites were picked based on previous dive, braille, and hand surveys, reports from former commercial musselers, reports of RTE species found, and other anecdotal evidence.

Sample sites were primarily in main channel border and side channel habitats. Substrates varied by site and included silt, sand, pea gravel, cobble, boulder, and bedrock.

Sites are identified in this report by features found at or near the site (island or chute name, river mile, town, etc.).

METHODS

All dive work was performed by divers experienced at diving in large flowing rivers. Surface air was provided through a compressor and diving bell. Communication with the diver was maintained through a system incorporated into the diving bell.

The primary purpose for most surveys was to document species presence or absence within particular beds. For this reason, transects and qualitative timed searches were the most commonly used collection techniques.

During transect searches, a weighted and marked line was sunk to the river bottom beginning at shore and moving outward. The diver picked up and bagged all mussels encountered along the transect. He also reported substrate composition and inner and outer limits of the mussel bed.

Timed searches were conducted within the boundaries of the identified bed boundaries and at multiple locations. Time searching depended on the number of mussels encountered. Some timed searches were within beds that had been identified from previous surveys.

All mussels collected were identified, counted, and released, except for voucher specimens. Specimens from several species were measured before release.

RESULTS

Of the 36 species of unionids historically documented in the Missouri/Illinois boundary of the Upper Mississippi River, 27 were collected during the various surveys (Tables 2A, 2B, and 2C). The ten species not found are either rarely found in large rivers (2), rarely found in this reach of river (6), or are species believed to be extirpated from this reach and are currently listed or candidate species for the Endangered Species Act (2).

A total of 12,549 animals were collected. The six most commonly encountered species, in order, were the threehorn wartyback, threeridge, mapleleaf, hickorynut, butterfly, and pimpleback (Table 2C). They comprised 74% of the total sample (Tables 3A, 3B, and 3C).

Pool 24 exhibited the most diverse species assemblage. The Orton/Fabius Island (Pool 22), Louisiana Riverfront (Pool 24), and Quiller (Pool 25) beds were the most diverse with 19 species each.

Pool 24 also contained the largest number of animals collected. This is reflected in the overall size of the pool (third largest on the Missouri/Illinois boundary) and the number of established beds that were sampled (10). Over 2,000 animals were collected from each of two beds, Blackbird Island (Pool 24) and Orton/Fabius Islands (Pool 22). Over 1,000 animals were also collected from three other Pool 24 beds, Fool's Creek, Sny Island, and Gosline Access.

Seven species of conservation concern in Missouri or Illinois were collected (Table 4). All seven were found in Pool 22, six in Pool 24 (no ebonyshell), and five each in Pools 20 and 25. The Orton/Fabius bed contained all but one of the seven species of concern and held the largest populations of butterfly, ebonyshell, black sandshell, and hickorynut. Seven beds were home to five of the species of concern and six more hosted four species.

Individually, ebonyshell was found live only in Pool 22. Hickorynut, black sandshell, and butterfly were more common in Pool 22 and wartybacks were more common in Pool 24. Spectaclecase were found live at only two sites. Although found live at eight sites, only one site (Quiller bed) produced more than one rock pocketbook.

Although not currently listed as a species of concern in either state, the monkeyface seems to be declining in the Mississippi River. They were collected at only 10 sites and only three sites produced 10 or more animals. The best site was the Orton/Fabius Islands bed where 57 of the 114 monkeyface were collected.

Washboards, the mussel with the highest commercial value, comprised 3.6% of the sample. Over half of the washboards were collected in Pool 24 with almost a third of the total sample coming from the Louisiana Riverfront (Table 5). Most of the washboards were collected from just six of the 27 beds. No washboards were collected from Pool 20.

As has been observed in past surveys, recruitment of juvenile washboards into the population is extremely low. Only four of 396 animals were less than 80 mm in height and only one of those was less than 50 mm.

The second-most commercially important species, the threeridge, comprised 18.5% of the total sample and was the most abundant species in pools 24 and 25. Threeridges were fairly evenly distributed throughout the reach and no bed contained more than 11% of the total sample (Gosline Access and Fool's Creek).

While the exotic zebra mussels were encountered, they were not at all abundant. Some were noted as being attached to native mussels and almost all natives displayed byssal thread attachments where zebra mussels had once been attached. It is likely that high water temperatures (90°+ F) in the years leading up to the survey maintained a high zebra mussel mortality rate.

Long-term Trends

There are eight beds where there is historical survey information. Available information from those surveys and the 2003 data are compiled in tables 6A through 6F.

Overall, most of the mussel beds appear to be physically and biologically stable. Some lower density species continue to remain rare while more common species continue to be prevalent. However, there were several substantial differences for a number of species.

On the positive side, mapleleafs showed marked increases at Hannibal, Orton/Fabius, and Fool's Creek. Percent composition increased by 42 – 165% in these beds. The total number of mussels collected also increased.

Other increases occurred for threehorn wartybacks at Fox Island (+154%), Blackbird (+128%), and Fool's Creek (+537%), butterflies at Blackbird (+78%), fragile papershell at Hickory Chute (+1500%), hickorynuts at Fool's Creek (+245%) and Blackbird (+629%). Pimplebacks also showed a rebound at Blackbird where they had been as little as 0.7% of the sample in 1995 but comprised 6.1% in 2003.

There were also some major declines. The most notable declines have been for both *Truncilla* species, the deertoe and the fawnsfoot. Deertoos were once common in many mussel beds. In previous surveys at Hannibal, Fool's Creek, Blackbird, Fabius Island, and Louisiana, deertoos ranged between 1.9 and 7.2/m². There were a total of 996 deertoos collected in those six surveys. In 2003, only four deertoos were collected from these five sites.

Some of this change might be explained by the differences in sampling regime. In earlier surveys, quantitative techniques, where buckets of substrate and mussels were scooped from the river bottom, were a large component of those samples. In 2003, most of the samples were qualitative, where mussels were felt and picked up. In theory, it would be possible for a diver to pass over a small shell or mistake it for a rock. However, during the same time periods and in these same beds, threehorn wartybacks, a species of similar size and shape that utilizes the same habitat, made major increases in abundance.

Fawnsfoot saw similar decreases, though they were not as frequently encountered in past surveys. A total of 151 animals were collected at Hannibal and Fool's Creek in 1988 and at Louisiana in 1990. No fawnsfoot mussels were collected at these sites in 2003.

Percent composition of two species at Blackbird Island also decreased at a surprising rate. Fragile papershells made up 7.3% of the sample in 1995 and was not collected in 2003. Wartybacks comprised 6.2% of the sample in 1995 and was less than one percent of the sample in 2003.

Of the species of conservation concern, there were several positive changes. Hickorynut populations increased at Fox Island, Orton/Fabius, Fool's Creek, and Blackbird Island. Butterflies increased at Orton/Fabius and Fool's Creek. Black sandshells showed a four-fold increase at Orton/Fabius and ebonyshells were observed in this same bed for the first time, although they were all older specimens. Wartybacks showed an increase at Fox Island and have shown a slow but steady increase at Hannibal over the last 16 years. Their numbers decreased at Blackbird Island.

DISCUSSION AND CONCLUSIONS

The 2003 surveys present a mixed bag of both good and bad news. While most beds appear to be stable in total numbers of mussels, some rare, and some not-so-rare species have ebbed into or out of the population.

Overall, it appears that Pool 22 holds the greatest potential for reintroducing species of concern. All seven identified species were found in this pool. The Orton/Fabius bed holds the most promise. Not only were six of the seven species present, but several showed increases in relative abundance here.

Also, although the monkeyface mussel is not on either state's list, it occurs only at low levels in most beds. It was relatively abundant in Pool 22 beds and is doing best at the Orton/Fabius bed.

Ebonyshells continue to show the effects of no fish hosts. Their primary host, the skipjack herring, remains only in very small numbers in the Mississippi River. All of the ebonyshells collected were in Pool 22 and all were quite old. Many more dead shells were collected. Without artificial propagation and release, this species is likely to disappear from the Missouri/Illinois boundary waters of the Mississippi River.

Pool 24 also holds promise as a good site for reintroduction. Six of the seven species of concern were collected here. Blackbird Island and the upper portion of Fool's Creek show the most promise.

Reports from past commercial mussel harvesters touted the Hickory Chute bed as a stronghold for spectaclecase. Surveys over the last seven years show that this small population continues to decline. It too may collapse without infusion of young.

While deertoos are not listed as a species of concern in either state, there is significant reason for concern. This species has shown dramatic decreases in relative abundance. It is possible that zebra mussels could have had some impact on this population. It is also possible that predators such as muskrats, carp, drum, or some other fish species may be impacting them. However, while this species has been on a quick decline, the similar species (threehorn wartyback) continues to increase in relative abundance. Threehorn wartybacks are also a favorite of various predators and could have just as easily been impacted by zebra mussels. There is obviously some other factor affecting deertoos and possibly affecting the other *Truncilla*, the fawnsfoot. Biologists in other Upper Mississippi River states have also seen marked declines in *Truncilla* species. Further research will likely be necessary to determine the cause for these declines.

Also of significant concern is that very few juveniles of most species were observed. Recruitment remains low.

Although several species have been in decline, there are a few bright spots. For instance, relative abundance of two species of concern, hickorynut and butterfly, are on the rise at most sites. A half dozen other species also seem to be relatively abundant with stable populations.

It is plausible that we could eventually have a commercial mussel harvest season again, but it is unlikely that the harvest of washboards would be allowed. They appear to be following the same path to extirpation as the ebonyshell.

The second and third historically most important commercial species, the threeridge and the mapleleaf, seem to be increasing in abundance. These species could someday support a limited harvest. However, given the overall decline of many other species, caution would be prudent.

One bed in particular, Fool's Creek, has also been experiencing significant changes in its habitat. In the middle of the traditional survey reach lies the mouth of Fool's Creek. A large gravel bar is present at the mouth of this creek. In 1994, it was observed that for approximately 100 yards downstream of this gravel bar, mussel densities were lower and there was an increased amount of cobble-sized rock. The further downstream you proceeded from the gravel bar, the smaller the size of the substrate until it returned to pea-sized gravel.

In 2003, we observed that the cobble had extended much further downstream. Very few mussels were encountered in this reach. There is no doubt that transport of cobble from Fool's Creek is having a detrimental effect on the mussel bed.

In 1994, mussels upstream of the rock bar were confined to sand-filled cracks in bedrock. In 2003, divers reported that there were large numbers of mussels "lying on the surface of the bedrock." When asked about an approximate density, they believed it would exceed 70/m².

While these surveys have been important in determining what species we have in what locations, it is time for us to not simply monitor these populations, but to get involved in their recovery. Research into host identification and artificial propagation of mussel glochidia is of utmost importance. Projects that strive to identify barriers to recovery and which actively try to increase populations should also be pursued. Without taking a more active role in their recovery, it is likely that additional mussel species may be extirpated from our waters or may become extinct.

Table 1. Historical list of mussel species found in Missouri/Illinois boundary waters of the pooled portion of the Mississippi River and their “species of concern” ranking in each state as of 2006.

Scientific Name	Common Name	Missouri Status	Illinois Status	Missouri Status Description
<i>Actinonaias ligamentina</i>	Mucket			
<i>Amblema plicata</i>	Threeridge			
<i>Anodonta suborbiculata</i>	Flat Floater	S2		S1 Critically imperiled, less than 5 occurrences
<i>Arcidonta confragosa</i>	Rock Pocketbook	S3		
<i>Cumberlandia monodonta</i>	Spectaclecase	S3 & Endangered	Endangered	
<i>Cyclonaias tuberculata</i>	Purple Wartyback		Threatened	S2 Imperiled, rare, 6 – 20 occurrences
<i>Ellipsaria lineolata</i>	Butterfly		Threatened	
<i>Ellipto crassidens</i>	Elephant Ear	S1	Threatened	S3 Rare and uncommon, 21 to 100 occurrences
<i>Elliptio ditlittata</i>	Spike		Threatened	
<i>Fusconaiia ebena</i>	Ebonyshell	S1 & Endangered		
<i>Fusconaiia flava</i>	Wabash Pigtoe			
<i>Lampsilis cardium</i>	Pocketbook			
<i>Lampsilis higginsii</i>	Higgin’s Eye			
<i>Lampsilis teres</i>	Yellow Sandshell			
<i>Lasmigona complanata</i>	White Heelsplitter	SA	Endangered	SA Accidental occurrences, outside of range
<i>Lasmigona costata</i>	Fluted Shell			
<i>Leptodea fragilis</i>	Fragile Papershell		Threatened	
<i>Ligumia recta</i>	Black Sandshell	S2	Threatened	
<i>Megalonaias nervosa</i>	Washboard			
<i>Obliquaria reflexa</i>	Threehorn Wartyback			
<i>Obovaria olivaria</i>	Hickorynut	S3		
<i>Plethobasus cyphus</i>	Sheepnose	S2	Endangered	
<i>Pleurobema sintoxia</i>	Round Pigtoe			
<i>Potamilius alatus</i>	Pink Heelsplitter			
<i>Potamilius capax</i>	Fat Pocketbook			
<i>Potamilius ohioensis</i>	Pink Papershell	S1 & Endangered	Endangered	
<i>Pyganodon grandis</i>	Giant Floater			
<i>Quadrula metanerva</i>	Monkeyface			
<i>Quadrula pustulosa</i>	Pimpleback			
<i>Quadrula nodulata</i>	Wartyback			
<i>Quadrula quadrula</i>	Mapleleaf	S3		
<i>Strophitus undulatus</i>	Creeper			
<i>Toxotasma parvus</i>	Lilliput			
<i>Tritigonia verrucosa</i>	Pistolgrip			
<i>Truncilla donaciformis</i>	Fawnsfoot			
<i>Truncilla truncate</i>	Deertoe			
<i>Utterbackia imbecillus</i>	Paper Pondshell			
<i>Sphaeriidae Family</i>	Fingernail Clams			

Table 6A. Historical mussel population statistics from the Fox Island bed in Pool 20 of the Upper Mississippi River.

Species	1992 ^a		1995 ^b		2003	
	Number	Percent Comp	Number	Percent Comp	Number	Percent Comp
<i>Amblema plicata</i>	Present		222	40.2	210	26.7
<i>Arcidens confragosus</i>	Present		1	0.2		
<i>Ellipsaria lineolata</i>	Absent		2	0.4	2	0.25
<i>Fusconaia flava</i>	Present		16	2.9	20	2.5
<i>Lampsilis cardium</i>	Present		14	2.5	22	2.8
<i>Lampsilis teres</i>	Present					
<i>Lasmigona complanata</i>	Present		3	0.5	5	0.6
<i>Leptodea fragilis</i>	Present		5	0.9	1	0.1
<i>Ligumia recta</i>	Absent		1	0.2	2	0.3
<i>Megaloniaias nervosa</i>	Present					
<i>Obliquaria reflexa</i>	Present		85	15.4	216	27.4
<i>Obovaria olivaria</i>	Present		39	7.1	65	8.3
<i>Potamilius alatus</i>	Present		7	1.3	2	0.3
<i>Potamilius ohioensis</i>	Present		7	1.3	3	0.4
<i>Pyganodon grandis</i>	Present		14	2.5	4	0.5
<i>Quadrula metanerva</i>	Present		1	0.2	1	0.1
<i>Quadrula nodulata</i>	Present		5	0.9	21	2.7
<i>Quadrula pustulosa</i>	Present		72	13.0	84	10.7
<i>Quadrula quadrula</i>	Present		57	10.3	124	15.8
<i>Truncilla donaciformis</i>	Present				2	0.3
<i>Truncilla truncata</i>	Present		5	0.9	3	0.4
Total Number of Animals			556		787	
Total Species	19		18		18	

a Koch, 1993. (No information exists on the numbers of these animals encountered.)

b Moore, 1995.

Table 6B. Historical mussel population statistics from the Orton/Fabius Islands bed in Pool 22 of the Upper Mississippi River.

Species	Fabius Island – 1997 ^c			Orton and Fabius Islands - 2003		
	Number	Percent Comp	Density (#/m ²)	Number	Percent Comp	
<i>Actinonaias ligmentina</i>	1	<0.1	0.04	1	0.05	0.05
<i>Amblyma plicata</i>	49	3.5	1.26	151	7.2	7.2
<i>Cumberlandia monodonta</i>				1	0.05	0.05
<i>Ellipsaria lineolata</i>	225	15.9	4.19	306	14.5	14.5
<i>Fusconaia ebena</i>				5	0.2	0.2
<i>Fusconaia flava</i>	6	0.4	0.08	24	1.1	1.1
<i>Lampsilis cardium</i>	19	1.3	0.38	43	2.0	2.0
<i>Lampsilis teres</i>				4	0.2	0.2
<i>Lasmigona complanata</i>	2	0.1	0.04	9	0.4	0.4
<i>Lasmigona costata</i>	1	<0.1	0.04			
<i>Leptodea fragilis</i>	32	2.3	1.10			
<i>Ligumia recta</i>	9	0.6	0.19	36	1.7	1.7
<i>Megalonaias nervosa</i>	13	0.9	0.38	66	3.1	3.1
<i>Obliguia reflexa</i>	462	32.7	11.7	587	27.9	27.9
<i>Obovaria olivaria</i>	253	17.9	5.68	413	19.6	19.6
<i>Potamilus alatus</i>	2	0.1	0.08			
<i>Potamilus ohioensis</i>	1	<0.1	0.04			
<i>Pyganodon grandis</i>	1	<0.1	--			
<i>Quadrula metanerva</i>	50	3.5	0.72	57	2.7	2.7
<i>Quadrula nodulata</i>	1	<0.1	0.04	8	0.4	0.4
<i>Quadrula pustulosa</i>	65	4.6	1.98	115	5.5	5.5
<i>Quadrula quadrula</i>	81	5.7	2.02	276	13.1	13.1
<i>Tritigone verrucosa</i>	1	<0.1	0.04			
<i>Truncilla donaciformis</i>	4	0.3	0.15			
<i>Truncilla truncata</i>	134	9.5	4.34	1	0.05	0.05
<i>Strophitus undulatus</i>				1	0.05	0.05
Total Animals Collected	1412			2104		
Total Species	22			19		
Total Density (#/m ²)		34.19				

c Moore, 1998.

Table 6C. Historical mussel population statistics from the Hannibal, Missouri bed in Pool 22 of the Upper Mississippi River.

Species	1988 ^d		1997 Mark Twain Bridge ^e		2003	
	Number	Density (#/m ²)	Number	Percent Comp	Number	Percent Comp
<i>Amblyma plicata</i>	62	2.55	95	22.4	108	20.1
<i>Arcidens confragosas</i>		0.16	1	<1	5	0.9
<i>Cumberlandia monodonta</i>			1	<1		
<i>Ellipsaria lineolata</i>	46	2.05	28	6.6	19	3.5
<i>Fusconaia ebena</i>			4	1		
<i>Fusconaia flava</i>		0.04	3	<1	5	0.9
<i>Lampsilis cardium</i>		0.13	9	2.1	7	1.3
<i>Lampsilis teres</i>		0.08	4	1	5	0.9
<i>Lasmigona complanata</i>			3	<1	4	0.7
<i>Leptodea fragilis</i>	24	1.08	9	2.1	15	2.8
<i>Ligumia recta</i>		0.04	3	<1	2	0.4
<i>Megaloniaias nervosa</i>	43	1.79	35	8.3	43	8.0
<i>Obliquaria reflexa</i>	78	3.30	81	19.1	143	26.7
<i>Obovaria olivaria</i>	26	1.09	18	4.3	8	1.5
<i>Plethobasus cyphus</i>		0.08				
<i>Potamilus alatus</i>	7	0.29	2	<1	1	0.2
<i>Potamilus ohioensis</i>			7	1.7		
<i>Pyganodon grandis</i>			1	<1	2	0.4
<i>Quadrula metanerva</i>		0.08	1	<1		
<i>Quadrula nodulata</i>		0.25	12	2.8	20	3.7
<i>Quadrula pustulosa</i>	24	0.99	16	3.8	11	2.1
<i>Quadrula quadrula</i>	83	3.50	41	9.7	138	25.7
<i>Truncilla donaciformis</i>	45	1.86	13	3.1		
<i>Truncilla truncata</i>	82	3.46	36	8.5		
<i>Utterbackia imbecillus</i>		0.51				
Total Animals Collected			423		528	
Total Species		20	23		18	
Total Density (#/m ²)		23.33				

^d Koch, 1990.

^e Dunn and Seitman, 1997

Table 6D. Historical mussel population statistics from the Fool's Creek Sanctuary bed in Pool 24 of the Upper Mississippi River.

	1986 – 1992 ^f		1988 ^d		1994 ^e		2003	
	Present	Number	Density (#/m ²)	Number	Percent Comp	Density (#/m ²)	Number	Percent Comp
<i>Actinonaias ligmentina</i>	Present						1	<0.1
<i>Amblyma plicata</i>	Present	32	1.54	341	21.7	8.00	298	23.7
<i>Arcidens confragosus</i>	Present						1	<0.1
<i>Cumberlandia monodonta</i>	Present							
<i>Ellipsaria lineolata</i>	Present	81	3.71	174	11.1	3.86	164	13.0
<i>Elliptio crassidens</i>	Present							
<i>Fusconata ebena</i>	Present							
<i>Fusconata flava</i>	Present		0.21	14	<1	0.28	13	1.0
<i>Lampsilis cardium</i>	Present		0.21	10	<1	0.23	8	0.6
<i>Lampsilis teres</i>	Present		0.05				1	<0.1
<i>Lasmigona complanata</i>	Present							
<i>Leptodea fragilis</i>	Present	22	0.99	14	<1	0.26	2	0.2
<i>Ligumia recta</i>	Present		0.04	5	<1	0.11	11	0.8
<i>Megalonaias nervosa</i>	Present	43	1.52	16	1.0	0.36	22	1.7
<i>Obliquaria reflexa</i>	Present	78	3.68	385	24.4	9.30	497	39.4
<i>Obovaria olivaria</i>	Present	26	0.54	30	1.9	0.62	90	7.1
<i>Plethobasus cyphus</i>	Present							
<i>Potamilus alatus</i>	Present	10	0.42	2	<1	0.03		
<i>Potamilus ohioensis</i>	Present		0.05	1	<1	0.03		
<i>Pyganodon grandis</i>	Present							
<i>Quadrula metanerva</i>	Present		0.12	3	<1	0.09	14	1.1
<i>Quadrula nodulata</i>	Present		0.04	9	<1	0.14	6	0.5
<i>Quadrula pustulosa</i>	Present	18	0.75	69	4.4	1.65	44	3.5
<i>Quadrula quadrula</i>	Present	17	0.75	75	4.8	1.92	86	6.8
<i>Strophitus undulatus</i>	Present			145	9.2			
<i>Taxolasma parvus</i>	Present							
<i>Tritogonia verrucosa</i>	Present							
<i>Truncilla donaciformis</i>	Present	51	2.75	12	<1	0.23		
<i>Truncilla truncata</i>	Present	177	7.22	269	17.1	6.41		
<i>Utterbackia imbecillus</i>	Present		0.09					
Sphaeriidae Family	Present						1	<0.1
Total Animals Collected				1574			1259	
Total Species	30		19	18			16	
Total Density			24.68			33.52		

^f Koch. No information exists on the numbers of these animals encountered.

^d Koch, 1990. ^e g Moore, 1995.

Table 6E. Historical mussel population statistics from the Blackbird Island bed in Pool 24 of the Upper Mississippi River.

Species	1989 ^h		1992 ^a	1995 ^b		1998 ⁱ		2003	
	Number	Density (#/m ²)		Number	Percent Comp	Number	Percent Comp	Number	Percent Comp
<i>Amblema plicata</i>	258	3.97	Present	187	20.0	235	36	228	16.6
<i>Arcidens confragosus</i>		0.05	Present	3	0.3	1	<1		
<i>Ellipsaria lineolata</i>	68	1.04	Absent			22	3	121	8.8
<i>Fusconaia ebena</i>		0.02	Absent						
<i>Fusconaia flava</i>	29	0.44	Present	4	0.4	20	3	13	0.9
<i>Lampsilis cardium</i>		0.12	Present	5	0.5	7	1	13	0.9
<i>Lampsilis teres</i>			Present	5	0.5	2	<1	11	0.8
<i>Lasmigona complanata</i>			Present	2	0.2	3	<1	2	0.1
<i>Leptodea fragilis</i>		0.03	Present	69	7.3	5	1		
<i>Ligumia recta</i>			Absent			1	<1	6	0.4
<i>Megaloniais nervosa</i>	21	0.32	Present			12	2	18	1.3
<i>Obliquaria reflexa</i>	184	2.81	Present	200	21.3	132	20	419	30.5
<i>Obovaria olivaria</i>	38	0.58	Present	30	3.2	32	5	277	20.2
<i>Potamilius alatus</i>		0.02	Present	34	3.6				
<i>Potamilius ohioensis</i>			Present	101	10.8	4	1		
<i>Pyganodon grandis</i>		0.21	Present	41	4.3	5	1	2	0.1
<i>Quadrula metanerva</i>		0.02	Present			2	<1	8	0.6
<i>Quadrula nodulata</i>		0.21	Present	58	6.2	1	<1	12	0.9
<i>Quadrula pustulosa</i>	81	1.24	Present	7	0.7	53	8	133	3.2
<i>Quadrula quadrula</i>	65	0.99	Present	177	18.9	76	12	108	7.9
<i>Truncilla donaciformis</i>	69	1.05	Present	11	1.2	15	2		
<i>Truncilla truncata</i>	123	1.89	Present			25	4	3	0.2
<i>Utterbackia imbecillus</i>		0.03	Present	2	0.2				
Total Number of Animals	Est. 980			936		653		1374	
Total Species	19		20	17		20		16	
Total Density		14.83							3.92

^h Koch and Neuswanger, 1998.

^a Koch, 1993. No information exists on the numbers of these animals encountered.

ⁱ Corgiat and Moore, 2000.

Table 6F. Historical mussel population statistics from the Cash Island and Lower Hickory Chute beds in Pool 24 of the Upper Mississippi River.

Species	Cash Island			Lower Hickory Chute		
	1999 ¹	2003	2003	1999 ¹	2003	2003
	Number	Density (#/m ²)	Number	Number	Number	Number
	Percent Comp		Percent Comp	Percent Comp	Percent Comp	Percent Comp
<i>Actinonaias ligmentina</i>					2	1
<i>Ambleria plicata</i>	256	0.24	89	32.0	44	20
<i>Arcidens confragosus</i>	4	*				
<i>Cumberlandia monodonta</i>					5	2
<i>Ellipsaria lineolata</i>	1	*				
<i>Fusconaia flava</i>	8	*	2	0.7	1	<1
<i>Lampsilis cardium</i>	9	0.04			1	<1
<i>Lampsilis teres</i>	4	*	12	4.3	17	8
<i>Lasmigona complanata</i>	2	0.04				
<i>Leptodea fragilis</i>	13	*	3	1.1	3	1
<i>Ligumia recta</i>					1	<1
<i>Megaloniais nervosa</i>	53	*	1	0.4	85	39
<i>Obliquira reflexa</i>	223	0.08	89	32.0	17	8
<i>Obovaria olivaria</i>	21	*	23	8.3	15	7
<i>Potamilus alatus</i>	1	0.04	1	0.4		
<i>Potamilus ohioensis</i>	8	0.04			5	2
<i>Pyganodon grandis</i>	9	0.04	1	0.4		
<i>Quadrula nodulata</i>	25	*	13	4.7	2	1
<i>Quadrula pustulosa</i>	18	*	5	1.8	3	1
<i>Quadrula quadrula</i>	76	0.2	39	14.0	18	8
<i>Truncilla donaciformis</i>	2	*			1	<1
<i>Truncilla truncata</i>	11	0.04				
<i>Utterbackia imbecillus</i>	1	0.04				
<i>Sphaeriidae Family</i>						
Total Animals Collected	745		278		220	156
Total Species	20		12		16	10
Total Density		0.8				

* Information not available.

i Corgiat and Moore, 2000.

Table 6G. Historical mussel population statistics from the Louisiana, Missouri bed in Pool 24 of the Upper Mississippi River.

Species	Louisiana Riverfront - 1990		Champ Clark Bridge (Louisiana) – 1999 ¹		Louisiana Riverfront - 2003	
	Number	Percent Comp	Number	Percent Comp	Number	Percent Comp
<i>Amblyma plicata</i>	132	12.8	21	12	142	26.9
<i>Arcidens confragosus</i>					1	0.2
<i>Ellipsaria lineolata</i>	41	4.0			5	0.9
<i>Fusconaia flava</i>	9	0.9			1	0.2
<i>Lampsilis cardium</i>	4	0.4			4	0.8
<i>Lampsilis teres</i>					3	0.6
<i>Lasmigona complanata</i>			2	1	1	0.2
<i>Leptodea fragilis</i>	104	10.1	3	2	2	0.4
<i>Ligumia recta</i>					1	0.2
<i>Megaloniaias nervosa</i>	86	8.3	97	56	170	32.2
<i>Obliquaria reflexa</i>	193	18.7	19	11	75	14.2
<i>Obovaria olivaria</i>	5	0.5			6	1.1
<i>Potamilius alatus</i>	17	1.6			2	0.4
<i>Potamilius ohioensis</i>	7	0.7	3	2	2	0.4
<i>Pyganodon grandis</i>	25	2.4	1	<1	3	0.6
<i>Quadrula nodulata</i>	12	1.1			2	0.4
<i>Quadrula pustulosa</i>	19	1.8	3	2	5	0.9
<i>Quadrula quadrula</i>	87	8.4	20	12	102	19.3
<i>Truncilla truncata</i>	211	20.4	2	1		
<i>Truncilla donaciformes</i>	55	5.3				
<i>Toxolasma parvus</i>	20	1.9				
<i>Utterbackia imbecillus</i>	6	0.6	1	<1	1	0.2
Total Animals Collected	1,033		172		528	
Total Species	18		11		19	

i Corgiat and Moore, 2000.

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