

# **Appendix N**

## **Mussels**



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# **St. Johns Bayou Basin and New Madrid Floodway, MO**

## **MUSSEL SURVEY**

**October 2010**

## Abstract

Qualitative mussel surveys were completed on twenty-five of the twenty-eight planned survey locations for the St. Johns Bayou Basin/New Madrid (SJNM) Floodway, Missouri project during October 2010. The surveys were conducted in order to determine whether adequate unionid mussel populations were present for long-term monitoring of potential project impacts related to the authorized SJNM project. Beginning in the spring of 2009, many of the ditches in the project area were cleaned out as part of a Natural Resources Conservation Service funded effort, including many of the ditches in which Barnhart (1998) conducted surveys. Several of these locations were subsequently surveyed by U. S. Army Corps of Engineers (USACE) personnel in 2005. Sites surveyed during the 2010 USACE effort included locations in St. Johns Bayou, St. Johns Ditch, Setback Levee Ditch (Spillway Ditch), St. James Ditch, Mud Ditch, St. John's Diversion Ditch, Wilkerson Ditch, and Ten Mile Pond Conservation Area. A total of 160 live unionid mussels representing 15 different species were collected. The most common species, in order of abundance, were: *Amblema plicata*, *Pyganodon grandis*, and *Lasmigona complanata*. Two species were represented by only one live individual (*Lampsilis cardium* and *Truncilla truncata*). Two species considered rare in Missouri were also collected *Arcidens confragosus* and *Anodonta suborbiculata*. Although mussel surveys were not conducted in 2010 at three locations due to site conditions, previous studies indicated that habitat at these sites did not support healthy freshwater mussel populations.

The results of the surveys conducted in 2010 indicate that the recent and ongoing ditch cleanouts have eliminated a large portion of the previously encountered freshwater mussel population in the project area ditches. The existing communities do not appear to be adequate at this time for establishing baseline conditions from which to assess potential impacts from the SJNM project. Studies currently underway in other locations on the recovery of mussel populations after channel cleanouts may help determine when the appropriate level of recovery that would allow for meaningful data collection can be expected in these ditches.

## **Introduction**

The SJNM Floodway Project was originally authorized for construction by the Water Resources Development Act of 1986 (PL 99-662), Section 401(a). This authorization was based on the Report of the Chief of Engineers, dated 4 January 1983, which was part of the Phase I General Design Memorandum documents prepared in response to Section 101(a) of the Water Resources Development Act of 1976 (PL 94-587). An Environmental Impact Statement (EIS) for SJNM is currently being developed.

Several construction items are authorized in the St. Johns Bayou Basin. These items consist of channel enlargements in the lower 4.5 miles of St. Johns Bayou, 8.1 miles of Setback Levee Ditch, and 7.1 miles of St. James Ditch. Freshwater mussel surveys were conducted in 2010 to update previous surveys (Barnhart, 1998; USACE 2005); determine potential relocation sites, and aid in determining appropriate methods for implementing long-term monitoring of the freshwater mussel resource. Previous coordination between USACE and federal and state resource agencies resulted in the recommendation that a portion of the mussel population in Setback Levee Ditch be relocated, and that long-term monitoring be conducted over a 10-year time period to measure recolonization following channel alteration.

## **Objectives**

The objective of this monitoring effort was to determine the status of existing mussel populations within the SJNM Project Area. The approach utilized generally followed that used by Barnhart (1998) and previous surveys conducted by USACE (2005). Catch-per-unit effort (CPUE) data was collected during these qualitative sampling efforts and were used to compare previous mussel populations with current conditions.

## **Previous Project Area Surveys**

Barnhart (1998) surveyed 28 sites within the SJNM project area. The major ditches in the project area were surveyed at intervals of approximately 2-miles. A total of 988 live unionids representing 23 species were collected during this effort. Overall CPUE was 14.17 live individuals per man-hour. The most abundant species, in order of abundance, were: *Amblema plicata*, *Quadrula quadrula*, and *Pyganodon grandis*. The highest species diversity and greatest abundance were found in the lower portions of St. James Ditch and in Setback Levee Ditch. Barnhart's survey found the SJNM project area supported a diverse and fairly abundant unionid fauna, typical of drainage canals in the Mississippi lowlands of Missouri and Arkansas.

In June 2005, fourteen locations were surveyed in the SJNM project area by USACE personnel. The objectives of this study were to conduct pre-construction surveys of Mud Ditch, where four 10-foot by 10-foot gated box culverts were to be constructed; determine if previous surveys results (Barnhart, 1998) were still valid with current conditions; identify potential relocation sites, and to aid in determining methods for implementing long-term monitoring of the freshwater mussel resource. Previous coordination with resource agencies recommended relocating a portion of the unionid mussel population of Setback Levee Ditch and conducting long-term monitoring over a 10-year period to measure recolonization success following project related channel alteration. A total of 802 live unionids representing 13 species were collected.

Overall CPUE was 37.53 live individuals per man-hour. The most abundant species in the 2005 effort, in order of abundance, were: *A. plicata*, *Q. quadrula*, and *L. complanata*. As was the case during Barnhart's surveys, the highest species diversity and greatest abundance were found in the lower portions of St. James Ditch and in Setback Levee Ditch. This survey confirmed that the SJNM still supported a diverse and abundant freshwater mussel population.

## **Methods**

Qualitative mussel surveys were conducted in 2010 by wading and grubbing to locate freshwater mussels. Although a minimum of one person-hour search time at each specific site was initially proposed, discussions with Missouri Department of Conservation and U.S. Fish and Wildlife Service malacologists determined less than one person-hour at each location would suffice if potential mussel habitat was poor. Therefore timed searches were conducted that continued at least 15 minutes after the last new species was collected. Catch-per-unit effort data was collected and used to compare previous mussel populations with current conditions. The general habitat (depth, current, turbidity) at each site was noted and the substrate of the surveyed reach was recorded. All available microhabitats within the survey site were searched. Live mussels encountered were identified, enumerated, and placed back into the substrate from where they were collected. Fresh dead shells were identified and recorded. Nomenclature followed Turgeon *et al.* (1998). GPS coordinates were recorded. Survey results are archived in the Memphis District's GIS database. A copy of the field datasheets can be found in the Appendix.

## **Results**

A total of 25 sites were searched over a 23.05 man-hour period (Figure 1, Table 1). The average search time per site was 0.94 man-hours. A total of 160 live unionid mussels representing 15 different species were collected (Table 1). Overall CPUE was 6.94 individual mussels.

Beginning in the spring of 2009 and continuing through the present time (January 2010), the local levee district has dredged many project area channels to authorized levels. This activity was funded through the U.S. Department of Agriculture, Natural Resources Conservation Service. Thirteen of the surveyed locations have been dredged to date as part of the current effort. Of the remaining nine non-impacted locations, two are scheduled to be dredged with the current funding while the clean-out schedule for the remaining seven locations is unclear.

At seven locations no mussels were encountered (five locations in the St. Johns Bayou Basin and two locations in the New Madrid Floodway). Sixteen sites had five or less mussels collected.

Habitat and depths varied throughout the survey sites. Table 2 provides information on the general habitat type and substrate observed.

## **Discussion**

The project area supported a relatively diverse, abundant, and stable freshwater mussel population typical of a deltaic stream systems prior to this recent channel cleanout. These cleanouts may explain the low number of live mussels collected in 2010 when compared to previous unionid mussel surveys within the project area. Whether this decrease in population is permanent or merely temporary is unknown at this time, but if past sampling events are the

measure, the mussel population has the ability rebound back to similar, pre-disturbance levels, given a sufficient amount of time.

Overall mussel numbers were reduced, but similar species were collected in comparison to previous studies in the project area (Tables 3-6). In areas that have not been dredged, the mussel population trended in a similar fashion to previous studies and overall abundance was higher than non-dredged locations.

In one area that had been recently dredged (Site 17), a strip of mussels were observed on the bank opposite of where the cleanout occurred. This indicates areas of mussels may exist where the heavy equipment “missed” any existing mussel beds.

Channel maintenance history indicated portions of the ditches surveyed in 1998 had been previously cleaned out between 1984 and 1988. Mussel populations appeared to have re-colonized from this impact by 1998. A similar trend in abundance and densities were observed in the 2005 surveys. These data indicate the mussel populations in SJNM should be able to re-colonize within 10-15 years, with additional perturbations either slowing down or halting growth of the population. Recolonization would also be dependent on availability of suitable habitat and hosts.

Authorized project features, *i.e.* channel widening may further affect the mussel population by decreasing water levels in the main ditches of the project area surveyed. Overall habitat would be potentially decreased, in a similar fashion to the recent ditch cleanouts, but the population would be expected to return to pre-disturbance levels.

The seven locations where no mussels were collected were: four in the upper St. James Ditch, two in lower Mud Ditch, and one location in St. Johns Ditch. The St. James Ditch locations were in areas with low to no flow, impeded by beaver dams or minimal water levels. Similar results were obtained in the previous Barnhart survey in the upper three locations. The two locations in lower Mud Ditch were most likely attributable to poor habitat as the 2010 data closely paralleled the 1998 data. The St. Johns location may be associated with the recent channel work or poor habitat, however only four mussels were collected in 1998 suggesting this may be habitat related. These data would indicate that habitat is the controlling force in the project area.

**Table 1. Results of October 2010 surveys<sup>1,2</sup>.**

Site Number	1	2	3	4	5	6	7	8	9	10	11	12	13	15	16	17	18	19	20	21	22	23	24	25	26
	SJoD	SJoD	SJoD	SJoD	SJoB	WD	SJaD	WD	SJDD	MD	MD	MD	SJoD	TMP	SLD	SLD	SLD	SLD	SLD	SLD	SJaD	SJaD	SJaD	SJaD	SJaD
Species																									
Anodonta suborbiculata				4							1					1	3		2						
Amblyma plicata	1	3													5	20	7	6	3	3					
Arcidens confragosus								1								3	1		2	2	2				
Lampsilis cardium							1																		
Lampsilis teres							6		1							2				2					
Lasmigona complanata	1							2								1	2	4	3		3				
Leptodea fragilis					1	1										2	1								
Potamilus purpuratus		1					2		1							3		1			1				
Pyganodon grandis							7	3						5					2		3				
Quadrula pustulosa						1									1						1				
Quadrula quadrula						1		3	1		1					1	6	2							
Tritogonia verrucosa	1	1											2						1						
Truncilla truncata																1									
Unio merus tetralasmus							3																		
Strophitus undulatus							1																		
<b>Total Search Time (min)</b>	50	80	60	58	50	60	72	80	66	32	46	32	60	84	60	80	64	74	60	60	72	30	32	20	30
<b>Total Search Time (hr)</b>	0.83	1.33	1.00	0.97	0.83	1.00	1.20	1.33	1.10	0.53	0.77	0.53	1.00	1.40	1.00	1.33	1.07	1.23	1.00	1.00	1.20	0.50	0.53	0.33	0.50
<b>Number of Live Individuals</b>	3	5	0	4	1	3	20	9	3	0	2	0	2	5	6	34	20	13	13	7	10	0	0	0	0
<b>CPUE (Individuals/hr)</b>	3.60	3.75	0.00	4.14	1.20	3.00	16.67	6.75	2.73	0.00	2.61	0.00	2.00	3.57	6.00	25.50	18.75	10.54	13.00	7.00	8.33	0.00	0.00	0.00	0.00
<b>Total Number of Species</b>	3	3	0	1	1	3	6	4	3	0	2	0	1	1	2	9	6	4	6	3	5	0	0	0	0

<sup>1</sup> Stream abbreviations used: St. Johns Bayou (SJoB), St. Johns Ditch (SJoD), St. Johns Diversion Ditch (SJDD), Mud Ditch (MD), Setback Levee Ditch (SLD), St. James Ditch (SJaD), Ten Mile Pond Ditch (TMD), Wilkerson Ditch (WD). Basin Abbreviations used: St. Johns Bayou Basin (SJBB) and New Madrid Floodway (NMF).

<sup>2</sup>Site 14 was not sampled in 2010.

**Table 2. 2010 Freshwater Mussel Survey, Habitat Conditions.<sup>1</sup>**

Site	General Habitat	Approx. Avg. Depth	Approx. Width	Substrate	Recent Dredging
01	Some woody debris, low turbidity	0.5 m	30 m	Sand	Yes
02	Unstable sand, some woody debris, low turbidity	0.5 m	30 m	Sand	Yes
03	Unstable sand, low turbidity	0.5 m	30 m	Sand over clay	Yes
04	Unstable sand, low turbidity	0.5 m	30 m	Sand over clay	Yes
05	Lots of woody debris, trash, turbid	0.5 m	35 m	Clay, gravel, sand	No
06	Low current, woody debris, high turbidity	0.5 m	35 m	Silt, sand	Yes
07	Few aquatic plants, woody debris, low turbidity, trash dump to east	0.5 m	15 m	Silt, some sand	No
08	Aquatic vegetation, high turbidity	0.5 m	20 m	Silt	Yes
09	Lots of woody debris, unconsolidated silt, turbid	0.75 m	20 m	Unconsolidated silt, woody debris	No
10	Very turbid, aquatic vegetation, woody debris, immediately downstream of on-going cleanout	0.5 m	7 m	Clay, unconsolidated silt	No*
11	Very turbid, some woody debris, downstream of on-going cleanout	0.5 m	7 m	Clay, unconsolidated silt	No*
12	Turbid, some woody debris	0.5 m	15 m	Unconsolidated silt	Yes
13	Turbid, some woody debris	0.5 m	30 m	Unstable sand	Yes
15	Turbid, some woody debris	1 m	15 m	Clay with fairly stable silt and limited unconsolidated silt pockets	Yes
16	Low turbidity, highly degraded site	0.2 m	15 m	Unstable sand, some silt and sand	Yes
17	Low turbidity, cattle grazing on east side	0.3 m	25 m	Sand with some silt	Yes
18	Low turbidity, cattle grazing on east side	0.3 m	25 m	Sand with some silt	Yes
19	Low turbidity, some woody debris	0.7 m	25 m	Sand, hard clay	Yes
20	Low turbidity, some woody debris	0.5 m	25 m	Silt with some clay	Yes

<b>Site</b>	<b>General Habitat</b>	<b>Approx. Avg. Depth</b>	<b>Approx. Width</b>	<b>Substrate</b>	<b>Recent Dredging</b>
21	Low turbidity, some aquatic vegetation	0.4 m	25 m	Unstable sand with some silt	Yes
22	Silt, turbid, Hydrilla and algae, downstream of beaver dam	0.1 m	3 m	Silt	No
23	Aquatic plants, algae, low turbidity	0.2 m	11 m	Very thick layer of silt with particles of vegetation	No
24	Sand covered with algae, aquatic vegetation, minnows abundant	0.04 m	1 m	Sand covered with algae	No
25	Woody Debris, some vegetation, downstream of beaver dam, low turbidity	10 cm		Silt, organic	No
26	Woody Debris, low turbidity	30 cm	15 m	Sand with algae on top	No

<sup>1</sup>Site 14 not sampled during 2010.

**Table 3. Comparison of results of mussel surveys over time at each site.**

Stations	Barnhart 1998		MVM 2005 <sup>1</sup>		MVM 2010	
	No. of Individuals	No. of species	No. of Individuals	No. of species	No. of Individuals	No. of species
1	14	7			3	3
2	34	5			5	3
3	4	2			0	0
4	3	3			4	1
5	0	0			1	1
6	34	4			3	3
7	86	6			20	6
8	8	5			9	4
9	18	7			3	3
10	3	2			0	0
11	1	1			2	2
12	11	3			0	0
13	27	9	24	8	2	1
14	9	4			-	-
15	7	1			5	1
16	30	7	31	4	6	2
17	236	10	92	9	34	9
18	37	11			20	6
19	26	6	35	10	13	4
20	23	7			13	6
21	81	4	101	9	7	3
22	170	10	209	7	10	5
23	96	11	31	5	0	0
24	1	1			0	0
25	2	1			0	0
26	0	0			0	0
27	18	5			-	-
28	9	4			-	-
Totals	988	23 spp.	523	13 spp.	160	15 spp.

<sup>1</sup>Of the fourteen sites surveyed in 2005, only seven locations occurred in the vicinity of previous studies, the remaining seven locations focused on potential re-location areas. Numbers presented in this table reflect only those seven similar locations. Sites 14, 27, and 28 were not surveyed in 2010 due to site conditions.

**Table 4. Number of live mussels collected by species during the 2010 survey effort.**

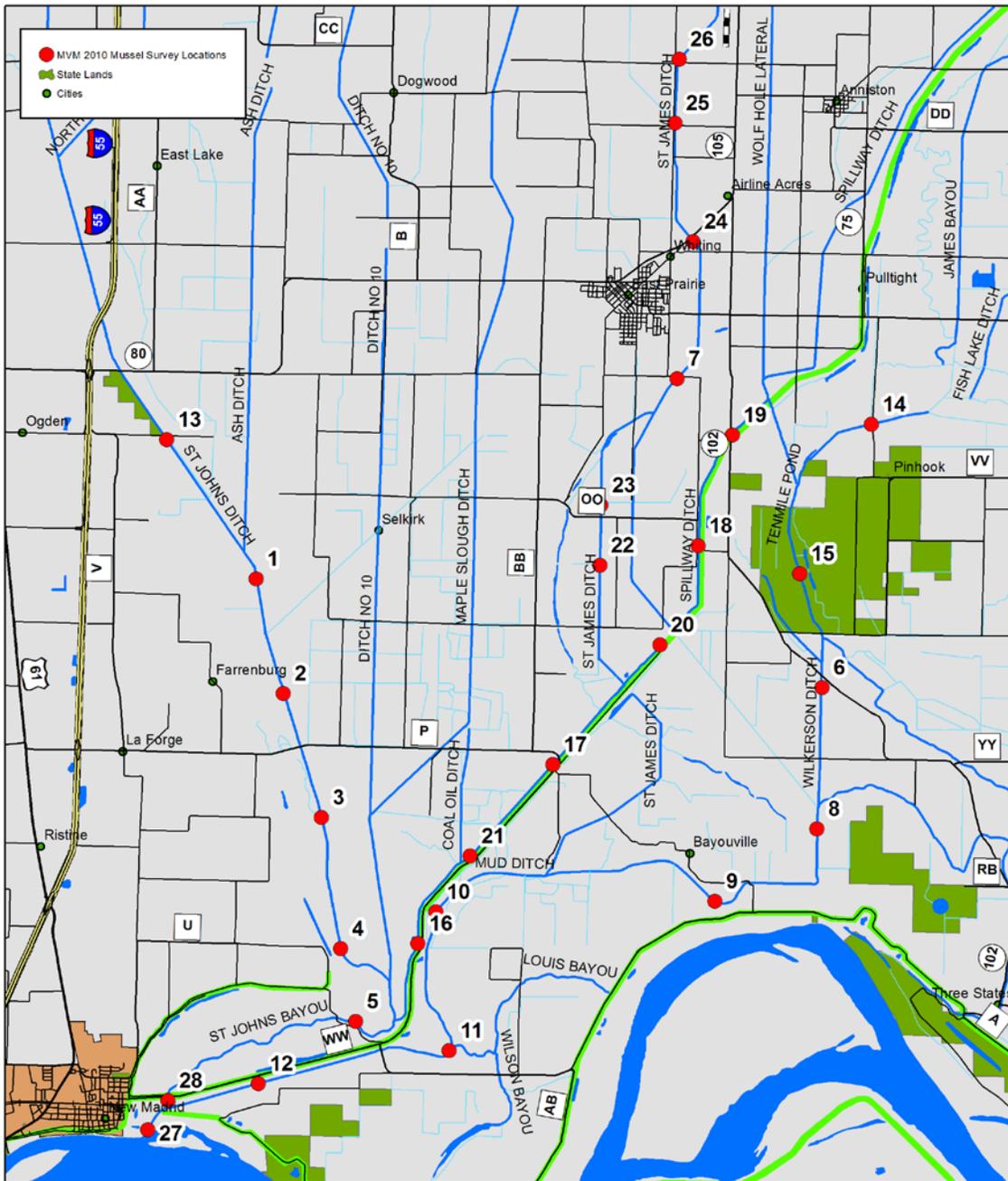
Species	Total Live Mussels	Percent of Total	Number of Sites	Percent of Sites
<i>Amblema plicata</i>	48	30.00	8	32
<i>Pyganodon grandis</i>	20	12.50	5	20
<i>Lasmigona complanata</i>	16	10.00	7	28
<i>Quadrula quadrula</i>	15	9.38	7	28
<i>Anodonta suborbiculata</i>	11	6.88	5	20
<i>Arcidens confragosus</i>	11	6.88	6	24
<i>Lampsilis teres</i>	11	6.88	4	16
<i>Potamilus purpuratus</i>	9	5.63	6	24
<i>Leptodea fragilis</i>	5	3.13	4	16
<i>Tritogonia verrucosa</i>	5	3.13	4	16
<i>Quadrula pustulosa</i>	3	1.88	3	12
<i>Unio merus tetralasmus</i>	3	1.88	1	4
<i>Lampsilis cardium</i>	1	0.63	1	4
<i>Truncilla truncata</i>	1	0.63	1	4
<i>Strophitus undulatus</i>	1	0.63	1	4

**Table 5. Number of live mussels collected by species during the 2005 sampling effort.**

Species	Total Live Mussels	Percent of Total	Number of Sites	Percent of Sites
<i>Amblema plicata</i>	535	66.71	10	71.4
<i>Quadrula quadrula</i>	79	9.85	9	64.3
<i>Lasmigona complanata</i>	50	6.23	9	64.3
<i>Quadrula pustulosa</i>	32	3.99	7	50.0
<i>Tritogonia verrucosa</i>	26	3.24	5	35.7
<i>Lampsilis teres</i>	24	2.99	7	50.0
<i>Pyganodon grandis</i>	18	2.24	7	50.0
<i>Potamilus purpuratus</i>	17	2.12	8	57.1
<i>Arcidens confragosus</i>	10	1.25	6	42.9
<i>Leptodea fragilis</i>	5	0.62	3	21.4
<i>Fusconaia flava</i>	3	0.37	2	14.3
<i>Truncilla truncata</i>	2	0.25	2	14.3
<i>Lampsilis cardium</i>	1	0.12	1	7.1

**Table 6. Number of live mussels collected by species by Barhart during the 1998 sampling effort.**

Species	Total Live Mussels	Percent of Total	Number of Sites	Percent of Sites
<i>Amblema plicata</i>	528	53.44	15	53.6
<i>Quadrula quadrula</i>	90	9.11	15	53.6
<i>Pyganodon grandis</i>	84	8.50	17	60.7
<i>Quadrula pustulosa</i>	74	7.49	11	39.3
<i>Lasmigona complanata</i>	47	4.76	15	53.6
<i>Potamilus purpuratus</i>	28	2.83	14	50.0
<i>Leptodea fragilis</i>	24	2.43	10	35.7
<i>Lampsilis teres</i>	23	2.33	4	14.3
<i>Arcidens confragosus</i>	16	1.62	5	17.9
<i>Utterbackia imbecillis</i>	15	1.52	2	7.1
<i>Quadrula nodulata</i>	14	1.42	4	14.3
<i>Tritogonia verrucosa</i>	12	1.21	5	17.9
<i>Potamilus ohioensis</i>	7	0.71	1	3.6
<i>Lampsilis cardium</i>	5	0.51	5	17.9
<i>Toxolasma parvus</i>	5	0.51	1	3.6
<i>Anodonta suborbiculata</i>	3	0.30	3	10.7
<i>Obliquaria reflexa</i>	3	0.30	2	7.1
<i>Toxolasma texasensis</i>	3	0.30	1	3.6
<i>Truncilla truncata</i>	3	0.30	2	7.1
<i>Fusconaia flava</i>	1	0.10	1	3.6
<i>Ligumia subrostrata</i>	1	0.10	1	3.6
<i>Potamilus alatus</i>	1	0.10	1	3.6
<i>Unio merus tetralasmus</i>	1	0.10	1	3.6



US Army Corps of Engineers Memphis District

0 1 2 4 6 8 Miles  
0 1 2 4 6 8 Kilometers

Figure 1. Locations of Sampling Sites for Freshwater Mussels in the St. Johns/New Madrid Project Area.

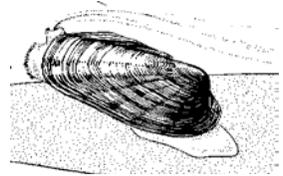
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## **Appendix**



# FIELD DATA SHEET



Project Name:

Date:

1. Survey Site:
2. Surveyors:
4. GPS Coordinates:
5. Survey Methods Used (circle all applied):
6. River Stage:

Reach (m):  
Search Time:

Relic      Hand      Rake      Snorkel      Scuba

Species	Common Name	Present (√)	Number identified		
AC – Arkansas Commercial E – Endangered SC – AR tracked sp. of concern			Relic	Live	Total Live
<i>Actinonaias ligamentina</i>	Mucket				
<i>Alasmidonta marginata</i>	Elktoe				
<i>Amblema plicata</i> (AC)	Threeridge				
<i>Anodonta suborbiculata</i> (SC)	Flat floater				
<i>Arcidens confragosus</i>	Rock pocketbook				
<i>Corbicula fluminea</i>	Asian clam				
<i>Cyclonaias tuberculata</i>	Purple wartyback				
<i>Cyprogenia aberti</i> (SC)	Western Fanshell				
<i>Dreissena polymorpha</i>	Zebra mussel				
<i>Ellipsaria lineolata</i>	Butterfly				
<i>Elliptio dilatata</i>	Spike				
<i>Fusconaia ebena</i> (AC)	Ebonyshell				
<i>Fusconaia flava</i>	Wabash pigtoe				
<i>Lampsilis abrupta</i> (E) (SC)	Pink mucket				
<i>Lampsilis cardium</i>	Plain pocketbook				
<i>Lampsilis hydiana</i>	Louisiana fatmucket				
<i>Lampsilis teres</i>	Yellow sandshell				
<i>Lasmigona complanata</i>	White heelsplitter				
<i>Leptodea fragilis</i>	Fragile papershell				
<i>Ligumia recta</i>	Black sandshell				
<i>Ligumia subrostrata</i>	Pondmussel				
<i>Megalonaias nervosa</i> (AC)	Washboard				
<i>Obliquaria reflexa</i>	Threehorn wartyback				
<i>Obovaria olivaria</i>	Hickorynut				
<i>Plectomerus dombeyanus</i>	Bankclimber				
<i>Pleurobema rubrum</i> (SC)	Pyramid pigtoe				
<i>Pleurobema sintoxia</i>	Round pigtoe				
<i>Potamilus alatus</i> (SC)	Pink heelsplitter				
<i>Potamilus capax</i> (E) (SC)	Fat pocketbook				
<i>Potamilus ohiensis</i>	Pink papershell				
<i>Potamilus purpuratus</i>	Bleufer				
<i>Pyganodon grandis</i>	Giant floater				
<i>Quadrula cylindrica</i> (SC)	Rabbitsfoot				
<i>Quadrula metanevra</i>	Monkeyface				
<i>Quadrula nodulata</i>	Wartyback				
<i>Quadrula pustulosa</i>	Pimpleback				
<i>Quadrula quadrula</i> (AC)	Mapleleaf				
<i>Toxolasma sp. (lividus-purple:SC)</i>	Lilliput sp				
<i>Tritogonia verrucosa</i>	Pistolgrip				
<i>Truncilla truncata</i>	Deertoe				
<i>Unio merus tetralasmus</i>	Pondhorn				
<i>Utterbackia imbecillis</i>	Paper pondshell				
TOTAL:					



**Report:**

**A Survey of Unionid Mussels in the St. John's Basin  
and the New Madrid Floodway**

March 1, 1998

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## Abstract

A survey of unionid mussels was conducted in the St. John's Basin and the New Madrid Floodway in the summer of 1997. The survey was undertaken in order to describe the unionid fauna of reaches that will be impacted by the anticipated East Prairie Phase of the St. John's Bayou-New Madrid Floodway Project. The study reaches were located in St. John's Bayou, St. John's Ditch, Setback Levee Ditch (=Spillway Ditch), St. James Ditch, Mud Ditch (=East Bayou Ditch), St. John's Diversion Ditch, Wilkerson Ditch, and the 10-Mile Pond Wildlife Area. A total of 28 sites were searched spaced at intervals of approximately 2 miles. Total catch was 998 live unionids representing 23 species. Overall catch per unit effort (CPUE) was 15.3 individual mussels per man-hour. The seven most abundant species, in order of abundance, were the threeridge, mapleleaf, giant floater, pimpleback, white heelsplitter, bleufer, and fragile papershell. Each of these species was found at more than half of the sites that were examined. Four species that are considered rare in Missouri were found. These species are the rock pocketbook (*Arcidens confragosus*), flat floater (*Anodonta suborbiculata*), wartyback (*Quadrula nodulata*), and Texas lilliput (*Toxolasma texasensis*). The highest species diversity and greatest abundance of individuals was found in the lower portions of St. James Ditch and in the Setback Levee (Spillway) Ditch. Overall, the study area supports a diverse and fairly abundant unionid fauna, consisting of at least 24 species. This fauna appears to be typical of the drainage canals of the Mississippi lowlands in Missouri and Arkansas.

Presently, the outlet of the New Madrid Floodway is the only directly-connected tributary of the Mississippi River in the entire Missouri Bootheel. This gap would be closed by the proposed project. A gated outlet would be constructed for the New Madrid Floodway to limit flooding from the Mississippi, and auxiliary pumping stations would be installed for both outlets to move water out of the basins when the gates are closed.

The study reaches in the St. John's Bayou drainage basin were located in St. John's Bayou, St. John's Ditch, Setback Levee Ditch (also known as "Spillway Ditch"), and St. James Ditch. Study reaches in the New Madrid Floodway basin were located in Mud Ditch (also known as "East Bayou Ditch"), St. John's Diversion Ditch, Wilkerson Ditch, and the 10-Mile Pond Wildlife Area (Appendix 1, Figures 2,3).

### Study Methods

All sites were surveyed between July 16 and September 20, 1997. Water depths during the searches were generally less than 1-meter. Study sites were located at approximately 2-mile intervals in most reaches. Some sites were accessible from roadways, but most were reached by canoe. Each site was visited by a crew of 2-4 workers. Qualitative sampling was carried out by visual searches when the substrate was visible, or more often by sweeping the substrate by hand. In areas that were relatively free of debris, a 1.5-meter length of PVC pipe was pushed sideways along the surface of the substrate. Contact with shells anywhere along the length of the pipe can be felt, and the effective search area is thereby considerably increased. Mean search time was 2.25 man-hours per site. Mussels were placed in mesh bags as they were collected during the timed search. Afterward, specimens were examined, identified to species, and measured. Most individuals were then returned to the substrate in proper orientation.

Qualitative sampling is efficient in determining relative abundance and species richness (Vaughn et al. 1997, Obermeyer 1998). We also performed quantitative sampling at ten of the 28 study sites in order to ascertain the practicality of measuring population densities. Following the timed search, from 16 to 28 quadrats were searched in the area immediately downstream of the qualitative sampling area. Each quadrat was

0.25-m<sup>2</sup> in area. The quadrats were placed randomly at an average density of 1 quadrat per 25 m<sup>2</sup> (i.e. average 1% coverage). The relatively uniform and fine-grained substrates in many Bootheel ditches permit the recovery of small (young) individuals, which are difficult to locate in gravel and cobble substrates (Roberts et al., 1997). Quadrat sampling was carried out using a sampling device similar in design to a Surbur sampler. This device consisted of a sieve box, open on one end, attached to a 0.25 meter<sup>2</sup> (side length 0.5 meter) quadrat frame. The sieve box and quadrat frame were made from 1-inch steel tubing, and the sieve box was lined with 0.25-inch mesh galvanized hardware cloth. In use, the sampler was laid on the substrate with the quadrat frame positioned upstream. Substrate was excavated by hand to a depth of several inches within the frame and pushed downstream into the sieve box. When the excavation was complete the frame was tilted up and shaken to flush the sediments through the screened sides.

In each ditch, at least one individual of each species collected was retained as a voucher specimen. Voucher specimens were fixed in buffered formalin and preserved in 70 percent ethanol. Specimens were labeled with species identification, the date and the locality of collection. Voucher specimens were deposited with the Missouri Department of Conservation, Columbia, Missouri.

## Results

*Qualitative sampling:* A total of 28 sites were searched (Table 1). The average search time per site was 2.24 man-hours. Total search time was 62.8 man-hours. In total, 998 live unionids were recovered, representing 23 species. Overall catch per unit effort (CPUE) in the qualitative sampling was 15.3 individual mussels per man-hour. These figures are based on live individuals. Consideration of dead shells added somewhat to the species counts at some sites (Table 1). Live individuals greatly outnumbered dead shells. Therefore, it appears that shells probably degrade or are buried rather quickly in this habitat. For this reason, the presence of dead shells in good condition is probably a reliable indicator of the presence of live individuals of that species at the site.

In total, live individuals of 23 species were recovered. One other species (*Lampsilis siliquoidea*) was found only as recently dead shells. Percent of catch and percent of sites where present were tabulated for each species (Table 2, Figures 4, 5). *Amblema plicata* was particularly common, occurring at 57% of the sites examined and accounting for 53% of the total catch. This species was particularly abundant in the St. James Ditch and the Setback Levee Ditch, where it exceeded 60% of the catch (Figure 7). In descending order, the seven most numerically abundant species were *Amblema plicata*, *Quadrula quadrula*, *Pyganodon grandis*, *Quadrula pustulosa*, *Lasmigona complanata*, *Potamilus purpuratus*, and *Leptodea fragilis* (Table 2, Figure 4). These same seven species were all widespread as well as abundant within the survey area. Each was found at more than half of the sites that were examined (Table 2, Figure 5). Four species that are considered rare in Missouri were found. These species are *Arcidens confragosus*, *Anodonta suborbiculata*, *Quadrula nodulata*, and *Toxolasma texasensis*.

*Comparisons of study basins and reaches:* The mean number of species found per site and the mean CPUE were determined for each of the four major ditch reaches sampled (Table 3). Species composition within these reaches was tabulated (Figures 6, 7, 8, 9). The difference between overall and local species composition in these reaches was also calculated (Figures 10, 11, 12, 13).

St. John's Bayou and St. John's Ditch: The eight sites sampled in St. John's Bayou and St. John's Ditch were relatively unproductive, with mean CPUE of 6.3 mussels/hour and a mean of 4.9 species/site. Species composition in these reaches contrasted somewhat with the overall survey results. *Quadrula pustulosa* and *Potamilus purpuratus* were more common, while *Amblema plicata* was relatively less common (Figures 6, 10). Substrate in these ditches was generally fine, dark sand, often with woody debris mixed in, and appeared to be relatively loose and unstable. Channel width was 30-40 meters and water depth was typically 60-80 cm.

Setback Levee Ditch: The six sites surveyed in the Setback Levee (Spillway) Ditch were the richest of the four major reaches, with mean CPUE of 27.7 mussels/hour and a mean of 7.8 species/site. Compared to the overall survey, *Amblema plicata* was relatively abundant (Figures 7, 11). Particularly productive sites were numbers 17, 18,

and 21. These sites were wooded with mature trees on the west bank, while the east bank (the levee side) was devoid of woody vegetation. Most mussels at these sites were found within 1-2 meters of the wooded bank. These areas had clean, fine sand substrate that was relatively compact and stable. The ditch was relatively narrow (12-20 meters wide), and water depth of the sampled areas was shallow, generally 25-45 cm.

St. James Ditch: The St. James Ditch was the narrowest ditch surveyed. Channel width was only 6-11 m. Depth was variable and was often less than 20 cm in the upper reaches. Probably for this reason, both CPUE and species/site dropped substantially moving from the downstream to the upstream sites (Figure 14). The lower sites were quite productive with CPUE up to 56.7 and up to 11 species per site. Average CPUE in St. James Ditch was 22.4 mussels/hour and mean species/site was 6.2. Species composition was similar to that of the overall survey (Figures 8, 12). Substrate at the lower, productive sites (22, 23, 7) consisted of fine silt overlaying sand. Trees were present at most sites, but most of the woody vegetation at site 24 had recently been cut. This area did not appear to have been dredged for some time.

New Madrid Floodway ditches: The eight study sites within the New Madrid Floodway Basin (Mud Ditch, St. John's Diversion Ditch, Wilkerson Ditch, 10-Mile Pond) yielded 91 individual mussels of ten species. Overall CPUE for these sites was relatively low at 5.8 mussels/hour. The mean number of species/site was 5.1. For comparison between basins, the 20 study sites within the St. John's Basin yielded 897 individuals of 22 species, CPUE of 19.2 and species/site of 5.4. Species composition of the New Madrid ditches differed somewhat from the overall survey results. *Amblema plicata* was less abundant, while *Quadrula quadrula*, *Pyganodon grandis*, *Leptodea fragilis*, and *Quadrula nodulata* comprised a larger proportion of the catch (Figures 9, 13). No species were found in the New Madrid basin that were not also found in the St. John's basin. On the other hand, 13 species found in the St. John's basin were not recovered from the New Madrid basin. Channel widths at sites in the New Madrid basin ranged from 14-25 m and depths of sampled areas generally ranged from 25-80 cm. Downstream sites in Mud Ditch had soft mud substrate, while more upstream sites in St. John's Diversion Ditch and Wilkerson Ditch had sand substrate. Sites in the Ten-Mile Pond area had mud substrate. Substrate was generally loose throughout.

*Quantitative sampling.* Overall, only 25 individual mussels were recovered in 204 quadrat samples, indicating an overall population density in the sampled area of 0.49 individuals per m<sup>2</sup>. Mussel densities in the survey area were too low to be accurately estimated by the number of quadrat samples employed. The overall population density in the study area is probably still lower, because the sites chosen for quadrat sampling were generally those with higher densities. These results are consistent with our subjective impression that mussel populations within the ditches are generally more dispersed than is typical of natural waterways. In natural rivers and streams, unionid distribution is highly clumped, and the population concentrations are referred to as 'beds'. Natural streams are highly heterogeneous environments, and mussel beds appear to form in localized areas of suitable habitat. In the ditches, we did not note concentrations that would warrant the term 'bed'. Presumably, the relative uniformity of physical habitat and substrate results in a less clumped distribution of individuals.

*Size and age distributions.* The ages of individual *Amblema plicata*, estimated by counting annuli, were correlated with shell length, although there was considerable variation in size within age classes (Figure 17). The youngest individuals recovered were in their second year of growth and were less than 20 mm long. Individuals below 100 mm shell length generally appeared to be less than 10 years in age. It was difficult to accurately count annuli in older individuals. Growth slows in older individuals, so that annuli are more closely spaced, and erosion of shells of older individuals also tends to obscure the growth lines.

The size distribution of *Amblema plicata* in the Setback Levee Ditch was markedly bimodal. Relatively few individuals were recovered in the range of 80-120 mm in length (Figure 18). Size distributions varied among sites, but this cohort was relatively rare at all sites (Figure 19). In contrast, the size distribution of *Amblema* in the St. James Ditch was unimodal, with most individuals in the range of 60-100 mm in length (Figure 20).

## Discussion

Most of the over 300 North American species of unionid mussels have declined greatly in recent decades and many species are in danger of extinction (Williams et al. 1992). The man-made waterways that drain the agricultural lands in southeast Missouri and northeast Arkansas are significant unionid habitat. The combination of moderate depth and current speed, stable flows, sandy substrates, substantial groundwater flow, and, presumably, abundant fish hosts found in these ditches provides good conditions for certain unionid species. Relative to natural rivers of similar size, mussel populations in these ditches appear to be relatively diverse, abundant, and rather uniformly distributed.

Two other surveys of mussels in ditch habitats are available for comparison with the present study. Ahlstedt and Jenkinson sampled 31 sites in man-made ditches and modified St. Francis River tributaries in east-central and northeast Arkansas. These sites were studied as part of an extensive survey of the St. Francis River and its tributaries (Ahlstedt and Jenkinson 1987, Jenkinson and Ahlstedt 1987, Ahlstedt and Jenkinson 1991). Roberts et al. (1997) surveyed 67 sites on ditches in Dunklin and Pemiscott Counties in southeastern Missouri. Both of these surveys were undertaken primarily to investigate the presence and abundance of the federally listed fat pocketbook mussel, *Potamilus capax*. The combined data from the present and previous surveys are consistent and show that at least 30 species of unionids presently inhabit the lowland drainage ditches (Figures 15, 16). Overall, *Amblema plicata* is the most abundant ditch species, followed by *Potamilus purpuratus*, *Pyganodon grandis*, *Quadrula quadrula*, *Quadrula nodulata*, *Leptodea fragilis*, and *Quadrula pustulosa* (Figure 15). The most frequently encountered species are *Potamilus purpuratus*, *Pyganodon grandis*, *Leptodea fragilis*, *Amblema plicata*, *Quadrula quadrula*, *Lasmigona complanata*, and *Lampsilis teres* (Figure 16).

Federally endangered species: The federally endangered fat pocketbook mussel, *Potamilus capax*, is found in ditch tributaries of the St. Francis River at least as far north as Dunklin County, Missouri (Roberts et al. 1997, Ahlstedt and Jenkinson 1991). Fat pocketbooks were not found in the present survey. However, a previous environmental

survey reported fat pocketbooks to be present in Fish Lake Ditch at Hwy 80, just northeast of the Ten Mile Pond area (ESEI 1978). No other unionid species or sites were reported in that study. Without voucher specimens available for examination, it is impossible to determine whether this is a valid record, and we are inclined to discount it. Untrained observers readily confuse several other relatively inflated species of unionids with *Potamilus capax*, including female *Lampsilis cardium* and *Potamilus purpuratus* (personal observations).

State-listed rare species: Four Missouri state-rare species were found in this survey. These are the rock pocketbook (*Arcidens confragosus*), flat floater (*Anodonta suborbiculata*), wartyback (*Quadrula nodulata*), and Texas lilliput (*Toxolasma texasensis*). Missouri is well within the historic range of the rock pocketbook, flat floater and wartyback, whereas the Texas lilliput is probably on the edge of its range in the study area. The ditches of the Bootheel lowlands appear to provide the most important habitat for all of these species within the state of Missouri.

The rock pocketbook (*Arcidens confragosus*) was historically distributed in the Mississippi River and major tributaries from Minnesota to the Gulf of Mexico, as well as several Gulf river systems from Texas to Alabama (Clarke 1981). In Missouri, it has previously been found sporadically in the lower Meramec River, St. Francis River, and the Osage River (Oesch 1984) and more commonly in the ditches of the Missouri Bootheel (Jenkinson and Ahlstedt 1987; Roberts et al. 1997). This species generally inhabits medium to large rivers in pools and areas of reduced flow in mud and sand (Baker 1928, Cummings and Mayer 1992). In the lowlands, *Arcidens confragosus* appears to be associated with stable but silty substrate (Jenkinson and Ahlstedt 1987, present study). Suspected host fishes include freshwater drum, gizzard shad, rock bass, white crappie, and American eel (Surber 1913, Wilson 1916 cited by Watters 1994). However, this list is based upon limited observations of attached glochidia on wild-caught fish and these host relationships need to be confirmed by lab study. According to Utterback (1915) the rock pocketbook is bradytic and probably gravid from September to June.

In the present survey, *Arcidens confragosus* comprised 1.62% of the total catch and was 9<sup>th</sup> in abundance of 17 ranks (Table 2, Figure 4). Other ditch surveys report abundances of 0.5% (Roberts et al. 1997) and 1.29% (Ahlstedt and Jenkinson 1991). This species was most abundant in the lower St. James Ditch at sites 22 and 23. Occasional live individuals and dead shells were also found in sites at the Setback Levee Ditch, Mud Ditch, and the 10-Mile Pond area.

The flat floater (*Anodonta suborbiculata*) occurs within the Mississippi River basin from Nebraska, Iowa, Illinois, Indiana, and Kansas, south to Louisiana (Murray and Leonard 1962, Cummings and Mayer 1992). Although the range of *A. suborbiculata* covers a large area, the distribution of the species is not continuous. Over much of its range the flat floater appears to be a relatively specialized inhabitant of the oxbow lakes and backwaters of large rivers (Utterback 1915, Johnson 1980, Oesch 1984). Flat floaters typically can be found in soft mud substrate in still or slowly flowing water (Cope 1983). In suitable habitats, flat floaters may be abundant, but habitat loss has left this species highly local in distribution and threatened over much of its range. Flat floaters in Kansas spawn in September and October and release glochidia in January and February. Many fishes appear to serve as hosts. Natural glochidial cysts were observed on gizzard shad, white crappie, bluegill, largemouth bass, golden shiners, freshwater drum, and brook silverside. Transformation of glochidia to juveniles was observed on golden shiners, warmouth, white crappie and largemouth bass (Barnhart et al. 1996). In the present survey, flat floaters comprised 0.3% of the total catch. Abundance was 15<sup>th</sup> of 17 ranks (Table 2, Figure 4). Other ditch surveys report abundances of 0.3% (Roberts et al. 1997) and 2.11% (Ahlstedt and Jenkinson 1991). Live individuals and recently dead shells were found in Mud Ditch, Ten-Mile Pond, and St. James Ditch.

The wartyback mussel (*Quadrula nodulata*) is found in the Mississippi, Illinois and Ohio rivers and the lower portions of major tributaries, where it prefers areas of sand or fine gravel (Cummings and Mayer 1992). In Missouri, this species has not generally been found far from the mainstem Mississippi, although there are isolated records from the South Grand River in Henry County, Missouri (an Osage River tributary) and several sites on the Salt River in Pike, Ralls and Monroe Counties (Oesch 1984). This species appears to be relatively abundant in the drainage canals and ditches of the lowlands in

southeastern Missouri and northeastern Arkansas (Roberts et al. 1997, Jenkinson and Ahlstedt 1987). Principle component analysis of habitat associations suggest that this species may prefer relatively unstable substrates (Jenkinson and Ahlstedt 1987). The wartyback is tachytictic and is gravid with embryos or glochidia at least into mid-July (Coker et al. 1921, Roberts et al. 1997), probably releasing its glochidia in late July and early August. A few glochidia attributed to *Quadrula nodulata* were observed in natural infections on white crappie by Surber (1914) and channel catfish (Coker et al. 1921) but the natural hosts of this mussel need to be systematically investigated. One or more species of catfish appear to be the most likely hosts, based on other *Quadrula* species. The distribution of wartybacks suggests that the host may be found primarily in or close to large rivers. In the present survey, the wartyback made up 1.42% of the catch and ranked 11<sup>th</sup> in abundance of 17 ranks (Table 2, Figure 4). Other ditch surveys report abundances of 9.5% (Roberts et al. 1997) and 8.31% (Ahlstedt and Jenkinson 1991). This species occurred at three sites in the New Madrid Floodway ditches, specifically in St. John's Diversion Ditch (site 9) and Wilkerson Ditch (sites 6, 8). *Quadrula nodulata* was also found at site 17 in the Setback Levee Ditch.

The Texas lilliput mussel (*Toxolasma texasensis*) was first reported in Missouri in the last decade from the Belle Fountain Ditch drainage in Pemiscot County (Ahlstedt and Jenkinson 1987, Roberts et al, 1997). This is a southern species that finds the northern limit of its distribution in southern Illinois and Missouri (Cummings and Mayer 1992). Natural glochidia cysts of this species have been observed on warmouth and bluegill (Stern and Felder 1978). In the present study, the Texas lilliput was rare and was found at only sites 22 and 23 in the St. James Ditch. It comprised only 0.3% of the total survey catch. Other ditch surveys report abundances of 1.2% (Roberts et al. 1997) And 0.12% (Ahlstedt and Jenkinson 1991).

*Fish hosts:* The distribution and abundance of fishes is a major influence on the distribution and abundance of unionids, because the larval stages of unionids are obligate parasites on fishes. Most mussels are able to utilize only one or a few species of fish as host. Unionid diversity and fish diversity are strongly correlated in the Ohio River Basin, with a slope of approximately 2.2 fish species per unionid species (Watters 1992). A

higher ratio of fish species to mussel species appears to characterize the present study area. Preliminary results of fish sampling indicate more than 74 fish species are present in the study area (Robert Sheehan, personal communication). Based upon Watter's results we might, therefore, expect  $74/2.2 = 33$  species of mussels. Although the present man-made habitats in the lowlands are favorable for some mussel species, it appears likely that many others have been lost from the natural fauna.

Host specificity varies among unionids. Some species appear to utilize a single host, while others are able to transform on several host species. The host relations of most mussel species are poorly known. Many of the mussel species found in the lowland ditches are known to utilize freshwater drum as a primary or sole host for the transformation of the glochidia larvae. These include fat pocketbook (*Potamilus capax*), bleufer (*P. purpuratus*), pink papershell (*P. ohioensis*), pink heelsplitter (*P. alatus*), fragile papershell (*Leptodea fragilis*), fawnsfoot (*Truncilla donaciformis*), deertoe (*Truncilla truncata*). Others that are suspected of utilizing drum as host include the rock pocketbook (*Arcidens confragosus*). Catfishes are probable hosts of *Quadrula* species, and centrarchids such as white crappie are probable hosts of the abundant threeridge.

Mussel diversity and abundance are dependent upon a diverse and abundant fish population. The dispersal of unionids and their ability to colonize new habitats and to recolonize after local extirpation also depends upon the freedom of fish hosts to move among sites, particularly at those times when glochidia are encysted. Therefore, mussel conservation efforts must necessarily include native fish conservation efforts.

*Dredging history and age distributions:* The lowland drainage ditches were created by dredging and are maintained by periodic dredging. Dredging necessarily displaces and destroys a large proportion of the local mussel fauna. Because adult mussels are relatively immobile, recovery of depleted populations must take place by recruitment of juveniles from upstream or downstream mussel populations, transported by fish hosts. Hypothetically, therefore, the effects of dredging an area should be evident years later as a truncated age distribution, i.e., one lacking individuals older than the last dredging event. The time course of population recovery and the effects of dredging on subsequent recruitment might be deduced from local age distributions.

Records indicate that the most recent large-scale dredging of the Setback Levee Ditch occurred in 1988, approximately 9 years preceding our survey (Table 4). Interestingly, the size distribution of *Amblema plicata* in this ditch is not truncated, but rather is strongly bimodal, with numbers of large, apparently old individuals (>120 mm, probably >15 years old) and of small, apparently young individuals (<80 mm, probably <10 years old), with very few individuals of intermediate age (Figure 18). Evidently, dredging did not destroy all adult individuals at most sites, since individuals that predate the dredging are still present. These older individuals tended to be concentrated along the wooded bank at sites where only one side was cleared at the time of the dredging. The presence of older mussels, missed by the dredging, and of younger mussels, recruited since the dredging, is not surprising. However, the relative rarity of the intermediate age cohort is puzzling. If this age cohort was present at the time of the dredging, it should have been spared along with the older individuals.

The relative rarity of the 80-120 mm (roughly 9-15 year old) class of *Amblema* in Setback Levee Ditch could be the result of increased recruitment following the dredging in 1988. If the survival rate of juvenile mussels improved following the dredging, this might be reflected in the strong numbers in the 60-80 mm cohort (roughly 5-8 year olds). The suggestion that dredging might enhance mussel recruitment must certainly be considered with caution, but should not be dismissed out of hand. It should be remembered that dredging in these low-gradient waterways is carried out in order to maintain uniform gradient and flow and thereby reduce siltation. These restoration of these conditions and the exposure of clean sand substrates by dredging could very well favor mussel recruitment.

It is unfortunate that essentially nothing is known of the timing of the recovery of mussel populations following dredging events in these lowland ditches. Given that dredging occurs routinely throughout the lowlands, and has for many decades, opportunities clearly exist to study the time course of population recovery and species succession following these events. Studies that would correlate local dredging history with the age structure and species composition of mussel communities could be highly instructive, and could easily and quickly be carried out. Such studies are necessary before informed decisions can be made regarding mussel conservation in this area.

Conclusions: The study area supports a diverse, abundant, and generally distributed unionid fauna which is apparently typical of the drainage canals of the Mississippi lowlands in Missouri and Arkansas. At least 24 species are present. Four Missouri state-rare species are present in the surveyed area. The highest species diversity and greatest abundance of individuals was found in the lower portions of St. James Ditch and in the Setback Levee Ditch. The presence of mature woody vegetation on banks in the Setback Levee Ditch appeared to correlate with the presence of relatively abundant and diverse unionids. Areas of obviously loose, silty and unstable substrate in the lower St. John's Bayou were depauperate of mussels, as was the upper end of the surveyed reach of the St. James Ditch. Comparison of the survey results from the two drainage basins showed that the New Madrid Floodway ditches support a subset of the species found in the St. John's basin. The size distribution of *Amblema* in the Setback Levee Ditch is bimodal, with most individuals either <80 mm (<10 years old) or >120 mm (>15 years old). This distribution suggests that recruitment of *Amblema* may have been enhanced following dredging in 1988. Further study on the effects of dredging on mussel populations is needed and could be accomplished efficiently by correlating mussel populations with dredging history in selected reaches.

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Table 1. Summary of survey results by site number. Abbreviations indicate reaches as follows: St. Johns Bayou Ditch (SJoD), St. John's Bayou (SJoB), Wilkerson Ditch (WD), St. James Ditch (SJdD), St. John's Diversion Ditch (SJDD), Mud Ditch (MD), Ten Mile Pond (TMP), Setback Levee Ditch (SLD), and the St. John's Bayou Outlet Ditch (OL).

Species	Site numbers and reaches																												
	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	27	28	
	SJoD	SJoD	SJoD	SJoD	SJoB	WD	SJdD	WD	SJDD	MD	MD	MD	SJoD	TMP	TMP	SLD	SLD	SLD	SLD	SLD	SLD	SLD	SJdD	SJdD	SJdD	SJdD	SJdD	OL	OL
<i>Anodonta suborbiculate</i>	-	-	-	-	-	-	-	-	-	-	(2)	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Ambleria plicata</i>	4	8	1	1	-	-	-	-	1	-	-	-	8	-	-	12	194(3)	19(3)	10(1)	8	48(2)	141(1)	3	(1)	-	-	-	-	-
<i>Arcidens contrigosus</i>	-	-	-	-	-	-	-	-	-	(1)	-	-	-	-	(1)	-	-	1(1)	-	1	-	7	6	-	-	-	-	-	-
<i>Fusconella flava</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
<i>Lampsilis cardium</i>	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1(1)	-	-	-	-	1	-	1(1)	-	-	-	-	-
<i>Lampsilis teres</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(1)	-	-	(1)	-	-	-	-	-	-	-	-	-	-
<i>Lampsilis silivoides</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Lesmapona complanata</i>	2	-	-	-	-	2	3	1(1)	1	-	-	-	1	1(2)	-	2	1	1(1)	3	7	1	9(2)	12(1)	(1)	-	-	-	-	-
<i>Lepidocsa fragilis</i>	-	(2)	-	-	-	6(2)	-	2	6	(7)	(2)	(1)	-	(2)	-	2	-	2	-	1(1)	-	1(1)	-	-	-	-	-	-	-
<i>Ligumia subcostata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Obliquaria reflexa</i>	-	-	-	-	-	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Potamilius alatus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Potamilius ohioensis</i>	-	-	-	-	-	-	-	-	-	(1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Potamilius purpuratus</i>	1(2)	1	-	1	-	-	-	(1)	1	-	-	-	1(3)	1	-	2	2(1)	4(1)	3(2)	-	2	2	(2)	-	-	-	-	-	-
<i>Pygostodon grandis</i>	(1)	-	-	-	-	-	-	4(5)	2	-	(1)	1(2)	9	1	6(10)	7(2)	1(2)	1	2(1)	1	2(2)	-	2(5)	35(9)	-	2	-	-	-
<i>Quadrula noctulata</i>	-	-	-	-	-	7	-	2	2	-	-	-	-	-	-	3	-	3	-	-	-	-	-	-	-	-	-	-	-
<i>Quadrula pustulosa</i>	4	22	3	1	-	-	-	5	-	-	-	-	3	-	-	4	5	1(1)	4(2)	-	22(1)	-	-	-	-	-	-	-	-
<i>Quadrula quadralia</i>	1(1)	2	-	-	-	19	3	1	-	2	-	-	7	(1)	-	8	24(1)	4(1)	4	1	10	3(1)	-	-	-	-	-	-	-
<i>Toxolasma parvius</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Toxolasma texasensis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Triglophina verrucosa</i>	1	1	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	3	3(1)	-	-	-	-	-	-	-	-	-	-
<i>Truncilla truncata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-
<i>Unio macer lehrleimus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Ullarbeckia imbecillis</i>	-	-	-	-	-	-	-	-	-	-	(1)	(1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Minutes search time</b>	196	240	120	120	120	120	120	120	120	120	80	80	240	160	160	240	180	180	150	120	120	120	180	180	90	60	120	30	30
<b>Number of live individuals</b>	14	34	4	3	0	34	86	8	18	3	1	11	27	9	7	30	236	37	26	23	81	170	96	1	2	0	18	9	
<b>CPU (Individuals/hour)</b>	4.3	8.5	2.0	1.5	0.0	17.0	43.0	4.0	9.0	1.5	0.8	8.3	6.8	3.4	2.6	7.5	78.7	14.8	13.0	11.5	40.5	56.7	32.0	0.7	2.0	0.0	9.0	18.0	
<b>Number of species live</b>	7	5	2	3	0	4	6	5	7	2	1	3	9	4	1	7	10	10	10	6	7	4	10	11	1	1	0	5	4
<b>Additional species dead</b>	1	1	0	0	0	0	2	1	0	5	4	0	0	2	2	1	1	0	1	0	0	0	1	0	5	0	0	2	2
<b>Total number of species</b>	8	6	2	3	0	4	8	6	7	7	6	3	9	6	3	8	11	10	7	7	7	4	11	11	6	1	0	6	6

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Table 2. Live catch summary by species. Columns show total live individuals captured, percent of total live catch by species, number of sites at which each species was found live, and percent of total sites at which each species was found live.

Species	Common name	Total live mussels	Percent of total	Number of sites	Percent of sites
<i>Amblema plicata</i>	threeridge	528	53.44	16	57.1
<i>Quadrula quadrula</i>	mapleleaf	90	9.11	16	57.1
<i>Pyganodon grandis</i>	giant floater	84	8.50	19	67.9
<i>Quadrula pustulosa</i>	pimpleback	74	7.49	11	39.3
<i>Lasmigona complanata</i>	white heelsplitter	47	4.76	16	57.1
<i>Potamilus purpuratus</i>	bleufer	28	2.83	16	57.1
<i>Leptodea fragilis</i>	fragile papershell	24	2.43	15	53.6
<i>Lampsilis teres</i>	yellow sandshell	23	2.33	6	21.4
<i>Arcidens confragosus</i>	rock pocketbook	16	1.62	7	25.0
<i>Utterbackia imbecillis</i>	paper pondshell	15	1.52	4	14.3
<i>Quadrula nodulata</i>	wartyback	14	1.42	4	14.3
<i>Tritogonia verrucosa</i>	pistolgrip	12	1.21	5	17.9
<i>Potamilus ohioensis</i>	pink papershell	7	0.71	3	10.7
<i>Lampsilis cardium</i>	plain pocketbook	5	0.51	5	17.9
<i>Toxolasma parvus</i>	lilliput	5	0.51	1	3.6
<i>Anodonta suborbiculata</i>	flat floater	3	0.30	5	17.9
<i>Obliquaria reflexa</i>	threehorn wartyba	3	0.30	2	7.1
<i>Toxolasma texasensis</i>	Texas lilliput	3	0.30	2	7.1
<i>Truncilla truncata</i>	deertoe	3	0.30	2	7.1
<i>Fusconaia flava</i>	Wabash pigtoe	1	0.10	1	3.6
<i>Ligumia subrostrata</i>	pond mussel	1	0.10	1	3.6
<i>Potamilus alatus</i>	pink heelsplitter	1	0.10	1	3.6
<i>Unio merus tetralasmus</i>	pondhorn	1	0.10	2	7.1
<i>Lampsilis siliquoidea</i>	fat mucket	0	0.00	2	7.1

Table 3. Descriptions of qualitative searches and search results summarized by reach.

Totals and means for qualitative searches in St. John's Bayou Outlet (OL), St. John's Bayou (SJB), and St. John's Ditch (SJoD)									
Reach	OL	OL	SJoB	SJoD	SJoD	SJoD	SJoD	SJoD	Means
Site numbers	27	28	5	4	3	2	1	13	
Minutes search time	120	30	120	120	120	240	196	240	148.3
Number of live individuals	18	9	0	3	4	34	14	27	13.6
CPUE (individuals/hour)	9.0	18.0	0.0	1.5	2.0	8.5	4.3	6.75	6.3
Number of species live	5	4	0	3	2	5	7	9	4.4
Additional species dead	0	2	0	0	0	1	1	0	0.5
Total number of species	5	6	0	3	2	6	8	9	4.9

Totals and means for qualitative searches in the Setback Levee Ditch (SLD)							
Reach	SLD	SLD	SLD	SLD	SLD	SLD	Means
Site numbers	16	17	21	20	18	19	
Minutes search time	240	180	120	120	150	120	155.0
Number of live individuals	30	236	81	23	37	26	72.2
CPUE (individuals/hour)	7.5	78.7	40.5	11.5	14.8	13.0	27.7
Number of species live	7	10	4	7	10	6	7.3
Additional species dead	1	1	0	0	0	1	0.5
Total number of species	8	11	4	7	10	7	7.8

Totals and means for qualitative searches in the St. James Ditch (SJaD)							
Reach	SJaD	SJaD	SJaD	SJaD	SJaD	SJaD	Means
Site numbers	22	23	7	24	25	26	
Minutes search time	180	180	120	90	60	60	115.0
Number of live individuals	170	96	86	1	2	0	59.2
CPUE (individuals/hour)	56.7	32.0	43.0	0.7	2.0	0.0	22.4
Number of species live	10	11	6	1	1	0	4.8
Additional species dead	1	0	2	5	0	0	1.3
Total number of species	11	11	8	6	1	0	6.2

Totals and means for sites searched in Mud Ditch (MD), St. John's Diversion Ditch (SJDD), Wilkerson Ditch (WD) and Ten Mile Pond (TMP)									
Reach	MD	MD	MD	SJDD	W	W	TMP	TMP	Means
Site numbers	12	11	10	9	8	6	15	14	
Minutes search time	80	80	120	120	120	120	160	160	120.0
Number of live individuals	11	1	3	18	8	34	7	9	11.4
CPUE (individuals/hour)	8.3	0.8	1.5	9.0	4.0	17.0	2.6	3.4	5.8
Number of species live	3	1	2	7	5	4	1	4	3.4
Additional species dead	0	4	5	0	1	0	2	2	1.8
Total number of species	3	5	7	7	6	4	3	6	5.1

Table 4: Channel maintenance history. Information supplied by Kristen Palizza, USACE.  
Source: St. John Levee and Drainage District.

<b>Ditch Name</b>	<b>Years</b>	<b>Reach dredged</b>
Setback Levee Ditch	1988	Downstream from St. James Ditch
Mud Ditch	1984-1987	Most of ditch length, working downstream to upstream
St. John's Diversion Ditch	1984-1985	Most of ditch length, working downstream to upstream

Figure 1. Study area.

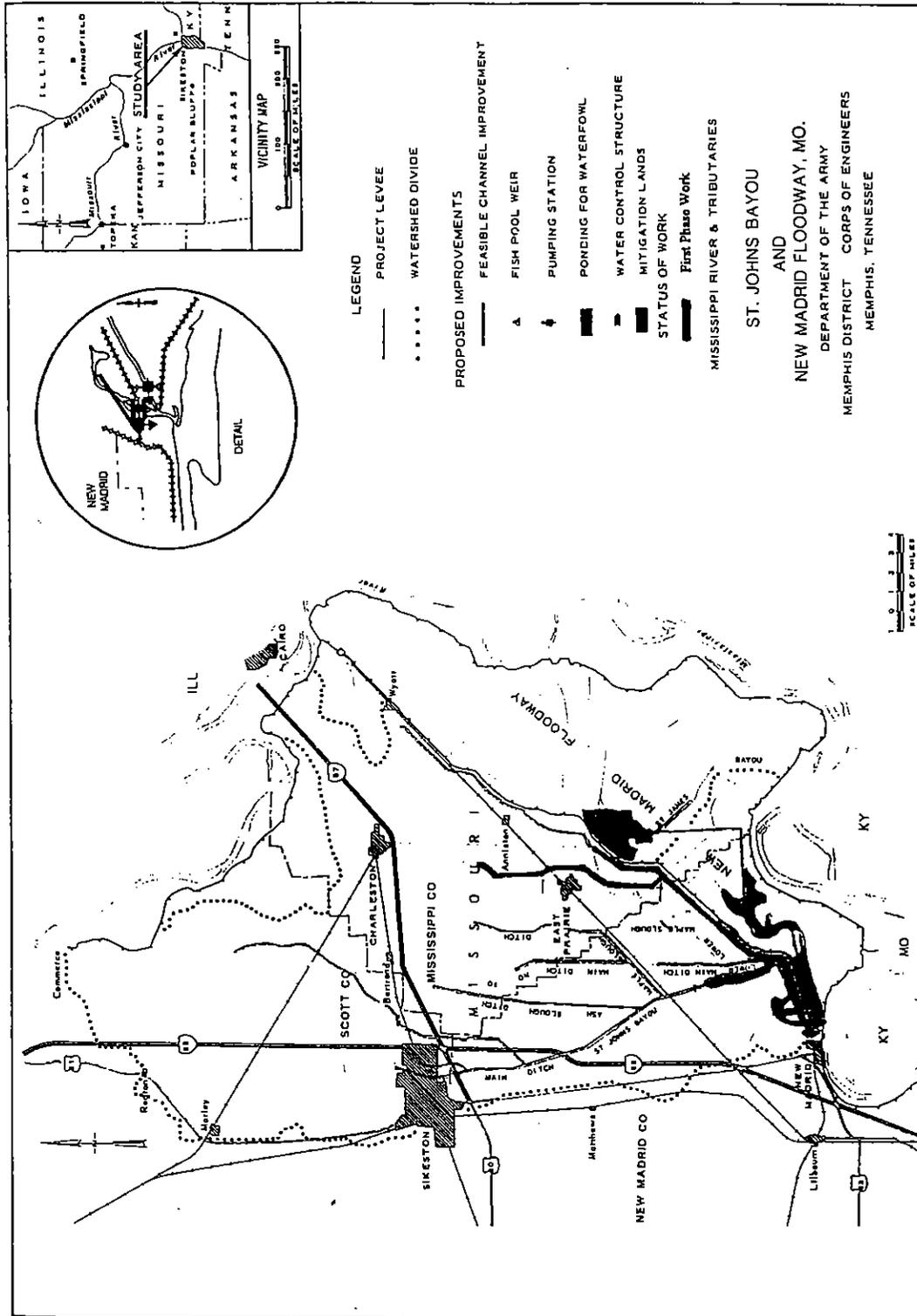


Figure 2. Study sites in New Madrid County, Missouri.

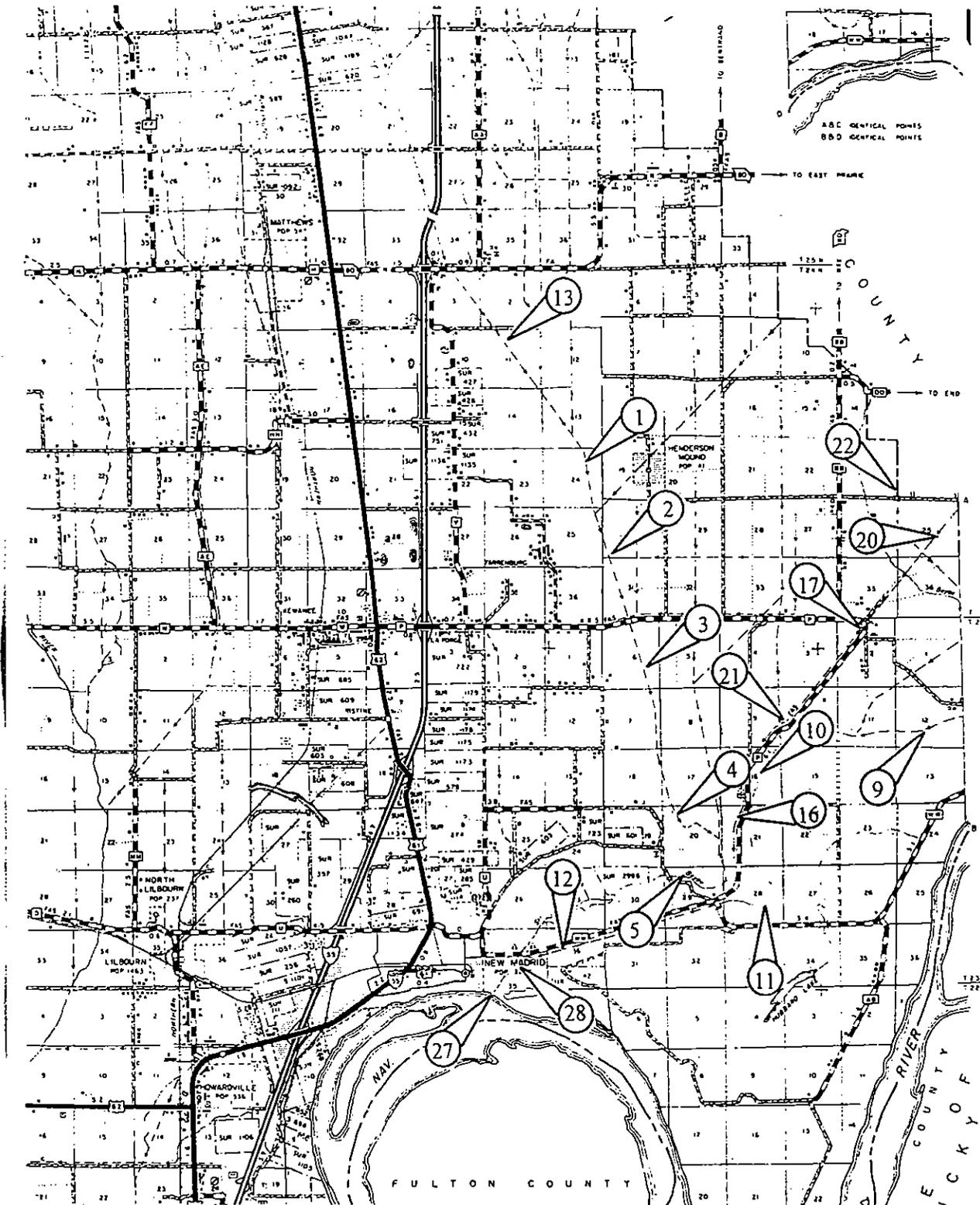


Figure 3. Study sites in Mississippi County, Missouri.



Figure 4. Relative species abundance in live catch.

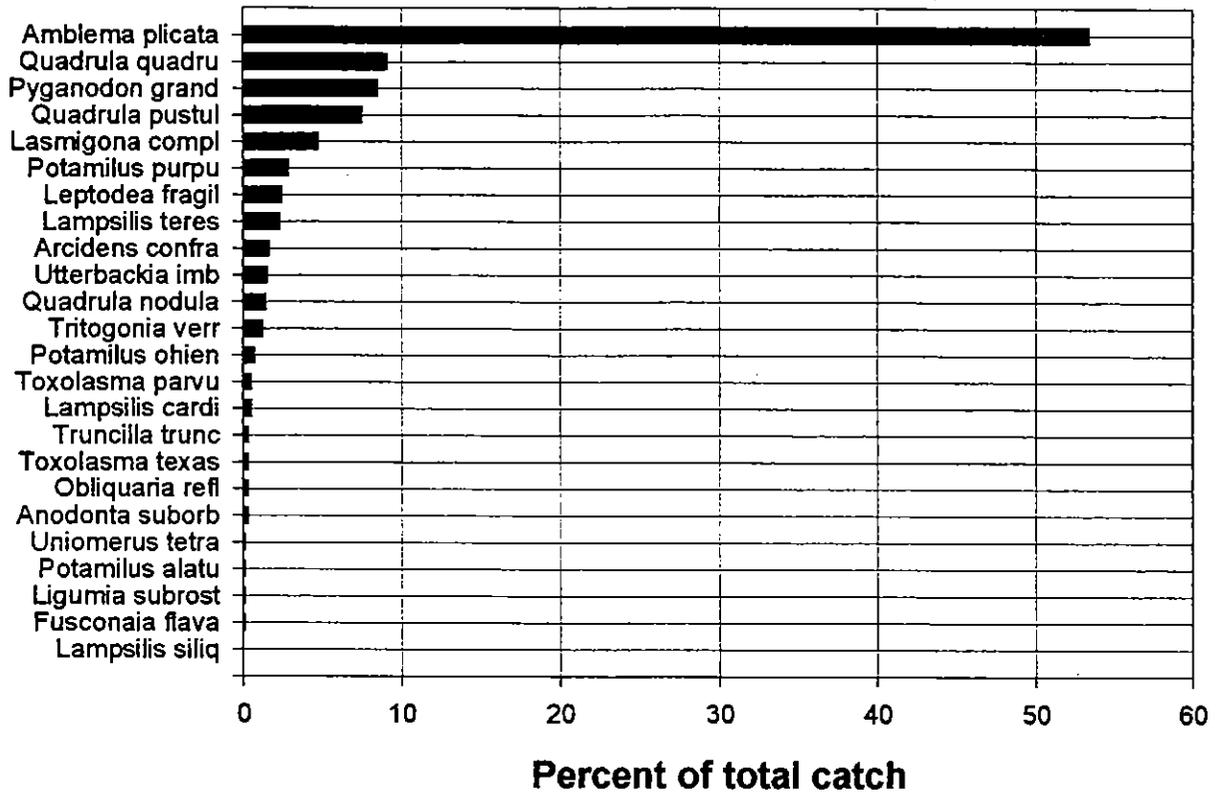


Figure 5. Percentage of sites at which each species was found live.

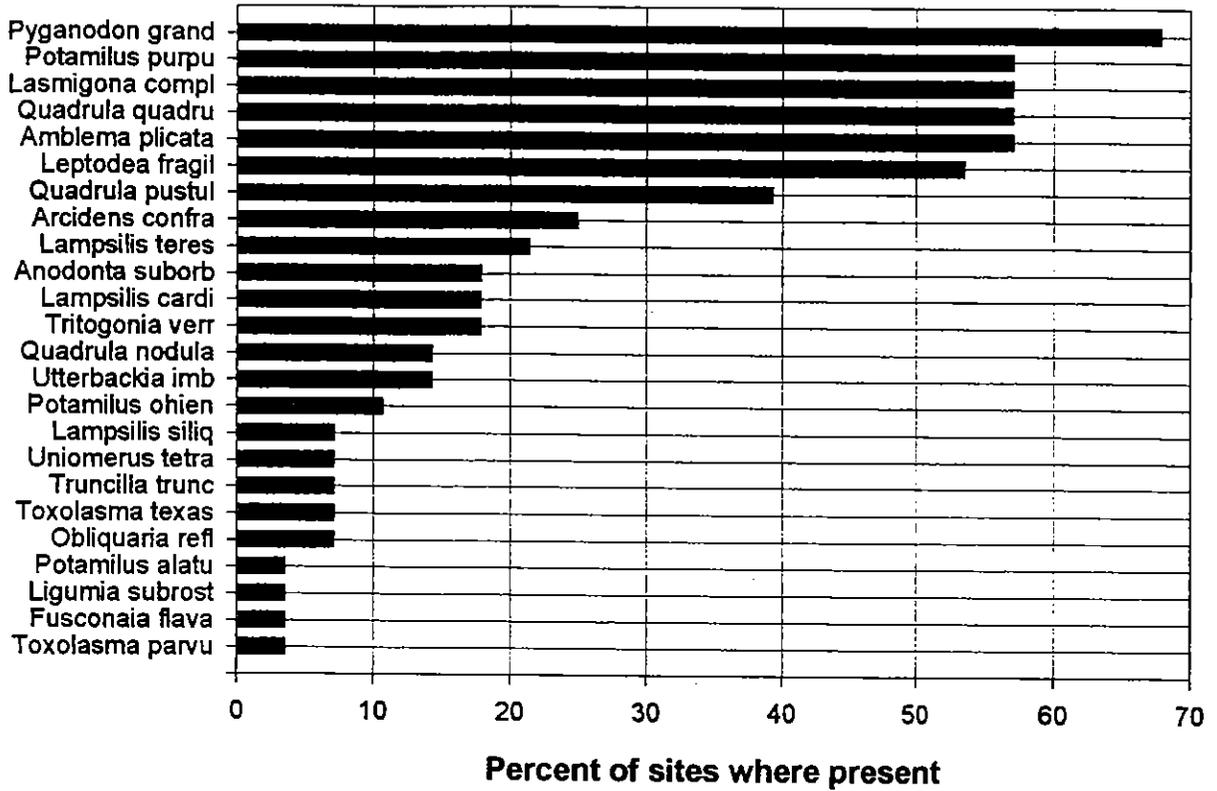


Figure 6. Relative species abundance in St. John's Ditch and St. John's Bayou.

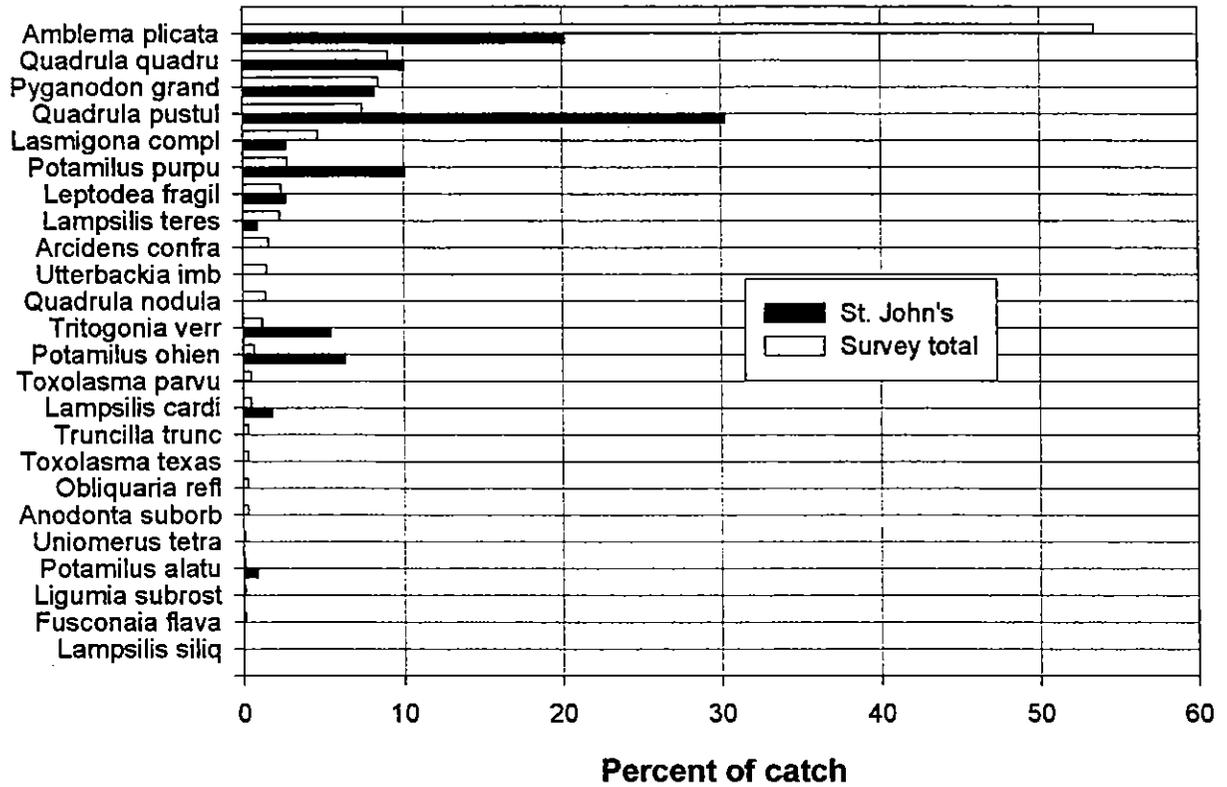


Figure 7. Relative species abundance in Setback Levee Ditch.

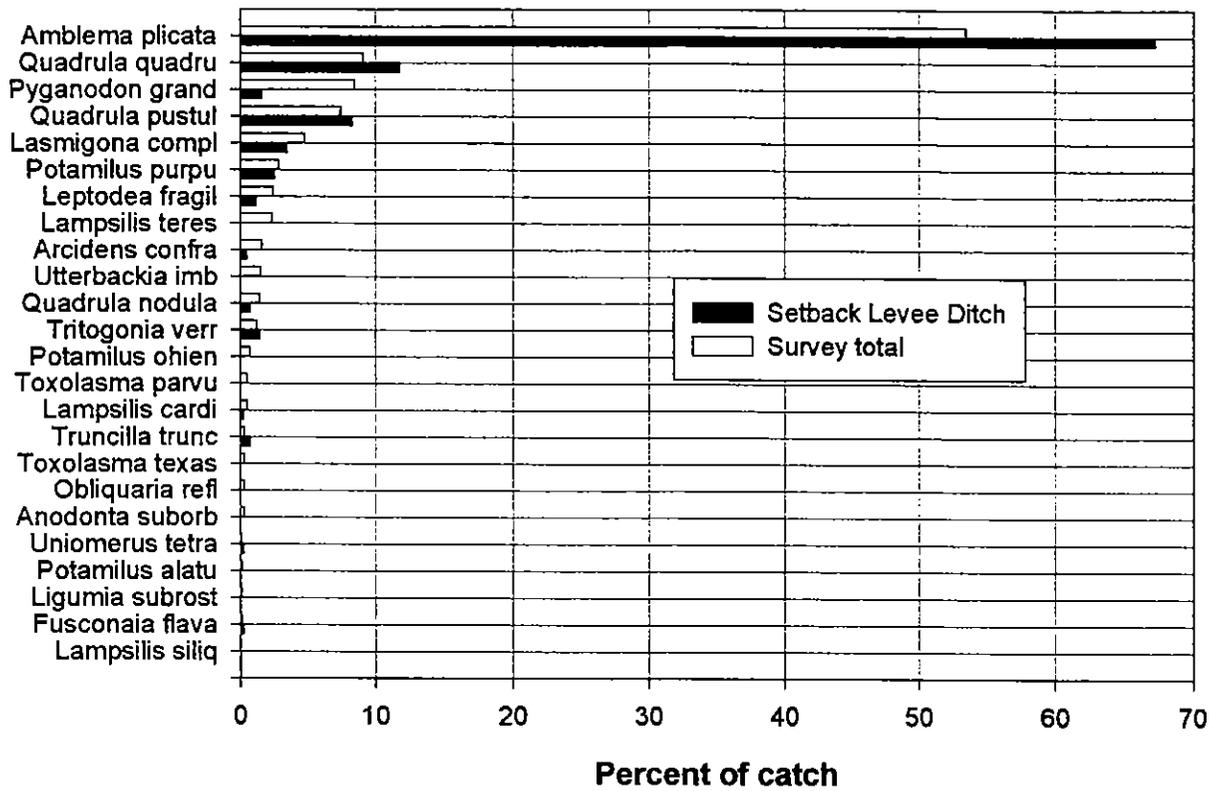


Figure 8. Relative species abundance in St. James Ditch.

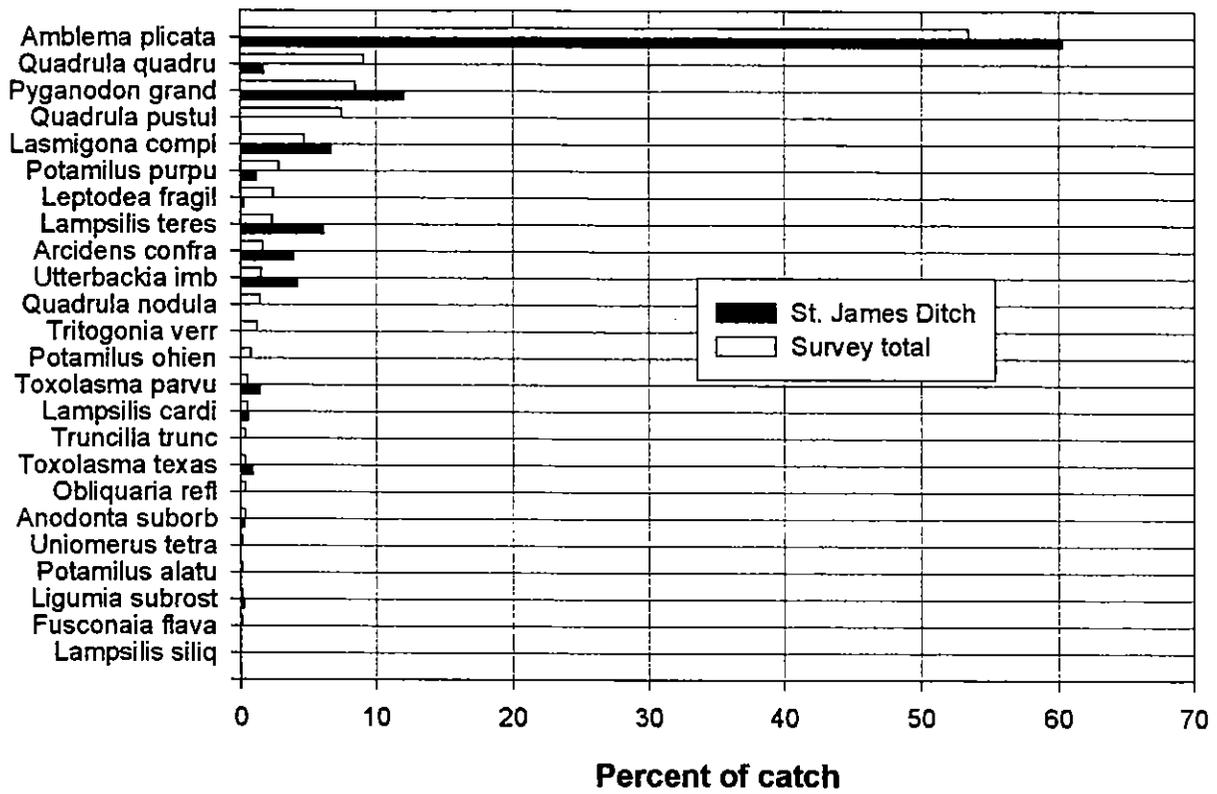


Figure 9. Relative species abundance in the New Madrid Floodway.

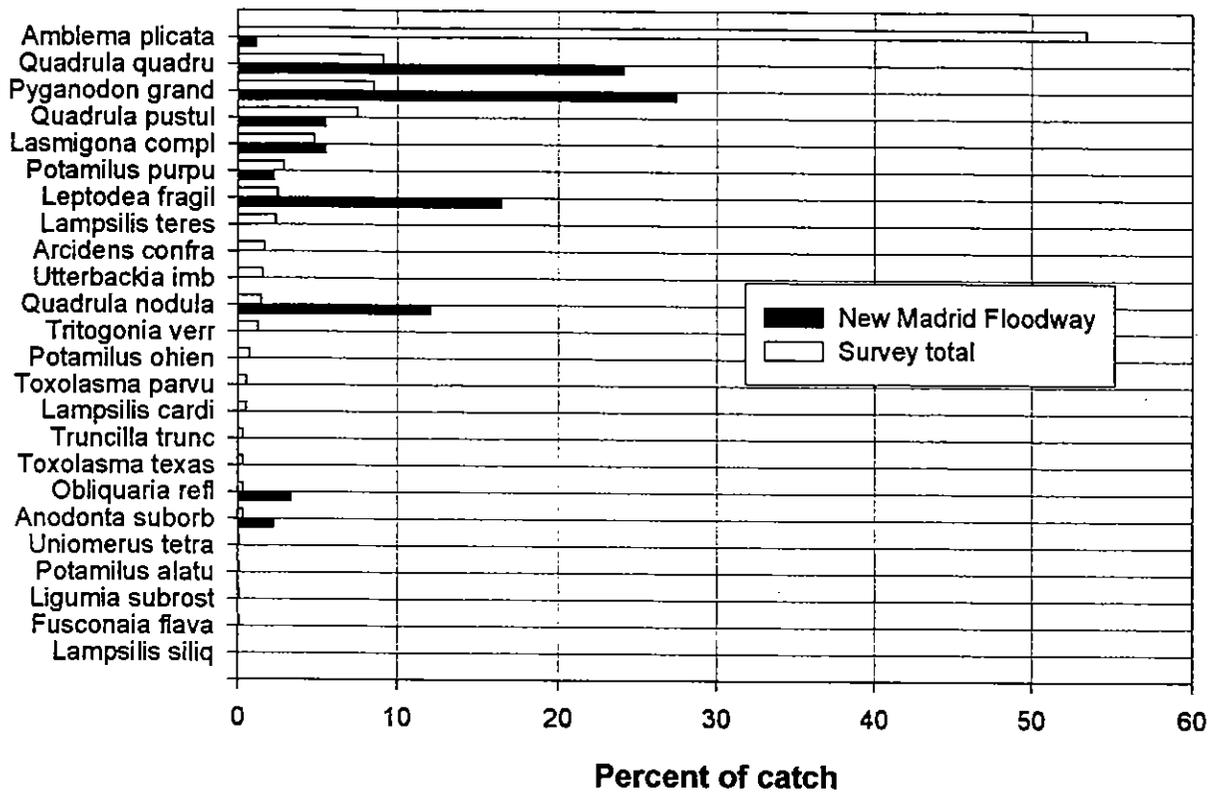


Figure 10. Difference between local and overall species abundance: St. John's Bayou and St. John's Ditch.

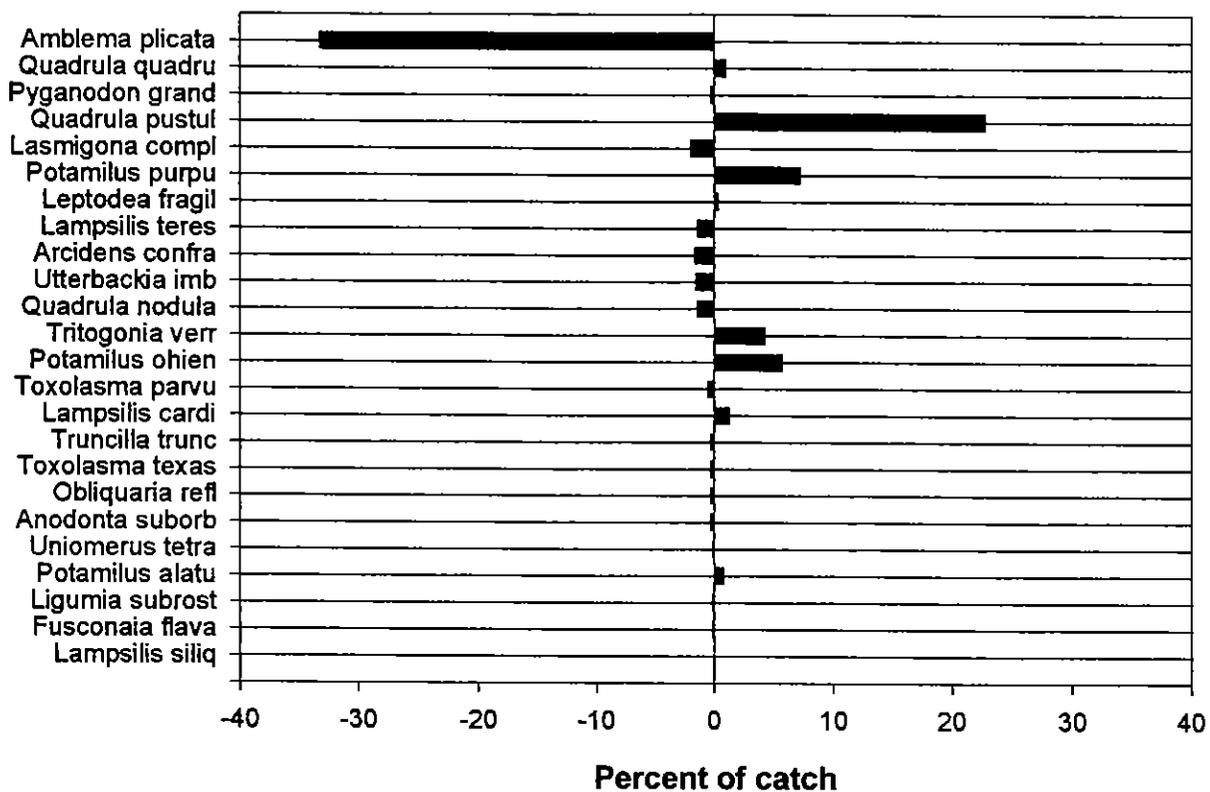


Figure 11. Difference between local and overall species abundance: Setback Levee Ditch.

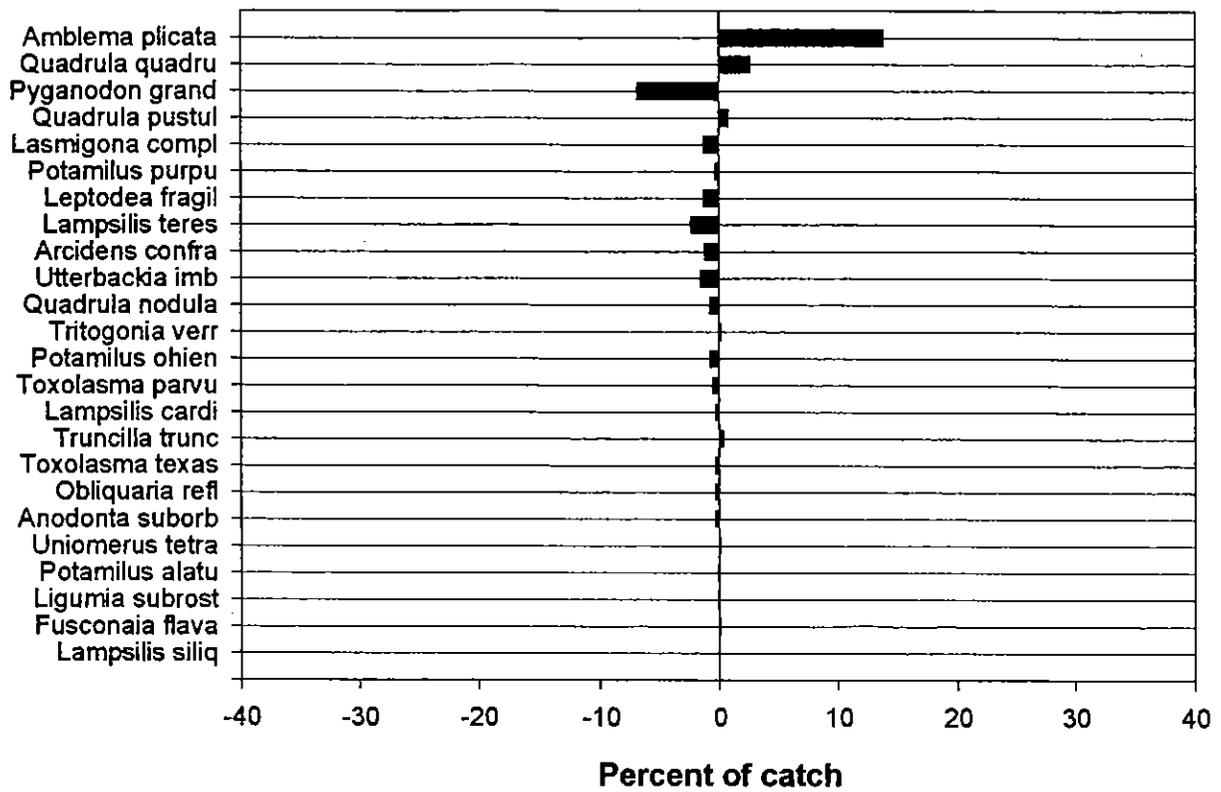


Figure 12. Difference between local and overall species abundance: St. James Ditch.

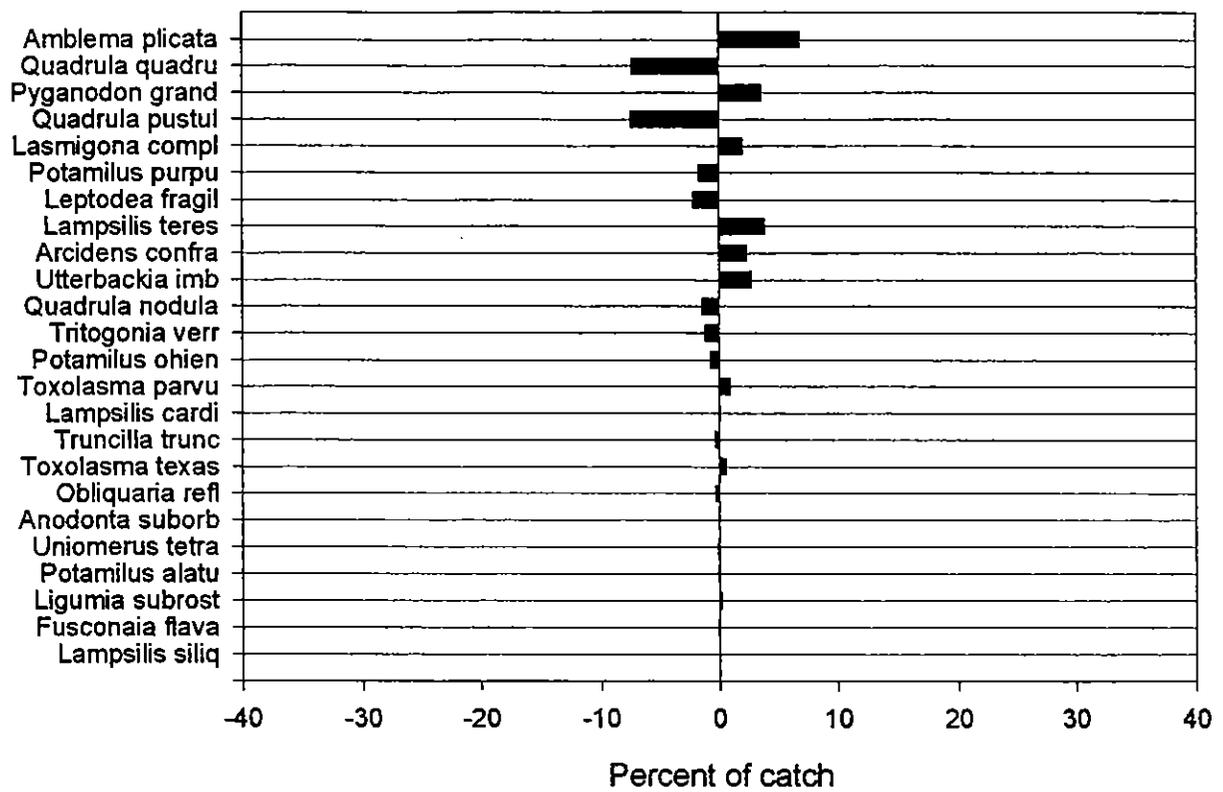


Figure 13. Difference between local and overall species abundance: New Madrid Floodway ditches.

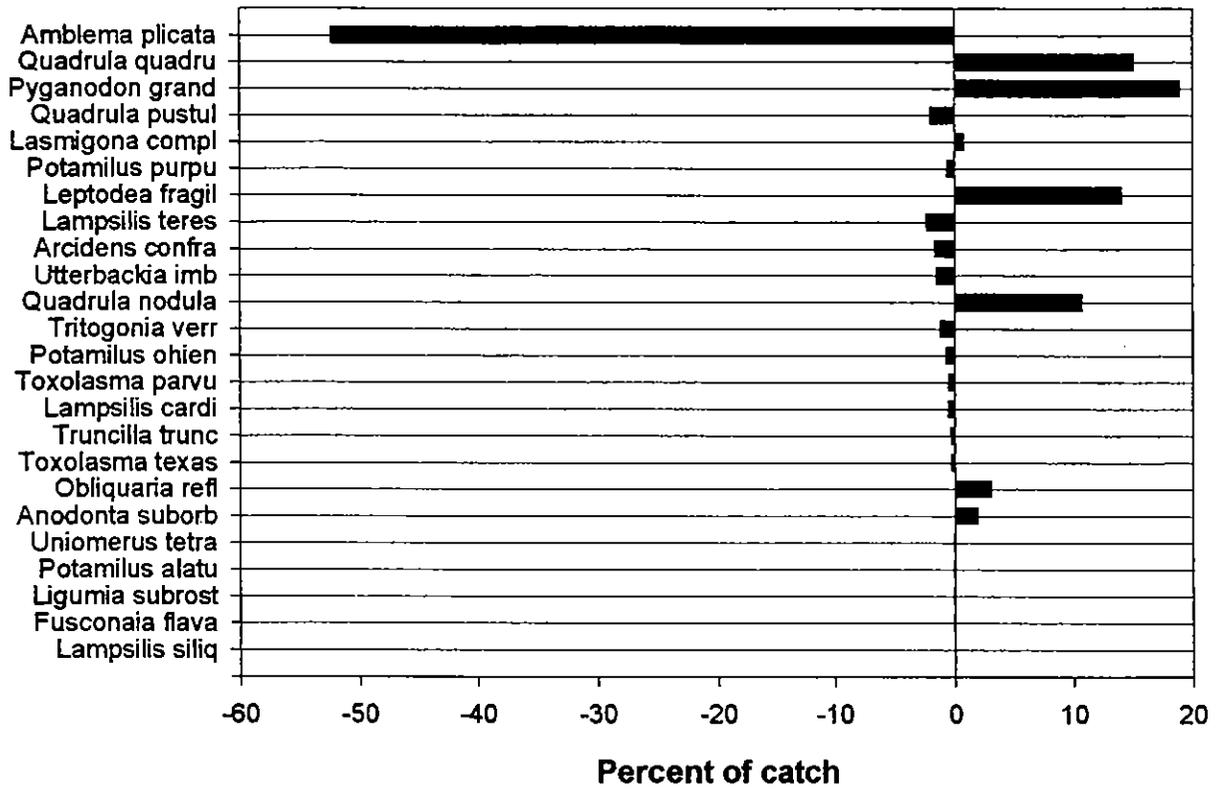


Figure 14. Catch per unit effort and number of species versus position upstream in St. James Ditch.

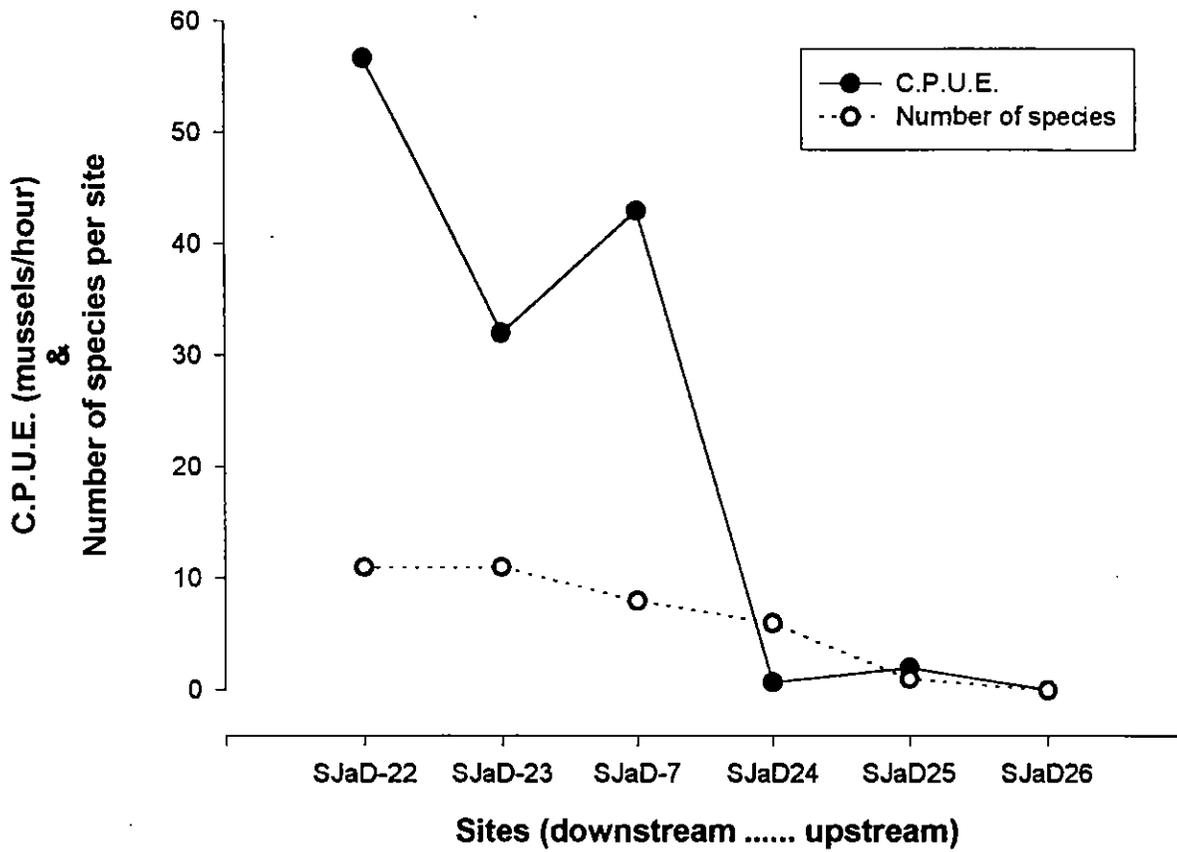


Figure 15. Relative abundance (percent of catch) by species in three ditch surveys in southeastern Missouri and northeastern Arkansas.

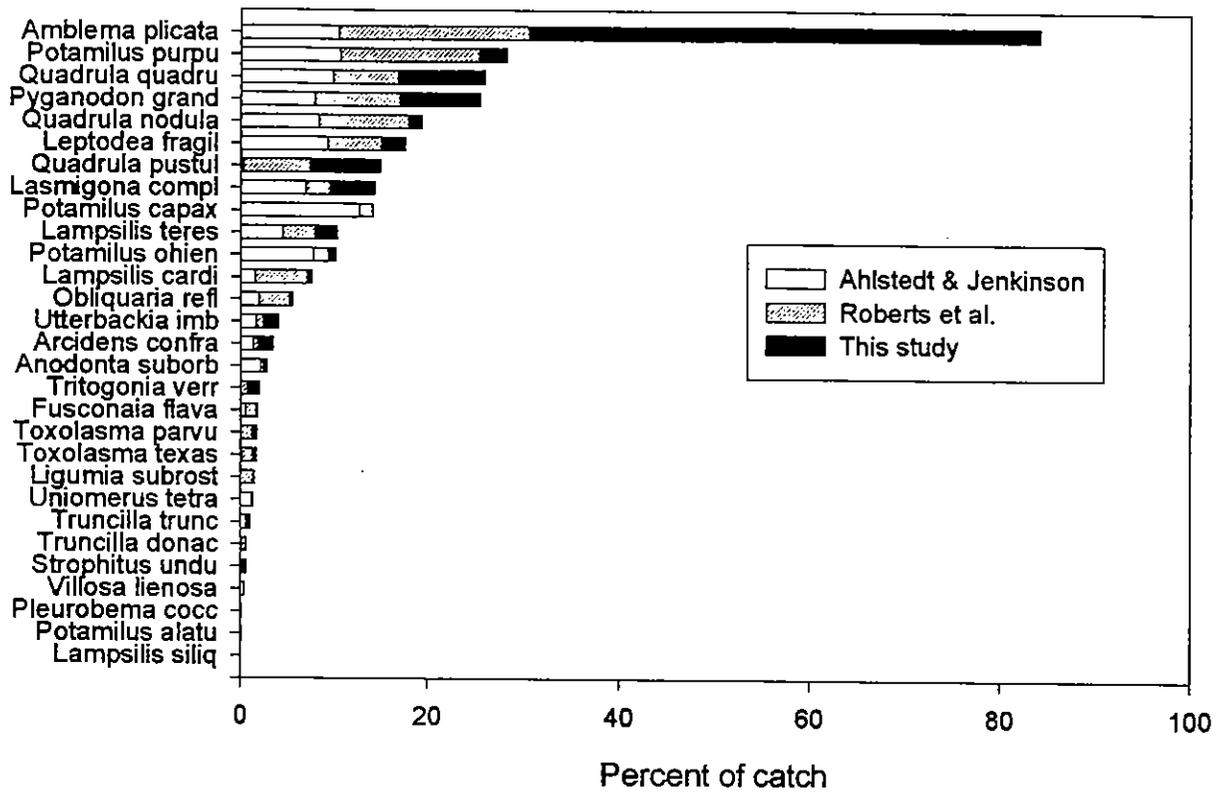


Figure 16. Number of sites at which each unionid species was found live in three ditch surveys in southeastern Missouri and northeastern Arkansas.

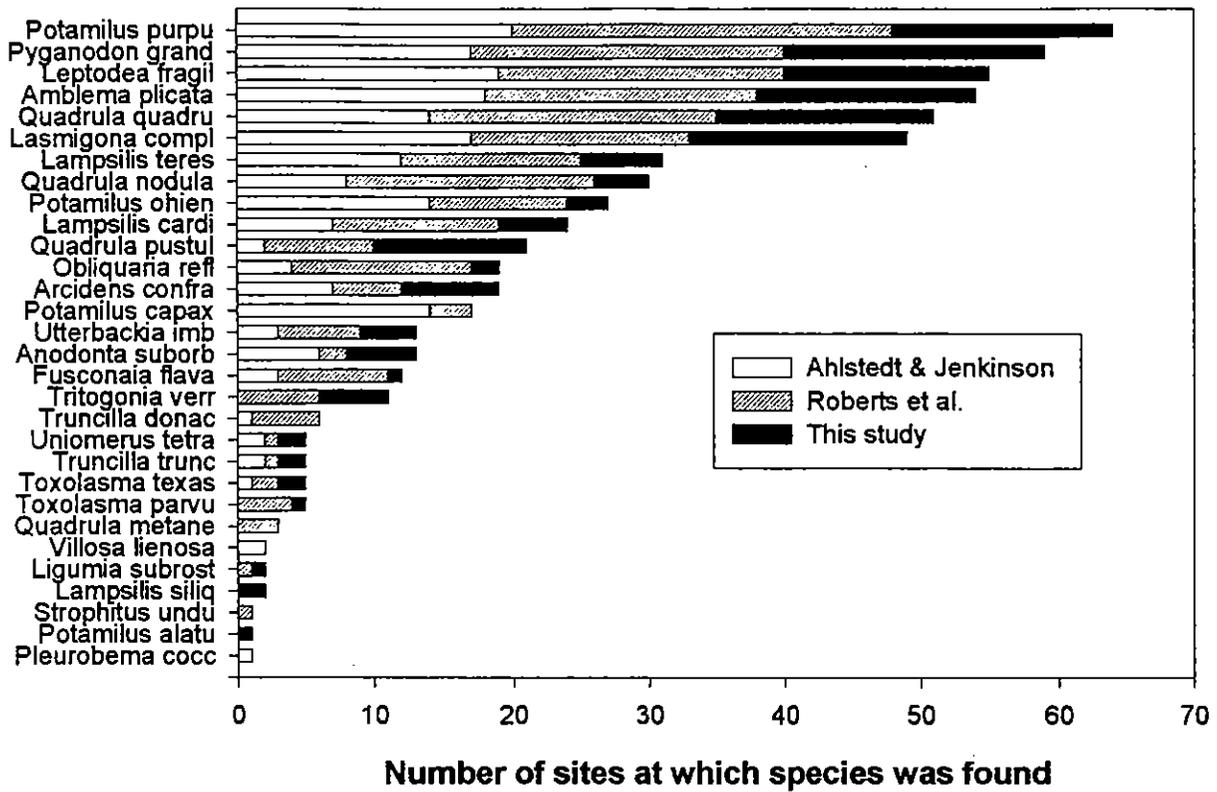


Figure 17. Shell length versus age estimated from annuli counts in *Amblema plicata* from Setback Levee Ditch and St. James Ditch.

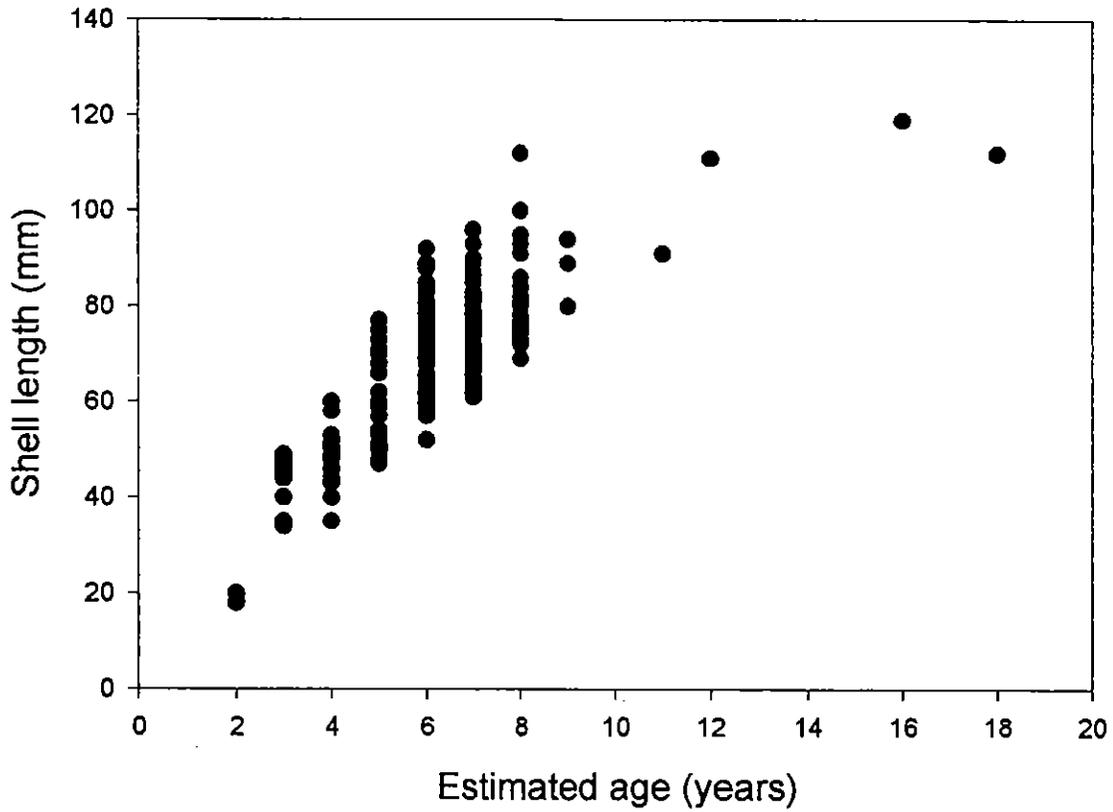


Figure 18. Length class frequency distribution of *Amblema plicata* from the Setback Levee Ditch.

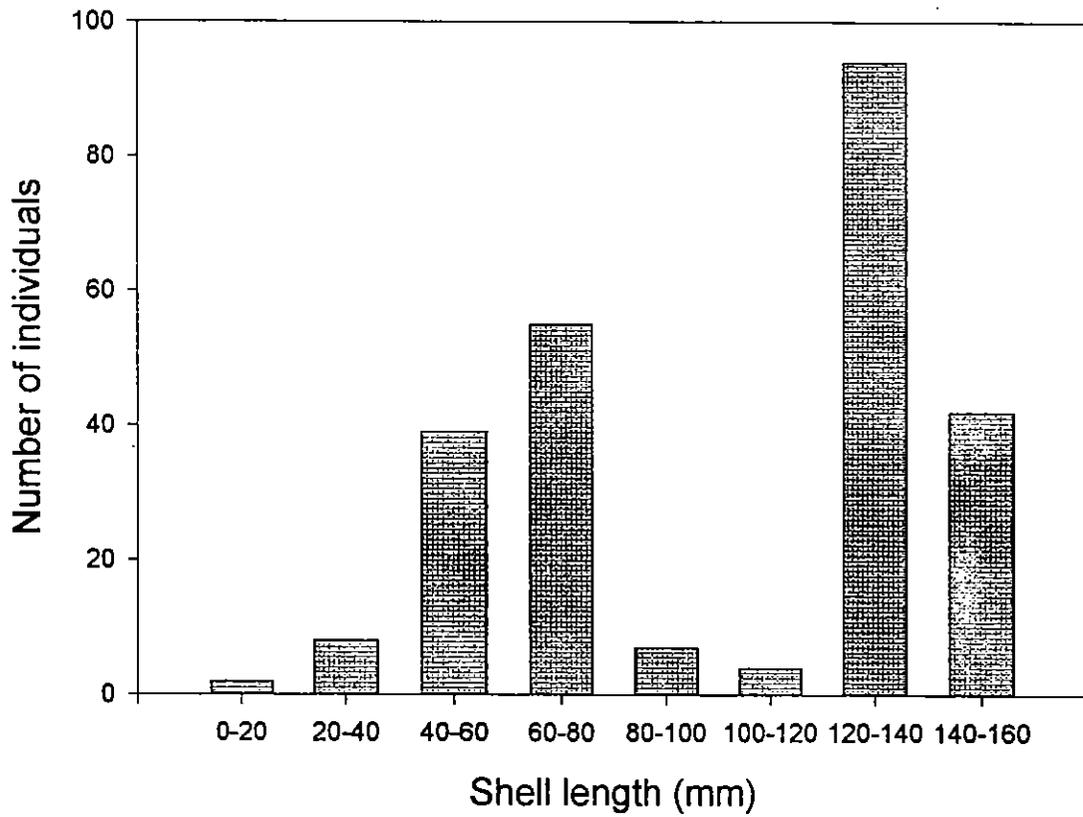


Figure 19. Length class frequency distributions of *Amblema plicata* from individual sites in the Setback Levee Ditch. Sites are arranged from upstream (top) to downstream (bottom) (Same data as Figure 18).

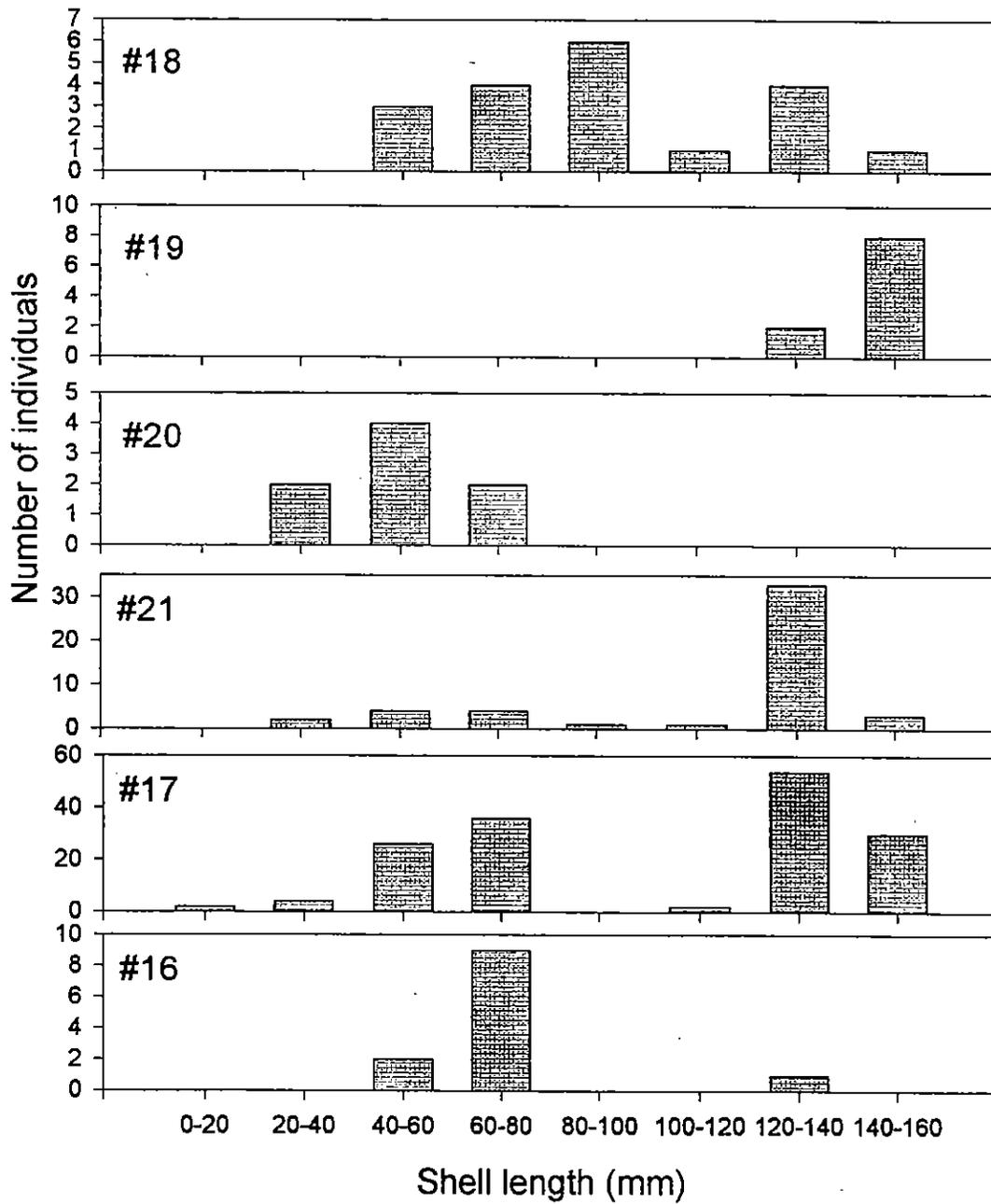
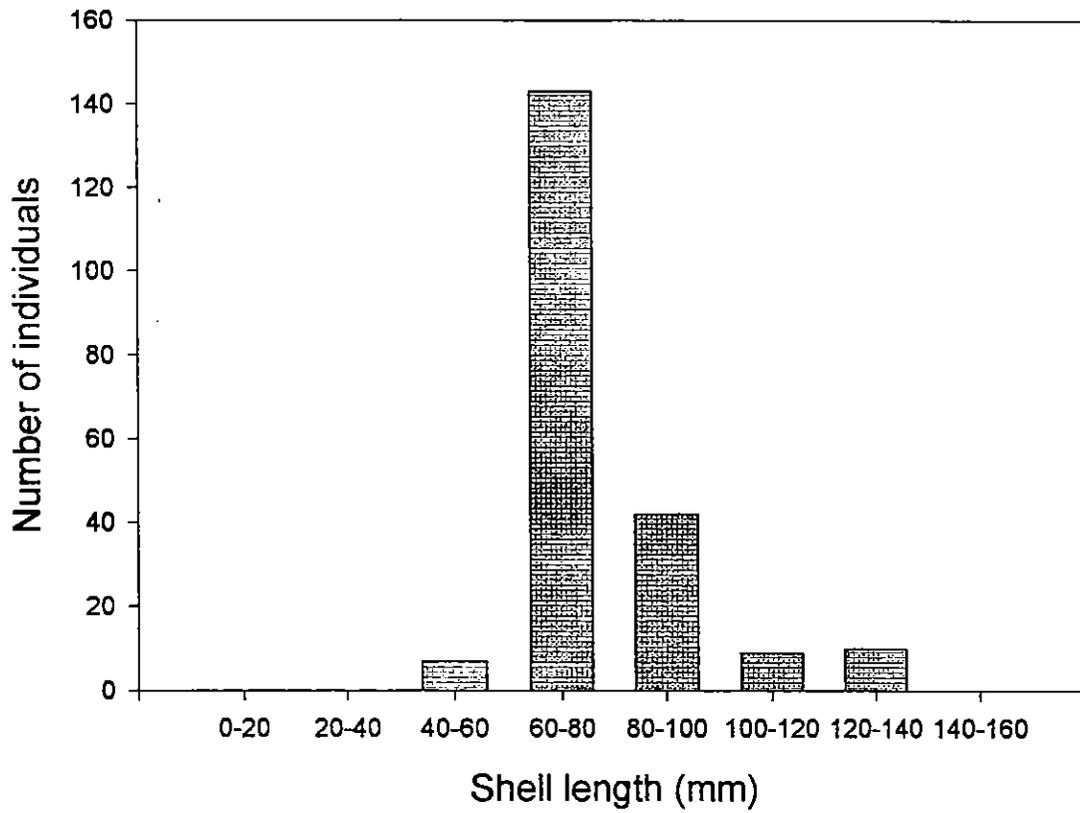


Figure 20. Length class frequency distributions of *Amblema plicata* from sites 7 and 22 in the St. James Ditch.



Site #: NM-01-97

Stream: St. John's Bayou Ditch

Date(s): 16 July 1997

Collector(s): Brian Obermeyer, Frank Riusech, Darby M. Hansen, and Dave T. Howlett

**Locality:**

Lat/Long: N 36 42.726 W089 29.340

Legal: Missouri; New Madrid Co., T24N R14E NE1/4 Sec. 24

**Methods:** Conducted 196 minutes of groping searches (BO=36; FR=50; DMH=55; DTH=55). Most mussels were collected along the left (east) side of ditch (i.e., ~2 meters from stream edge). We also sampled 16 quadrats (1/4 sq. m) immediately downstream from the qualitative sampling area.

**Site description:** Substrate consisted of fine, dark-colored sand, which was relatively uniform with depths ranging from 60 to 70 cm. The substrate seemed unstable since it was somewhat loose and had woody debris mixed in, suggesting recent disturbances. Although we did not note any recent dredging at this site, there was evidence of recent dredging (last 2 yrs) about 1/2 mile downstream. Flow in this ditch was fairly swift, which may also explain why the substrate was unstable. Ditch was approximately 29 m wide. Canopy was approximately 10%.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblema plicata</i>	4	-	-	found near stream edge
<i>Arcidens confragosus</i>	-	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	1	-	-	found near stream edge
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	2	-	-	found near stream edge
<i>Leptodea fragilis</i>	-	-	-	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	1	-	2	found near stream edge
<i>Pyganodon grandis</i>	-	-	1	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	4	-	-	most found near stream edge
<i>Quadrula quadrula</i>	1	-	1	found near stream edge
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	1	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecilis</i>	-	-	-	
<b>Total</b>	<b>14</b>	<b>0</b>		
Corbiculidae				
<i>Corbicula fluminea</i>	1	1	few	

Site #: NM-02-97

Stream: St. John's Bayou Ditch

Date(s): 16 July 1997

Collector(s): Brian Obermeyer, Frank Riusech, Darby M. Hansen, and Dave T. Howlett

**Locality:**

Lat/Long: N 36 41.141 W089 28.826

Legal: Missouri; New Madrid Co., T24N R15E SW1/4 Sec. 30

**Methods:** Conducted 240 minutes of groping searches (BO=60; FR=60; DMH=60; DTH=60). Most mussels were collected along the left (east) side of ditch (1 to 2 meters from stream edge). We also sampled 16 (1/4 sq. m) quadrats downstream from timed searches.

**Site description:** Substrate was similar to NM-01-97, with of fine, dark-colored sand. Depths ranged from 50 to 70 cm. The substrate seemed unstable since it was somewhat loose and had woody debris mixed in. The area looked like it had been dredged in the last year or two since there were no no mature trees, only annual weeds and young saplings, and because of recent dredge spoils along the left (east) bank. Ditch was approximately 34 m wide. Canopy was 0%.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblema plicata</i>	8	-	-	found near edge of ditch (left)
<i>Arcidens confragosus</i>	-	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	-	-	-	
<i>Leptodea fragilis</i>	-	-	2	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohiensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	1	-	-	found near edge of ditch (left)
<i>Pyganodon grandis</i>	-	-	-	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	22	-	-	most near edge; a few in mid-channel
<i>Quadrula quadrula</i>	2	-	-	found near edge of ditch (left)
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	1	-	-	found near edge of ditch (left)
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecilis</i>	-	-	-	
<b>Total</b>	<b>34</b>	<b>0</b>		
<b>Corbiculidae</b>				
<i>Corbicula fluminea</i>	-	0	few	

Site #: NM-03-97

Stream: St. John's Bayou Ditch

Date(s): 17 July 1997

Collector(s): Brian Obermeyer, Frank Riusech, Darby M. Hansen, and Dave T. Howlett

**Locality:**

Lat/Long: N 36 39.415 W089 28.232

Legal: Missouri; New Madrid Co., T23N R15E SE1/4 Sec. 6

**Methods:** Conducted 120 minutes of groping searches (BO=30; FR=30; DMH=30; DTH=30). We concentrated most of our effort along edges of ditch. We also sampled 16 (1/4 sq. m) quadrats downstream from timed searches.

**Site description:** Substrate was similar to NM-01-97 & NM-02-97 in that it had fine, dark-colored sand, and because the substrate was loose and seemed unstable. Depths averaged about 60 cm. Width of ditch was approximately 37 m. Area did not appear to have been recently dredged, although there were no mature trees on banks. Canopy was 0%.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblema plicata</i>	1	-	-	found near edge of ditch (right)
<i>Arcidens confragosus</i>	-	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	-	-	-	
<i>Leptodea fragilis</i>	-	-	1	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	-	-	-	
<i>Pyganodon grandis</i>	-	-	-	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	3	-	-	most near edge; a few in mid-channel
<i>Quadrula quadrula</i>	-	-	-	
<i>Toxolasma parvum</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecilis</i>	-	-	-	
<b>Total</b>	<b>4</b>	<b>0</b>		
Corbiculidae				
<i>Corbicula fluminea</i>	-	1	few	

Site #: NM-04-97

Stream: St. John's Bayou Ditch

Date(s): 17 July 1997

Collector(s): Brian Obermeyer, Frank Riusech, Darby M. Hansen, and Dave T. Howlett

**Locality:**

Lat/Long: N 36 37.644 W089 27.758

Legal: Missouri; New Madrid Co., T23N R15E NW1/4 Sec. 20

**Methods:** Conducted 120 minutes of groping searches (BO=30; FR=30; DMH=30; DTH=30). We concentrated most of our effort along the right edge of ditch (west) since there was mature vegetation on the right bank. We also sampled 16 (1/4 sq. m) quadrats downstream from timed searches.

**Site description:** Substrate was similar to NM-01-97 & NM-02-97 in that it had fine, dark-colored sand; however, the substrate seemed to be less stable, less uniform, and less compacted. Depths varied from 60 to 90 cm and width was approximately 37 m. There was a substantial area of timber on the left side of ditch and about a 75 wide band of timber on the right bank. The site is immediately upstream from the entrance of the "natural" bayou channel.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Ambleria plicata</i>	1	-	-	found near edge of ditch (right)
<i>Arcidens confragosus</i>	-	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	-	-	-	
<i>Leptodea fragilis</i>	-	-	-	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	1	-	-	found near edge of ditch (right)
<i>Pyganodon grandis</i>	-	-	-	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	1	-	-	found near edge of ditch (right)
<i>Quadrula quadrula</i>	-	-	-	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecilis</i>	-	-	-	
<b>Total</b>	<b>3</b>	<b>0</b>		
Corbiculidae				
<i>Corbicula fluminea</i>	-	1	few	

Site #: NM-05-97

Stream: St. John's Bayou

Date(s): 17 July 1997

Collector(s): Brian Obermeyer, Frank Riusech, Darby M. Hansen, and Dave T. Howlett

**Locality:**

Lat/Long: N 36 36.667 W089 27.766

Legal: Missouri; New Madrid Co., T23N R15E NW1/4 Sec. 29

Methods: Conducted 120 minutes of groping searches (BO=30; FR=30; DMH=30; DTH=30).

Site description: Substrate was similar to NM-01-97 & NM-02-97 in that it had fine, dark-colored sand, and because the substrate was loose and seemed unstable. Depths varied from about 50 to 100 cm. Width of bayou was approximately 40 m. The area sampled was upstream about 25 m from old, iron bridge.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblema plicata</i>	-	-	-	
<i>Arcidens confragosus</i>	-	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	-	-	-	
<i>Leptodea fragilis</i>	-	-	-	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	-	-	-	
<i>Pyganodon grandis</i>	-	-	-	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	-	-	-	
<i>Quadrula quadrula</i>	-	-	-	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Uniomerus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecilis</i>	-	-	-	
<b>Total</b>	<b>0</b>			
Corbiculidae				
<i>Corbicula fluminea</i>	-	-	-	

Site #: NM-06-97

Stream: Wilkerson Ditch

Date(s): 18 July 1997

Collector(s): Brian Obermeyer, Frank Riusech, Darby M. Hansen, and Dave T. Howlett

**Locality:**

Lat/Long: N 36 41.407 W089 19.667

Legal: Missouri; New Madrid Co., T24N R16E S1/2 Sec. 28

**Methods:** Conducted 120 minutes of groping searches (BO=30; FR=30; DMH=30; DTH=30). We also sampled 20 quadrats.

**Site description:** Substrate consisted of fine, clean sand that seemed to be fairly unstable and loose. Area appeared to have been recently dredged (last 2 yrs) since there was little perennial vegetation on banks and because of dredge spoils. Depths ranged from 20 to 60 cm. Width of channel was 25 m. Canopy was 0%.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblema plicata</i>	-	-	-	
<i>Arcidens confragosus</i>	-	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	2	-	-	
<i>Leptodea fragilis</i>	6	-	2	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	-	-	-	
<i>Pyganodon grandis</i>	-	-	-	
<i>Quadrula nodulata</i>	7	-	-	
<i>Quadrula pustulosa</i>	-	-	-	
<i>Quadrula quadrula</i>	19	1	-	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecilis</i>	-	-	-	
<b>Total</b>	<b>34</b>	<b>1</b>		
Corbiculidae				
<i>Corbicula fluminea</i>	-	1	-	

Site #: NM-07-97  
 Stream: St. James Ditch  
 Date(s): 18 July 1997  
 Collector(s): Brian Obermeyer, Frank Riusech, and Dave T. Howlett

Locality:  
 Lat/Long: N 36 45.643 W089 22.261

Legal: Missouri; New Madrid Co., T25N R16E SW1/4 Sec. 31

Methods: Conducted 120 minutes of groping searches (BO=40; FR=40; DTH=40) in a 10 m wide by 115 m long stretch of habitat.

Site description: Substrate consisted of fine sand and mud that seemed to be fairly stable. Substrate was covered in places with a layer of algae. Area searched did not seem to have been recently dredged because of mature perennial vegetation on the channel banks. Woody debris (e.g., fallen trees) was common in the channel. Canopy was ~85%. The channel was approximately 10 m wide. Depths were up to 1 m.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblema plicata</i>	70	-	-	
<i>Arcidens confragosus</i>	1	-	1	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	5	-	-	
<i>Lampsilis siliquoidea</i>	-	-	4	
<i>Lasmigona complanata</i>	3	-	-	
<i>Leptodea fragilis</i>	-	-	-	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	-	-	-	
<i>Pyganodon grandis</i>	4	-	5	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	-	-	-	
<i>Quadrula quadrula</i>	3	-	-	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecilis</i>	-	-	common	
<b>Total</b>	<b>86</b>			
<b>Corbiculidae</b>				
<i>Corbicula fluminea</i>	C	-	A	

Site #: NM-08-97

Stream: Wilkerson Ditch

Date(s): 19 July 1997

Collector(s): Brian Obermeyer, Frank Riusech, Darby M. Hansen, and Dave T. Howlett

**Locality:**

Lat/Long: N 36 39.447 W089 19.697

Legal: Missouri; New Madrid Co., T23N R16E Sec. 4

**Methods:** Conducted 120 minutes of groping searches (BO=30; FR=30; DMH=30; DTH=30). We also sampled 20 quadrats.

**Site description:** Substrate consisted of fine, clean sand that seemed to be fairly unstable and loose. Area appeared to have been recently dredged (last 2 yrs) since there was little perennial vegetation on banks and because of dredge spoils. Lots of old stumps along shoreline. Water was very turbid. Depth ranged from 50 to 100 cm. Width was approximately 25 m. Canopy was 0%.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblema plicata</i>	-	-	-	
<i>Arcidens confragosus</i>	-	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	1	-	1	
<i>Leptodea fragilis</i>	2	1	-	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	-	-	1	
<i>Pyganodon grandis</i>	2	1	-	
<i>Quadrula nodulata</i>	2	-	-	
<i>Quadrula pustulosa</i>	-	-	-	
<i>Quadrula quadrula</i>	1	-	-	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecillis</i>	-	-	-	
<b>Total</b>	<b>8</b>	<b>2</b>		
Corbiculidae				
<i>Corbicula fluminea</i>	-	0	-	

Site #: NM-09-97

Stream: St. John's Diversion Ditch

Date(s): 19 July 1997

Collector(s): Brian Obermeyer, Frank Riusech, Darby M. Hansen, and Dave T. Howlett

**Locality:**

Lat/Long: N 36 38.418 W089 21.373

Legal: Missouri; New Madrid Co., T23N R15E Sec. 12

**Methods:** Conducted 120 minutes of groping searches (FR=40; DMH=40; DTH=40). We also sampled 24 quadrats.

**Site description:** Site was immediately downstream from an artificial fish weir. Substrate consisted of muddy sand with cleaner sand in mid-channel. Water was very turbid. Sampling was conducted at depths to 80 cm. Channel width was approximately 14 m. Canopy cover was about 2%.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblyma plicata</i>	1	-	-	
<i>Arcidens confragosus</i>	-	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	1	-	-	
<i>Leptodea fragilis</i>	6	-	-	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	2	2	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohiensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	1	-	-	
<i>Pyganodon grandis</i>	-	-	-	
<i>Quadrula nodulata</i>	2	-	-	
<i>Quadrula pustulosa</i>	5	-	-	
<i>Quadrula quadrula</i>	-	-	-	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecilis</i>	-	-	-	
<b>Total</b>	<b>18</b>	<b>2</b>		
<b>Corbiculidae</b>				
<i>Corbicula fluminea</i>	-	-	-	

Site #: NM-10-97

Stream: Mud Ditch

Date(s): 19 July 1997

Collector(s): Brian Obermeyer, Frank Riusech, Darby M. Hansen, and Dave T. Howlett

**Locality:**

Lat/Long: N 36 38.784 W089 23.353

Legal: Missouri; New Madrid Co., T23N R15E NE1/4 Sec. 16

**Methods:** Conducted 120 minutes of groping searches (BO=30; FR=30; DMH=30; DTH=30).

**Site description:** Substrate consisted of layers of sand, silt, and clay. Sampling was conducted at depths up to 70 cm. Channel width was about 25 m. Canopy was approximately 2%.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblema plicata</i>	-	-	-	
<i>Arcidens confragosus</i>	-	-	1	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	-	-	-	
<i>Leptodea fragilis</i>	-	-	7	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	1	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	1	
<i>Potamilus purpuratus</i>	-	-	-	
<i>Pyganodon grandis</i>	-	-	1	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	-	-	-	
<i>Quadrula quadrula</i>	2	-	-	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecillis</i>	-	-	1	
<b>Total</b>	<b>3</b>			
<b>Corbiculidae</b>				
<i>Corbicula fluminea</i>	-	-	-	

Site #: NM-11-97

Stream: Mud Ditch

Date(s): 19 July 1997

Collector(s): Brian Obermeyer, Frank Riusech, Darby M. Hansen, and Dave T. Howlett

**Locality:**

Lat/Long: N 36 36.137 W089 26.277

Legal: Missouri; New Madrid Co., T23N R15E SE1/4 Sec. 28

**Methods:** Conducted 80 minutes of groping searches (BO=20; FR=20; DMH=20; DTH=20).**Site description:** Substrate consisted primarily of loose sand and mud. Areas near shore consisted of soupy mud. Sampling was conducted at depths of 10 to 40 cm. Width of area sampled was about 20 m. Canopy cover was 0%.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	1.5	
<i>Amblema plicata</i>	-	-	-	
<i>Arcidens confragosus</i>	-	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	-	-	-	
<i>Leptodea fragilis</i>	-	-	2	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	-	-	-	
<i>Pyganodon grandis</i>	1	-	2	found outside timed search
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	-	-	-	
<i>Quadrula quadrula</i>	-	-	-	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecillis</i>	-	-	1	
<b>Total</b>	<b>1</b>			
Corbiculidae				
<i>Corbicula fluminea</i>	-	-	R	one valve

Site #: NM-12-97

Stream: Mud Ditch

Date(s): 20 July 1997

Collector(s): Brian Obermeyer, Frank Riusech, Darby M. Hansen, and Dave T. Howlett

**Locality:**

Lat/Long: N 36 35.630 W089 26.368

Legal: Missouri; New Madrid Co., T23N R14E Sec. 36

**Methods:** Conducted 80 minutes of groping searches (BO=20; FR=20; DMH=20; DTH=20).

**Site description:** Substrate consisted of soupy mud with areas of sandy mud in mid-channel. Sampling was conducted at depths up to 80 cm, although depths exceeded 80 cm above and below the area sampled. Water was very turbid and warm. Canopy cover was 0%.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	1	-	-	
<i>Amblema plicata</i>	-	-	-	
<i>Arcidens confragosus</i>	-	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	-	-	-	
<i>Leptodea fragilis</i>	1	-	1	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	-	-	-	
<i>Pyganodon grandis</i>	9	-	-	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	-	-	-	
<i>Quadrula quadrula</i>	-	-	-	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecillis</i>	-	-	-	
<b>Total</b>	<b>11</b>			
Corbiculidae				
<i>Corbicula fluminea</i>	-	-	-	

Site #: NM-13-97

Stream: St. John's Bayou Ditch

Date(s): 21 July 1997

Collector(s): Brian Obermeyer, Frank Riusech, Darby M. Hansen, and Dave T. Howlett

**Locality:**

Lat/Long: N 36 44.691 W089 30.953

Legal: Missouri; New Madrid Co., T24N R14E NW1/4 Sec. 11

**Methods:** Conducted 240 minutes of groping searches (BO=60; FR=60; DMH=60; DTH=60).

**Site description:** Substrate consisted primarily of fine, dark colored sand that seemed fairly stable. It appeared that dredging had not occurred at this site in the past 10 years, although most of the live mussels were found near the timbered edge of the channel (left or east side). Depths up to 80 cm were sampled. Width at site was about 33 m.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblema plicata</i>	8	-	-	
<i>Arcidens confragosus</i>	-	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	1	-	-	
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	1	-	-	found outside timed search
<i>Leptodea fragilis</i>	1	-	-	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	1	-	3	
<i>Pyganodon grandis</i>	1	-	-	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	3	-	-	
<i>Quadrula quadrula</i>	7	-	-	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	4	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecillis</i>	-	-	-	
<b>Total</b>		<b>27</b>		
<b>Corbiculidae</b>				
<i>Corbicula fluminea</i>	-	-	-	

Site #: NM-14-97

Stream: Ten Mile Pond Ditch

Date(s): 21 July 1997

Collector(s): Brian Obermeyer, Frank Riusech, Darby M. Hansen, and Dave T. Howlett

Locality:

Lat/Long: N 36 45.077 W089 18.939

Legal: Missouri; New Madrid Co., T24N R16E SW1/4 Sec. 3

Methods: Conducted 160 minutes of groping searches (BO=40; FR=40; DMH=40; DTH=40).

Site description: Site is approximately 30 m upstream from a concrete bridge on the MDC Tenmile Pon Wildlife Area. Substrate was mostly soft mud, although there was some sand mixed in, particularly in mid-channel. Water was very turbid and warm. Width of channel where we sampled was about 29 m.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	1	-	-	
<i>Amblema plicata</i>	-	-	-	
<i>Arcidens confragosus</i>	-	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	1	-	2	
<i>Leptodea fragilis</i>	-	-	1.5	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	1	-	-	
<i>Pyganodon grandis</i>	6	-	10	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	-	-	-	
<i>Quadrula quadrula</i>	-	-	1	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecillis</i>	-	-	-	
<b>Total</b>	<b>9</b>			
<b>Corbiculidae</b>				
<i>Corbicula fluminea</i>	-	-	-	

Site #: NM-15-97

Stream: Ten Mile Pond Ditch

Date(s): 21 July 1997

Collector(s): Brian Obermeyer, Frank Riusech, Darby M. Hansen, and Dave T. Howlett

**Locality:**

Lat/Long: N 36 42.982 W089 20.093

Legal: Missouri; New Madrid Co., T24N R16E NE1/4 Sec. 17

**Methods:** Conducted 160 minutes of groping searches (BO=40; FR=40; DMH=40; DTH=40).

**Site description:** Substrate consisted of soupy mud with areas of woody debris. There were no signs of recent dredging. Depths ranged from 40 to 80 cm. Width of channel was about 23 m. Canopy was about 5%.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	2	
<i>Amblema plicata</i>	-	-	-	
<i>Arcidens confragosus</i>	-	-	1	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	-	-	-	
<i>Leptodea fragilis</i>	-	-	-	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohiensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	-	-	-	
<i>Pyganodon grandis</i>	7	-	2	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	-	-	-	
<i>Quadrula quadrula</i>	-	-	-	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecillis</i>	-	-	-	
<b>Total</b>	<b>7</b>			
<b>Corbiculidae</b>				
<i>Corbicula fluminea</i>	-	-	-	

Site #: NM-16-97

Stream: Spillway Ditch (Setback Levee Ditch)

Date(s): 22 July 1997

Collector(s): Brian Obermeyer, Frank Riusech, Darby M. Hansen, and Dave T. Howlett

**Locality:**

Lat/Long: N 36 37.735 W089 26.436

Legal: Missouri; New Madrid Co., T23N R15E NW1/4 Sec. 21

**Methods:** Conducted 240 minutes of groping searches (BO=60; FR=60; DMH=60; DTH=60). We also sampled 24 quadrats.

**Site description:** We sampled upstream from old concrete bridge. Substrate consisted of firm sand, with a few areas of soft mud. The left bank was void of mature perennial vegetation, whereas the right bank (west) was well timbered. Most of the live mussels were found along the right edge (within 2-3 m) of channel. Depths varied from 20 to 50 cm. Width of channel was about 15 m. Canopy was ~8%.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblema plicata</i>	12	2	-	
<i>Arcidens confragosus</i>	-	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	-	-	1	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	2	-	-	
<i>Leptodea fragilis</i>	2	-	-	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	-	-	-	
<i>Pyganodon grandis</i>	1	-	2	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	4	-	-	
<i>Quadrula quadrula</i>	8	3	-	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	1	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecillis</i>	-	-	-	
<b>Total</b>	<b>30</b>	<b>5</b>		
<b>Corbiculidae</b>				
<i>Corbicula fluminea</i>	R	6	R	

Site #: NM-17-97

Stream: Spillway Ditch (Setback Levee Ditch)

Date(s): 22 July 1997

Collector(s): Brian Obermeyer, Frank Riusech, Darby M. Hansen, and Dave T. Howlett

## Locality:

Lat/Long: N 36 44.428 W089 24.098

Legal: Missouri; New Madrid Co., T23N R15E NW1/4 Sec. 2

**Methods:** Conducted 180 minutes of groping searches (BO=60; FR=30; DMH=30; DTH=60). We also sampled 24 quadrats.

**Site description:** Substrate consisted of relatively clean, firm sand, except along the channel edge where some mud was encountered. The left or east bank was relatively free of mature perennial vegetation, suggesting recent dredging activities. The right or west bank had mature trees. The area sampled was immediately upstream from a concrete bridge. Channel width was ~19 m. Canopy was ~5%. Sampling depths varied from 30 to 60 cm. Most unionids were found near the right edge of channel. Specimens collected in mid-channel tended to be 5 years and younger.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblema plicata</i>	194	1	3	
<i>Arcidens confragosus</i>	-	-	-	
<i>Fusconaia flava</i>	-	-	0.5	old shell
<i>Lampsilis cardium</i>	1	-	0.5	
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	1	-	-	
<i>Leptodea fragilis</i>	-	-	-	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohiensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	2	-	-	
<i>Pyganodon grandis</i>	1	-	-	
<i>Quadrula nodulata</i>	3	-	-	
<i>Quadrula pustulosa</i>	5	-	-	
<i>Quadrula quadrula</i>	24	1	1	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	3	-	-	
<i>Truncilla truncata</i>	2	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecillis</i>	-	-	-	
<b>Total</b>	<b>236</b>	<b>2</b>		
<b>Corbiculidae</b>				
<i>Corbicula fluminea</i>	R	1	R	

Site #: NM-18-97

Stream: Spillway Ditch (Setback Levee Ditch)

Date(s): 31 July 1997

Collector(s): Brian Obermeyer, Frank Riusech, and Dave T. Howlett

**Locality:**

Lat/Long: N 36 43.336 W089 21.837

Legal: Missouri; New Madrid Co., T24N R16E Sec. 18

**Methods:** Conducted 150 minutes of groping searches (BO=50; FR=50; DTH=50).

**Site description:** Substrate consisted of fine, relatively compacted sand. Depth of site was generally shallow (20-40 cm), although some areas were about 60 cm deep. Most mussels were found along the extreme right or west side of channel. Like site 16 & 17, the left or east bank was void of mature vegetation. Width of channel was ~12 m.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblema plicata</i>	19	-	3	
<i>Arcidens confragosus</i>	1	-	0.5	
<i>Fusconaia flava</i>	1	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	1	-	1	
<i>Leptodea fragilis</i>	2	-	-	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	2	-	0.5	
<i>Pyganodon grandis</i>	2	-	0.5	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	1	-	0.5	
<i>Quadrula quadrula</i>	4	-	1	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	3	-	1	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	1	-	-	
<i>Utterbackia imbecillis</i>	-	-	-	
<b>Total</b>	<b>37</b>			
Corbiculidae				
<i>Corbicula fluminea</i>	A	-	A	

Site #: NM-19-97

Stream: Spillway Ditch (Setback Levee Ditch)

Date(s): 1 August 1997

Collector(s): Brian Obermeyer, Frank Riusech, and Dave T. Howlett

**Locality:**

Lat/Long: N 36 44.886 W089 21.301

Legal: Missouri; New Madrid Co., T24N R16E SW1/4 Sec. 5

Methods: Conducted 120 minutes of groping searches (BO=40; FR=40; DTH=40).

Site description: Substrate was predominantly sand with areas of mud along the edge of channel. Channel width was approximately 12 m. Depths ranged from 20 to 60 cm.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblema plicata</i>	10	-	1	
<i>Arcidens confragosus</i>	-	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	-	-	0.5	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	3	-	-	
<i>Leptodea fragilis</i>	-	-	1	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	4	-	0.5	
<i>Pyganodon grandis</i>	1	-	-	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	4	-	2	
<i>Quadrula quadrula</i>	4	-	-	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecillis</i>	-	-	-	
<b>Total</b>	<b>26</b>			
Corbiculidae				
<i>Corbicula fluminea</i>	A	-	A	

Site #: NM-20-97

Stream: Spillway Ditch (Setback Levee Ditch)

Date(s): 1 August 1997

Collector(s): Brian Obermeyer, Frank Riusech, and Dave T. Howlett

**Locality:**

Lat/Long: N 36 41.975 W089 22.455

Legal: Missouri; New Madrid Co., T24N R15E NE1/4 SE1/4 Sec. 25

Methods: Conducted 120 minutes of groping searches (BO=40; FR=40; DTH=40).

**Site description:** Substrate consisted mostly of sand, although the sand was mixed with more silt than other Spillway Ditch sites. Area appeared to have been recently altered. A small channel converges into the main channel on the right side. We sample both the main channel and the small feeder ditch. Width of the main channel was between 11 and 12 m. Depth ranged from 20 to 30 cm. Canopy was 1%.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblema plicata</i>	8	-	-	
<i>Arcidens confragosus</i>	1	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	7	-	-	
<i>Leptodea fragilis</i>	1	-	2	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	3	-	2	
<i>Pyganodon grandis</i>	2	-	2	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	-	-	-	
<i>Quadrula quadrula</i>	1	-	-	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecillis</i>	-	-	-	
<b>Total</b>	<b>23</b>			
<b>Corbiculidae</b>				
<i>Corbicula fluminea</i>	A	-	A	

Site #: NM-21-97

Stream: Spillway Ditch (Setback Levee Ditch)

Date(s): 1 August 1997

Collector(s): Brian Obermeyer, Frank Riusech, and Dave T. Howlett

**Locality:**

Lat/Long: N 36 38.954 W089 25.547

Legal: Missouri; New Madrid Co., T23N R15E W1/2 Sec. 10

**Methods:** Conducted 120 minutes of groping searches (BO=40; FR=40; DTH=40).

**Site description:** Substrate consisted of relatively clean, fine sand, with areas of mud along the extrem edge of ditch. Live mussels were found mostly along the right side of channel, which corresponded with the presence of mature, overhanging trees. The left bank was void of mature perennial vegetation. Width of channel varied from 14 to 19 m. Depths ranged from 20 to 60 cm. Canopy was ~ 2%.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblyma plicata</i>	48	-	2	
<i>Arcidens confragosus</i>	-	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	1	-	-	
<i>Leptodea fragilis</i>	-	-	-	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohiensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	-	-	-	
<i>Pyganodon grandis</i>	-	-	-	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	22	-	1	
<i>Quadrula quadrula</i>	10	-	-	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecillis</i>	-	-	-	
<b>Total</b>	<b>81</b>			
<b>Corbiculidae</b>				
<i>Corbicula fluminea</i>	-	-	-	

Site #: NM-22-97

Stream: St. James Ditch

Date(s): 2 August 1997

Collector(s): Brian Obermeyer, Frank Riusech, and Dave T. Howlett

## Locality:

Lat/Long: N 36 42.169 W089 23.443

Legal: Missouri; New Madrid Co., T24N R15E SE1/4 Sec. 23

Methods: Conducted 180 minutes of groping searches (BO=60; FR=60; DTH=60). We also sampled 28 quadrats.

Site description: Substrate consisted of fine mud. Many of the trees along the bank were recently cut. Ditch did not appear to have been recently dredged. Channel width was 10 to 11 m. Depths ranged from 10 to 40 cm. Canopy was ~10%.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblema plicata</i>	141	12	1	
<i>Arcidens confragosus</i>	7	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	1	-	-	
<i>Lampsilis teres</i>	2	-	2	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	9	-	2	
<i>Leptodea fragilis</i>	1	1	1	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	2	-	-	
<i>Pyganodon grandis</i>	2	-	5	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	-	-	-	
<i>Quadrula quadrula</i>	3	-	1	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	1	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecillis</i>	2	-	5	
<b>Total</b>	<b>170</b>	<b>13</b>		
Corbiculidae				
<i>Corbicula fluminea</i>	C	-	F	

Site #: NM-23-97  
 Stream: St. James Ditch  
 Date(s): 2 August 1997  
 Collector(s): Brian Obermeyer, Frank Riusech, and Dave T. Howlett

Locality:  
 Lat/Long: N 36 43.705 W089 23.484

Legal: Missouri; New Madrid Co., T24N R15E NE1/4 Sec. 14

Methods: Conducted 180 minutes of groping searches (BO=60; FR=60; DTH=60).

Site description: Substrate consisted of soupy mud. Channel was approximately 11 m wide. Depths ranged from 20 to 70 cm.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	1	-	2	
<i>Amblema plicata</i>	3	-	-	
<i>Arcidens confragosus</i>	6	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	15	-	1	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	12	-	0.5	
<i>Leptodea fragilis</i>	-	-	-	
<i>Ligumia subrostrata</i>	1	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	2	-	-	
<i>Pyganodon grandis</i>	35	-	9	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	-	-	-	
<i>Quadrula quadrula</i>	-	-	-	
<i>Toxolasma parvus</i>	5	-	-	
<i>Toxolasma texasensis</i>	3	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecillis</i>	13	-	8	
<b>Total</b>	<b>96</b>	<b>0</b>		
Corbiculidae				
<i>Corbicula fluminea</i>	A	-	A	

Site #: NM-24-97

Stream: St. James Ditch

Date(s): 3 August 1997

Collector(s): Brian Obermeyer, Frank Riusech, and Dave T. Howlett

**Locality:**

Lat/Long: N 36 47.419 W089 21.984

Legal: Missouri; New Madrid Co., T25N R16E SW1/4 Sec. 19

**Methods:** Conducted 90 minutes of visual and groping searches (BO=30; FR=30; DTH=30).**Site description:** Substrate consisted of sand. Channel was somewhat braided, and depths varied considerably (10 to 90 cm). Width of channel was between 5 and 8 m. Much of the sand substratum covered with a layer of algae. Banks were void of trees. Water was very clear. Fish were abundant.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblema plicata</i>	-	-	1	
<i>Arcidens confragosus</i>	-	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	1	-	0.5	
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	6	
<i>Lasmigona complanata</i>	-	-	1	
<i>Leptodea fragilis</i>	-	-	-	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	-	-	1.5	
<i>Pyganodon grandis</i>	-	-	-	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	-	-	-	
<i>Quadrula quadrula</i>	-	-	-	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecillis</i>	-	-	-	
<b>Total</b>	<b>1</b>			

## Corbiculidae

<i>Corbicula fluminea</i>	F	-	C	
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Site #: NM-25-97

Stream: St. James Ditch

Date(s): 3 August 1997

Collector(s): Brian Obermeyer, Frank Riusech, and Dave T. Howlett

**Locality:**

Lat/Long: N 36 49.165 W089 22.439

**Legal:** Missouri; New Madrid Co., T25N R16E SW1/4 Sec. 7

**Methods:** Conducted 60 minutes of groping searches (BO=20; FR=20; DTH=20).

**Site description:** Substrate consisted of sand with areas of woody debris. Much of the substrate was with algae. Water visibility was excellent. Depths varied from 30 to 120 cm. Width of channel average about 8 m.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblema plicata</i>	-	-	-	
<i>Arcidens confragosus</i>	-	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	-	-	-	
<i>Leptodea fragilis</i>	-	-	-	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	-	-	-	
<i>Pyganodon grandis</i>	2	-	-	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	-	-	-	
<i>Quadrula quadrula</i>	-	-	-	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecillis</i>	-	-	-	
<b>Total</b>	<b>2</b>			
Corbiculidae				
<i>Corbicula fluminea</i>	-	-	-	

Site #: NM-26-97  
 Stream: St. James Ditch  
 Date(s): 3 August 1997  
 Collector(s): Brian Obermeyer, Frank Riusech, and Dave T. Howlett

Locality:  
 Lat/Long: N 36 50.016 W089 22.434

Legal: Missouri; New Madrid Co., T25N R16E SW1/4 Sec. 6

Methods: Conducted 60 minutes of groping searches (BO=20; FR=20; DH=20).

Site description: Substrate consisted of sand, with much of it covered with algae. There was also a lot of old plant debris covering the the substrate. Depths up to 1 m were found. Width of channel was about 8 m.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblema plicata</i>	-	-	-	
<i>Arcidens confragosus</i>	-	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	-	-	-	
<i>Leptodea fragilis</i>	-	-	-	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	-	
<i>Potamilus purpuratus</i>	-	-	-	
<i>Pyganodon grandis</i>	-	-	-	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	-	-	-	
<i>Quadrula quadrula</i>	-	-	-	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecillis</i>	-	-	-	
<b>Total</b>	<b>0</b>			
Corbiculidae				
<i>Corbicula fluminea</i>	-	-	-	

Site #: NM-27-97

Stream: St. John's Bayou's confluence with Mississippi River

Date(s): 4 August &amp; 20 September 1997

Collector(s): Brian Obermeyer, Frank Riusech, and Dave Howlett &amp; M. Chris Barnhart and B. Obermeyer

**Locality:**

Lat/Long: N 36 34.991 W089 31.015

Legal: Missouri; New Madrid Co., T23N R14E Sec. 35

**Methods:** Conducted 120 minutes of groping searches (BO=60;MCB=60). We also took 10 Ekman dredge samples (4 Aug.).

**Site description:** Site appearance varied considerably between the first visit in early August and the second visit in September, which was due to lower water conditions in the Mississippi River. The substrate, which consisted of mud, seemed very unstable. Maximum depth during the 2nd search was about 1.4 m. Width of the Bayou channel was about 18 m, but the width of area searched at the mouth of Morrison Chute was about 90 m.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblema plicata</i>	-	-	-	
<i>Arcidens confragosus</i>	-	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	-	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	-	-	-	
<i>Leptodea fragilis</i>	2	-	present	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	1	-	present	
<i>Potamilus ohioensis</i>	7	-	present	
<i>Potamilus purpuratus</i>	4	-	-	
<i>Pyganodon grandis</i>	4	-	present	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	-	-	-	
<i>Quadrula quadrula</i>	-	-	-	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecillis</i>	-	-	-	
<b>Total</b>	<b>18</b>			
Corbiculidae				
<i>Corbicula fluminea</i>	C	-	C	

Site #: NM-28-97

Stream: St. John's Bayou - just downstream from water control structure

Date(s): 4 August 1997

Collector(s): Brian Obermeyer, Frank Riusech, and Dave T. Howlett

## Locality:

Lat/Long: N 36 35.431 W089 30.648

Legal: Missouri; New Madrid Co., T23N R14E Sec. 35

Methods: Conducted 30 minutes of groping searches (BO=30).

Site description: Substrate, which consisted of soupy mud, seemed to be very unstable, especially in mid-channel. Area sampled was along the west or right side of channel just downstream from the water control structure. Width of channel was about 25 m. Canopy was 0%.

Unionid species	Live		Dead	Comments
	qualitative	quadrats		
<i>Anodonta suborbiculata</i>	-	-	-	
<i>Amblema plicata</i>	-	-	-	
<i>Arcidens confragosus</i>	-	-	-	
<i>Fusconaia flava</i>	-	-	-	
<i>Lampsilis cardium</i>	-	-	-	
<i>Lampsilis teres</i>	1	-	-	
<i>Lampsilis siliquoidea</i>	-	-	-	
<i>Lasmigona complanata</i>	-	-	-	
<i>Leptodea fragilis</i>	-	-	1	
<i>Ligumia subrostrata</i>	-	-	-	
<i>Obliquaria reflexa</i>	-	-	-	
<i>Potamilus alatus</i>	-	-	-	
<i>Potamilus ohioensis</i>	-	-	1	
<i>Potamilus purpuratus</i>	3	-	-	
<i>Pyganodon grandis</i>	4	-	-	
<i>Quadrula nodulata</i>	-	-	-	
<i>Quadrula pustulosa</i>	-	-	-	
<i>Quadrula quadrula</i>	1	-	-	
<i>Toxolasma parvus</i>	-	-	-	
<i>Toxolasma texasensis</i>	-	-	-	
<i>Tritogonia verrucosa</i>	-	-	-	
<i>Truncilla truncata</i>	-	-	-	
<i>Unio merus tetralasmus</i>	-	-	-	
<i>Utterbackia imbecillis</i>	-	-	-	
<b>Total</b>	<b>9</b>			
Corbiculidae				
<i>Corbicula fluminea</i>	-	-	-	

**Freshwater Mussel Survey  
Mud Ditch and St. Johns Bayou Basin,  
New Madrid County, Missouri**

**Introduction**

The purposes of this mussel survey were to conduct a pre-construction survey of Mud Ditch in the New Madrid Floodway and conduct a preliminary survey of the St. Johns Bayou Basin. A closure levee is scheduled to be constructed across Mud Ditch. Four 10-foot by 10-foot gated box culverts will be constructed across Mud Ditch at the closure location.

Several construction items are scheduled in the St. Johns Bayou Basin. These items consist of channel enlargement of the lower 4.5 miles of St. Johns Bayou, 8.1 miles of Setback Levee Ditch, and 7.1 miles of St. James Ditch. Preliminary surveys were conducted to determine if previous surveys (Barnhart, 1998) were still accurate with present day conditions, determine relocation sites, and determine methods for implementing long term monitoring of the freshwater mussel resource. Previous National Environmental Policy Act Documents recommended relocating a portion of the population of Setback Levee Ditch and conducting long term monitoring over a 10-year time period to measure recolonization following channel alteration.

Barnhart (1998) surveyed a total of 28 sites within the St. Johns Bayou Basin and the New Madrid Floodway. The study area supports a diverse and fairly abundant unionid fauna consisting of at least 24 species that are typical of drainage canals of the lower Mississippi lowlands in Missouri and Arkansas. The seven most abundant species found, in order of abundance, were *Amblema plicata*, *Quadrula quadrula*, *Pyganadon grandis*, *Q. pustulosa*, *Lasmigona complanata*, *Potamilus purpuratus*, and *Leptodea fragilis*. The survey found four species that are considered rare within the State of Missouri. These species are *Arcidens confragosus*, *Anodonta suborbiculata*, *Q. nodulata*, and *Toxolasma texasensis*.

**Methods**

Qualitative freshwater mussel surveys were conducted between 13 and 15 June 2005 in 14 sites (Figure 1). Surveys were conducted by members of the U.S. Fish and Wildlife Service, Missouri Ecological Services Columbia Field Office and the U.S. Army Corps of Engineers, Memphis District Environmental Branch. Hand searches were conducted by diving, snorkeling, and wading to locate freshwater mussels. Survey sites were approximately 100 meters in length and all available microhabitats within the survey reach were sampled. A minimum of 0.3 person hours were spent at each site. Searches were continued at least 0.25 person hours after the last new species was encountered. Mussels encountered (live and fresh dead) were enumerated and placed back in the substrate from where they were found. Mussels were occasionally placed in cloth mesh

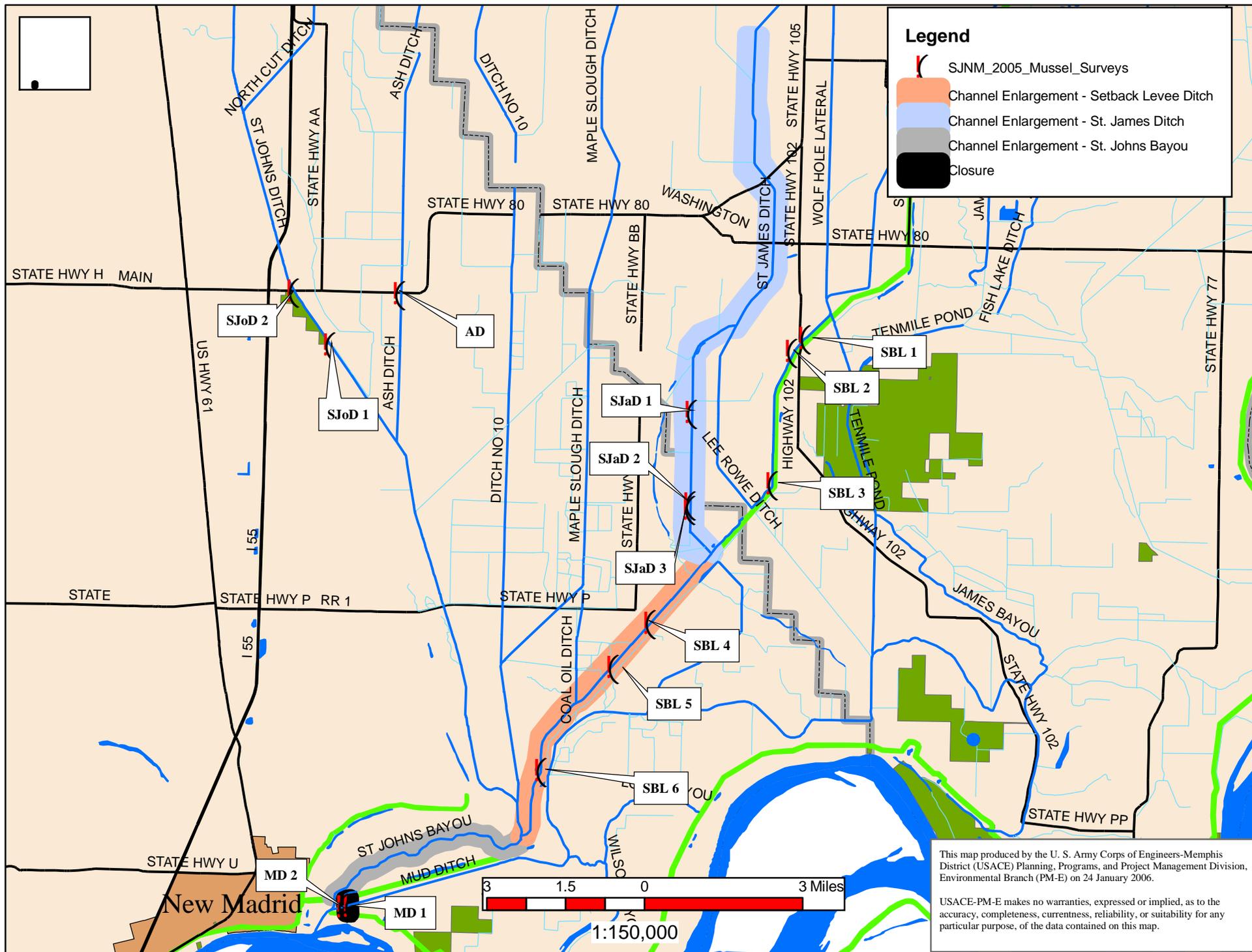


Figure 1. Freshwater mussel survey locations, St. Johns Bayou Basin and Mud Ditch, June 2005, Missouri.

bags, kept submerged, and brought to the surface for identification. Once identified, mussels were returned to the substrate from where they were found.

## **Results**

Tables 1 and 2 provide results. A total of 802 live individuals representing 14 species were collected from 14 different sites. The upper reaches of Setback Levee Ditch yielded the highest number of live species. St. James Ditch yielded the greatest catch per unit effort. No mussels were found in the lower section of Mud Ditch, St. Johns Ditch at Highway 80, and Ash Ditch at Highway 80.

*A. plicata* was distributed most widely (10 sites) followed by *L. complanata* (9 sites), *Q. quadrula* (9 sites) *L. teres* (8 sites), *P. purpuratus* (8 sites), and *P. grandis* (8 sites). No Federally listed threatened or endangered species were found in the survey. State listed rare species found include *A. suborbiculata* (1 relic shell) and *A. confragosus* (six sites).

Substrate varied throughout the survey sites. Table 3 provides information on the general habitat type and substrate of the sample sites.

## **Discussion**

Figure 2 provides survey results from the present survey, surveys conducted in the summer of 2004, and surveys conducted by Barnhart (1998).

### Mud Ditch

One *P. grandis* was found in the levee closure location of Mud Ditch. Barnhart (1998) sampled Mud Ditch approximately 4,000 feet upstream of the construction zone. Table 4 provides data from the current survey and Barnhart's (1998) earlier survey.

Barnhart found three species of live mussels as compared to one species in the present survey. Sampling was conducted by wading (depths were approximately 80 cm) in Barnhart's (1998) survey while sampling entailed diving (depths exceeded three meters) in the present survey. The differences in survey methods may explain the small differences in survey results. However, the freshwater mussel community within the lower section of Mud Ditch does not appear to be significant. No further freshwater mussel surveys of the lower portion of Mud Ditch are planned.

### St. Johns Bayou Basin

St. Johns Ditch downstream of the Swift Ditch area (SJoD 1) supported a moderate number of species observed (8 species) but a low number of CPUE (9.6). No construction is proposed in this section of St. Johns Ditch. This section of channel may offer suitable habitat to relocate a portion of the mussels from Setback Levee Ditch or St. James Ditch.

**Table 1. Freshwater mussel survey locations, St. Johns Bayou Basin and Mud Ditch, Missouri.**

Site	Date	Latitude (dd.dddd)	Longitude (dd.ddddd)	Reach (meters)	Search Time (minutes)	Survey Method
Mud Ditch 1	13 June 2005	36.590290	-89.504289	100	36	Scuba
Mud Ditch 2	13 June 2005	36.589935	-89.506563	50	20	Scuba
St. Johns Ditch 1	14 June 2005	36.744720	-89.516130	200	150	Hand
St. Johns Ditch 2	14 June 2005	36.759207	-89.529115	90	27	Scuba
Ash Ditch	14 June 2005	36.759280	-89.492740	200	100	Hand/Snorkel
St. James Ditch 1	14 June 2005	36.728597	-89.391736	50	100	Hand/Snorkel
St. James Ditch 2	14 June 2005	36.703359	-89.391426	100	90	Hand/Snorkel
St. James Ditch 3	14 June 2005	36.702065	-89.391539	75	40	Hand/Snorkel
Setback Levee Ditch 1	14 June 2005	36.748090	-89.355630	100	80	Hand/Snorkel
Setback Levee Ditch 2	14 June 2005	36.748090	-89.355630	100	60	Hand/Snorkel
Setback Levee Ditch 3	15 June 2005	36.709480	-89.363430	150	200	Hand/Snorkel
Setback Levee Ditch 4	15 June 2005	36.670310	-89.404100	100	150	Hand/Snorkel
Setback Levee Ditch 5	15 June 2005	36.657740	-89.416320	100	150	Hand/Snorkel
Setback Levee Ditch 6	15 June 2005	36.628780	-89.440120	100	125	Hand/Snorkel

**Table 2. Freshwater mussel survey results, St. Johns Bayou Basin and Mud Ditch, Missouri.**

Species	MD1	MD 2	SJoD1	SJoD 2	AD	SJaD1	SJaD 2	SJaD 3	SBL1	SBL2	SBL3	SBL4	SBL5	SBL6
<i>Amblema plicata</i>			8 (2)			17	189	91	13	14	49	70	65	19
<i>Anodonta suborbiculata</i>							0 (1)							
<i>Arcidens confragosus</i>							1		1	1	3	2	2	
<i>Fusconia flava</i>										1	2	0 (1)	0 (1)	
<i>Lampsilis cardium</i>			1											
<i>Lampsilis teres</i>						6	5	7		1	2	1	2	0 (1)
<i>Lasmigona complanata</i>			2 (1)			4	7	1	4	8	15	5	4	
<i>Leptodea fragilis</i>			1								1			3
<i>Potamilus purpuratus</i>			1				1		1	1 (1)	5	1	4	3
<i>Pyganodon grandis</i>	1					4	1 (2)		2	4	5	1	0 (1)	
<i>Quadrula pustulosa</i>			2						2	2	13	2	10	1
<i>Quadrula quadrula</i>			5				5	12	3	2	29	9	9	5
<i>Tritogonia verrucosa</i>			4						2	1 (1)	15		4	
<i>Truncilla truncate</i>												1	1	
<i>Utterbackia imbecillis</i>						0 (1)								
Number of Individuals (Relic)	1	0	24 (3)	0	0	31 (1)	209 (3)	111	28	35 (2)	139	92 (1)	101 (2)	31 (1)
Number of Live Species	1	0	8	0	0	4	7	4	8	10	11	9	9	5
Search Time (person hours)	0.6	0.33	2.5	0.45	1.7	1.7	1.5	0.67	1.3	1.0	3.3	2.5	2.5	2.1
CPUE Live	1.7	0	9.6	0	0	18.2	139.3	165.7	21.5	35.0	42.1	36.8	40.4	14.8

MD1 – Mud Ditch Site 1  
MD2 – Mud Ditch Site 2  
SJoD 1 – St. Johns Ditch 1  
SJoD 2 – St. Johns Ditch 2  
AD – Ash Ditch  
SJaD1 – St. James Ditch 1  
SJaD2 – St. James Ditch 2

SJaD3 – St. James Ditch 3  
SBL1 – Setback Levee Ditch 1  
SBL2 – Setback Levee Ditch 2  
SBL3 – Setback Levee Ditch 3  
SBL4 – Setback Levee Ditch 4  
SBL5 – Setback Levee Ditch 5  
SBL6 – Setback Levee Ditch 6

**Table 3. Freshwater mussel surveys, habitat conditions, St. Johns Bayou Basin and Mud Ditch, Missouri.**

Site	Substrate	Depth	General Habitat
Mud Ditch 1	Clay/woody debris/mud	> 3 m	Steep unstable banks, large woody debris abundant
Mud Ditch 2	Clay/woody debris/mud	> 3 m	Steep unstable banks, large woody debris abundant
St. Johns Ditch 1	Black sand	60 cm	Stable banks, thalweg along left bank
St. Johns Ditch 2	Black sand, riprap	60 cm	Stable banks, uniform depth
Ash Ditch	sand	30 cm	Clear water, filamentous algae
St. James Ditch 1	Thick silt/mud	45 cm	Stable banks, little riparian zone
St. James Ditch 2	Silt/mud, limited clay	45 cm	Stable banks, little riparian zone
St. James Ditch 3	Silt/mud, limited clay	45 cm	Stable banks, little riparian zone
Setback Levee Ditch 1	Mud/clay, sand mid-channel	60 cm	Stable banks, good riparian zone on right bank, most mussels found along toe of right bank, some mussels found on left bank where substrate consisted of mud/clay
Setback Levee Ditch 2	Mud/clay, sand mid-channel	60 cm	Stable banks, good riparian zone on right bank, most mussels found along toe of right bank, some mussels found on left bank where substrate consisted of mud/clay
Setback Levee Ditch 3	Mud/clay, sand mid-channel	60 cm	Stable banks, good riparian zone on right bank, most mussels found along toe of right bank, some mussels found on left bank where substrate consisted of mud/clay

**Table 3. Continued.**

Site	Substrate	Depth	General Habitat
Setback Levee Ditch 4	Mud/clay, sand mid-channel	60 cm	Stable banks, good riparian zone on right bank, most mussels found along toe of right bank, some mussels found on left bank where substrate consisted of mud/clay
Setback Levee Ditch 5	Mud/clay, sand mid-channel	60 cm	Stable banks, good riparian zone on right bank, most mussels found along toe of right bank, some mussels found on left bank where substrate consisted of mud/clay
Setback Levee Ditch 6	Mud/clay, sand mid-channel	60 cm	Stable banks, good riparian zone on right bank, most mussels found along toe of right bank, some mussels found on left bank where substrate consisted of mud/clay

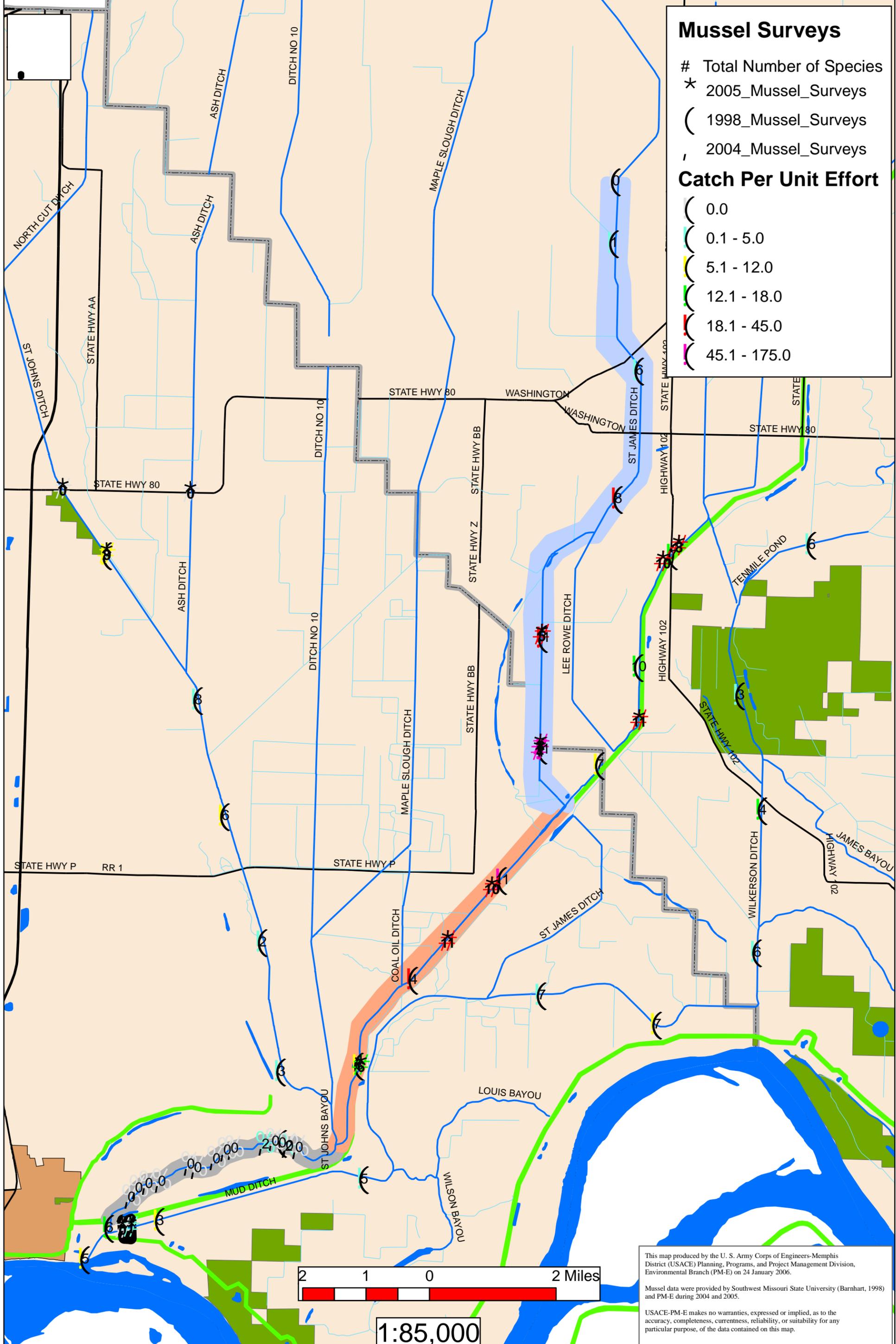


Figure 2. Freshwater mussel surveys (1998 - 2005), St. Johns Bayou Basin and the New Madrid Floodway, Missouri

**Table 4. Freshwater mussel survey results from Barnhart (1998) and present survey, Mud Ditch, New Madrid Floodway, Missouri.**

Species	Barnhart (1988)	Mud Ditch 1	Mud Ditch 2
<i>Anodonta suborbiculata</i>	1		
<i>Leptodea fragilis</i>	1 (1)		
<i>Pyganadon grandis</i>	9	1	
Number of Individuals (Relic)	11 (1)		0
CPUE Live (number/hour)	8.3	1.7	0

No mussels were found in Ash Ditch. Ash Ditch will not be used as a relocation site. No further freshwater mussel surveys of Ash Ditch are planned.

Table 5 provides a comparison of freshwater mussel species found in the Setback Levee Ditch and St. James Ditch in the present survey and those found by Barnhart (1998). The current survey found 12 and eight species of freshwater mussels in Setback Levee Ditch and St. James Ditch, respectively. Barnhart (1998) found 15 and 14 species of freshwater mussels from Setback Levee Ditch and St. James Ditch, respectively.

Setback Levee Ditch still supports a relatively diverse population of freshwater mussels throughout the construction reach. Habitat conditions were generally better in the upper reaches and decreased downstream, based on CPUE and total number of species observed. The majority of mussels collected in the upper reaches were generally found along the toe of the right descending bank. Mussels were distributed more widely throughout the entire channel bottom within the lower reaches. Proposed construction entails widening the channel to increase the bottom width by 10 feet. A nine-foot strip along the right descending bank will be avoided during construction. However, this area may become de-watered following channel excavation.

A quantitative freshwater mussel survey of Setback Levee Ditch, within the construction zone is planned. This survey will be conducted prior to construction and one year after construction to monitor the impacts of channel widening. A portion of the population will be relocated. Monitoring will continue within the construction reach over a period of 10 years to monitor recolonization rates.

The upper portions of Setback Levee Ditch, above the planned construction zone, appear to offer suitable habitat for relocated mussels. A portion of this area will be designated a control site to monitor trends in the mussel population over the next 10 years. The remaining area will be used to relocate mussels. Survivorship of this area will also be monitored.

The lower reaches of St. James Ditch support the greatest concentrations of freshwater mussels surveyed within the project area, based upon CPUE. *A. plicata* made up approximately 88% of the total mussels observed from the two lower most reaches

combined. Proposed construction within the surveyed reach entails widening the bottom width by 10 feet. A portion of the population will be relocated prior to construction.

**Table 5. Freshwater mussel surveys, Setback Levee Ditch and St. James Ditch, Missouri.**

Species	Setback Levee Ditch (1998)	Setback Levee Ditch (2005)	St. James Ditch (1998)	St. James Ditch (2005)
<i>Amblema plicata</i>	X	X	X	X
<i>Anodonta suborbiculata</i>			X	Relic only
<i>Arcidens confragosus</i>	X	X	X	X
<i>Fusconia flava</i>	X	X		
<i>Lampsilis cardium</i>	X		X	
<i>Lampsilis siliquoidea</i>			Relic only	
<i>Lampsilis teres</i>	Relic only	X	X	X
<i>Lasmigona complanata</i>	X	X	X	X
<i>Leptodea fragilis</i>	X	X	X	
<i>Ligumia subrostrata</i>			X	
<i>Potamilus purpuratus</i>	X	X	X	X
<i>Pyganodon grandis</i>	X	X	X	X
<i>Quadrula nodulata</i>	X			
<i>Quadrula pustulosa</i>	X	X		
<i>Quadrula quadrula</i>	X	X		X
<i>Toxolasma parvus</i>			X	
<i>Toxolasma teasensis</i>			X	
<i>Tritogonia verrucosa</i>	X	X		
<i>Truncilla truncata</i>	X	X		
<i>Uniomerus tetralasmus</i>	X			
<i>Utterbackia imbecillis</i>			X	
Total Number of Species	15	12	14	8
Number of Sites Surveyed	6	6	5	2

Potential relocation sites were visited upstream of the construction zone on St. James Ditch. However, these sites will not be suitable because of the littering problem. A small portion of the relocated mussels from St. James Ditch will be relocated to St. Johns Bayou Ditch downstream of the Swift Ditch area (SJoD 1). Remaining mussels will be moved into the relocation area established on Setback Levee Ditch. Additional qualitative surveys will be conducted in St. James Ditch and the relocation areas to determine recolonization and survivorship.

Additional freshwater mussel surveys, including relocation efforts, will be discussed in the detailed monitoring plan. This plan will be coordinated with the interagency mitigation team made up of members from the U.S. Fish and Wildlife Service, Environmental Protection Agency, Missouri Department of Conservation, and the Missouri Department of Natural Resources.