

Miller & Harris 1987

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A SURVEY FOR MOLLUSCS IN THE WHITE RIVER NEAR NEWPORT, ARKANSAS, 1986

by
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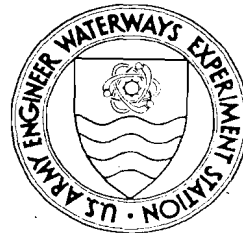
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19. ABSTRACT (Continue on reverse if necessary and identify by block number) <p>A survey for live molluscs and shells was made on 27-30 October 1986 in the White River, near Newport, Arkansas, river mile 254.6 to 230.7. Molluscs were collected at 12 dredged material disposal sites using divers equipped with SCUBA, and by hand on shore and in shallow water. Twenty-four species of unionid molluscs, in addition to the Asiatic clam, <i>Corbicula fluminea</i>, were collected alive and seven additional species were found only as shells. The existing fauna is dominated by thick-shelled species, <i>Udrula pustulosa</i> (26.0 percent), <i>Fusconaia ebena</i> (22.4 percent), <i>Ellipsaria lineolata</i> (9.9 percent), <i>Obovaria olivaria</i> (7.3 percent), and <i>Obliquaria reflexa</i> (5.2 percent). Live species that made up less than 1 percent of the community included <i>Anodonta grandis grandis</i>, <i>Corbicula fluminea</i>, <i>Cyprogenia aberti</i>, <i>Lampsilis teres</i>, <i>Lasmigona complanata</i>, <i>Potamilus laevis</i>, <i>Tritogonia verrucosa</i>, and <i>Truncilla truncata</i>. Live mussels were found in 1- to 2-m linear strips of sand and gravel within 20 m of shore, or in</p> <p style="text-align: right;">(Continued)</p>			
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depositional zones with mud substrate. The endangered *Potamilus capax* and *Lampsilis orbiculata* were not collected alive; however, relict shells of the latter species were found at seven sites. Fresh *L. orbiculata* shells were collected at river mile 236.2 where previous workers reported finding this species alive. Other important sites on this reach of the White River for mussels are at river miles 250.0 (left descending bank) and 241.9 (right descending bank). The mussel fauna in this reach of the river has been stressed by maintenance dredging and to some extent by commercial harvesting and hypolimnetic reservoir releases upriver. However, evidence of recent recruitment was found for 10 species of unionids, many of which were collected in close proximity to previously dredged areas.

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PREFACE

On 27-30 October 1986 a survey was conducted on the White River, Jackson and White Counties, Arkansas, for freshwater mussels (Mollusca:Unionidae). The purpose of the study was to collect information on mussels for the US Army Engineer District, Memphis (LMM), to be used for decisions concerning the environmental effects of maintenance dredging at selected sites between river miles 254.6 and 230.7 on the White River. This report was prepared by Dr. Andrew C. Miller, US Army Engineer Waterways Experiment Station (WES), Vicksburg, Mississippi, and Dr. John L. Harris, Arkansas Highway and Transportation Department, Little Rock, Arkansas. Additional assistance was provided by Dr. Morris Mauney, LMM; Mr. Manual Barnes, US Army Engineer District, Little Rock; and Mr. Jim Stewart, US Fish and Wildlife Service, Jackson, Mississippi. Messrs. Robert Leisure and Raymond Spicer, Grand Glaize, Arkansas, provided information on existing and past mussel resources in the river. The following divers from Lake Dardanelle, Arkansas, collected mussels during the survey: Messrs. Jerry Howard, Sam Jones, and Spencer Cox. The report was edited by Ms. Jamie W. Leach of the WES Information Products Division.

This report was conducted under the general supervision of Mr. Richard Coleman, Acting Chief, Aquatic Habitat Group; Dr. Conrad J. Kirby, Chief, Environmental Resources Division; and Dr. John Harrison, Chief, Environmental Laboratory, WES.

Commander and Director of WES was COL Dwayne G. Lee, CE. Technical Director was Dr. Robert W. Whalin.

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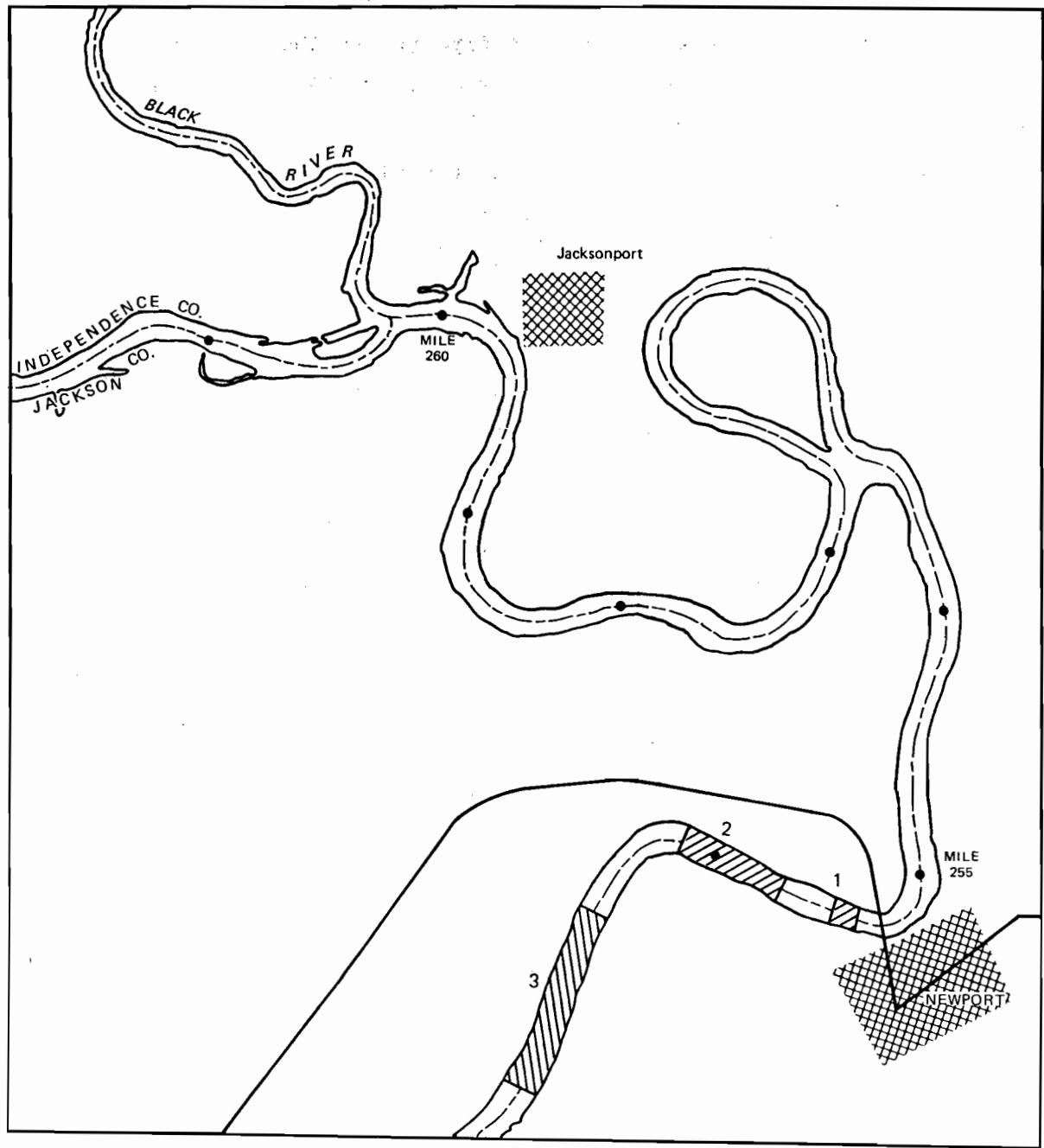


Figure 1. Sites surveyed for molluscs on the White River near Newport, Arkansas, river miles 254.6 to 230.7, Jackson and White Counties, 27-30 October 1986 (Sheet 1 of 4)

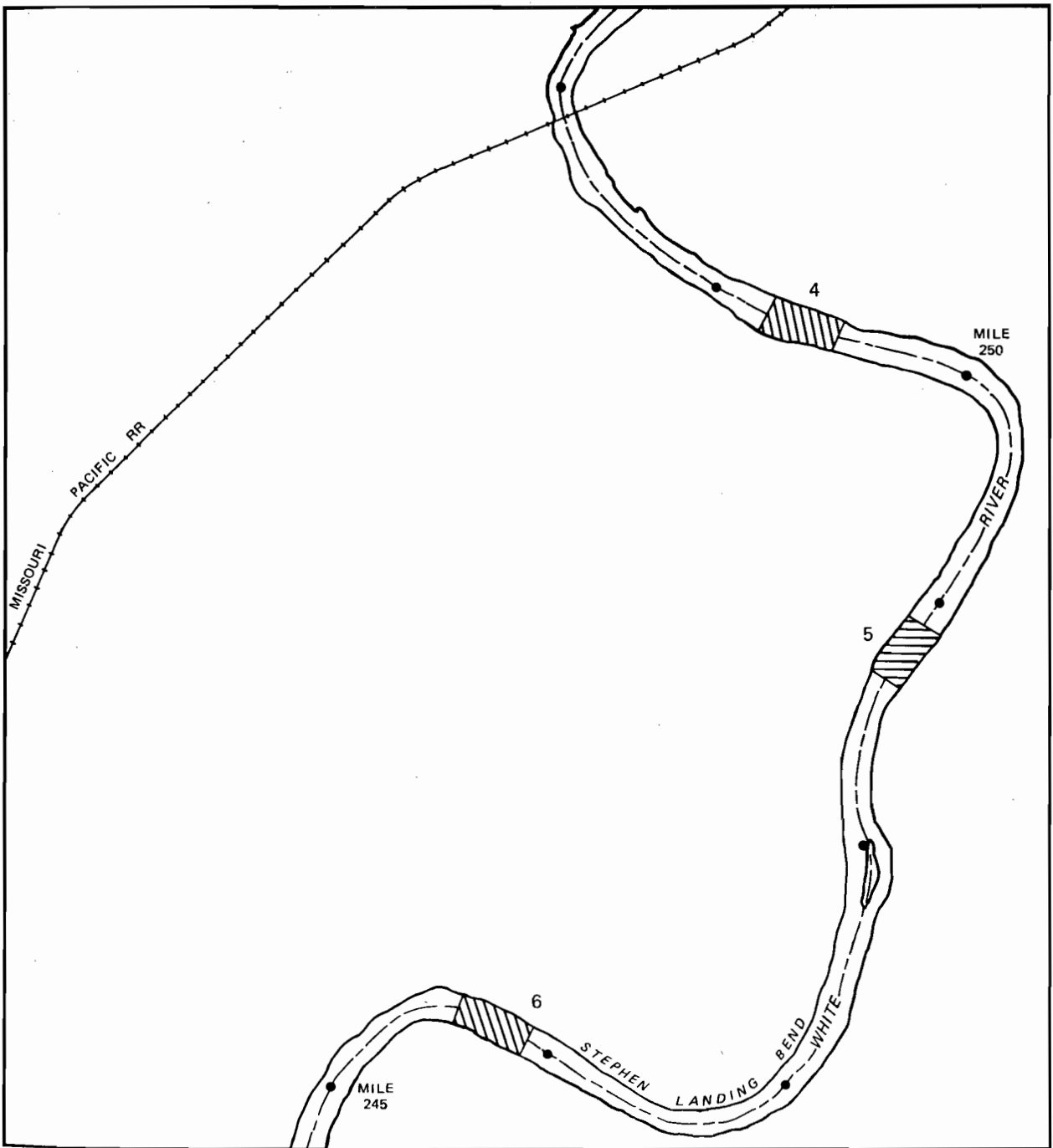


Figure 1. (Sheet 2 of 4)

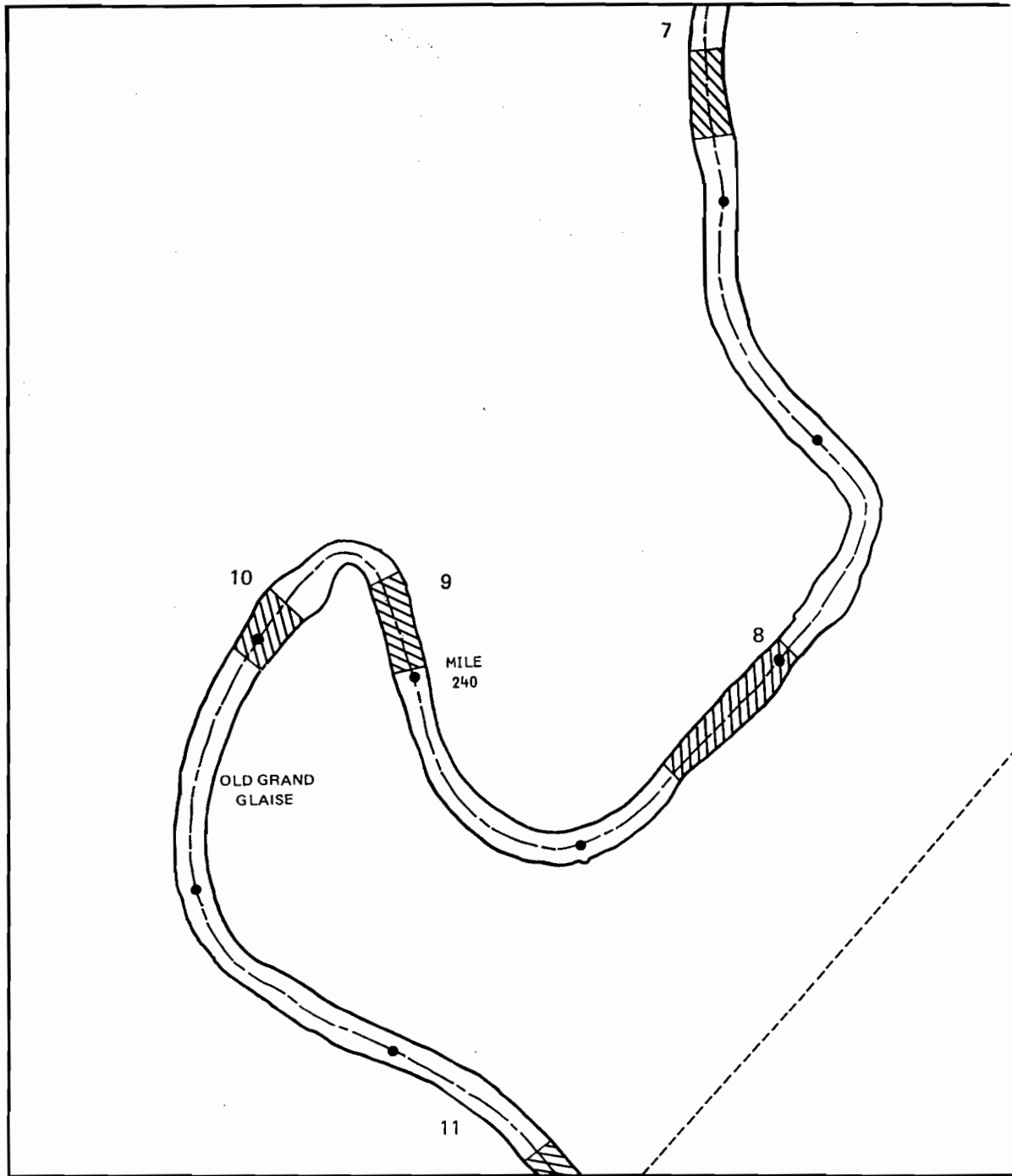


Figure 1. (Sheet 3 of 4)

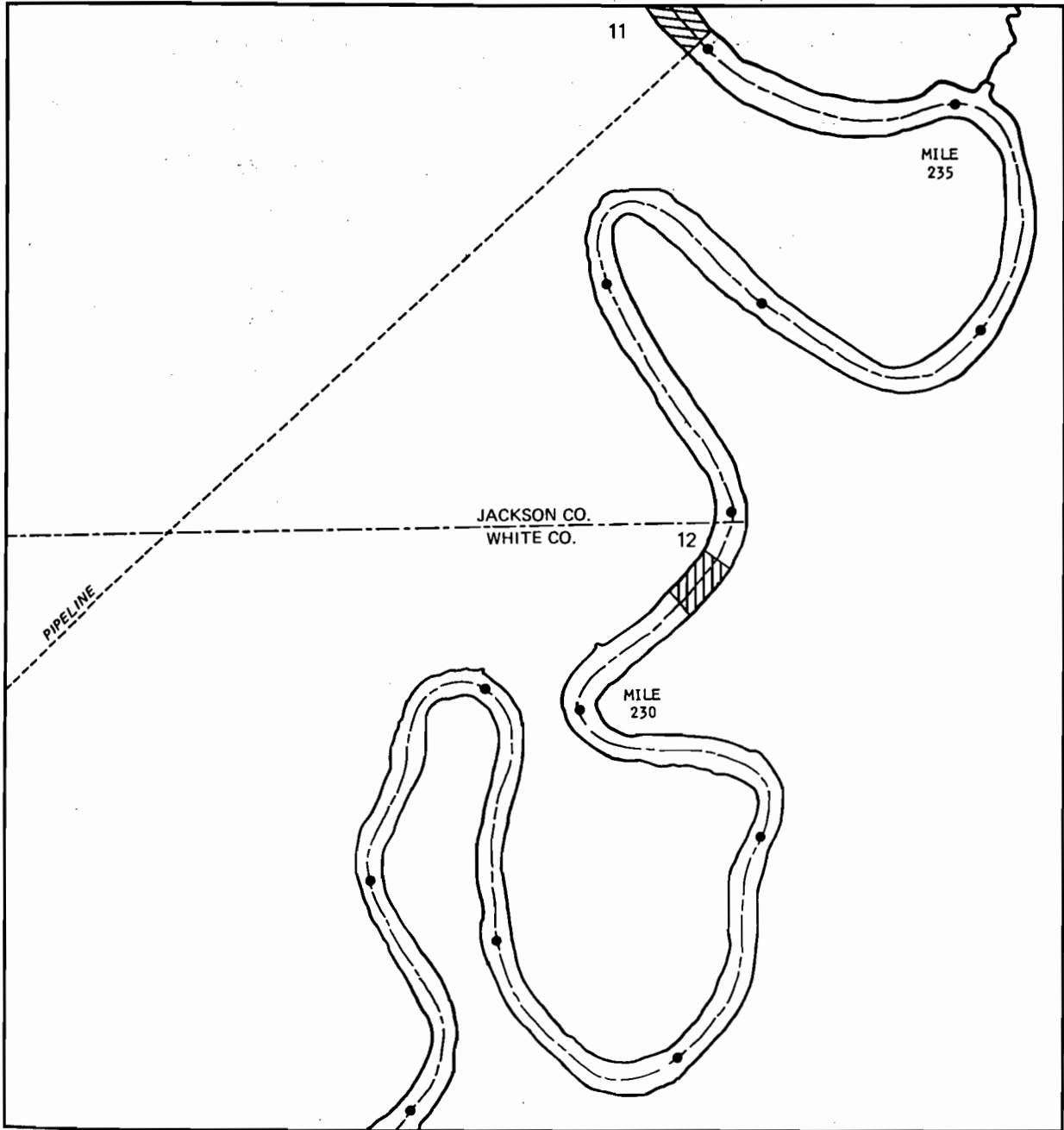


Figure 1. (Sheet 4 of 4)

the White River at St. Charles, Arkansas County (south of the study area). She collected 17 species of unionids and the Asiatic clam *Corbicula fluminea*, although no Federally listed endangered species were obtained. Stein and Stansbery (1980) used a brail and a hard hat diver to collect live molluscs from a bridge construction site in Jackson County. The bridge, located at river mile 236.2 in the present study area, was recently completed. Stein and Stansbery collected 25 species including two specimens of the endangered mollusc *L. orbiculata*.

11. Between 1912 and 1914 the commercial shell industry in Arkansas was responsible for half of the yearly production from the Interior Basin south of the Missouri River including the Ohio River and Gulf Drainages. The White River was the fourth most productive river in the United States, receiving the highest yearly price per ton of shells (Coker 1919). The White River near Newport was the site of extensive commercial shell harvesting during the early 1950's.*

* Personal Communication, Robert Leisure, 27 Oct 1986, Commercial Shell Fisherman and Buyer, Grand Glaise, Arkansas.

PART II: METHODS

12. Qualitative and semiquantitative collections for molluscs were made with a three-man diving crew supplied by the US Army Engineer District, Little Rock (Figure 3). At each site the boat was anchored and a diver equipped with



a. Dive boat



b. Retrieving mussels

Figure 3. Positioning the dive boat and retrieving mussels from the White River, Arkansas

SCUBA searched for a specific period of time (usually 15 min) for live mussels (Tables A1 and A2, Appendix A). Because of the high water velocities (often in excess of 50 cm/sec), the diver was tethered at all times. At most sites lateral motion across the current was considerably restricted. Typically, the diver moved away from the boat with the current as far as possible, then worked toward the shoreline or the main channel. Usually the boat had to be repositioned several times to ensure adequate coverage. At each site the diver provided information on current velocity, depth, substrate composition, and presence of shells and live mussels.

13. One or more nondivers searched the shoreline and shallow water at each site for shells and live mussels (Tables A2 and A3, respectively). Notes were made on physical conditions at each site, and the relative age (i.e.,

fresh or old material) of the shells. Semiquantitative samples were obtained by divers at river mile 236.2 (the Highway 67 site, Figure 4) by collecting all mussels from within a 0.25-sq-m quadrat (Table A4). High current velocity made it impossible for the diver to obtain total substrate samples. Mr. Robert Leisure, a commercial shell fisherman and buyer, worked two transects with his brail boat at river mile 236.2 (Table A5).

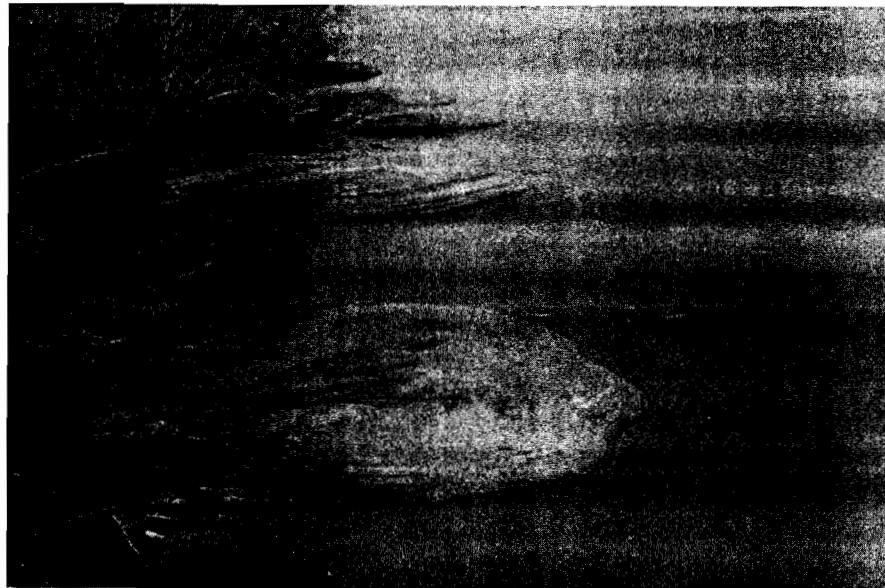


Figure 4. A dredged material disposal site on the White River, river mile 236.2

14. Live mussels obtained during the survey were identified and counted. Selected specimens were weighed (0.01 g) and total length recorded (0.1 mm). All mussels not needed for voucher specimens were returned to the White River.

PART III: RESULTS AND DISCUSSION

Molluscs of the White River

15. Thirty-one species of unionid molluscs, and the Asiatic clam, *Corbicula fluminea*, were collected from 12 dredge disposal sites on the White River in Jackson and White Counties, Arkansas (Table 1). Twenty-four species were found alive, and seven additional species were represented only as shells. The endangered pink mucket, *Lampsilis orbiculata*, and the fat pocket-book (*Potamilus capax*) were not found alive during the survey. However, fresh shells of *L. orbiculata* were found at river mile 236.2 (site 11, see Figure 1) and relict shells were found at seven additional sites (Table 2). Figures 5-8 show four of the species collected.

16. Based upon collections of shells, the molluscan fauna in this reach of the White River was dominated by the three-ridge (*Amblema plicata*), butterfly (*Ellipsaria lineolata*), ebony shell (*Fusconaia ebena*), fragile papershell (*Leptodea fragilis*), hickorynut (*Obovaria olivaria*), three-horned wartyback (*Obliquaria reflexa*), bank climber (*Plectomerus dombeyanus*), bloofer (*Potamilus purpuratus*), monkeyface (*Quadrula metanevra*), pimpleback (*Q. pustulosa*), and buckhorn (*Tritogonia verrucosa*) that were found at 10 or more of the sites (Table 1). The least common species were the deertoe (*Truncilla truncata*), pyramid pigtoe (*Pleurobema pyramidatum*, = *P. rubrum*), Ouachita kidneyshell (*Ptychobranthus occidentalis*), and pink papershell (*Potamilus laevissima*). Eight of the twelve sites had 20 or more species. Dredged areas with the highest richness were sites 1, 2, 8, 10, and 11, where 20 or more species were obtained (Figure 1, Table A2). The fewest species of shells were obtained at sites 3 and 9 where 15 and 12 species, respectively, were collected.

17. Using SCUBA and collecting by hand in shallow water, 192 live mussels were taken at 8 of the 12 sites (Tables 2 and A3). The majority of the mussels, 96.8 percent, were obtained at sites 4, 5, 8, 11, and 12 (Figure 1). The most common species were *F. ebena* (22 percent, taken at five sites), *Q. pustulosa* (26 percent, collected at six sites), *O. olivaria* (7 percent, found at two sites), and *E. lineolata* (22 percent found at five sites). A total of nine species were taken only at a single site, and eight species were represented by a single live individual.

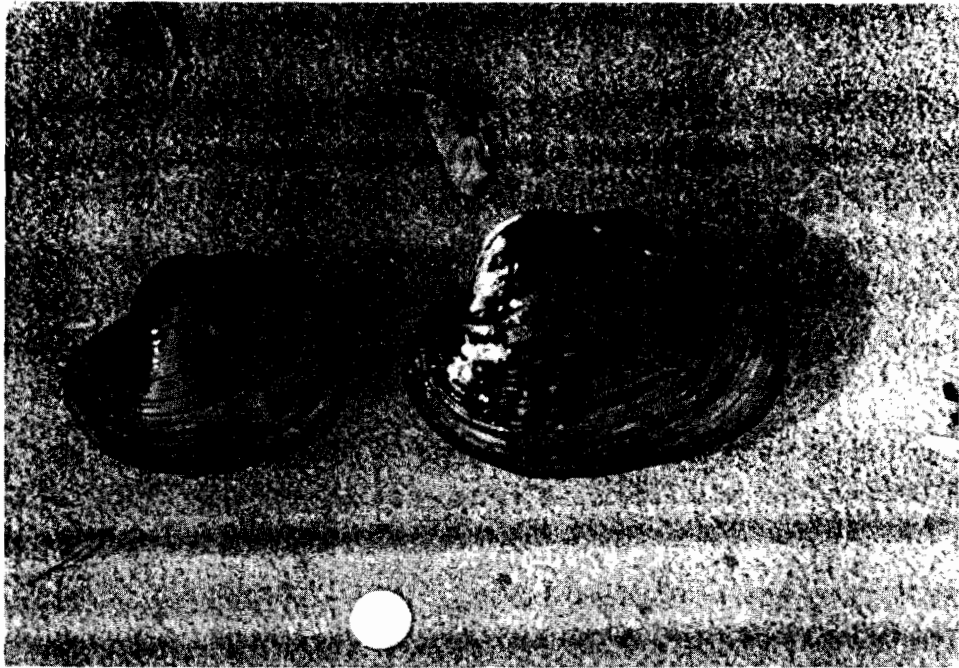


Figure 5. *Lampsilis ventricosa* from the White River, Arkansas

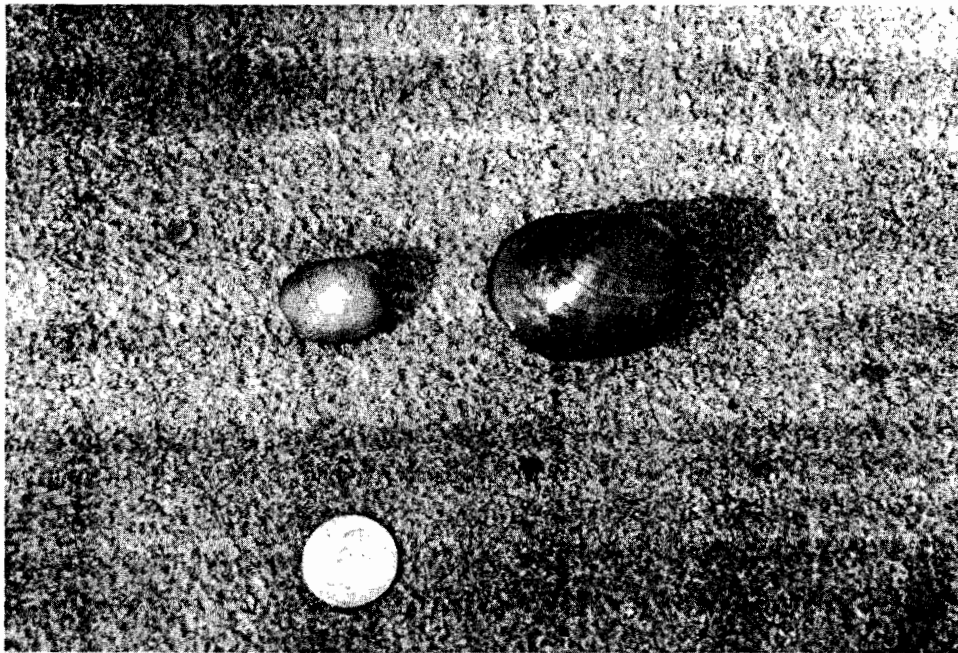


Figure 6. *Obovaria olivaria* from the White River, Arkansas

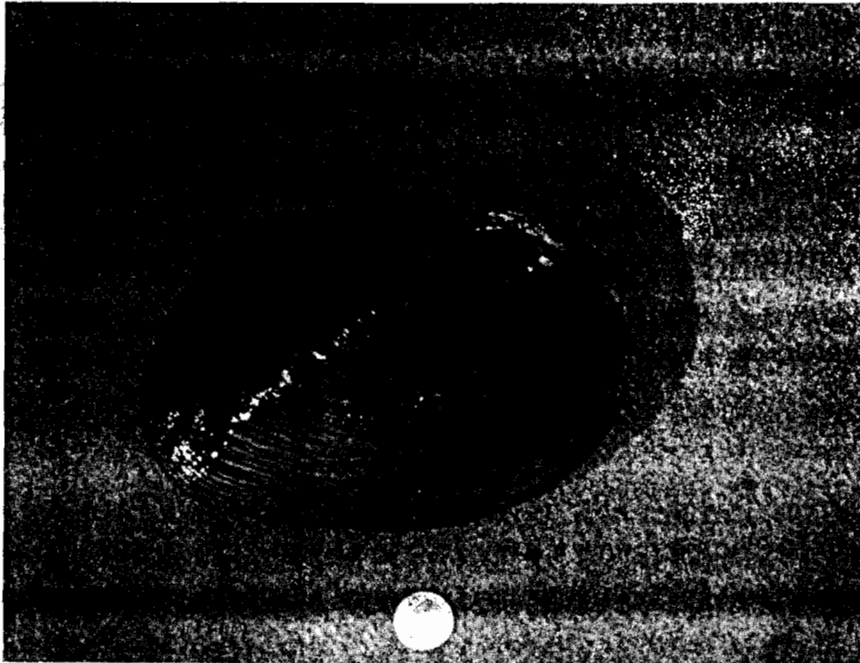


Figure 7. *Megaloniais gigantea* from the
White River, Arkansas

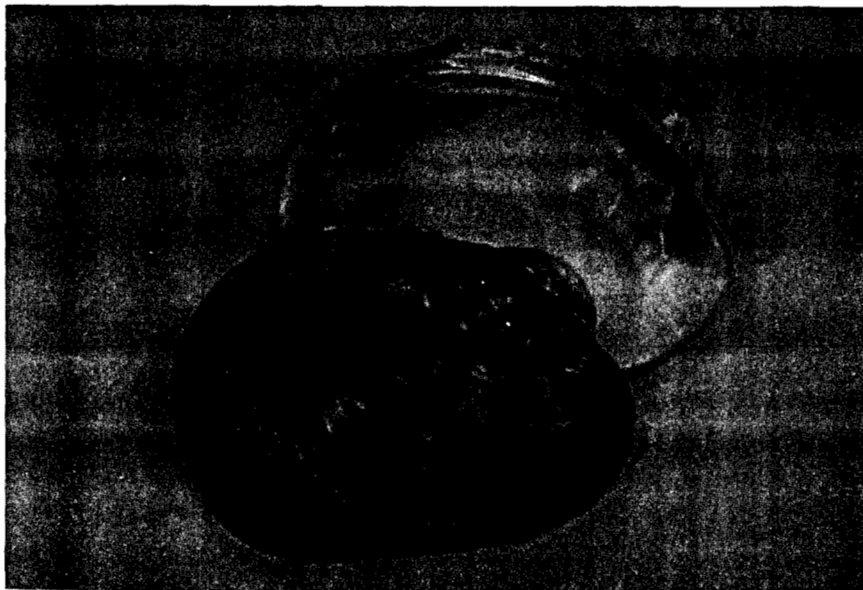


Figure 8. *Lampsilis orbiculata* from the
White River, Arkansas

18. Mussels were confined to fairly narrow (1-2 m) gravel strips parallel to the shore. They were usually in water 4 to 6 m deep and about 5 to 15 m from shore. Closer to shore the substrate consisted of mud or clay, but in deeper water toward midchannel the bottom was composed of sand and small amounts of gravel and dead shells. At site 4, a relatively large number of mussels (28 individuals representing nine species) were found in shallow water near the dredged material. At site 8, 10 species and 26 individuals were collected in mud substrate in low velocity water (<15 cm/sec) within 20 m of the shore. These mussels were on the opposite side of the river from the disposal sites in a segment that probably did not require dredging. These depositional areas supported *L. fragilis*, *P. laevissima*, and *Lasmigona complanata*, as well as lesser numbers of thick-shelled species.

19. Six semiquantitative 0.25-sq-m samples were taken at site 11 (Table A4). Unionid density was estimated to range from 4 to 44 individuals/sq m, and species richness from one to five per quadrat. These samples were dominated by *E. lineolata* (37 percent) and *Q. pustulosa* (31.2 percent); the other eight species each represented less than 10 percent of the collection. The two braill samples (Table A5) were dominated by *E. lineolata* and *O. olivaria* (both 24.3 percent), and fewer numbers of *Q. pustulosa* and *O. reflexa* (both 16.2 percent).

20. Evidence of recent recruitment (i.e. specimens that were at least half the maximum size) was noted for 10 of the 24 species collected alive in the study area (Table 1). About 10 percent of the live *O. olivaria* were subadults. For the remaining nine species, evidence of recruitment was based upon either one or a few subadults.

Community Characteristics

21. The mussel fauna of the White River near Newport, Arkansas, is moderately diverse, consisting of at least 24 species. The community is dominated by thick-shelled species (*Fusconaia* spp., *Quadrula* spp., and *E. lineolata*), which are common inhabitants of sand/gravel and mud substrate (Buchanan 1980, Parmalee 1967). Less common species, *L. fragilis*, *Potamilus laevissima*, *Anodonta grandis*, and *Lasmigona complanata*, typically collected in soft substrate (Parmalee 1967) were found in depositional zones in deep water in mud or silt.

22. Unionid communities in large rivers are usually dominated by a single species (such as the three-ridge, *A. plicata*, the ebony shell, *F. ebena*, or the washboard, *Megalonaias gigantea*), which can comprise about 50 percent of the community (Miller and Payne 1987, Payne and Miller 1987). Typically when *F. ebena* is present it is often the most abundant taxon; when absent, usually *A. plicata* or *M. gigantea* are most common. Based upon live and shell collections, and observations of commercial fishermen (Robert Leisure, personal communication), the unionid community in this reach of the White River was probably always dominated by *F. ebena*.

23. Based upon a comparison of live molluscs and shells collected from the dredge disposal area (Table 1), certain unionids have either been extirpated, or else are now extremely uncommon in the study area. Seven species (*Actinonaias ligamentina*, *Elliptio dilatata*, *L. orbiculata*, *P. rubrum*, *P. occidentalis*, *Q. metanevra*, and *T. truncata*) were found as shells but not taken alive (Table 1). Of these seven species, Stein and Stansbery (1980) collected all but three (*P. occidentalis*, *P. rubrum*, and *E. dilatata*) in an intensive survey at river mile 236.2 (site 11). In their survey a diver spent more than 5 hr in the water and collected over 800 live mussels. This degree of effort should ensure collecting even the least common species; it is possible that the above three species are no longer found in this reach of the White River.

24. Live molluscs and shells in the study area were robust, with little evidence of erosion. Specimens of *A. ligamentina*, *P. occidentalis*, and *Lampsilis ventricosa* were exceptionally thick, the nacre not stained, and the periostracum mostly intact. These attributes characterize the water quality as good, with adequate dissolved calcium and moderate levels of suspended sediments which, with high velocity water, can erode shells. Cold-water releases from Bull Shoals and Norfolk Lakes have a minor influence on water temperatures in this reach of the White River (Figure 2). Periodic releases of cold water from hydropower facilities have affected recruitment of unionids in the Cumberland River (Miller, Rhodes, and Tippit 1984) and the Caney Fork River, Tennessee (Miller, unpublished information).

Lampsilis orbiculata

25. *Lampsilis orbiculata* has always been reported as uncommon, although distributed over a wide area. Its range included the Niagara River at Buffalo, New York; the Illinois River in Illinois; the upper and lower Ohio River and some tributaries (Allegheny, Monongahela, Kanawha, Muskingum, Scioto, Green, Wabash, and White Rivers); the Cumberland and a tributary, the Obey River; and the Tennessee River and some of its tributaries (Clinch, Holston, French Broad, Flint, and Duck Rivers, and Limestone Creek). It has been found in the Cumberland River, Tennessee, and the lower Tennessee River below Wilson and Guntersville Dams in Alabama, and below Pickwick Dam in Tennessee, and in the Meramec River Basin, Missouri (Buchanan 1980).

26. Results of previous studies illustrate the rarity of this species. In Illinois, Parmalee (1967) reported that this species was uncommon to rare and taken only from large rivers in deep water. Buchanan (1980) reported that *L. orbiculata* was found in a variety of substrate types ranging from silt to cobble but was most common in gravel and cobble. Typically it was collected in water 0.3 to 1.5 m deep with currents ranging from 0.0 to 30 cm/sec at the bottom. *Lampsilis orbiculata* represented only 1 percent of the mussel fauna in the Meramec River Basin. The Arkansas State Highway and Transportation Department (1984) searched 1,483 sq m of bottom at a site in the Spring River and collected only six live *L. orbiculata*. Stein and Stansbery (1980) found only two *L. orbiculata* out of a total of 814 live molluscs collected during their survey. In a survey of the Black River near Pochahontas, Arkansas, 44 sites were searched and over 1,000 mussels were collected including two live *L. orbiculata* (Miller and Hartfield 1986).

27. Although gravel substrate in the study area provides suitable habitat for the endangered *L. orbiculata*, no live specimens were found during this survey. The number of relict shells collected in the dredged material disposal piles (i.e. they were dredged from the river) indicates that live *L. orbiculata* were widely distributed, although uncommon, in this reach of the river (Table 2). Commercial shell fishermen bring approximately 15 *L. orbiculata* to a local shell buyer each year. Most of these *L. orbiculata* probably originate from the study area, although some could be brought in from areas downriver. Presumably some individuals of this species are identified by the shell

shermen and returned to the river immediately after capture (Robert Leisure, personal communication).

28. One intact set of fresh shells (the organism had died during the summer of 1986) was collected at river mile 236.2 (site 11, see Figure 1). Based upon the results of this survey and that of Stein and Stansbery (1980), the most likely site to find live *L. orbiculata* is at river mile 236.2. It is possible that live *L. orbiculata* could exist at any of the dredged sites where relict shells were collected; however, the most valuable site for common and uncommon molluscs, as well as *L. orbiculata*, is at river mile 236.2 (Table 2).

Density

29. At site 11, mussel densities ranged from 4 to 44 individuals/sq m (based on six quantitative samples). These values can be contrasted with the densities on the lower Mississippi River, where average densities ranged from 2.8 to 202.0 organisms/sq m (based on 10 quadrats) at 15 sites (Miller and Payne 1987). The Black River, near Pocahontas, Arkansas, which has about half the discharge of the White River but is similar in other respects, has a fairly extensive mussel fauna. Miller and Hartfield (1986) conducted a 3-day survey on that river using divers and collected over 1,000 live mussels from 44 sites. Presumably the mussel fauna of the White River in the study area can be characterized as having moderate to low densities when compared with other sites.

Effects of Dredging

30. The White River near Newport, Arkansas, has been known as one of the most productive sites in the United States for commercial quality shells (Coker 1919, Robert Leisure, personal communication). However, this fauna has been impacted by dredging for commercial navigation and harvesting by commercial shell fishermen. Currently, about eight local individuals work this reach of the river for shells on a part-time basis. In 1985 and 1986 approximately 20-25 tons and 12 tons of shells, respectively, mostly the ebony shell (*S. ebena*), were harvested from this reach of the river (Robert Leisure, personal communication). Maintenance dredging, which removes gravel substrate and live organisms, has been conducted for the last 10 years at selected sites

on an annual or as needed basis (Table 1). Commercial harvesting was, and is still being done with the brail, divers equipped with surface air supply, and for a period in the past, benthic dredges dragged from a boat. It is not possible to determine the extent that dredging, as compared with commercial harvesting methods, contributed to loss of the molluscan fauna.

31. At site 11 live mussels and fresh shells (less than 5 percent of the collection) were found that had been damaged by a hydraulic dredge. However, at sites 8 and 12 about six intact shells were found that could not have been the result of dredging in 1986 (Table 1). These individuals could have been stranded by low water or died of other causes. At sites 4 and 9, small live unionids were collected in gravel in water less than 0.5 m deep and within 3 m of shore. These juveniles could have been displaced from deep water by the dredge (possible for site 4, river mile 250.0), or could have recently invaded these dredged areas.

32. Although mussel densities have been affected by activities of man, there was evidence of recent recruitment for at least 10 species in this reach of the White River (Table 1). Juvenile mussels were found at sites 4, 9, and 11 (river miles 250.8, 239.9, and 236.2, respectively). These three sites represent the most important areas in the study area for mussels. At the latter site small mussels were collected with the brail (Table A5) and in quantitative samples (Table A4).

PART IV: SUMMARY AND CONCLUSIONS

33. The White River near Newport, Arkansas, has been well known for supporting a dense mussel fauna including commercially valuable species. Currently, the fauna is dominated by the ebony shell, *Fusconaia ebena*, in addition to three other thick-shelled species. Based upon results of this survey, three unionids (*Pleurobema pyramidatum*, *Ptychobranhus occidentalis*, and *Uliptio dilatata*) may have been extirpated from this reach of the river. The endangered *Lampsilis orbiculata* was found only as shells at 8 of the 12 study sites; however, two live individuals were collected during an intensive survey conducted in 1980 (Stein and Stansbery 1980). Dredging to maintain the navigation channel has negatively affected density and species richness of these invertebrates. In addition to dredging, the disposal of sand and gravel on existing mussel beds has been detrimental to the fauna. However, evidence of recent unionid recruitment was found for 10 of the 24 species of mussels collected during this survey. Although cold-water releases from Norfork and Bull Shoals Lakes, located upriver of the study area, could have contributed to loss of mussels, they have not eliminated the fauna, or recruitment.

34. Recently published papers contain accounts of the loss of unionid species in large rivers due to dredging, sewage effluents, or other activities of man (Horne and McIntosh 1979, Klippel and Parmalee 1979, Strayer 1980, Taylor and Hughart 1981, Taylor and Spurlock 1982, Neves and Zale 1982, Clarke 1986). While the mussels of the White River near Newport have been affected by water resource development, sampling with the brail, with SCUBA, and careful searches along the shore has demonstrated the presence of juveniles of at least ten species. This indicates that while the fauna has been severely stressed, it has the potential to recover if suitable substrate is available.

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Table 1

Bivalves Collected on the White River, October 1986

<u>Scientific Name</u>	<u>Common Name</u>	<u>Shells*</u>	<u>Live*</u>	<u>Recruitment**</u>
<i>Actinoaias ligamentina</i>	Mucket, grandma	U	N	N
<i>Amblema plicata</i>	Three-ridge	C	U	Y
<i>Anodonata grandis grandis</i>	Common floater	U	U	N
<i>Cyprogenia aberti</i> ✓	Western fanshell	U	U	N
<i>Elliptio dilatata</i> ✓	Spike, ladyfinger	U	N	N
<i>Ellipsaria lineolata</i> ✓	Butterfly	A	A	N
<i>Fusconaia ebena</i> ✓	Ebony shell	A	A	N
<i>Fusconaia flava</i>	Wabash pigtoe	U	U	N
<i>Lampsilis orbiculata</i> ✓	Pink mucket, Higginsi	U	N	N
<i>Lampsilis teres</i>	Yellow sandshell	U	U	N
<i>Lampsilis ventricosa</i>	Plain pocketbook, grandma	A	A	Y
<i>Lasmigona complanata</i>	White heelsplitter	N	U	Y
<i>Leptodea fragilis</i>	Fragile papershell	U	U	Y
<i>Ligumia recta</i> ✓	Black sandshell	U	U	N
<i>Megalonaias gigantea</i>	Washboard	U	U	N
<i>Obliquaria reflexa</i>	Three-horned wartback	U	U	Y
<i>Obovaria olivaria</i>	Hickorynut, eggshell	A	A	Y
<i>Plectomerus dombeyanus</i>	Ohio River pigtoe	U	U	N
<i>Pleurobema cordatum</i> ✓	Pyramid pigtoe	U	N	N
<i>Pleurobema pyramidatum</i> ✓	Pink papershell	U	U	Y
<i>Potamilus laevissima</i>	Bank climber	U	U	N
<i>Potamilus purpuratus</i>	Bloofer	U	U	Y
<i>Ptychobranhus occidentalis</i> ✓	Ouachita kidneyshell	U	N	N
<i>Quadrula cylindrica</i> ✓	Rabbitsfoot, cucumber	U	U	Y
<i>Quadrula metanevra</i> ✓	Monkeyface	U	N	N
<i>Quadrula nodulata</i>	Wartyback	U	U	Y
<i>Quadrula pustulosa</i>	Pimpleback	A	A	Y
<i>Quadrula quadrula</i>	Mapleleaf	U	U	N
<i>Tritogonia verrucosa</i>	Buckhorn	U	U	Y
<i>Truncilla truncata</i>	Deertoe	U	N	N
<i>Truncilla fluminea</i>	Asiatic clam	U	U	Y
Total species		31	24	

* A = abundant; C = common; U = uncommon; N = not found.

* Recruitment: Y = yes; N = no.

Table 2
Summary Data for Bivalves Collected at Dredge Disposal Sites
on the White River, 27-30 October 1986

Site No.	River Mile*	No. of Species		Dredging Schedule**	Last Dredged	Notes
		Shells	Live			
1	254.3 N35°36.50' W91°17.77'	25	1	2	7/86	Relict shells <i>L. orbiculata</i>
2	254.0 N35°36.58' W91°17.99'	20	3	1	7/86	Relict shells <i>L. orbiculata</i>
3	252.8 N35°36.06' W91°18.65'	15	--	1	7/86	High density and richness; relict <i>L. orbiculata</i>
4a	250.8 N35°34.61' W91°18.47'	18	--	--	8/85	Shells uncommon
4b	250.2 N35°34.47' W91°17.89'	18	--	--	8/85	Shells uncommon
4c	250.0 N35°34.41' W91°17.71'	18	10	1	7/86	Shells uncommon, relict <i>L. orbiculata</i>
5	248.7 N35°33.32' W91°18.06'	19	7	2	7/86	Relict shells
A 6	245.8 N35°32.19' W91°19.45'	16	--	3	7/82	Shells uncommon, relict <i>L. orbiculata</i>
7	244.6 N35°31.67' W91°20.37'	12	--	3	7/82	Shells uncommon
8	241.9 N35°29.64' W91°20.22'	26	10	1	8/85	Fresh shells, relict <i>L. orbiculata</i>
9	239.9 N35°29.81' W91°21.57'	12	2	2	--	High density
10	239.2 N35°29.92' W91°22.03'	22	--	2	7/86	High density, relict <i>L. orbiculata</i>
11	236.2 N35°28.10' W91°21.05'	27	13	2	10/80	High density, richness, fresh <i>L. orbiculata</i> shells
12	230.8 N35°26.19' W91°20.92'	22	9	2	10/72	Fresh shells

* River miles are approximations; see Figure 1.

** Dredging schedule: 1 = yearly; 2 = every other year; 3 = every third year.

APPENDIX A: SUMMARY DATA

Table A1

Summary Data for Live Molluscs, Collected by SCUBA Diving and by Hand
in Shallow Water, 27-30 October 1986

Site	River Mile	Bank*	Replicate	Method**	No. of Species	No. of Individuals	Notes
1	254.6	R(25)†	1	D(15)†	--	--	Sand, gravel
1	254.65	R(20)	2	D(15)	--	--	Sand, gravel
1	254.4	R(25)	3	D(20)	1	1	Mud (6-10 cm) over sand
2	254.2	R(50)	1	D(15)	3	3	Mud, gravel
3	253.0	R(25)	1	D(15)	--	--	Gravel, few dead shells
4	250.6	R(15)	1	D(15)	1	1	Sand, gravel
4	250.7	L(25)	2	D(15)	--	--	Gravel from dredge
4	250.7	C(100)	3	D(10)	--	--	Gravel, few shells
4	250.7	R(75)	4	D(10)	--	--	Gravel
4	250.8	L(25)	5	D(10)	--	--	Sand, mud, no shells
4	250.6	L	1	HC	9	24	Gravel from dredge
5	248.6	R(20)	1	D(15)	1	1	Mud, gravel
5	248.6	R(30)	2	D(30)	7	21	Gravel
6	245.7	C(100)	1	D(13)	--	--	Sand
6	246.0	R(20)	2	D(14)	--	--	Sand
7	244.3	L(50)	1	D(15)	--	--	Sand
8	242.8	R(75)	1	D(9)	--	--	Sand
8	242.8	R(50)	2	D(10)	--	--	Sand
8	241.9	R(20)	3	D(6)	--	--	Gravel from dredge
8	242.9	L(20)	4	D(15)	6	19	Mud
8	243.1	L(40)	5	D(15)	--	--	Mud
8	243.1	L	1	HC	6	7	Mud
9	239.8	L(35)	1	D(15)	1	1	Sand, gravel
9	240.0	R	1	HC	1	1	Gravel from dredge
10	239.0	R(50)	1	D(3)	--	--	Clay
10	239.1	R(20)	2	D(5)	--	--	Clay
11	236.0	L(15)	1	D(19)	8	27	Gravel
11	236.0	L(15)	2	D(15)	8	13	Gravel
11	236.0	R	1	HC	2	3	Gravel from dredge
12	230.7	L(30)	1	D(15)	7	34	Gravel
12	230.7	L(20)	2	D(20)	7	33	Gravel
12	230.7	R	1	HC	2	3	Gravel from dredge

* R = Right bank; L = Left bank; C = Center.

** D = Diver collected; HC = Hand collected.

† Numbers in parentheses refer to distance from bank in feet.

Table A2

Summary Data by Site for Shells Collected on Shore or in Shallow Water
by Hand 27-30 October 1986 (X = Present)

Species	Site												Total Sites
	1	2	3	4	5	6	7	8	9	10	11	12	
<i>Actinonaias ligamentina</i>	X	X	--	--	X	--	--	--	--	X	X	X	6
<i>Amblema plicata</i>	X	X	X	X	X	X	--	X	X	X	X	X	11
<i>Anodonata grandis</i> <i>grandis</i>	--	--	--	--	--	--	--	X	--	--	--	--	1
<i>Cyprogenia aberti</i>	X	X	X	X	--	X	--	X	--	--	X	--	7
<i>Elliptio dilatata</i>	--	--	--	--	--	--	--	--	--	X	X	X	3
<i>Ellipsaria lineolata</i>	X	X	X	X	X	X	X	X	X	X	X	X	12
<i>Fusconaia ebena</i>	X	X	X	X	X	X	X	X	X	X	X	X	12
<i>Fusconaia flava</i>	X	X	--	X	X	--	--	X	--	X	--	X	7
<i>Lampsilis orbiculata</i>	X	X	X	X	--	X	--	X	--	X	X	--	8
<i>Lampsilis teres</i>	X	X	X	--	X	--	--	X	--	X	X	X	8
<i>Lampsilis ventricosa</i>	X	--	--	X	--	X	X	X	--	X	X	X	8
<i>Lasmigona complanata</i>	X	--	--	--	--	--	--	--	--	--	X	--	2
<i>Leptodea fragilis</i>	X	--	X	X	X	X	X	X	X	X	X	--	10
<i>Ligumia recta</i>	X	X	X	X	--	--	X	X	--	--	X	--	7
<i>Megalonaias gigantea</i>	X	--	--	--	--	--	--	X	--	X	X	--	4
<i>Obliquaria reflexa</i>	X	X	X	X	X	X	--	X	X	X	X	X	11
<i>Obovaria olivaria</i>	X	X	X	X	X	--	--	--	X	X	X	--	8
<i>Plectomerus dombeyanus</i>	X	X	X	X	X	--	X	X	--	X	X	X	10
<i>Pleurobema cordatum</i>	X	--	X	--	X	--	--	--	--	X	X	X	6
<i>Pleurobema pyramidatum</i>	--	X	--	--	--	--	--	--	--	--	X	--	2
<i>Potamilus laevissima</i>	--	--	--	--	--	--	--	--	--	X	--	--	1
<i>Potamilus purpuratus</i>	X	X	--	X	X	X	X	X	--	X	X	X	10
<i>Ptychobranchnus</i> <i>occidentalis</i>	--	--	--	--	--	--	--	X	--	--	--	--	1
<i>Quadrula cylindrica</i>	X	X	--	X	--	X	--	X	X	X	X	X	9
<i>Quadrula metanevra</i>	X	X	X	X	X	X	--	X	X	X	X	--	10
<i>Quadrula nodulata</i>	X	--	--	--	X	X	X	X	X	--	X	X	8
<i>Quadrula pustulosa</i>	X	X	X	X	X	X	X	X	X	X	X	X	12
<i>Quadrula quadrula</i>	X	X	--	--	X	X	--	X	X	X	X	--	8
<i>Tritogonia verrucosa</i>	X	X	X	X	X	X	X	X	--	--	X	X	10
<i>Truncilla truncata</i>	X	X	--	X	X	X	--	X	--	--	X	X	8
<i>Corbicula fluminea</i>	--	--	--	--	--	--	X	X	X	--	--	--	3
Total species	25	20	15	18	18	16	11	24	12	21	26	17	

NOTE: This table represents fresh shells and relicts. Live specimens (Tables A1 and A3) were found as relicts and fresh shells. With the exception of several fresh *L. orbiculata* collected at river mile 236.2, species not found alive were represented by relict shells.

Table A3

Live Molluscs Collected by SCUBA or by Hand in Shallow Water
27-30 October 1986

Species	Site												Total Sites	Total Individuals	Percent		
	1	2	4	5	8	9	11	12									
<i>Actinonaias ligamentina</i>	1																
<i>Amblema plicata</i>				4													3.12
<i>Anodonata grandis grandis</i>					1												0.52
<i>Cyprogenia aberti</i>																	0.52
<i>Elliptio dilatata</i>																	
<i>Ellipsaria lineolata</i>					8												9.89
<i>Fusconaias ebena</i>			1		1												22.39
<i>Fusconaias flava</i>					1												2.60
<i>Lampsilis orbiculata</i>																	
<i>Lampsilis teres</i>			1														0.52
<i>Lampsilis ventricosa</i>			5														3.64
<i>Lasmigona complanata</i>		1			1												1.04
<i>Leptodea fragilis</i>			1														0.52
<i>Ligumia recta</i>																	
<i>Megalonaias gigantea</i>				1													2.08
<i>Obliaquaria reflexa</i>		1	1	4	2												5.21
<i>Obovaria olivaria</i>			12	2													7.29
<i>Plectomerus dombeyanus</i>																	1.04
<i>Pleurobema cordatum</i>				1	1												1.04
<i>Pleurobema pyramidatum</i>																	
<i>Potamilius laevis</i>	1																0.52
<i>Potamilius purpuratus</i>			1		1												1.56
<i>Ptychobranchius occidentalis</i>																	
<i>Quadrula cylindrica</i>																	
<i>Quadrula metanevra</i>																	2.66
<i>Quadrula nodulata</i>					1												1.04
<i>Quadrula pustulosa</i>		1	1	9	9												26.04
<i>Quadrula quadrula</i>			1	1													5.21
<i>Tritogonia verrucosa</i>			1														0.52

(Continued)

Table A3 (Concluded)

Species	Site												Total Sites	Total Individuals	Percent
	1	2	4	5	8	9	11	12							
<i>Truncilla truncata</i>	--	--	--	--	--	--	--	1	1	--	--	--	1	1	0.52
<i>Corbicula fluminea</i>	--	--	--	--	--	--	--	--	--	--	--	--	1	1	0.52
Total species	1	3	10	7	10	2	13	10				24			
Total individuals	1	3	25	22	26	2	43	70				192			

Table A4

Summary Data by Site for Molluscs Collected in 0.25-sq-m Quadrats,
Using SCUBA Divers, at River Mile 236, 31 October 1986

Species	Site						Total Individuals	Percent
	1	2	3	4	5	6		
<i>Ellipsaria lineolata</i>	--	7	2	2	1	--	12	37.5
<i>Fusconaia ebena</i>	1	--	--	--	1	--	2	6.2
<i>Leptodea fragilis</i>	--	1	--	1	--	--	2	6.2
<i>Obliquaria reflexa</i>	--	--	1	1	--	1	3	9.4
<i>Potamilus purpuratus</i>	--	1	--	--	--	--	1	3.1
<i>Quadrula pustulosa</i>	1	1	1	7	--	--	10	31.2
<i>Quadrula quadrula</i>	--	--	1	--	--	--	1	3.1
<i>Tritogonia verrucosa</i>	--	1	--	--	--	--	1	3.1
Total species	2	5	4	4	2	1		
Total individuals	2	11	5	11	2	1		
No./sq m	8	44	20	44	8	4		

Table A5

Summary Data for Molluscs Collected With A Brail by Mr. Robert Leisure,
River Mile 236, 30 October 1986

Species	Collection		Total Individuals	Percent	Minimum Length, mm
	1	2			
<i>Amblema plicata</i>	1	--	1	2.7	114.2
<i>Ellipsaria lineolata</i>	7	2	9	24.3	67.9
<i>Fusconaiia ebena</i>	--	1	1	2.7	80.8
<i>Lampsilis ventricosa</i>	1	1	2	5.4	21.0
<i>Obliquaria reflexa</i>	6	--	6	16.2	46.5
<i>Obovaria olivaria</i>	5	4	9	24.3	40.7
<i>Quadrula cylindrica</i>	1	--	1	2.7	59.2
<i>Quadrula pustulosa</i>	4	2	6	16.2	60.0
<i>Quadrula quadrula</i>	2	--	2	5.4	67.5
Total species	8	5			
Total individuals	27	10			

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