AN EVALUATION OF THE MUSSEL COMMUNITY IN THE LOWER OUACHITA RIVER

WILLIAM R. POSEY II
ARKANSAS DEPARTMENT OF POLLUTION CONTROL AND ECOLOGY

JOHN L. HARRIS
ARKANSAS HIGHWAY AND TRANSPORTATION DEPARTMENT

GEORGE L. HARP
ARKANSAS STATE UNIVERSITY

AUGUST 1996

INTRODUCTION

In 1990, a multi-discipline work group was formed to determine the cause (s) for the decline of fishes in the Lower Ouachita River. It became apparent that traditional fisheries management efforts would not suffice in improving a fisheries with so many known anthropogenic factors. The Lower Ouachita River Work Group (LORWG) determined that more data were needed to determine the actual cause(s) for the decline in the fisheries of the lower Ouachita. From that point, different disciplines began working to characterize abiotic and biotic factors affecting the Ouachita River Fisheries.

The Ouachita River originates in west central Arkansas along the northern slope of the Ouachita Mountains. It flows southeast approximately 136 air km before turning south to flow through Louisiana. Of the 816 Ouachita River km, 462 are found in Arkansas. The river drains 17,411 km^2 of the Ouachita Mountain and Gulf Coastal Plain Ecoregions in Arkansas (USGS, 1970). The elevation ranges from 492 m mean sea level (msl) in the headwaters to 15.2 m msl at the mouth near Jonesville, La., with the greatest gradient occurring upstream of Malvern, Ark. Near Malvern, the river leaves the Ouachita Mountain Ecoregion, after flowing over rocks of the Paleozoic age, and enters the Gulf Coastal Plain to flow over the less resistant rock of the Cretaceous and Tertiary age

(ADPCE, 1979).

A series of navigational structures are operated in the Ouachita River by the U.S. Army Corps of Engineers. These structures provide a 3 m X 30 m navigational channel from the Red River in southern Louisiana upstream to Camden, Ark. The uppermost structure, H.K. Thatcher Lock and Dam, occurs near Calion, Ark. (RM 281). This dam provides a 4.0 m lift and is maintained upstream to Camden, Ark. The lowest structure occurring in Arkansas, Felsenthal Lock and Dam, is located approximately 8.3 river km upstream from Louisiana. This structure provides a 6.0 m lift for 104 river km upstream to H.K. Thatcher Lock and Dam as well as provides a 1.6 m fish and wildlife pool used to manage the 162.5 km^2 Felsenthal National Wildlife Refuge.

The lower Ouachita River is designated as the portion of river extending from Remmel Dam to the Louisiana State Line. This region has been divided into eight segments based on different river characteristics. These segments are:

Segment Number	Location
1	Remmel Dam to Rockport
2	Rockport to Caddo River
3	Caddo River to Little Missouri River
4	Little Missouri River to Camden
5	Camden, Ark. to Smackover Creek
6	Smackover Creek to Felsenthal Pool
7	Felsenthal Pool
8	Felsenthal Dam to Louisiana Line

Data for this report are from segments 4-8.

METHODS AND MATERIALS

FIELD METHODS

Suitable mussel habitats were searched in the field using a surface based, oil-less air compressor. Air was supplied to the diver via a hose attached to a regulator. All field equipment and personnel were transported in a 4.88 m boat powered by a 25 h.p. outboard motor.

Mussel searches were conducted by a diver who would descend to the river bottom and feel for mussels in the substrate while moving downstream. When an estimated average density of 10 mussels/m^2 or higher was encountered, a curvature bobber was released to the surface. The diver would then search laterally across the area until the number of individuals ceased to average 10 mussels/m^2. At this point a second bobber was released and the two bobbers marked the width of the mussel bed at this point. The diver returned to the surface to report substrate, species composition and average densities. Locations of searches were marked on a reproduced 7.5 minute topographic map. Water depth (determined by a Hummingbird™ Depth Finder),river structure (bend, straight or meander), and information from the diver were recorded. This process was continued downstream at 50 m

intervals until the densities ceased to average 10 mussels/m^2. The length of a bed was measured by a standardized range finder.

After the initial investigation was completed, the area was categorized and sampled using three methods. Qualitative notes on species composition, relative species abundance and estimated densities were taken in areas with less than 10 mussels/m^2. Only qualitative data were taken at these sites.

The second level of sampling intensity was for beds containing densities of 10 mussels/m^2 or more but inhabiting an area of more than 100 m^2 but less than 500 m^2 (mbeds). Five m^2 quadrats were collected non-randomly from the areas of greatest bivalve density in the bed.

The greatest level of sampling intensity was for beds containing densities of 10 mussels/m^2 or greater and with an area larger than 500 m^2 (Mbeds). Sample sizes for beds were determined based on bed area. Ten quadrats were taken for beds of 500-999 m^2, and 25 quadrats were collected for beds of 2500 m^2 or greater. Beds with areas between 1000 m^2 and 2500 m^2 were sampled by taking a one percent subsample of the area. If appropriate, the bed was stratified by depth, substrate or river structure (bendway or straightway). Random numbers were utilized to select Mbed sample sites, and the number of samples collected reflected the proportion of the stratum size. A minimum of two quadrats was collected from each stratum.

Divers collected mussels within a 1 m^2 quadrat delineated by 2.5 cm PVC pipe. All mussels within the quadrat were removed from the substrate and placed into a collecting bag to be transported to the surface. On the surface, mussels were identified, measured for length, width and/or depth in millimeters by vernier calipers and mass was recorded in grams using an electronic balance. The measured axis reflected the "legal dimension" for a particular mussel species. Legal dimensions for Arkansas Mussels are listed in Table 1. After measurement, all mussels were returned to the substrate. All endangered species were individually replaced in the substrate in life position. Data were recorded on data sheets and entered into a Lotus 123™ spreadsheet.

STATISTICAL TREATMENT

Summary statistics were calculated on collected data in a program developed in a Lotus 123™ spreadsheet. Total individuals, minimum, maximum and mean density, variance and standard deviation were calculated for each species in each bed.

Population and community estimates were calculated according to Sampford (1962), which is summarized below. The total number of mussels is:

$$[1] \quad X = \sum_{o}^{i} y_i * g_i$$

where X is the total number of mussels in a bed, i is the number of strata, y_i is the sample total (total number of organisms encountered in all the n_i sampling units) and g_i is the raising factor ($g_i = 1/f_i$, where f_i is the fraction sampled, and is defined by n_i/N_i with n_i being the number of sampling units counted in the ith stratum, and N_i the total potential number of sampling units in the ith stratum).t for the effective degrees of freedom.

The 95% confidence interval (CI) around the total number of mussels in the bed is given by:

$$[2] \quad X \pm \left(t * \sqrt{\sum_{0}^{i} N_i^2 * S^2 y_i * \frac{1-f_i}{n_i}} \right)$$

where S^2_{yi} is the sample variance computed from raw counts in the n_i sampling units in the ith stratum, and t is the Student's Research originally began in October 1992 and was finally completed in September 1995. A total of 236 person days were required to complete the Ouachita River Mussel Survey.

Table 1. Legal dimensions for commercial species in mm as directed by the Arkansas Game and Fish Commission in Arkansas and parameters measured for all species. Equivalent inch measurements are shown parenthetically.

Species	Parameter	Minimum legal size
Actinonaias ligamentina	length	101.6 (4.00)
Amblema plicata	depth	69.85 (2.75)
Arcidens confragosus	length	NC
Ellipsaria lineolata	depth	63.5 (2.50)
Elliptio dilatata	length	101.6 (4.00)
Fusconaia ebena	depth	63.5 (2.50)
Fusconaia flava	depth	63.5 (2.50)
Lampsilis abrupta	length	
	depth	ES
	width	
Lampsilis cardium	length	NC
Lampsilis teres	length	101.6 (4.00)
Lasmigona costata	length	NC
Leptodea fragilis	length	NC
Megalonaias nervosa	depth	95.25 (3.75)
Obliquaria reflexa	depth	63.5 (2.50)
Plectomerus dombeyanus	length	101.6 (4.00)
Pleurobema pyramidatum	depth	63.5 (2.50)
Pleurobema coccineum	depth	63.5 (2.50)
Potamilus purpuratus	length	101.6 (4.00)
Quadrula pustulosa	depth	63.5 (2.50)
Quadrula quadrula	depth	69.85 (2.75)
Tritogonia verrucosa	length	101.6 (4.00)

NC = no commercial value
ES = Endangered species

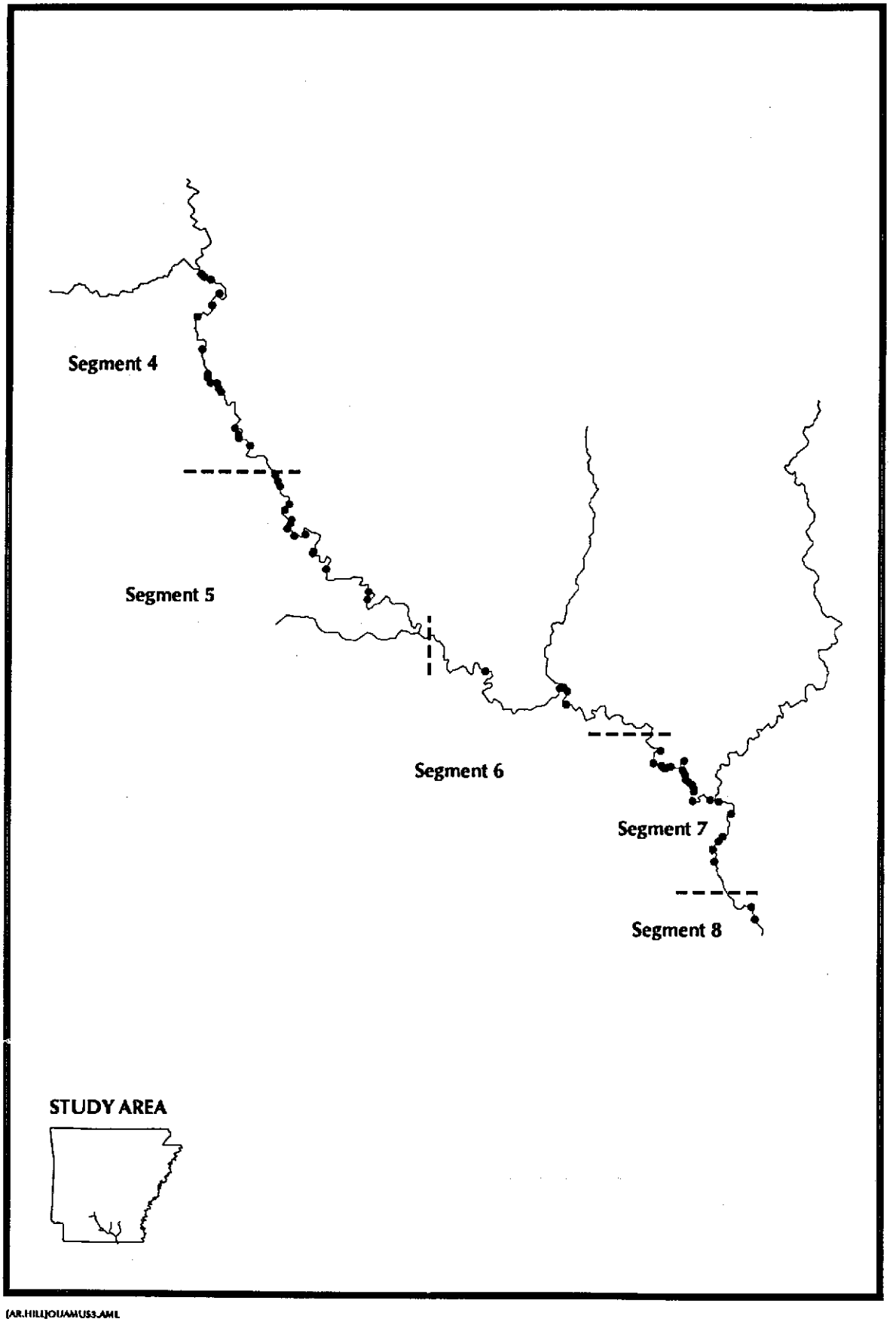
Results and Discussion

A total of 61 mussel beds were located within the lower Ouachita River (Figure 1). Of these, 45 (73.8%) occupied an area larger than 500 m^2 and are designated as major beds (Mbeds). An additional 16 (26.2%) were smaller than 500 m^2 and are designated as minor beds (mbeds).

A total of 847 1 m^2 quadrats were collected yielding 23,465 mussels represented by 36 species (Table 2). Three additional species, (*Cumberlandia monodonta, Toxolasma texasensis and Utterbackia imbecillis*) were encountered during qualitative analysis. Two species collected during the survey were recently identified by Dr. David Stansbery of Ohio State University as *Quadrula apiculata* and the endangered *Quadrula fragosa*. While *Q. apiculata* was recorded for this river by Wheeler (1918) near Arkadelphia, it has not been recorded since. The discovery of *Q. fragosa* is a new state record and a substantial southern range extension.

Amblema plicata was the most abundant taxon in the lower Ouachita River, composed 18.1% of all mussels collected and was present in every bed. *Pleurobema pyramidatum* (16.0%) was the second most abundant species followed by *Fusconaia ebena* (14.1%) *Quadrula pustulosa* (14.1%), and *Fusconaia flava* (10.8%). Of the 41 species collected, *Lasmigona costata, Potamilus ohiensis, Ligumia recta* and the endangered *Arkansia wheeleri* were represented by single individuals.

Figure 1. Location of mussel beds in the Lower Ouachita River



[AR.HILL]OUAMUS3.AML

Table 2. Species collected and frequency of bed occurrence for the Lower Ouachita River mussels.

Species	Minor (16)	Major (45)
Actinonaias ligamentina	7	25
Amblema plicata	16	45
Arcidens confragosus	1	2
Arkansia wheeleri	-	1
Cyprogenia aberti	1	4
Ellipsaria lineolata	7	26
Elliptio dilatata	7	21
Fusconaia ebena	13	45
Fusconaia flava	11	45
Lampsilis abrupta	1	7
Lampsilis cardium	7	42
Lampsilis hydiana	1	9
Lampsilis teres	2	13
Lasmigona costata	-	1
Leptodea fragilis	2	30
Ligumia recta	1	-
Megalonaias nervosa	14	44
Obliquaria reflexa	14	44
Obovaria olivaria	1	12
Plectomerus dombeyanus	13	45
Pleurobema pyramidatum	9	36
Potamilus ohiensis	1	-
Potamilus purpuratus	6	39
Ptychobranchus occidentalis	2	13
Pyganodon grandis	1	2
Quadrula cylindrica	1	5
Quadrula metanevra	5	24
Quadrula nodulata	4	23
Quadrula pustulosa	6	45
Quadrula Quadrula	10	42
Strophitus undulatus	5	17
Tritogonia verrucosa	7	42
Truncilla donaciformis	1	18
Truncilla truncata	10	33
Total Species	32	33
Total species by river	36	

( ) = Number defined by beds.

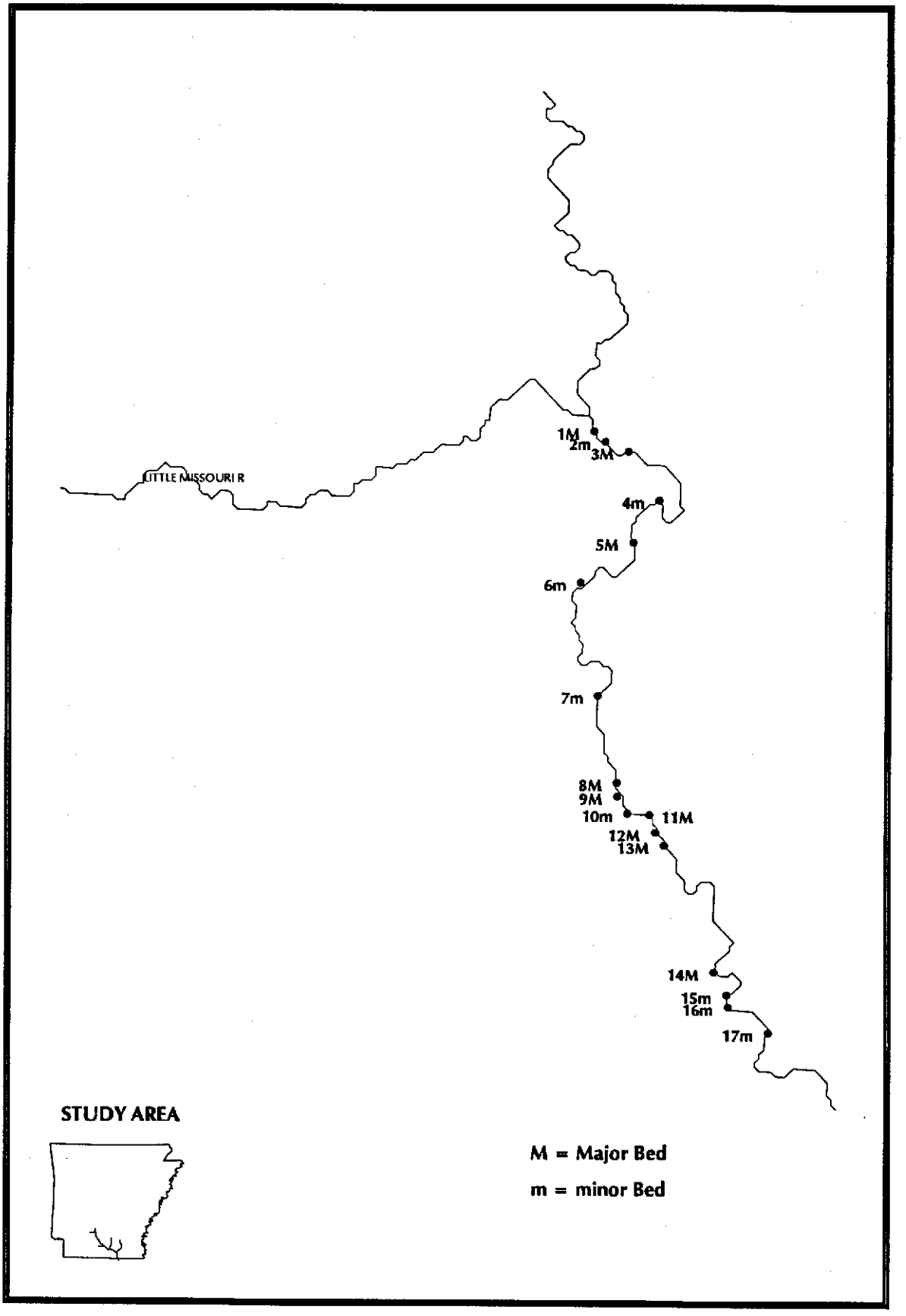
Major Beds

Quadrat sampling ... sels representing 35 species from 847 m^2 qu... ities for Mbeds were 6.0-67.6 mussels/m^2 w... ean density of 25.3 mussels/m^2. *Amblema p...* ally dominant within Mbeds comprising 17.... s collected. This dominance was slightly... than for all beds. *Pleurobema pyramidatum* ... ost abundant species and composed 16.1% o... llected in Mbeds. Following in dominanc... bena and *Quadrula pustulosa*. Bed areas ...,000 m^2 and occupied a variety of substr... gravel to sand and gravel.

Minor Beds

A total of 2,00... ting 32 species was collected from 80 m^2 qu... ities for mbeds were 10.2 - 75.6 mussels/m^2 ... n of 25.1 mussels/m^2. The greatest density ... ndividual sample was 155.0 mussels/m^2. Age... rta was found to be numerically dominan... % of all mussels collected. Also am... robema *pyramidatum*, *Fusconaia flava* and F... , 10.4%, and 10.0%, respectively. Bed areas ...0 m^2 with substrates

Figure 2. Location for mussel beds in Segment 4.



[AR.HILL]OUAMUSSA.AML

substrates similar to Mbeds.

Segment 4

Seventeen beds were delineated from Segment 4 (Figure 2). A total of 4,835 mussels representing 31 species was collected from 185 m^2 quadrats.

Major Beds

Eleven Mbeds were located and sampled within this segment. A total of 3,950 mussels representing 31 species were collected from 155 m^2 quadrats. Species numbers ranged from 17-31 species/bed. Bed areas ranged from 600-6375 m^2 with a mean of 1841 m^2. Mean densities were 16.2-36.8 mussels/m^2 with an overall mean density of 25.5 mussels/m^2. *Pleurobema pyramidatum* numerically dominated 16 of 17 beds and composed 32.8% of all mussels collected within Segment 4. *Quadrula pustulosa* was second most abundant followed by *Fusconaia flava* and *Amblema plicata* at 14.4%, 14.2% and 7.1%, respectively. *Quadrula pustulosa* was also numerically dominant in one bed found in Segment 4.

Minor Beds

Six mbeds were located within this segment. A total of 885 individuals representing 26 species were collected from 30 m^2 quadrats. The number of species per bed ranged from 9-17 and five of these species were represented by single individuals. Bed densities for individual quadrats ranged from 4.0/m^2 to 52.0/m^2 with an overall mean density of 29.5

mussels/m^2. Bed areas ranged from 210-480 m^2 with an overall mean of 317 m^2.

Again, *Pleurobema pyramidatum* numerically dominated all mussels encountered. It was the most abundant species in all six mbeds and comprised 33.9% of all mussels collected from mbeds in Segment 4. *Fusconaia flava* (20.3%) was second most abundant followed by *Quadrula pustulosa* (8.8%) and *Fusconaia ebena* (7.3%).

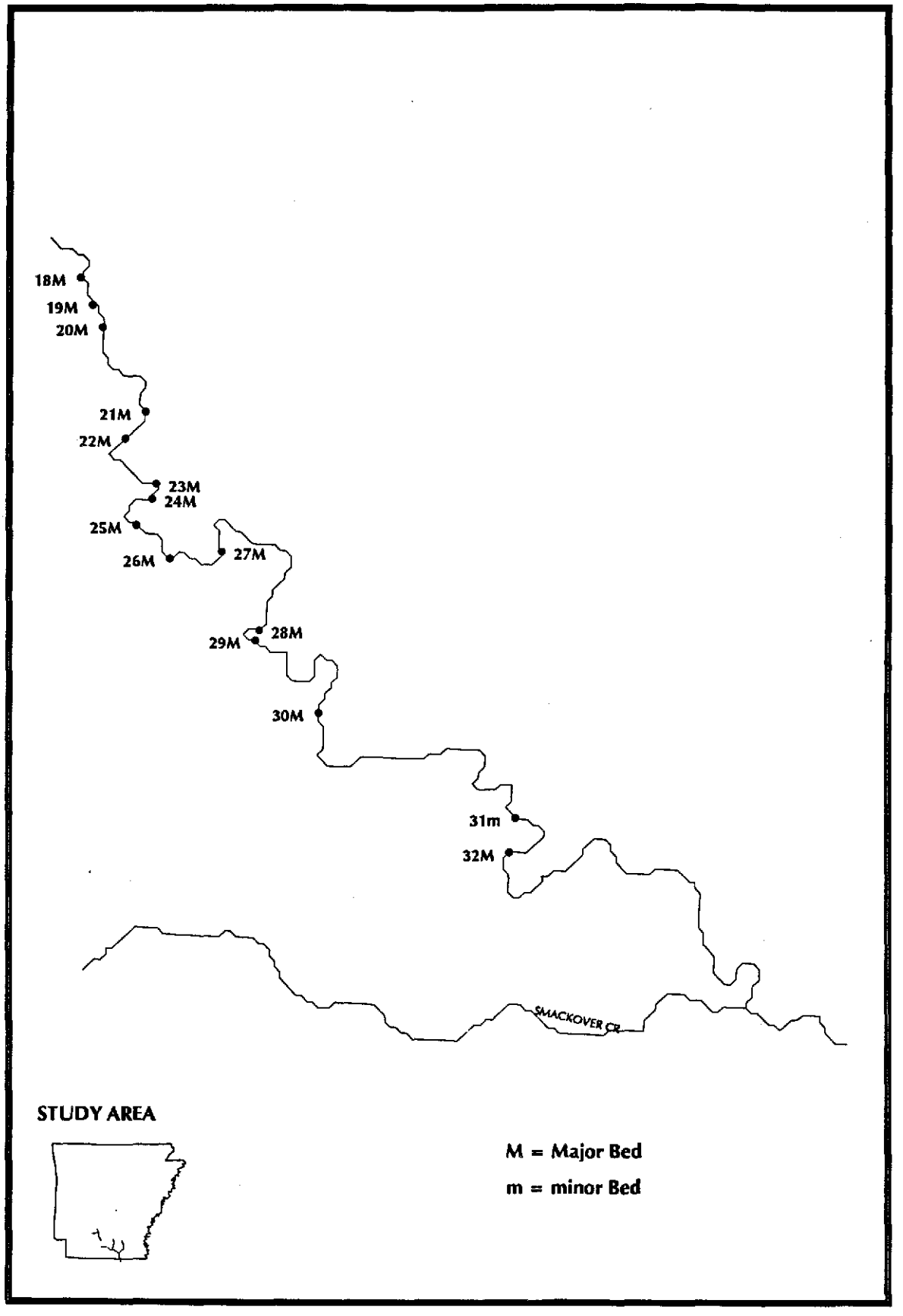
Segment 5

A total of 15 beds were located within Segment 5 (Figure 3). Quadrat sampling yielded 8210 mussels from 322 m^2 quadrats and an overall mean density of 25.5 mussels/m^2. A total of 30 species were found within Segment 5.

Major Beds

Fourteen Mbeds were located within Segment 5. Quadrat sampling yielded 8147 mussels from 317 quadrats with an overall mean density of 25.7 mussels/m2. Mean densities ranged from 11.2 - 52.9 mussels/m^2. Thirty species of mussels were found in Segment 5 and three of these species were represented by single individuals. Bed areas ranged from 1200-11,000 m^2 with an overall mean area of 4143 m^2. Ten beds (71.4%) were larger than 2500 m^2, and five (35.7%) were larger than 5000 m^2.

Figure 3. Location of mussel beds in Segment 5.



As in the previous segment, *Pleurobema pyramidatum* was numerically dominant and comprised 26.1% of all mussels collected. This species was the most abundant species in 64.2% of the major beds. Other numerically abundant species included *Fusconaia flava* (15.0%), *Quadrula pustulosa* (14.4%), and *Amblema plicata* (7.1%).

Minor Beds

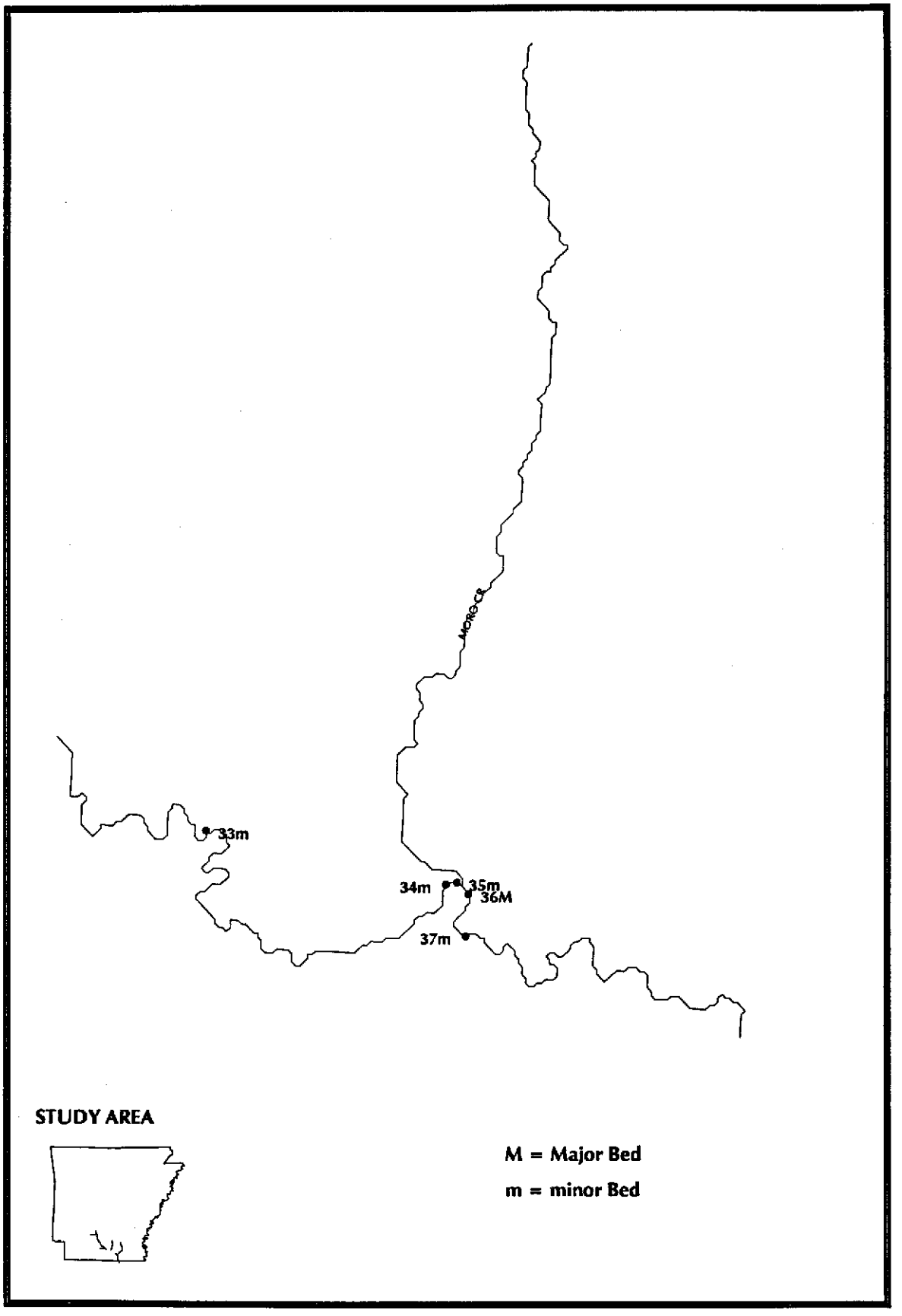
A single mbed was located in Segment 5. A total of 63 mussels representing 10 species were collected from 5.0 m^2 quadrats. The mean density was 12.6 mussels/m^2 and the bed area was 200 m^2.

Quadrula Quadrula was the most abundant species in this bed and made up 33.3% of all mussels collected. Also numerically significant were *Megalonaias nervosa* and *Quadrula pustulosa* comprising 15.9% each.

Segment 6

A total of five beds were delineated and sampled in this segment (Figure 4). Quadrat sampling yielded 1377 mussels from 45 m^2 quadrats. Twenty-five species were collected from this region and six of these species were represented by single individuals. The mean density for the region was 30.6 mussels/m^2.

Figure 4. Location of mussel beds in Segment 6



Major Beds

One Mbed was delineated and sampled in Segment 6. Twenty-five quadrats yielded 956 mussels from the 3750 m^2 bed. The range of densities was 14.0-93.0 mussels/m^2 and the mean density was 38.2 mussels/m^2. Twenty-five species were identified from this bed and one of these, *Elliptio dilatata* was represented by one individual.

Amblema plicata comprised 34.6% of all mussels collected, followed closely by *Fusconaia ebena* at 31.3%. *Plectomerus dombeyanus* was also abundant at 13.1% and was followed by *Quadrula pustulosa* at 7.4%.

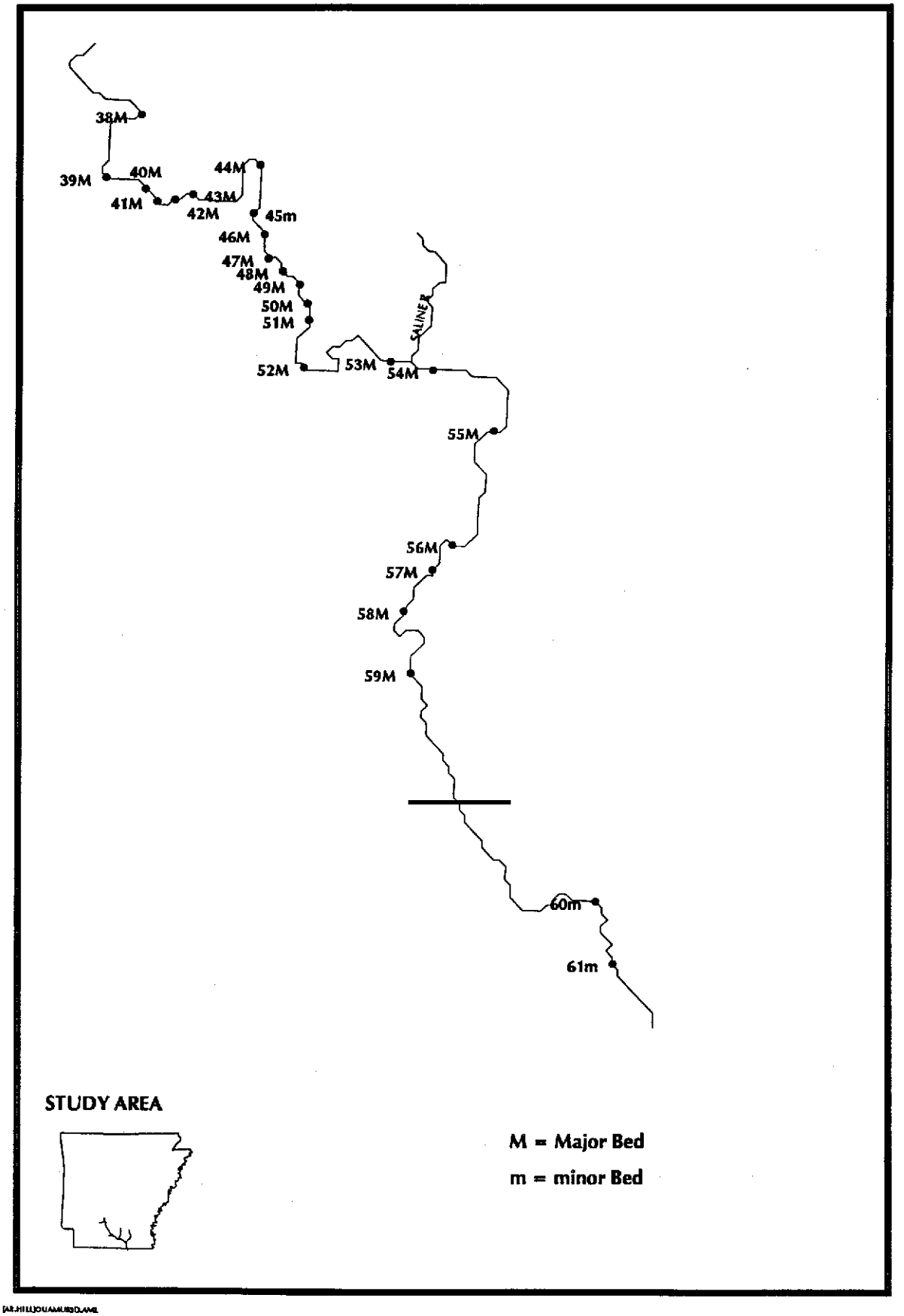
Minor Beds

Four mbeds were delineated and sampled in Segment 6. Twenty quadrats yielded 421 individuals with an overall mean of 21.05 mussels/m^2. Eighteen species were found within minor beds in Segment 6. *Amblema plicata* numerically dominated all beds, and comprised 48.5% of mussels collected. *Quadrula Quadrula* and *Quadrula pustulosa* were also abundant at 13.7% and 13.1%, respectively.

Segment 7

Segment 7 had the most major and minor beds of all segments with 22 beds in the 44.8 river km segment (Figure 5). A total of 8,756 mussels was collected from 361 quadrats yielding an overall mean of 24.3 mussels/m^2. Twenty-four

Figure 5. Location of mussel beds in Segments 7 & 8.



species were collected from Segment 7 with five species represented by single individuals.

Major Beds

Twenty Mbeds were delineated and sampled in Segment 7. Bed areas ranged from 800-6950 m^2 with an overall mean of 2498 m2. A total of 351 quadrats yielded 8318 mussels and mean bed densities ranged from 15.2-40.0 mussels/m^2. The overall mean density for Segment 7 was 23.7 mussels/m^2. Twenty-four species were present in this segment, and each species was represented by two or more individuals. *Amblema plicata* comprised 29.7% of mussels collected and was most abundant in 14 of 20 Mbeds. *Fusconaia ebena* was also abundant totaling 21.4% of all mussels collected, and was numerically dominant in four of 20 beds. *Quadrula pustulosa* numerically dominated one Mbed and was third most abundant overall at 15.7%. Following *Q. pustulosa* was *Fusconaia flava* comprising 5.9% of all mussels collected.

Minor Beds

Two mbeds were located within Segment 7 and areas were 300 m^2 and 375 m^2. A total of 18 species was collected from 10 quadrats which yielded 438 mussels. Mean densities were 26.5 and 75.6 mussels/m^2 with an overall mean of 43.8 mussels/m^2. Again, *Amblema plicata* was numerically dominant with 40.9% of all mussels collected and was numerically most abundant in one bed. *Fusconaia ebena* was second most abundant

overall at 25.8%, and *Quadrula pustulosa* was third most abundant at 9.4% and numerically dominated one mbed.

Segment 8

No major beds and two minor beds were delineated in this segment (Figure 5). Bed areas were 400 m^2 for each bed. A total of eight species were collected from the 10 quadrat samples from which 181 mussels were collected. The overall mean for this region was 18.1 mussels/m^2. *Amblema plicata* clearly dominated all species in this region at 84.5% of all mussels collected and was the most abundant species in both beds. *Fusconaia ebena* and *Quadrula pustulosa* were the second most abundant species and comprised 3.9% each.

Discussion

Segment 4 was the most speciose of the all segments surveyed as well as second most prominent in number of beds in the Lower Ouachita River (Table 3). This is probably a result of no channelization practices in the river channel which leaves riffle-pool complexes intact. These complexes allow for a greater diversity of substrate particle size as well as diverse current velocities.

Segment 5 had the highest estimated total community numerical standing crop (CNSC) as well as the highest mean CNSC. The CNSC ranged from 24,098 to 223,154 mussels/bed with a mean of 109,260 mussels/bed. The greatest CNSC occurred in the upper portion of Segment 5 where *Pleurobema pyramidatum* numerically dominated all species, and the CNSC gradually decreased near the end of the segment where *P. pyramidatum* was less dominant (Table 4). This species was almost non-existent in the lower three segments. The author feels that since it occurs in large numbers in the upper segments where flow is good, that current velocity may play a role in the presence or absence of this species.

Segment 6 contained one major bed and four minor beds. The substrate in this region consisted mainly of sand or a thick layer of silt over sand. These substrates are not suitable for mussel bed establishment.

Segment 7, the Felsenthal Pool, contained the most major

Table 3. Selected characteristics of Segments 4-8, Lower Ouachita River.

Segment #	Length (km)	Mbeds	mbeds	Gradient (m/km)	# Species	Mean Depth (m)*	Mean Density (mussels/m^2)
4	51.2	11	6	0.2	31	3	26.1
5	73.3	14	1	0.04	30	4	25.5
6	70.7	1	4	0.06	22	6	30.6
7	44.5	20	2	0.07	26	8	24.3
8	7.8	0	2	<0.01	8	7	18.1

* = estimated averages

Table 4. Species contributing greater than 10% of the total community composition in Ouachita River Segments. Upper number is specimens collected with percent of total in parentheses.

Segment	4	5	6	7	8
Amblema plicata	X	X	535 (39.3)	2646 (30.2)	153 (84.5)
Fusconaia flava	858 (14.9)	1224 (14.9)	X	X	X
Fusconaia ebena	X	932 (11.4)	307 (22.6)	1894 (21.6)	X
Plectomerus dombeyanus	X	X	146 (10.7)	X	X
Pleurobema pyramidatum	1932 (33.5)	2125 (25.9)	X	X	X
Quadrula pustulosa	709 (12.3)	1183 (14.4)	X	1318 (15.1)	X
Total	5775	8210	1360	8756	181

beds. The upper portion of this segment is relatively isolated and relatively deep. Due to the depth, this segment would not need to be dredged as often as upstream segments. Therefore, the probability of a bed being dredged or covered by spoil is less likely. The number of species/bed was lower than for Segment 4 where the next most dense segment for major beds occurred.

Segment 8 had no major beds and only two minor beds. The author feels that the impoundment above the segment allows much of the transported organic materials to settle out. Also, there is little flow and the species found in this segment are generalists that occupy many types of flow and substrates (Oesch, 1984).

CONCLUSIONS

The mussels of the lower Ouachita River do not seem to be impacted when compared to other rivers in the state. Portions of the Black (Rust, 1993) and White Rivers (Christian, 1995) have been surveyed using similar techniques. These rivers each have a larger watershed than the Ouachita River but densities, species composition, and community estimates are lower than those found in the Ouachita River.

Literature Cited

Arkansas Deptartment of Pollution Control and Ecology. 1979. Section 303(c) Basin Plan (Ouachita River Basin) 563 pp.

Christian, A.D. 1995. Analysis of the commercial mussel beds in the Cache and White Rivers in Arkansas. Unpubl. M.S. Thesis. Arkansas State University, State University, AR. 197 pp.

Oesch, R.D. 1984. Missouri naiades, a guide to the mussels of Missouri. Missouri Department of Conservation, Jefferson City. 270 pp.

Rust, P.J. 1993. Analysis of the commercial mussel beds in the Black, Spring, Strawberry and Current Rivers in Arkansas.Unpubl. M.S. thesis, Arkansas State University, State University, AR. 125 pp.

Sampford, M.R. 1962. An introduction to sampling theory with applications to agriculture. Oliver & Boyd Ltd., Edinburgh.

U.S.G.S. 1979. Drainage areas of streams in Arkansas. Ouachita River Basin. United States Geological Survey. 87 pp.

Wheeler, H.W. 1918. The Mollusca of Clark County, Arkansas. Nautilus. 31:109-125.