Journal of the Arkansas Academy of Science

Volume 47 Article 13

1993

Distribution and Population Structure of Freshwater Mussels (Unionidae) in Lake Chicot, Arkansas

John L. Harris
Arkansas State University, omibob1@gmail.com

Peter J. Rust
Arkansas State University

Stephen W. Chordas III
Arkansas State University

George L. Harp
Arkansas State University

Distribution and Population Structure of Freshwater Mussels (Unionidae) in Lake Chicot, Arkansas

John L. Harris, Pete Rust, Steven W. Chordas, III, and George L. Harp
Department of Biological Sciences
Arkansas State University
State University, AR 72467

Abstract

A systematic survey of mussel concentrations (= beds) in Lake Chicot was conducted during June 10-15, 1991. The lake was divided into 58 relatively equal-sized quadrats for qualitative survey by two, 2-man teams using Hookah dive systems. A qualitative survey revealed a single mussel bed encompassing an area approximately 12 km long and four m wide. For population analysis, the bed was sub-divided into five strata encompassing 9600 m² each. Twenty random, 4 x 1 m, quantitative samples were taken from each of the five strata. Four mussel taxa; *Amblema plicata* (threeridge), *Quadrula quadrula* (mapleleaf) *Quadrula nodulata* (wartyback), and *Plectomerus dombeyanus* (bankclimber), accounted for 99.6% of the specimens sampled. The total mussel population for the bed was estimated to be 59,304 ± 8,392. Potential for commercial harvest of Lake Chicot mussel resources is minimal at this time due to small shell size and poor shell quality.

Introduction

The distribution and taxonomy of Arkansas freshwater mussels has been reviewed by Gordon, et al. (1980) and Gordon (1981), and the biology, general distribution, and commercial utilization of Arkansas mussels has been discussed by Harris and Gordon (1991). Freshwater mussels often occur in dense concentrations, referred to as mussel beds or shell runs, with densities sometimes exceeding 100 individuals/square meter (m²). To date, little effort has been made by the scientific, resource or regulatory communities to define the distribution and population size and structure of mussel beds within an entire lake or river system. This paper is the first of a series addressing the distribution and population structure of mussel beds in the larger rivers, impoundments, and lakes of Arkansas. These surveys will include the Black, Current, Ouachita, Saline, Spring, St. Francis, Strawberry, and White rivers, the Lake Ozark and Lake Dardanelle pools of the Arkansas River, Blue Mountain Lake, and, the subject of this paper, Lake Chicot.

Lake Chicot is located in Chicot County, extreme southeastern Arkansas, and is approximately 32 km north of the Arkansas - Louisiana line (Fig. 1). It is the largest natural lake in Arkansas (19.3 km²), currently approximately 27 km long and approximately 0.8 km wide, and was created more than 600 years ago by meandering of the Mississippi River (Cooper, 1984; Nix and Schiebe, 1984; Cooper and Knight, 1987). The lake originally had excellent water quality and a small drainage area (200 km²) with limited inflow from Connerly Bayou and outflow via Ditch Bayou (Cooper, 1984; Cooper and Knight, 1987). As a natural oxbow, Lake Chicot was subjected to periodic flushing by Mississippi River floodwaters before completion of the mainline Mississippi River levee (McHenry et al., 1984).

Channelization, basin enlargement by the 1927 flood, and construction of the Mississippi River levee enlarged the drainage area entering the lower lake via Connerly Bayou to 932 km² (Cooper, 1984). The increased inflow from the enlarged watershed formed a sand spit which partially isolated the northern part of the lake following the 1927 flood (Cooper, 1984). In 1948 additional materials were added to the sand spit to form a permanent levee which divided the lake into an isolated upper basin (3.9 km²) and a larger flow-through lower basin (15.4 km²) (Cooper and Knight, 1987). Sedimentation rates since 1954 have averaged 1 - 4 cm/yr, depending on location within the lake, and rates have been two to three times greater in the lower lake than in the upper lake (McHenry et al., 1984).

Lake Chicot morphology is typical of a large river bend with a deep thalweg along the outside bendway (Cooper, 1984). The inshore area consists of a sandy littoral zone which drops rapidly to the lake bottom (maximum depth approximately 9.5 m). The littoral zone on the inside bendway has a much more gentle slope, and the substrate is covered by fine silt and muck.

Cooper (1984) conducted a survey of Lake Chicot molluscans from 1977 through 1981 and identified 17 taxa from the system. Cooper concentrated his efforts in the shallower lake reaches and collected by hand grabbing, shallow diving, and raking or dip netting mussels. Deeper portions of Lake Chicot were sampled by Ekman and Peterson dredges.

Materials and Methods

Lake Chicot was subdivided into 58 relatively equal sized quadrats on 7.5 minute topographic maps to facilitate qualitative survey of the mussel fauna. Two, 2-man teams using Hookah dive rigs mounted in separate boats were utilized to search the qualitative quadrats. Qualitative survey methodology consisted of haphazardly exploring all habitat types within a quadrat, collecting vouchers of all mussel species encountered (both live and dead), and recording the location of mussel concentrations within each quadrat. The qualitative quadrat survey defined the size and location of one expansive mussel bed within the lake.

Once the bed was defined, quantitative sampling was initiated to estimate the population numbers for each species and the total mussel population. An attempt was made to stratify beds based on physical habitat variables such as water depth, substrate type, riparian land use (wooded, agricultural, residential) or location relative to geographic variables (e.g., tributary stream inflow, outflow, bendways). Since this bed was uniform in physical structure, it was somewhat arbitrarily divided into five equal sized strata for quantitative sampling (Fig. 1).

Twenty 4 x 1 m random samples were collected from each stratum for a total of 100 4 x 1 m quantitative samples. Sample locations were selected by utilizing a random numbers generator. A 1.0 m^2, weighted quadrat constructed of 2.0 cm diameter PVC pipe was used to define the sample area. The quadrat was placed at the most inshore point within the mussel bed at each sample site and flipped end over end toward mid-lake (generally downslope) until a 4 x 1 m area was sampled.

All mussels encountered by hand searching the quadrat area were bagged and brought to the surface for indentification and enumeration. Underwater visibility was zero at depths greater than 1.0 m. Nomenclature follows Turgeon et al. (1988). Each mussel was measured for either length or depth to the nearest 0.1 mm using dial calipers. Length was measured at the longest point from the anterior to posterior of the mussel. Depth was measured from the umbones to the ventral shell edge. The axis measured was determined by the definition of legal commercial size for a particular species. All specimens were weighed to the nearest 0.1 g with a portable electronic balance.

Voucher specimens were collected for each species and deposited in the Freshwater Mussel Collection of the Arkansas State University Museum of Zoology. Soft parts were preserved by first narcotizing live mussels in a MS 222 solution, then fixing the tissues in 10% formalin solution. Specimens were later soaked in water and transferred to 40% isopropanol for storage.

Summary statistics including mean, minimum, maximum, standard deviation, variance and sum were calculated for each stratum and for the entire data set. All summary statistics were performed using SYSTAT (Wilkinson, 1990).

Quantitative estimates were made using the Sampford method (Huebner et al., 1990) where the total number of mussels (by species or population) is:

$$[1]\quad x = \Sigma y_i \cdot g_i$$

where x is the total number of mussels in the lake, 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 if 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).

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

$$[2]\quad x \pm (t \cdot \sqrt{\Sigma N_i^{\,2} \cdot S^2 y_i \cdot (1-fi / ni)})$$

where S^2y_i is the sample variance computed from raw counts in the n_i sampling units in the ith stratum, and t is the Student's t for the effective degrees of freedom.

The effective degrees of freedom are given by:

$$[3]\quad 1/\Sigma\,(L_i^{2}) / \mathrm{df}$$

where

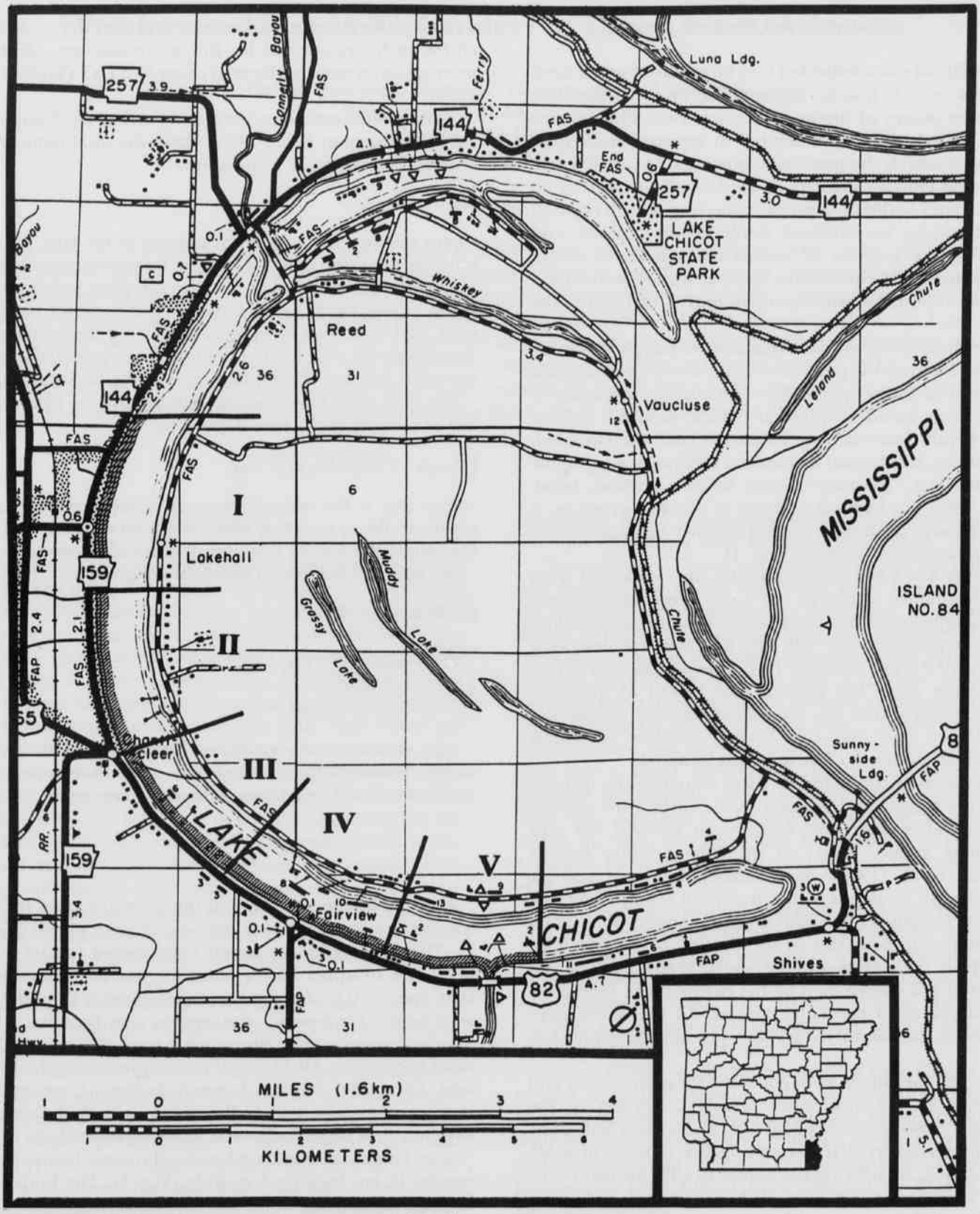
$$Li = \frac{N_i^2 \cdot S^2_{yi} \cdot (1-fi) / ni}{\Sigma N_i^2 \cdot S^2_{yi} \cdot (1-fi) / n_i}$$

Age versus growth estimates, length or depth versus weight relationships and age/size class distribution for each species will be addressed in a separate paper.

Results

A qualitative survey revealed the presence of 14 species within the upper and lower portions of Lake Chicot (Table 1). The upper lake supported very limited mussel numbers. The 14 upper lake qualitative quadrats yielded only four species (*Quadrula quadrula*, mapleleaf; *Q. nodulata*, wartyback; *Plectomerus dombeyanus*, bankclimber; and *Anodonta grandis*, giant floater) in a total of 30 live and 10 dead specimens. All 14 species were present in the lower lake. Three of these taxa, *Lampsilis hydiana* (Louisiana fatmucket), *Lampsilis teres* (yellow sandshell), and *Potamilus ohiensis* (pink papershell) were found as relict shells only.

The lower lake contained a singel mussel bed approximately 12 km long by 4 m wide (Fig. 1). The horizontal and vertical location of the mussel bed is illustrated in Fig. 2. Generally, the bed was located 25 - 35 m from the



I-V = Strata; ▨ = Limits of mussel bed.

Fig. 1. Location of Lake Chicot, mussel bed, and strate for quantitative sampling.

shoreline, and its location was closely associated with the "breakover point" separating the relatively shallow littoral areas and the precipitous slope descending to the lake bottom. The bed was usually found at depths ranging from 4 - 6 m, and substrate consisted of a firmly packed, fine to medium grain sand.

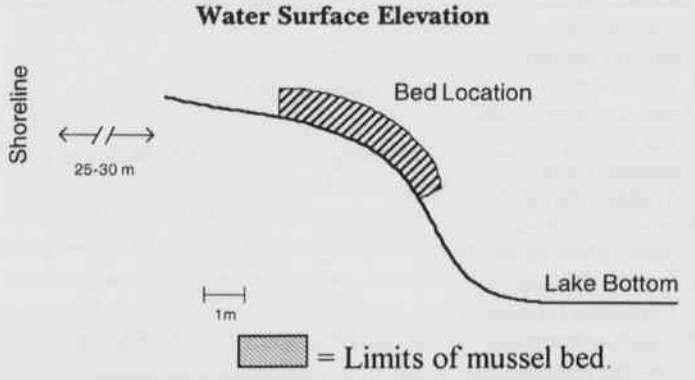


Fig. 2. Profile illustrating horizontal and vertical location of Lake Chicot mussel bed.

Table 1. Mussels collected from qualitative search quadrats.

Species Common Name	Live	Dead
Amblema plicata threeridge	221	45
Anodonta grandis giant floater	0	27
Anodonta suborbiculata flat floater	1	1
Lampsilis hydiana Louisiana fatmucket	0	1
Lampsilis teres yellow sandshell	0	10
Leptodea fragilis fragile papershell	1	13
Megalonaias nervosa washboard	1	0
Obliquaria reflexa threehorn wartyback	0	1
Plectomerus dombeyanus bankclimber	67	13
Potamilus ohiensis pink papershell	0	1
Potamilus purpuratus bleufer	3	16
Quadrula nodulata wartyback	76	20
Quadrula pustulosa pimpleback	2	0
Quadrula quadrula mapleleaf	195	48
Total - 14 Species	567	196

Within the lower lake mussel bed, densities ranged from 0 - 16 mussels / 4 x 1 m quantitative quadrat. Mean mussel densities across strata were relatively uniform with values of 5.1, 4.2, 6.3, 3.9, and 5.3 for strata I through V respectively. Mean mussel density for all quantitative samples was 4.9 / 4 x 1 m unit, standard deviation = 3.6.

Table 2 shows that bed population structure was dominated by four taxa, *Amblema plicata, Quadrula quadrula, Quadrula nodulata,* and *Plectomerus dombeyanus*, which comprised 99.6% of the total bed population. The population estimate was greatest for the threeridge, which composed 46% of the total mussel community (Table 2). Population estimates were calculated separately using individual variances, so Table 2 species estimates do not sum to the Total. Areas outside the defined bed contained very low mussel densities.

Legally harvestable mussels were virtually restricted to the threeridge and bankclimber populations. Approximately 88% of threeridges were of legal harvest size, and 72% of bankclimbers were legal size.

Table 2. Number collected, percent of total, percent legally harvestable, and population estimates derived from quantitative samples of the Lake Chicot mussel bed.

Species Common Name	Number Collected	Percent of Total (% legal)	Population Estimate
Amblema plicata threeridge	222	45.7 (87.8)	26651 ± 6000
Quadrula quadrula mapleleaf	126	25.9 (2.0)	15126 ± 2980
Quadrula nodulata wartyback	91	16.7 (1.2)	10924 ± 2585
Plectomerus dombeyanus bankclimber	55	11.3 (72.0)	6604 ± 1730
Anodonta grandis giant floater	1	0.2 (NCV)	124 ± 250
Obliquaria reflexa threehorn wartyback	1	0.2 (0)	121 ± 250
Total	496	100.0	59304 ± 8392

Discussion

Cooper (1984) reported 14 unionid mussel species and

the Asiatic clam, *Corbicula fluminea* from Lake Chicot (Table 3). Six species listed by Cooper were not found during the present survey. These include *Fusconaia flava* (Wabash pigtoe), *Lampsilis ovata* (= *Lampsilis cardium*, plain pocketbook), *Lampsilis straminea claibornensis* (southern fatmucket), *Quadrula apiculata* (southern mapleleaf), *Quadrula rumphiana* (ridged mapleleaf), and *Villosa lienosa* (little spectaclecase). Part of the discrepancy between species reported by Cooper (1984) and our survey is based in taxonomic uncertainty. Although *Quadrula apiculata* has been found as far north as the lower Ohio and Tennessee rivers, all voucher specimens from Lake Chicot were determined to be *Quadrula quadrula* (D. Stansbery pers, comm.). The distribution of *Quadrula rumphiana* is considered restricted to the Mobile River system (D. Stansbery, pers. comm.). Therefore, the senior author has chosen to refer to all "mapleleaf" specimens collected during this survey as *Quadrula quadrula*.

The present study found five species not reported by Cooper (1984). These include *Anodonta suborbiculata* (flat floater), *Leptodea fragilis* (fragile papershell), *Megalonaias nervosa* (washboard), *Obliquaria reflexa* (threehorn wartyback, and *Quadrula nodulata* (wartyback). The first four species, flat floater, fragile papershell, washboard, and threehorn wartyback were rare and represented by few individuals in our collections. The wartyback, however, was relatively common, and its omission from the Cooper study is curious. Its presence in our survey and absence in Cooper's may be the result of different collection methodologies. The wartyback is typically found in deeper water and our survey emphasized deepwater habitats whereas the Cooper survey emphasized inshore searches. As a final taxonomic note, *Leptodea laevissima* reported by Cooper (1984) has been synonomized with *Potamilus ohiensis* (Turgeon et al., 1988; A. Bogan, pers. comm.).

Substrate appeared to be the primary limiting factor of mussel numbers in upper Lake Chicot. Substrates toward mid-lake and in sheltered, wooded sections were composed of very fine silt and muck ranging from 0.5 - >1.0 m in depth. Inshore areas subject to wave action were virtually devoid of fine substrates, but instead, were composed of very dense, hard packed clay which may be unsuitable for mussel colonization.

The number and size of specimens sampled indicate that the bankclimber and threeridge provide the only real potential for commercial mussel harvest from Lake Chicot. However, bankclimbers are rarely saleable, and the commercial quality of Lake Chicot threeridges was poor because of nacre staining. Only two percent of the mapleleaf population and one percent of the wartyback population were legally harvestable. Overall, the Lake Chicot mussel population has little commercial value.

Table 3. Comparison of mussel species collected by Cooper (1984) and the present study.

Species Common Name	Cooper (1984)	This Study
Amblema plicata threeridge	*	*
Anodonta grandis giant floater	*	*
Anodonta suborbiculata flat floater		*
Fusconaia flava Wabash pigtoe	*	
Lampsilis cardium plain pocketbook	*	
Lampsilis hydiana Louisiana fatmucket	*	*
Lampsilis straminea southern fatmucket	*	
Lampsilis teres yellow sandshell	*	*
Leptodea fragilis fragile papershell		*
Megalonaias nervosa washboard		*
Obliquaria reflexa threehorn wartyback		*
Plectomerus dombeyanus bankclimber	*	*
Potamilus ohiensis pink papershell	*	*
Potamilus purpuratus bleufer	*	*
Quadrula apiculata rough mapleleaf	*	
Quadrula nodulata wartyback		*
Quadrula pustulosa pimpleback	*	*
Quadrula quadrula mapleleaf		*
Quadrula rumphiana ridged mapleleaf	*	
Villosa lienosa little spectaclecase	*	
Total - 20 Species	14	14

Acknowledgements

Funding for this project was provided by the Arkansas Game and Fish Commission, the U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers. The

Journal of the Arkansas Academy of Science, Vol. 47 [1993], Art. 13

authors appreciate the assistance of A. Carter, S. Filipek, R. Roberg, and L. Rider, of the AGFC; P. Hartfield and J. Stewart of the USFWS; and L. Cockman and D. Heffington of the USACOE. R. Doster and P. Bryant assisted with manuscript preparation. J. Nichols assisted with all phases of planning and implementation of this research, and his hard work in the field was essential to completion of this project.

Literature Cited

Cooper, C.M. 1984. The freshwater bivalves of Lake Chicot, an oxbow of the Mississippi in Arkansas. The Nautilus 98(4):142-145.

Cooper, C.M. and **S.S. Knight.** 1987. Residual pesticides in fishes from Lake Chicot, Arkansas. Proc. Ark. Acad. Sci. 41:26-28.

Gordon, M.E. 1981. Recent Mollusca of Arkansas with annotaions to systematics and zoogeography. Proc. Ark. Acad. Sci. 34:58-62.

Gordon, M.E., L.R. Kraemer and **A.V. Brown.** 1980. Unionacea of Arkansas: historical review, checklist, and observations on distributional patterns. Bull. Amer. Malacol. Union 1979:31-37.

Harris, J.L. and **M.E. Gordon.** 1991. Arkansas mussels. Arkansas Game and Fish Commission, Little Rock. 32 pp.

Huebner, J.D., D.F. Malley and **K. Donkersloot.** 1990. Population ecology of the freshwater mussel *Anodonta grandis grandis* in a Precambrian shield lake. Can. J. Zool. 68:1931-1941.

McHenry, J.R., F.R. Schiebe, J.C. Ritchie and **C.M. Cooper.** 1984. Deposited sediments of Lake Chicot. Pp. 18-47, *In* Limnological study of Lake Chicot, Arkansas. (J.F. Nix and F.R. Schiebe, eds.) Proc. Arkansas Lakes Symp., Ouachita Baptist Univ., Arkadelphia, AR.

Nix, J.F. and **F.R. Schiebe.** 1984. Limnological study of Lake Chicot, Arkansas. Proc. Arkansas Lakes Symp., Ouachita Baptist Univ., Arkadelphia, AR. 146 pp.

Turgeon, D.D., A.E. Bogan, E.V. Coan, W.K. Emerson, W.G. Lyons, W.L. Pratt, C.F.E. Roper, A. Scheltema, F.G. Thompsom and **J.D. Williams.** 1988. Common and scientific names of aquatic invertebrates from the United States and Canada: Mollusks. Am. Fish. Soc. Special Publ. 16. Am. Fish. Soc., Bethesda, MD. 277 pp.

Wilkinson, L. 1990. SYSTAT: The system for statistics. SYSTAT, Inc., Evanston, IL.