Clarke 1984

DRAFT REPORT

To: Department of the Army
Memphis District, Corps of Engineers
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Memphis, Tennessee 38103

From: ECOSEARCH, Inc.
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Subject: Mussel (Naiad) Study; St. Francis and White Rivers; Cross, St. Francis, and Monroe Counties; Arkansas. (Order No. 84M 1666R)

Prepared by

Arthur H. Clarke

Arthur H. Clarke, President
ECOSEARCH, Inc.

Date Submitted

October 12, 1984

1. Abstract

On September 10, 1984, a contract was awarded to ECOSEARCH, Inc. to carry out a survey between RM 36 and RM 59 of the St. Francis River (Western Waterway) for the mussels Proptera capax and Cyprogenia aberti, and between RM 91 and RM 93 of the White River for the mussel Quadrula cylindrica, all in Arkansas. During the next 2 1/2 weeks, four experienced field collectors floated these river reaches by canoe and carefully searched 46 measured study areas for freshwater mussels. Proptera capax was found to be common in the St. Francis River survey area but Cyprogenia aberti was not located. A few specimens of Quadrula cylindrica were also found in the White River opposite the town of Aberdeen in Monroe County. It is concluded that it is nearly impossible, and that it is unwise, to transplant all of the Proptera capax to another area but that other engineering options appear to exist which will mitigate upstream flooding and present a minimal hazard to Proptera capax, a species currently classed as endangered by the U.S. Department of the Interior. Quadrula cylindrica could be selectively moved from the White River study area in which it occurs, but any drastic habitat alteration in that area, such as that which would ensue from gravel dredging, would destroy the rich mussel beds there on which the local mussel fishery depends.

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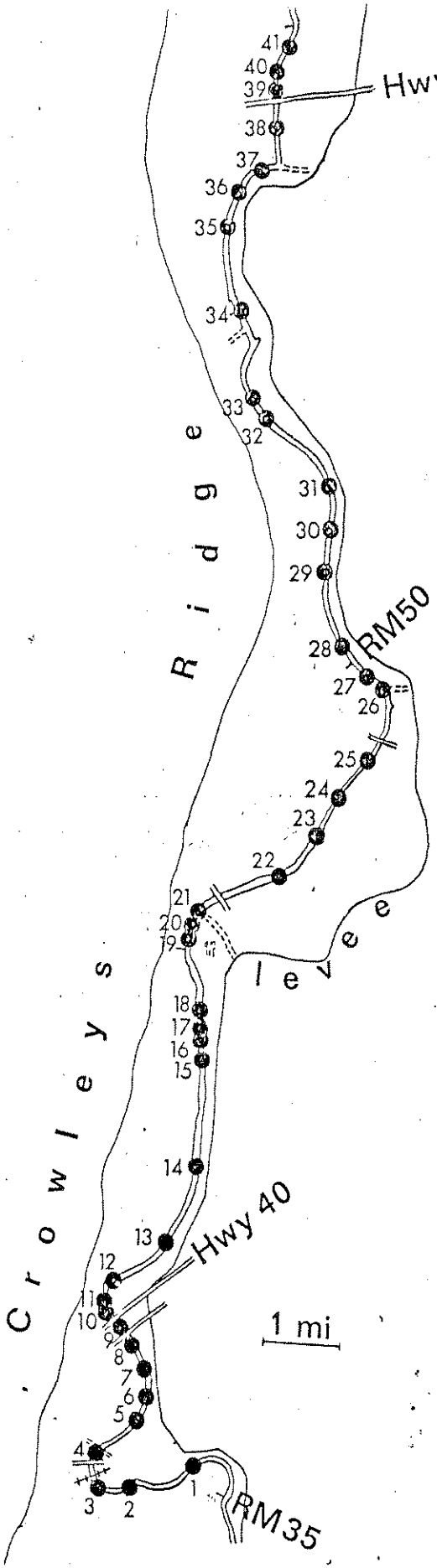
2. Introduction

On September 10, 1984 a contract (Order No. 84M 1666R) was awarded to ECOSEARCH, Inc. by the Department of the Army, Memphis District, Corps of Engineers to conduct mussel surveys in selected portions of the St. Francis and White Rivers, Arkansas. The specified objective of the program is to gather data and prepare a report which will: (1) document the presence or absence of live specimens of Proptera capax and of Cyprogenia aberti in the St. Francis River from river mile (RM)36 to RM59 (i.e. from below Madison, Ark. to above U.S. Highway 64) in St. Francis and Cross Counties, and of Quadrula cylindrica in the White River from RM91 to 93 (i.e. near Aberdeen) in Monroe County, Arkansas; (2) upon discovery of live specimens of these species, describe with reasonable accuracy the number and locations of individuals within these reaches; (3) through interpretation of results, comment upon the advisability of transplant of individuals of these species and; (4) recommend the extent of and specific procedures for any transplant activities deemed advisable.

The Principle Investigator, Dr. A.H. Clarke, and his field assistant, Judith M. Clarke arrived in the research area on Sept. 9. On that day and throughout the night heavy rain fell and the St. Francis River rose an estimated ten feet at the U.S. Highway 70 bridge near Madison, Ark. On Sept. 11 a reconnaissance of the research area revealed that the White River was still low, so on Sept. 12 permission was obtained from the Contract Officer to do preliminary work in the White River While the St. Francis River was still unworkable, and the PI and his wife surveyed the reach from RM 91.0 to 91.5. On Sept. 14 the St. Francis River was still high so another visit was made to the White River, this time in company with Mr. Marc Gordon of the University of Arkansas, and a careful survey was done from RM 91.5 to 93.0.

On Sept. 15 we were joined by Dr. Mark J. Imlay and on Sept. 17 by Mr. Steven N. Moyer. These men were employed by ECOSEARCH as field assistants during this investigation. On September 16 our survey of the Western Waterway of the St. Francis River began and it continued through Sept. 26. A canoe was used, the entire research area was floated, and 41 site surveys were made at intervals of about 0.8-1.0 km throughout the survey reach. The P.I. participated in most of the field work and identified all critical and/or questionable specimens encountered and much of the routine material which was collected as well.

A map of the research area of the Western Waterway of the St. Francis River is provided herein (Map 1). A brief explanation of the rather confusing geography of the St. Francis River is desirable here. Several decades ago, as part of a program to reduce flooding, the Corps of Engineers constructed a system of floodways and levees in the St. Francis River area. The meandering Portion between RM 36 and 59, and extending for several miles above and below this reach, was divided into two waterways by a long levee (much as the stroke through a capital S produces a dollar sign) and the severed ends of the meanders on each side of the levee were joined by large ditches. This produced what is now essentially two separate rivers which are confluent only a short distance above the original mouth of the St. Francis River. Proptera capax is believed to occur in the St. Francis River only in the Western


Hwy 64
Ridge
RM50
levee
Crowleys
Hwy 40
1 mi
RM35

Waterway between RM 36 and RM 59 (see Map 1).

A brief statement is appropriate here concerning the qualifications of each of our personnel.

Mark J. Imlay received his Ph.D. from Northwestern University in 1967 and has worked for many years with the U.S. Department of the Interior, Fish and Wildlife Service, Office of Endangered Species. He has published 25 scientific papers dealing principally with conservation of mollusks and the chemical ecology of mollusks.

Steven N. Moyer received his M.Sc. from Virginia Polytechnic Institute and State University in 1984. His M.Sc. thesis was entitled: "Age and growth characteristics of selected mussel species from Southwestern Virginia and an evaluation of mussel aging techniques".

Judith M. Clarke received early training in nursing and has an abiding interest in biology. She has participated with her husband, A.H. Clarke, in numerous field studies during the past 10 years.

Arthur H. Clarke received his Ph.D. from Harvard University in 1960. He served as Curator of Mollusks at the National Museum of Canada and at the Smithsonian Institution from 1959 to 1981 and is now President of ECOSEARCH, Inc. He has published more than 100 scientific papers and books on mollusks.

2.1 Acknowledgments

We wish to thank Mr. Marc E. Gordon, University of Arkansas, for assistance in the field and for initial information about the ecology of P. capax; Mr. Donald E. Martin, and Mr. David Dodd, both U.S. Army, Memphis District, Corps of Engineers for general information and support; and Mr. Steve N. Wilson, Director, Arkansas Fish and Game Commission, for providing a permit to the writer to investigate P. capax, C. aberti, and Q. cylindrica. This study was also greatly facilitateJ by use o@ the extensive report on the mussels of the St. Francis, White, and Cache Rivers by John M. Bates and Sally D. Dennis (1983).

3. Previous Research

Proptera capax (Green, 1833) is a well-known but rare mussel species characterized by its large, thin, and inflated shell; well-developed hinge teeth; tan, rayless periostracum; pink nacre; and ax-head shaped glochidia. It has recently been discussed and illustrated by Burch (1975) and Johnson (1980). Stansbery (1970) was the first author to point out that it may be endangered. In 1973 it was officially placed on the List of Endangered Species of Animals and Plants of the United States by the U.S. Department of the Interior, Fish and Wildlife Service.

Quadrula cylindrica (Say, 1817) and Cyprogenia aberti (Conrad, 1850) are also characteristic and easily recognized species. They are discussed in several recent publications on mollusks (e.g. Burch, 1975 and Johnson, 1980). In 1984 the U.S. Department of the Interior listed them both as candidate

species for possible inclusion on the List of Endangered Species.

Gordon, Kraemer, and Brown (1979) listed records of P. capax, C. aberti and Q. cylindrica. In 1983 Bates and Dennis, in a report on their field surveys of the St. Francis, White, and Cache Rivers, reported Proptera capax as occurring in the St. Francis River (Western Waterway) between Madison and the southrern end of Clark's Corner Cutoff (RM 37.0-45.5), Cyprogenia aberti from the St. Francis between Parkin and Madison, Arkansas [both Eastern and Western Waterways], and Quadrula cylindrica from the White River.

While the present survey was in progress, Clarke (1984) provided a preliminary list of sites from between RM 37.3 and RM 58.0 which yielded P. capax. That list has been considerably updated and partially corrected-in this report.

4. Study Methods

During the first two days of our work on the St. Francis River a concientous effort was made to locate the mussel beds which contain Proptera capax and to count the number of P. capax individuals which are present. It soon became obvious, however, that within this river reach we were not dealing with a rare, sedentary, or spatially-restricted species but rather with a common, activly-moving, and widespread one. (This is not meant to imply that the species is not endangered. It apparently exists nowhere else as a breeding population.) It was clearly apparent that it was impossible to find and count each of the several thousands of specimens which appeared to be present without greatly exceeding temporal limits which had been established and without inflicting unacceptable damage to this endangered species. On the other hand, we found that Quadrula cylindrica in the White River study reach is confined to a specific area and is amenable there to quantification by direct counting.

An acceptable sampling procedure for P. capax therefore had to be developed because, in my opinion, no entirely unbiased and statistically-rigorous sampling procedure for freshwater mussel populations has yet been proposed. Freshwater mussels frequently exhibit clumped and partially predictable distribution with the densest aggregations, and perhaps the only specimens, often occurring close to the bank, under an overhanging tree, or adjacent to a log. Random sampling techniques which subsample a measured site (of say 1000 M^2) may entirely fail to detect one or a few small clumps if the total of the quadrat areas (say 30 M^2) is only a small fraction of the measured site area.

We have attempted to solve this dilemma by utilizing large, randomly located quadrats which are of sufficient ecological diversity to encompass several microhabitats and by collecting all of the mussels in them. Over a period of several days the St. Francis River, from RM 36 to RM 59. was floated by canoe and stops were made at 41 study sites. There sites were spaced, on average, less than 1 km apart, and a rectangular area of 100 M^2 was measured and staked off, where possible, at each such site. Each measured area extended from one bank to the middle of the river or, where the river was narrow, reached from bank to bank, thus maintaining a uniform ratio of near-bank and mid-river habitats and a fairly even proportion of shallow@ and

deep subareas and of silt and sand substrates. Two to four experienced collectors, each with bare feet and with viewing boxes or masks and snorkels as appropriate, traversed each measured area over and over again until no more mussels could be found in it. This search ordinarily took about one to one-and-one-half hours. The specimens are then counted and tabulated by species, all specimens of the three critical species are measured, and except for a few voucher specimens of non-critical species, all are carefully returned to their habitats. Habitat attributes (substrate, water depth, specimen movements, etc.) for critical species were also noted. (Unfortunately the sexes of these critical species cannot be ascertained without examination of the soft parts, a procedure which might have been harmful or even fatal to the specimens, so sexing was not attempted.) The data are originally recorded in a field note-book and later transcribed onto data sheets for analysis.

5. Study Results

The locations of the study sites in the St. Francis and White Rivers are listed in Table 1. The St. Francis River sites are also graphically indicated on Map 1. A map is considered unnecessary for the White River sites because of the limited scope of that study.

5.1 St. Francis River Survey.

Table 2 presents a tabulation of occurrences of Proptera capax in the study sites. The findings, indicate that the species is generally distributed over the area but that it is approximately twice as numerous in the lower half of the study reach as in the upper half.

No living specimens of Cyprogenia aberti were found during this survey.

As required by the contract, nearly all of the living P. capax specimens were measured in the field. The results of those measurements, taken to the nearest full cm., are given in Table 3.

The results of length measurements indicate that in the material observed only 14% of the specimens are less than 8 cm long. Examination of growth lines indicates great variation in growth, e.g. the 15 cm specimen is only 7 years old, but one 10 cm specimen is 11 years old. In general, however, the 8 cm class is about 5 years old. This does not mean that juveniles are lacking from the area or that successful reproduction is not now occurring, however, because small and very small specimens of nearly all mussel species have always been apparently everywhere rare. This is probably because their habitat (often deep in gravel) is often overlooked. It does mean, rather, that conventional methods of collecting (hand picking, diving, etc.) are inadequate for locating young juvenile mussels and that total population estimates based on such techniques probably represent minimal values only.

Even though this limitation exists, it is still useful to calculate apparent population densities and population sizes. The average nurber of P. capax specimens found in each 1000 M^2 study site is 3.7. The approximate average width of the St. Francis River in the study reach is about 50 M and the area encompassed in 23 river miles is therefore about 1,840,000 M^2 This

Table 1

Locations of 1984 Study Sites, St. Francis and White Rivers, Arkansas

Site Sequence No.	River Mile	Location	County
		St. Francis River	
1	36.0	Bowman Bar just above Marianna Cut-off, Madison	St. Francis
2	36.9	Opposite mouth of Crow Creek, Madison	"
3	37.3	Just below RR bridge, Madison	"
4	37.6	200 m above Ark. Rt. 50 bridge, Madison	"
5	38.6	1.0 mi below US Rt. 70 bridge, nr. Madison	"
6	38.8	0.8 mi below US Rt. 70 bridge, nr. Madison	"
7	39.1	0.5 mi below US Rt. 70 bridge, nr. Madison	"
8	39.6	25 m above to 25 m below US Rt. 50 bridge, nr. Madison	"
9	39.7	Halfway between US Rt. 40 & US Rt. 70 bridges, nr. Madison	"
10	39.8	Under US Rt. 40 bridge, nr. Madison	"
11	40.0	0.2 mi above US Rt. 40 bridge, nr. Madison	"
12	40.3	0.5 mi N of US Rt. 40, just above Houston Bend	"
13	41.3	0.7 mi N of US Rt. 40, nr. Barn Crossing	"
14	42.5	1.5 mi N of US Rt. 40, E of Beaty Lake	"
15	43.9	Andrews Landing	"
16	44.1	0.2 mi N of Andrews Landing	"
17	44.3	1.5 mi S of Big Eddy	"
18	44.4	1.4 mi S of Big Eddy	"
19	45.1	0.7 mi S of Big Eddy (A, east side; B, west side)	"
20	45.3	0.5 mi S of Big Eddy	"
21	45.5	0.3 mi S of Big Eddy, S end of Clark Corner Cut-off	"
22	46.7	Clark Corner Cut-off, 2 mi SW of Old Military Rd. bridge	"
23	47.2	Clark Corner Cut-off, 1.5 mi SW of Old Military Rd. bridge	"
24	48.0	Clark Corner Cut-off, 0.7 mi SW of Old Military Rd. bridge	"
25	48.6	Clark Corner Cut-off, 0.1 mi SW of Old Military Rd. bridge	"
26	49.5	N. end of Clark Corner Cut-off, at Mussel Bar	Cross
27	49.7	1.0 mi above bridge at Old Military Road	"
28	50.2	1.5 mi above bridge at Old Military Road	"
29	51.2	0.3 mi N of Johnson Chapel	"
30	51.7	0.8 mi N of Johnson Chapel	"
31	52.2	1.2 mi ESE of St. Marks Church	"
32	53.4	0.4 mi NE of St. Marks Church	"
33	53.7	1.8 mi SE of Wittsburg	"
34	55.0	3.0 mi below US Rt. 64 bridge	"
35	56.2	1.8 mi below US Rt. 64 bridge	"
36	56.5	1.5 mi below US Rt. 64 bridge	"
37	57.0	1.0 mi below US Rt. 64 bridge	"
38	57.7	0.3 mi below US Rt. 64 bridge	"
39	58.0	Just above US Rt. 64 bridge	"
40	58.2	0.2 mi above US Rt. 64 bridge	"
41	58.8	0.8 mi above US Rt. 64 bridge	"
		White River	
W1	91.0	Opposite town boat landing, Aberdeen	Monroe
W2	91.0-91.3	From site W1 to 0.3 mi upstream, Aberdeen	"
W3	91.0-91.5	0 to 0.5 mi above boat landing, E side, Aberdeen	"
W4	92.0	W side, 1 mi above boat landing, Aberdeen	"
W5	92.0-93.0	E and W sides, 1-2 mi above boat landing, Aberdeen	"

Table 2

Occurrences of *Proptera capax* in the St. Francis River, RM 36-59

Site Sequence No.	Area Searched (M^2)	No. of Living *P. capax* found	N/1000 M^2 ([ ] if estimated)	No. of Empty *P. capax* shells
1	1000	3	3	4
2	1000	9	9	0
3	30	5	[10]	0
4	500	5	10	0
5	1000	7	7	0
6	1000	5	5	0
7	600	6	10	1
8	1000	2	2	1
9	1200	7	6	0
10	100	0	0	0
11	1000	5	5	0
12	1000	1	1	0
13	1000	3	3	0
14	1000	4	4	2
15	62	2	[10]	0
16	1200	4	3	0
17	1000	10	10	8
18	1000	2	2	2
19	1000	0	0	1
20	1000	6	6	2
21	1000	0	0	1
22	780	2	3	4
23	150	0	[0]	0
24	200	1	[5]	0
25	600	1	0	0
26	1000	3	3	2
27	1000	3	3	1
28	1000	0	0	3
29	1000	1	1	0
30	1000	4	4	0
31	1000	1	1	0
32	1000	3	3	1
33	1000	3	3	0
34	1800	4	2	1
35	1000	7	7	8
36	1000	0	0	2
37	1000	0	0	0
38	750	4	5	0
39	1000	7	7	0
40	1000	2	2	0

*Sites 53, 23 and 24 had very small shallow areas. At Site 15 an accident limited time of search.

Table 3

Length Measurements of Living Proptera capax

Size Class (cm)	N	Size Class (cm)	N
3	1	10	23
4	5	11	12
5	4	12	8
6	2	13	6
7	5	14	1
8	26	15	1
9	25	Total	119

means that the minimal population within the study reach comprises about 5,800 specimens.

Although P. capax is rather thin-shelled, and this is a feature often associated with mud-dwelling mussels, P. capax was found almost exclusively on and in sand and in water depths of 0.1 to 2.0 m. Fewer than 5% of the specimens occurred on or in mud. During periods of low water many P. capax were found at the ends of trails several feet in length. On flat area these trails were erratic but on sloping areas they were quite straight and led directly to deeper water. Empty shells of P. capax, of all size classes, were also frequently seen and in most instances no shell breakages or other signs of predation were apparent. It is believed that many of these specimens were probably stranded on flat sand bars during periods of low water and that they were unable to reach water and therefore died.

Twenty-one other species of freshwater mussels were also found in the St. Francis River study sites. They are named in the following list. Also included are the number of sites where they were observed, the number of living specimens observed (in parentheses), and the number of dead specimens (empty shells) in square brackets.

Leptodea laevissima: 29(122)[16]
Leptodea fragilis: 25(46)[10]
Quadrula pustulosa: 21(ca. 100)[many]
Proptera purpurata: 18(52)[3]
Lampsilis anodontoides: 18(35)[4]
Amblema plicata: 16(ca. 500)[many]
Quadrula quadrula: 11(22)
Lampsilis ventricosa: 10(16)[3]
Megalonaias gigantea: 6(15)[1]
Tritogonia verrucosa: 6(11)[1]
Pleurobema cordatum: 4(11)[2]
Obliquaria reflexa: 4(3)[1]
Quadrula nodulata: 3(7)
Fusconaia flava: 3(6)
Pleurobema coccineum: 2(3)
Fusconaia ebena: 2(1)[2]
Anodonta grandis: 2(2)
Truncilla truncata: 2(1)[1]
Quadrula metanevia: 1(1)[1]
Plectomerus dombeyana: 2[11]
Ligumia subrostrata (ident.?): 1[1]

Although these species all occurred in the same 1000 M2 study sites as P. capax, fhey did not all occur in the same habitat. Leptodea laevissima occurred principally in mud and L. fragilis, Q. pustulosa, P. purpurata, and A. plicata often occurred in sand and in mud. The most frequently-associated species with similar ecological requirements is Lampsilis anodontoides.

5.2 White River Survey.

During our investigations of this species-rich and fascinating river, the object of our search, Quadrula cylindrica, was found to occur only in one area. viz. near the east shore of the White River opposite the town boat

landing at Aberdeen, Monroe County, Arkansas. It was found in depths of 0.3 to 1.0 m and distributed in a band about 200 m long. The center of this band was marked by spraying a patch of orange paint on a tree above the shore. Twelve typical, healthy specimens of Q. cylindrica were found.

Local mussel fishermen are well aware of the mussel "run" (or bed) opposite Aberdeen and refer to Q. cylindrica as the "cucumber" or "pickle back". It is also known to occur in water depths up to about 15 feet at that site and it would be possible, with the aid of divers, to remove all of the specimens (estimated to number of the order of 100-200) from that short reach for transplant to another nearby site. Any massive habitat disruption such as that caused by gravel dredging would eliminate the Aberdeen mussel bed, however, and local mussel fishermen would suffer.

A diverse mussbl fauna comprising 10 species occurred opposite Aberdeen (see data sheets). The fauna there was dominated by Megalonaias gigantea and Amblema plicata. Above Aberdeen the fauna was much sparser and consisted only of occasional specimens of three widespread species.

6. Recommendations

6.1 St. Francis River.

Bates and Dennis (1983:85) have proposed four measurers for the conservation and recovery of Proptera capax, a species whose historical range has recently been greatly reduced and now which apparently survives as a healthy breeding population only in the RM 36-59 reach of the Western Waterway of the St. Francis River. These measures are paraphrased as follows: (1) initiation and completion of a research program to elucidate all aspects of the life history of Proptera capax, including the glochidial fish-host; (2) translocation of adult nussels out of the critical St. Francis River reach which is deemed precarious for long-term survival; (3) translocation of fish infected with P. capax glochidia; and (4) artificial propagation and stocking.

We concur in part with those recommendations. Certainly life history studies should be done, and if the Corps of Engineers wishes us to do so, ECOSEARCH, Inc. is prepared to carry them out. We also support translocation of some P. capax specimens on a trial basis to other areas within the historical range of P. capax (e.g. elsewhere in the St. Francis River, into the White River in Arkansas, or even into the White River in Indiana). At the moment, however, P. capax appears to be thriving in the St. Francis River and even to have considerably increased in abundance since the survey by Bates and Dennis was done. It is probable, however, that the 8 to 10 cm size class which now dominates the P. capax population was principally distributed within the cryptic 2 to 5 cm size class when that survey was carried out and that this was responsible in part for their conclusion that the P. capax population is small and in a precarious condition.

We believe that the present population of P. capax in the St. Francis River, which apparently numbers well in excess of 5000 individuals, is clear evidence that the species is doing well there adn that it woudl be wrong to transfer it ot another area at this time in order to improve its chances for

survival. It is probable that such an effort carried out now would, in fact, bring about dramatic reduction or even extinction of the species. We are sympathetic, however, to the need for mitigation of upstream flooding and we do desire to contribute to a solution of the problem.

We are molluscan biologists and not hydrological engineers and our recommendations must be viewed in that context. It appears to us, however, that several immediate possible courses of action exist (albeit of disparate levels of desirability) on which to base a program whose objectives combine mitigation of upstram flooding and a concern for conservation and recovery of Proptera capax. These options are:

1. Transplanting of all P. capax out of the RM 36-59 river reach of the St.Francis River Western Waterway to another area (e.g. the reach below Wappapello Damin Missouri) and dredging of the entire reach.

2. Transplanting part of the population, say those in RM 36 to 40.6 the first year combined with dredging of that reach, those in 40.6 to 45.2 the second year, and so on for 5 years until all specimens are moved and all dredging is done.

3. Transplanting all of the P. capax into one side of the river channel and dredging out the other side of the same channel.

4. Transplanting the specimens from the extreme northern end of the RM 36-59 reach (i.e. that part above RM 57.2); dredging out that reach; dredging out the old (now principally dry) river channel in those portions north and east of Wittsburg Island, i.e. east of RM 57.2, through the levee, around Block Bend, and to Grassy Cut-Off in the Eastern Waterway; by installation of a control structure at the levee and possibly elsewhere; by diverting excess flood water from the Western Waterway into the Eastern Waterway through this control structure; and by Frequently monitoring water levels in the RM 36.0-57.2 reach of the Western Waterway to ensure that the P. capax populations there were protected from dessicaiton.

The relative advantages and disadvantages of these options are various and appear to include the following:

Option 1 would solve the flooding problem quickly but would probably lead to extinction of Proptera capax and of the commercial mussels there upon which mussel fishermen base their livlihoods. It is also probably impossible to find all specimens of P. capax in such a large and widely distributed population and possibly thousands of missed P. capax would be killed by dredging. The others might also fail to reproduce in a new habitat which might lack essential ecological attributes (e.g. proper temperature, proper fish host, etc.)), attributes which will remain unknown until a life-history study is carried out. For example, the St.Francis River reach below Wappapello Dam might be too cold because of the hypolimnetic discharge at the dam. We therefore believe that Option 1 should be rejected.

Option 2 is less drastic than option 1 but, until life history details are known, it may have the same ultimate effect on survival of the species. It also may not solve the upstream flooding problem because dredging in one portion may cause severe siltation in another previously-dredged area. We

recommend rejection of Option 2 also.

Option 3 is more attractive from a biological viewpoint than options 1 or 2. It would probably be impossible to move so many P. capax specimens from one side of the river to the other, however, and even if this was accomplished the translocated specimens would probably be stranded on dry sand flats during periods of low flow because nearly all of the water would then flow through the new deep channel.

A combination of options 2 and 3, with modification, might be successful, however, at least from a conservationist viewpoint. It might be possible to remove all P. capax specimens from one critical reach at a time while that reach was dredged without undo harm to the species but certain precautions would have to be observed. These would include (a) transporting the mussels quickly (within about 2 hours) and in such a manner that they are kept cool (at about 50-60°F), kept moist (but not entirely immersed in water), and provided with free access to air; (b) promptly placing them in a natural position into a sandy substrate, along with resident specimens of P. capax, for temporary maintenance; (c) dredging the deep side of the temporarily vacated reach to a desirable depth and sloping the shallow side at about 10° to 20° so that replaced P. capax are able to migrate into deeper water during periods of low flow; (d) carefully returning the specimens back to the newly-dredged area and repositioning them in sand on the gently sloping side; and (e) monitoring the health and reproductive success of the specimens at frequent intervals. A pilot study of this method should be done by trained biologists before extensive mussel translocations are attempted but we believe that this option has possibilites and that it may deserve further consideration.

Option 4 is, in our judgement, the best solution. It would presumably solve the flooding problem quickly and at reasonable expense. It would also jeopardize only about 6% of the St. Francis River population of P. capax, a quantity which is probably below the threshold which would be considered dangerous for survival of the species. It might also facilitate the natural spread of P. capax into the Eastern Waterway, and it wouuld almost certainly allow sufficient safe time for the research to be completed and the transplants to be done which we hope will lead to enhancement of the species and its removal from the Endangered Species List.

6.2 White River

As we understand it, it is important to determine the presence or absence of Quadrula cylindrica within RM 91-93 reach of the White River so that a decision can be made regarding gravel dredging in that reach. Q. cylindrica clearly is present but its numbers probably do not exceed 100-200 individuals and they are restricted spatially to a small area opposite Aberdeen. It would be possible to move them, with the aid of divers, to another area. If gravel dredging were permitted the rich mussel bed at Aberdeen, on which many local mussel fishermen depend, would be destroyed, however. Downstream siltation would also result and other mussel beds might also be harmed. We therefore recommend against permitting gravel dredging to occur in the vicinity of the Aberdeen mussel beds.

recommend rejection of Option 2 also.

Option 3 is more attractive from a biological viewpoint than options 1 or 2. It would probably be impossible to move so many P. capax specimens from one side of the river to the other, however, and even if this was accomplished the translocated specimens would probably be stranded on dry sand flats during periods of low flow because nearly all of the water would then flow through the new deep channel.

A combination of options 2 and 3, with modification, might be successful, however, at least from a conservationist viewpoint. It might be possible to remove all P. capax specimens from one critical reach at a time while that reach was dredged without undo harm to the species but certain precautions would have to be observed. These would include (a) transporting the mussels quickly (within about 2 hours) and in such a manner that they are kept cool (at about 50-60°F), kept moist (but not entirely immersed in water), and provided with free access to air; (b) promptly placing them in a natural position into a sandy substrate, along with resident specimens of P. capax, for temporary maintenance; (c) dredging the deep side of the temporarily vacated reach to a desirable depth and sloping the shallow side at about 10° to 20° so that replaced P. capax are able to migrate into deeper water during periods of low flow; (d) carefully returning the specimens back to the newly-dredged area and repositioning them in sand on the gently sloping side; and (e) monitoring the health and reproductive success of the specimens at frequent intervals. A pilot study of this method should be done by trained biologists before extensive mussel translocations are attempted but we believe that this option has possibilites and that it may deserve further consideration.

Option 4 is, in our judgement, the best solution. It would presumably solve the flooding problem quickly and at reasonable expense. It would also jeopardize only about 6% of the St. Francis River population of P. capax, a quantity which is probably below the threshold which would be considered dangerous for survival of the species. It might also facilitate the natural spread of P. capax into the Eastern Waterway, and it wouuld almost certainly allow sufficient safe time for the research to be completed and the transplants to be done which we hope will lead to enhancement of the species and its removal from the Endangered Species List.

6.2 White River

As we understand it, it is important to determine the presence or absence of Quadrula cylindrica within RM 91-93 reach of the White River so that a decision can be made regarding gravel dredging in that reach. Q. cylindrica clearly is present but its numbers probably do not exceed 100-200 individuals and they are restricted spatially to a small area opposite Aberdeen. It would be possible to move them, with the aid of divers, to another area. If gravel dredging were permitted the rich mussel bed at Aberdeen, on which many local mussel fishermen depend, would be destroyed, however. Downstream siltation would also result and other mussel beds might also be harmed. We therefore recommend against permitting gravel dredging to occur in the vicinity of the Aberdeen mussel beds.

8. Appendices

8.1 Data Sheets (reduced from page size)

8.2 Arkansas Field Study Permit

8.3 Contract

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FIELD DATA RECORD Station No. 2180
Date Sept. 25/74 R. m. 36.9 Sequence No. 2
Collectors Allen McClarke, D. Dodd, D. Martin, M. Imlay, S. Moyer
Gear John boat, etc. Elapsed Time 1.4 hrs
Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, opposite mouth of Crow Creek, Madison
Ecology Sand, med. gravel. Collected 31 x 31 M area from S shore. Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides	6	
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis	1	
Pleurobema cordatum			Lep. laevissima	9	
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata	1		Proptera capax	9	
Q. pustulosa	4		P. purpurea	3	
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis	1				
Arcidens confragosus					
Strophitus undulatus					

Notes P. capax lengths 13, 11, 10, 8.8, 7½, 6, 4, 4 cm

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FIELD DATA RECORD Station No. 2179
Date Sept. 25/74 R. m. 36.0 Sequence No. 1
Collectors Allen McClarke, D. Martin, D. Dodd, M. Imlay
Gear John boat, etc. Elapsed Time 1.5 hrs
Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, Bowman Bar, just above Marianna Cutoff, Madison
Ecology Deep mud on S side, sand in middle. Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis		
Pleurobema cordatum			Lep. laevissima	16	
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax	3	4
Q. pustulosa			P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
			Corbicula fluminea	1	2
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Collected in 31 x 31 M area from S side toward N side (but not reaching N side). TV crew from Jonesboro Ark. channel 8 filmed us. P. capax lengths 11, 9½, 9 cm

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FIELD DATA RECORD Station No. 2161F
Date Sept 17/84 R.M. 32.3 Sequence No. 3
Collectors M.J. Imlay, S.N. Moyer
Gear Camera, viewing box Elapsed Time
Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, just below railroad bridge, Madison.
Ecology Collected on E side in 15M x 2M area only (sharp drop-off) Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata	1		Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa	2	
Plectomerus dombeyana			Leptodea fragilis	3	
Pleurobema cordatum			Lep. laevissima	3	
P. coccineum			Ligumia recta		
Quadrula quadrula	1		Obliquaria reflexa		
Q. nodulata			Proptera capax	5	
Q. pustulosa			P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Much same density as previously, therefore, in spite of small area sampled, P. capax density thought to be ca 10/1000 m². P. capax lengths 12, 10, 9, 8.8 cm. Bottom mud over sand. No current (pool).

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FIELD DATA RECORD Station No. 2161E
Date Sept 17/84 R.M. 32.6 Sequence No. 4
Collectors M.J. Imlay, S.N. Moyer
Gear Camera, viewing box Elapsed Time
Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, 200 M above Rt 50 bridge, Madison
Ecology Sandy and muddy areas. Current ca 2 mph above riffle. Notes (ove

	Alive	Dead		Alive	De
Amblema plicata	5		Actinonaias carinata	2 (?)	
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides	3	
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa	1	
Plectomerus dombeyana			Leptodea fragilis		
Pleurobema cordatum			Lep. laevissima	3	
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax	5	
Q. pustulosa	1		P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Area searched 100 x 50 ft (ca 500 M²). P. capax lengths were not measured.

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FIELD DATA RECORD Station No. 2161D
Date Sept. 17/84 R.M. 38.6 Sequence No. 5
Collectors M.J. Imlay, S.N. Moyer
Gear Canoe, viewing box Elapsed Time
Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, 1 mi below Rt. 70 bridge, near Madison.
Ecology Sand + muddy sand. Overhanging willows + brush at bank Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava	4		Lampsilis anodontoides	2	1
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa	4	
Plectomerus dombeyana			Leptodea fragilis		
Pleurobema cordatum			Lep. laevissima	4	
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax	7	
Q. pustulosa	3		P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Area sampled 100 x 100 ft (1000 m²). P. capax lengths: 13, 12, 9, 9, 9, 8, 7 cm.

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FIELD DATA RECORD Station No. 2161C
Date Sept. 17/84 R.M. 38.8 Sequence No. 6
Collectors M.J. Imlay, S.N. Moyer
Gear Canoe, viewing box Elapsed Time
Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, 3/4 mi below Rt. 70 bridge, nr. Madison.
Ecology Sandy bed. Area sampled 100 x 100 ft (ca 1000 m²) Notes (over)

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides	2	
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa	1	
Plectomerus dombeyana			Leptodea fragilis		
Pleurobema cordatum			Lep. laevissima	9	5
P. coccineum			Ligumia recta		
Quadrula quadrula	1		Obliquaria reflexa		
Q. nodulata			Proptera capax	5	
Q. pustulosa	3		P. purpurea	3	
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes P. capax lengths: 13, 11, 9, 8, 5 cm.

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FIELD DATA RECORD Station No. 2161B
Date Sept. 12/84 R.M. 39.1 Sequence No. 7
Collectors M.J. Imlay, S.N. Moyer
Gear Canoe, viewing box Elapsed Time
Drainage St. Francis R. State Arkansas County St. Francis
Locality St. Francis River, ½ mi below Rt 70 bridge, nr. Madison.
Ecology Sandy shoals Area 20 x 30 M Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata	63		Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides	2	
F. undata			L. radiata siliquoidea		
Megalonaias gigantea	2	1	L. ventricosa	1	
Plectomerus dombeyana			Leptodea fragilis	1	
Pleurobema cordatum			Lep. laevissima		
P. coccineum			Ligumia recta		
Quadrula quadrula	1		Obliquaria reflexa		
Q. nodulata			Proptera capax	6	1
Q. pustulosa	6		P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes All P. capax 8-10 cm. long

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FIELD DATA RECORD Station No. 2161A
Date Sept 12/84 R.M. 39.6 Sequence No. 8
Collectors M.J. Imlay & S.N. Moyer, Alice Jo Clarke
Gear canoe, water scopes Elapsed Time 0.8 hr.
Drainage St. Francis River State Arkansas County St. Francis
Locality 25M above to 25M below US Rt. 70 bridge, nr. Madison
Ecology Sandy shoal. Notes (over)(

	Alive	Dead		Alive	Dead
Amblema plicata	33		Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena		2	Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		1
Plectomerus dombeyana			Leptodea fragilis		
Pleurobema cordatum			Lep. laevissima		
P. coccineum			Ligumia recta		
Quadrula quadrula	8		Obliquaria reflexa		
Q. nodulata			Proptera capax	2	1
Q. pustulosa	13		P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa		1	Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Area about 1000 m² (Sta. 2161A) Area incidentally searched again under lower water conditions (Sta. 2178) while removing canoe from water. 15+ live P. capax found crawling around on sheal - in only a few in of water. Other species as in 2161A. List above represents 2161A (All P. capax there were)

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FIELD DATA RECORD Station No. 2161
Date Sept. 16/84 YR. H. 357 Sequence No. 9
Collectors AH & JM Clarke, M.J. Imlay
Gear Canoe, wetsuits Elapsed time 1.5 hrs.

Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, halfway between US 40 & US 70 bridges, 2 mi NNE of Madison
Ecology Sand. Water fairly low. Current moderate. Notes (over) ✕

	Alive	Dead		Alive	Dead
Amblema plicata	6		Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena	1		Cyprogenia aberti		
F. flava			Lampsilis anodontoides	3	
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis	1	
Pleurobema cordatum			Lep. laevissima	2	
P. coccineum			Ligumia recta		
Quadrula quadrula	2		Obliquaria reflexa	1	
Q. nodulata	3		Proptera capax	7	
Q. pustulosa	3		P. purpurea	6	
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Collected in area 200 M long, 6 M wide, starting 10 M from E shore (≤ 1200 M²) over 0.5 hr. period. Totals above reflect that. Additional collecting for 1.0 hrs. nearby revealed no P. capax but all other species listed. Lost anchor. P. capax photographed & returned to site. Tree stump at NE upper end of area marked with orange paint. (50' above area).

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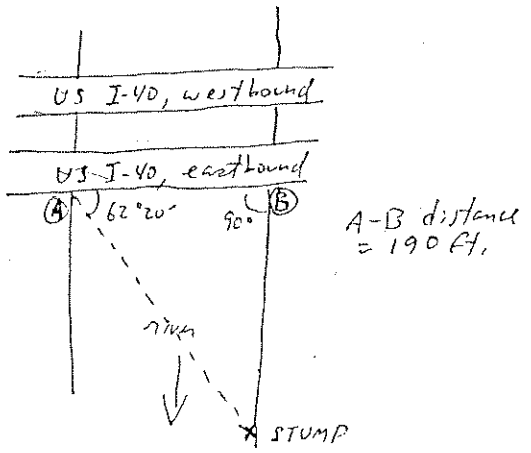
Sta. 2161 Seq No. 9

Area revisited. - Six more live P. capax found. Lengths 12, 11, 10, 8, 7½, 7½ cm. (Get other measurments from photograph). All in sand but some sand only 1" deep over mud. Collector AH Clarke, elapsed time 1½ hrs. Same associated species as previously seen.

Paint-marked stump located near E bank about 400 ft. S of point where E end of S side of US Rt. I-40 crosses E bank of river. Its precise location may be calculated from sketch below:



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FIELD DATA RECORD Station No. 216
Date Sept 14/84 R.M. 39.8 Sequence No. —
Collectors AH & SM Clarke
Gear Wet suits, view box Elapsed Time

Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River at US Hwy 40 bridge. Area ca. 10x10m
Ecology Mud. Area collected ca 10 x 10m. No current. Notes (over)(

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis		
Pleurobema cordatum			Lep. laevissima	c/	
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax		
Q. pustulosa			P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Very difficult exam. Not able to reach mussel bed upstream.

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FIELD DATA RECORD Station No. 3177
Date Sept 22/84 R.M. 40.0 Sequence No. 11
Collectors AH & SM Clarke, MS Lemley, SN Moyer
Gear Canoe, view box, etc. Elapsed Time

Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, ¼ mi above US Hwy 40 bridge.
Ecology Sandbar Notes (over)(

	Alive	Dead		Alive	Dead
Amblema plicata	V. many		Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides	2	
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa	3	
Plectomerus dombeyana			Leptodea fragilis		
Pleurobema cordatum			Lep. laevissima	3	
P. coccineum	2		Ligumia recta		
Quadrula quadrula	3		Obliquaria reflexa		
Q. nodulata			Proptera capax	5	
Q. pustulosa	12		P. purpurea	10	
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa	3		Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Heaviest Amblema plicata bed on sandbar. P. capax length 10, 10, 9, 8, 5 cm. Area searched 100 x 100 ft.

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FIELD DATA RECORD Station No. 2176
Date Sept. 22/84 R.M. 40.3 Sequence No. 12
Collectors
Gear Cane, viewbox, etc. Elapsed Time
Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, ¼ mi N of US Hwy 40, just above Houston Bend
Ecology Sandbar. Collected at mussel bar. Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata	V. many		Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava	1		Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis	4	
Pleurobema cordatum	4		Lep. laevissima		
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax	1	
Q. pustulosa			P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Utrophitus undulatus					

Notes Hundreds of Amblema in muddy area behind sandbar. P. capax 12 cm. long – found on river side of sandbar. 90% of others on shore side of sandbar. Have old piles of shells & live. Area searched 100 x 100 ft.

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FIELD DATA RECORD Station No. 2175
Date Sept. 22/84 R.M. 41.3 Sequence No. 13
Collectors A.H.J. M.C. Clarke, M.J. Imlay, S.K. Moyer
Gear Cane, viewbox, etc. Elapsed Time
Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, 0.7 mi N of US Hwy 40, W. Barn Crossing
Ecology Emergent sand bar Notes (over)(

	Alive	Dead		Alive	Dead
Amblema plicata	V. many		Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava	1		Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis	2	
Pleurobema cordatum		2	Lep. laevissima		
P. coccineum	1		Ligumia recta		
Quadrula quadrula	2		Obliquaria reflexa		
Q. nodulata			Proptera capax	3	
Q. pustulosa	many		P. purpurea	2	
Q. metanevra	1	1	Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Utrophitus undulatus					

Notes P. capax lengths 13, 11, 10 cm. Amblema ca. 4/ft² in muddy area near shore, Q. pustulosa ca 2/ft², same area Lg. old piles of shells here. Area searched 100 x 100 ft.

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FIELD DATA RECORD Station No. 217
Date Sept 22/84 R.M. 42.5 Sequence No. 14
Collectors AH & JM Clarke, M Mulay, SNR
Gear Canoe, viewbox, etc. Elapsed Time

Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, 1½ mi N of US Hwy 40
Ecology Emergent sandbar. Notes (over)(

	Alive	Dead		Alive	Dead
Amblema plicata	7		Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides	4	
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis	5	
Pleurobema cordatum			Lep. laevissima	3	
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax	4	2
Q. pustulosa		1	P. purpurea	1	
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis	1				
Arcidens confragosus					
Strophitus undulatus					

Notes Area searched 200 x 50 ft. (1000 M²). P. capax lengths 11, 10, 9, 7 cm. (five specimens).

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FIELD DATA RECORD Station No. 2170
Date Sept 21/84 R.M. 43.9 Sequence No. 15
Collectors AH & JM Clarke
Gear view box Elapsed Time 0.5 hr

Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, Andrews Landing
Ecology River 150 ft wide, sand & gravel, 1ft mud overlay. Notes (over)(

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		1
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis		
Pleurobema cordatum			Lep. laevissima	2	
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa	1	
Q. nodulata			Proptera capax	2	
Q. pustulosa	1		P. purpurea		1
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Almost drowned! P. capax lengths 9, 6 cm. Juvenile P. capax in mud, adult in muddy sand. Area searched ca 25 x 25 F

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FIELD DATA RECORD Station No. 2172
Date Sept. 22/84 R.M. 441 Sequence No. 16
Collectors AH & JM Clark, MJ Imlay, SN Meyer
Gear Canoe, viewbox, etc. Elapsed Time

Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, ca 2 mi below Big Eddy, 0.2 mi NW Andrews Landing
Ecology _____ Notes (over)

	Alive	Dead		Alive	Dead
Amblema plicata	22		Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis	1	
Pleurobema cordatum			Lep. laevissima	8	
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax	4	
Q. pustulosa	10		P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
			Viviparus subpurpurea	2	
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Area sampled 1200 M² (2-100M² areas + 1-1000M² area crossing river - see field book) List above records totals. P. capax lengths 11, 10, 9½, 9 cm

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FIELD DATA RECORD Station No. 2171
Date Sept. 22/84 R.M. 443 Sequence No. 17
Collectors AH & JM Clark, MJ Imlay, SN Meyer
Gear Canoe, viewbox, etc. Elapsed Time

Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River 1½ mi S of Big Eddy
Ecology River 20', sand (95%) + sand & mud in eddies. Notes (over)

	Alive	Dead		Alive	Dead
Amblema plicata	34		Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides	3	
F. undata			L. radiata siliquoidea		
Megalonaias gigantea	2		L. ventricosa		
Plectomerus dombeyana		3	Leptodea fragilis		
Pleurobema cordatum	5		Lep. laevissima		
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata	3		Proptera capax	10	8
Q. pustulosa	1		P. purpurea	2	
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa	1		Other Species		
			Corbicula fluminea	3	
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Most P. capax in 1 in 20 ft. of shore but some 100 ft. offshore. Area searched 100 x 100 ft. (1000 M²). P. capax lengths 12, 11, 10, 10, 9, 8.8, 5.5, 4 cm. (alive)

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FIELD DATA RECORD Station No. 2162E
Date Sept 18/84 R.M. 44.4 Sequence No. 18
Collectors M.J. Imlay, S.N. Moyer
Gear Cano, View box Elapsed Time
Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, 3/4 mi below Burnt Mill Bluff
Ecology River 50 M wide, fairly slow, depth in 100x100 ft area: 5-8 M Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata	9		Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis		2
Pleurobema cordatum			Lep. laevissima	5	
P. coccineum			Ligumia recta		
Quadrula quadrula	1		Obliquaria reflexa		
Q. nodulata			Proptera capax	2	2
Q. pustulosa	1		P. purpurea	9	
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
			Corbicula fluminea	2	
Anodonta grandis			Viviparus subpurpurea	1	
Arcidens confragosus					
Strophitus undulatus					

Notes P. capax lengths (live) 12, 8 cm; (dead) 8, 4 cm.

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FIELD DATA RECORD Station No. 2162A
Date Sept 18/84 R.M. 45.1 Sequence No. 19
Collectors M.J. Imlay, S.N. Moyer
Gear Cano, view box Elapsed Time
Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, downstream end of Burnt Mill Bluff, on low shoal.
Ecology Sandy shoal 40 m wide, slow current. Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis		
Pleurobema cordatum			Lep. laevissima	14	
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax		1
Q. pustulosa			P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Collected in E side of river in 100x100 ft. area. Empty P capax fresh, 8 cm long. L. laevissima mostly young.

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FIELD DATA RECORD Station No. 2162B
Date Sept. 18/84 R.M. 45.1 Sequence No. 198
Collectors M.J. Imlay, S.N. Moyer
Gear Canoe, view box Elapsed Time

Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, same area as St. 2162A but West side of river.
Ecology Silt & mud, current slow, area 100 x 100 ft. Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata	27		Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		1
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa	1	
Plectomerus dombeyana			Leptodea fragilis		4
Pleurobema cordatum	2		Lep. laevissima		
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax		
Q. pustulosa	9		P. purpurea	4	
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa	4		Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Amblema abundant - only few tabulated.

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FIELD DATA RECORD Station No. 2162D
Date Sept. 18, 1984 R.M. 45.3 Sequence No. 20
Collectors M.J. Imlay, S.N. Moyer
Gear Canoe, view box. Elapsed Time

Drainage St. Francis River State Arkansas County St. Francis
Locality Sandy shoal halfway between stations 2162 B & C, St. Francis River.
Ecology Sandy shoal, 100 x 100 ft. Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis		
Pleurobema cordatum			Lep. laevissima		
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax	6	2
Q. pustulosa			P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Other species not tabulated. P. capax lengths: 10, 10, 9, 8, 8, 8 cm. (live) and 8, 7 cm (dead). Area searched 1000 m². P. capax in 0.5 m depth on sand. River ca 50 m wide. Current fairly slow.

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FIELD DATA RECORD Station No. 2162C
Date Sept. 18, 1984 R.M. 45.5 Sequence No. 21
Collectors M.J. Imlay, S.N. Moyer
Gear Cane, Wire box Elapsed Time
Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, ½ mi below bridge at Big Eddy, at old channel
Ecology Sand & mud. Area 100 X 100 Ft. Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata	many		Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides	2	
F. undata			L. radiata siliquoidea		
Megalonaias gigantea	2		L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis		1
Pleurobema cordatum			Lep. laevissima		
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax		1
Q. pustulosa	2		P. purpurea	2	
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Old river channel now dry & overgrown. P. capax fresh, 8 cm long.

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FIELD DATA RECORD Station No. 2163F
Date Sept. 19, 1984 R.M. 46.7 Sequence No. 23
Collectors M.J. Imlay, S.N. Moyer
Gear Cane, Wire box Elapsed Time
Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, ca 2 mi below bridge at Old Military Road
Ecology Sand. River ca 50 M wide, fairly slow, up to 4½ Ft deep Notes (over)(

	Alive	Dead		Alive	Dead
Amblema plicata	1		Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis		
Pleurobema cordatum			Lep. laevissima	5	
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax	2	4
Q. pustulosa			P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Area searched 100' long x ½ river width (780 M²).
P. capax length: 2, 3 cm (alive), 4 cm (dead).

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FIELD DATA RECORD Station No. 2163E
Date Sept. 19, 1984 R.M. 47.2 Sequence No. 23
Collectors M.S. Inlan, S.N. Moyer
Gear Canoe, view box Elapsed Time
Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, ca 1½ mi below bridge at Old Military Road.
Ecology Clumpy clay, river 50 M wide, pool, slow. Zero. Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis		
Pleurobema cordatum			Lep. laevissima		
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax		
Q. pustulosa			P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Area sampled 100' long, 15' wide because of steep drop off. Channel steep sided on both sides. No mollusks found.

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FIELD DATA RECORD Station No. 2163D
Date Sept. 19, 1984 R.M. 48.0 Sequence No. 24
Collectors M.S. Inlan, S.N. Moyer
Gear Canoe, view box Elapsed Time
Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, 3/4 mi below bridge at Old Military Road
Ecology Mud & clumped clay. River ca 60M wide, pool, slow Notes (over)

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis		
Pleurobema cordatum			Lep. laevissima		
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax	1	
Q. pustulosa			P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Area searched 100' x 30', steep drop-off beyond. Both steep-sided. P. capax 13 cm long, ca 10 years old.

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FIELD DATA RECORD Station No. 2163A
Date Sept. 19, 1984 R.M. 48.6 Sequence No. 25
Collectors M.J. Imlay, S.N. Moyer
Gear Canoe, view box Elapsed Time
Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, ca 200 M below bridge at Old Military Road
Ecology Sand. Area checked 100 Ft X 60 Ft (600 M²) Notes (over)( )

	Alive	Dead
Amblema plicata		
Elliptio dilatata		
Fusconaia ebena		
F. flava		
F. undata		
Megalonaias gigantea		
Plectomerus dombeyana		
Pleurobema cordatum		
P. coccineum		
Quadrula quadrula		
Q. nodulata		
Q. pustulosa		1
Q. metanevra		
Q. cylindrica		
Tritogonia verrucosa		
Anodonta grandis		
Arcidens confragosus		
Strophitus undulatus		
Actinonaias carinata		
Carunculina parva		
Cyprogenia aberti		
Lampsilis anodontoides	1	
L. radiata siliquoidea		
L. ventricosa		
Leptodea fragilis		
Lep. laevissima	2	4
Ligumia recta		
Obliquaria reflexa		
Proptera capax	1	
P. purpurea	1	
Truncilla truncata		
T. donaciformis		
Other Species		

Notes River 40M wide, up to 0.8 M deep, current fairly slow. P. capax 11 cm long - found 10 M. from shore, in sand.

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FIELD DATA RECORD Station No. 2169
Date Sept. 20/84 R.M. 49.5 Sequence No. 26
Collectors A.H. Clark, M.J. Imlay, S.N. Moyer
Gear Canoe, view box Elapsed Time
Drainage St. Francis River State Arkansas County Cross
Locality St. Francis River at "Mussel Bar" (locality on Ubinet 1:62,500 Topo Map)
Ecology Sand, up to 4 ft deep, area searched 50' x 200', Notes (over)

	Alive	Dead
Amblema plicata		
Elliptio dilatata		
Fusconaia ebena		
F. flava		
F. undata		
Megalonaias gigantea		
Plectomerus dombeyana		8
Pleurobema cordatum		
P. coccineum		
Quadrula quadrula		
Q. nodulata		
Q. pustulosa	X	5
Q. metanevra		
Q. cylindrica		
Tritogonia verrucosa	1	
Anodonta grandis		
Arcidens confragosus		
Strophitus undulatus		
Actinonaias carinata		
Carunculina parva		
Cyprogenia aberti		
Lampsilis anodontoides		
L. radiata siliquoidea		
L. ventricosa		
Leptodea fragilis	2	1
Lep. laevissima		
Ligumia recta		
Obliquaria reflexa		1
Proptera capax	3	2
P. purpurea		
Truncilla truncata		
T. donaciformis		1
Other Species		
Ligumia subrostrata		1
~~Truncilla~~		

Notes Local. fr. at U end of Clark Corner Cut-Off. Width of river searched (200'). P. capax lengths: 13, 11, 9 cm (alive), 12, 11 (dead). Pl. dombeyana all subfoss. (as elsewhere in this reach of river)

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FIELD DATA RECORD Station No. 2163B
Date Sept. 19, 1984 R.M. 49.7 Sequence No. 27
Collectors MJ Imlay, SN Moyer
Gear Canoe, view box Elapsed Time
Drainage St. Francis River State Arkansas County Cross
Locality St. Francis River, 1 mile above bridge at Old Military Road.
Ecology Large sandy shoal. River 30 M wide, fairly slow. Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides	1	
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa	1	1
Plectomerus dombeyana			Leptodea fragilis		1
Pleurobema cordatum			Lep. laevissima		
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax	3	1
Q. pustulosa			P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Area searched 100 x 100 ft. P. capax lengths 10, 9, 7 cm [11, 8, 4 yrs old] alive; 9 cm dead.

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FIELD DATA RECORD Station No. 2163C
Date Sept. 19, 1984 R.M. 50.2 Sequence No. 28
Collectors MJ Imlay & SN Moyer
Gear Canoe, view box Elapsed Time
Drainage St. Francis River State Arkansas County Cross
Locality St. Francis R. Vy, 1½ mi abov bridge at Old Military Road.
Ecology Sandbar. Area sampled 100 x 100 ft. Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis		1
Pleurobema cordatum			Lep. laevissima	1	
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax		3
Q. pustulosa			P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes All P. capax 11 cm long.

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FIELD DATA RECORD Station No. 2168
Date Sept. 20/84 R.M. 51.2 Sequence No. 29
Collectors AH Clarke, MJ Imlay, SN Meyer
Gear Canoe, view box Elapsed Time
Drainage St. Francis River State Arkansas County Cross
Locality St. Francis River 1/4 mi N of Johnson Chapel, just above L-hand curve.
Ecology Sandy. Area searched 50 × 200 Ft. (1000 M²). Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata	1		Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides	1	
F. undata			L. radiata siliquoidea		
Megalonaias gigantea	5		L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis	1	
Pleurobema cordatum			Lep. laevissima	6	2
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa	1	
Q. nodulata			Proptera capax	1	
Q. pustulosa		1	P. purpurea	4	
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes P. capax 10 cm long.

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FIELD DATA RECORD Station No. 2167
Date Sept. 20/84 R.M. 51.7 Sequence No. 30
Collectors AH Clarke, MJ Imlay, SN Meyer
Gear Canoe, view box Elapsed Time
Drainage St. Francis River State Arkansas County Cross
Locality St. Francis River, ca 0.8 mi N of Johnson Chapel
Ecology Sand. Mussels mostly buried in shell nests in Eddy. Notes (over)

	Alive	Dead		Alive	Dead
Amblema plicata	4		Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides	1	
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis	6	1
Pleurobema cordatum			Lep. laevissima	4	
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax	4	
Q. pustulosa	1		P. purpurea	2	
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Many mussels making trails. Area searched 50 × 200 Ft. (ca 1000 M²). P. capax lengths 15, 11, 10, 9 cm. (largest in ca 7 years old).

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FIELD DATA RECORD Station No. 2166
Date Sept. 20/84 R.M. 52.2 Sequence No. 31
Collectors ~~Allen~~ Clarke, MJ Imlay, SN Mayes
Gear Canoe, view box Elapsed Time
Drainage St. Francis River State Arkansas County Cross
Locality St. Francis River, 1.2 mi ESE of St. Mark's Church
Ecology Mussels from mud-sand area on W side, in middle of long R bend. Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata	4		Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea	1		L. ventricosa		
Plectomerus dombeyana		2	Leptodea fragilis	1	
Pleurobema cordatum			Lep. laevissima	1	
P. coccineum			Ligumia recta		
Quadrula quadrula	1		Obliquaria reflexa		
Q. nodulata			Proptera capax	1	
Q. pustulosa			P. purpurea	1	
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
			Corbicula fluminea	1	
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes P. capax 4.0 cm long at end of trail behind boat. Sandbar on E side sandy succession, muddy nr. W shore. Pl. dombeyana subfossil.

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FIELD DATA RECORD Station No. 2165
Date Sept. 20/84 R.M. 53.4 Sequence No. 32
Collectors ~~Allen~~ Clarke, MJ Imlay, SN Mayes
Gear Canoe, view box Elapsed Time
Drainage St. Francis River State Arkansas County St. Cross
Locality St. Francis River, 0.4 mi NE of St. Mark's Church
Ecology River 200 ft wide. Collected across width and 40-50 ft length. Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata	34		Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides	1	1
F. undata			L. radiata siliquoidea		
Megalonaias gigantea	3		L. ventricosa	3	1
Plectomerus dombeyana			Leptodea fragilis	1	1
Pleurobema cordatum			Lep. laevissima	1	
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax	3	1
Q. pustulosa		4	P. purpurea		1
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
			Corbicula fluminea	1	1
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Mussels all in E side near shore, muddy sand, 1-3 ft. depth. P. capax lengths 10, 8, 4 cm (alive). 1 juvenile L. laevissima even at end of 65' trail.

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FIELD DATA RECORD Station No. 2164
Date Sept 20/84 R.M. 537 Sequence No. 33
Collectors AH, Clarke, MJ Imlay, SN Meyer
Gear Canoe, view box Elapsed time
Drainage St. Francis River State Arkansas County St. Francis
Locality St. Francis River, 1.8 mi SE of Wittsburg
Ecology Collected 100 sq. area just below sandbar in eddy. Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis		1
Pleurobema cordatum			Lep. laevissima	1	
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax	3	
Q. pustulosa			P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
			Corbicula fluminea	1	
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Substrate muddy sand. P. capax lengths 13, 12, 9.5 cm.

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FIELD DATA RECORD Station No. 2170
Date Sept 21/84 R.M. 550 Sequence No. 34
Collectors MJ Imlay SN Meyer
Gear Canoe, view box Elapsed time
Drainage St. Francis River State Arkansas County Cross
Locality St. Francis River, 3 mi below US Rt. 64 bridge
Ecology River 80 M wide, up to 0.8 M deep, slow, sandy. Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis		1
Pleurobema cordatum			Lep. laevissima	2	
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax	4	1
Q. pustulosa			P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Area searched 150 Ft x half of river. P. capax lengths 10, 8, 8, 7 cm (alive).

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FIELD DATA RECORD Station No. 2170D
Date Sept. 21/84 R.M. 56.2 Sequence No. 35
Collectors MJ Imlay, SN Moyer
Gear Cano, View box Elapsed time
Drainage St. Francis River State Arkansas County Cross
Locality St. Francis River, 1 3/4 mi below US Rt. 64 bridge.
Ecology Extensive sand shoal-shallow. Collected there (W side) Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis	5	
Pleurobema cordatum			Lep. laevissima	3	
P. coccineum			Ligumia recta		
Quadrula quadrula	1		Obliquaria reflexa		
Q. nodulata			Proptera capax	7	8
Q. pustulosa			P. purpurea	1	
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Area 100 x 100 ft (1000 M²). P. capax lengths (alive): 14, 13, 10, 9, 9, 9, 7 (cm).

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FIELD DATA RECORD Station No. 2170
Date Sept. 21/84 R.M. 56.5 Sequence No. 3
Collectors M.J Imlay, S.N. Moyer
Gear Cano, View box Elapsed time
Drainage St. Francis River State Arkansas County Cross
Locality St. Francis River 1 ½ mi below U.S Rt. 64 bridge.
Ecology Sand on E side, silt & sand on W, river 60M x 2.5M Notes (over)

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis	1	
Pleurobema cordatum			Lep. laevissima	5	4
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax		2
Q. pustulosa			P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Current slow. Area looks promising but actually poor. Area searched 1000 M².

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FIELD DATA RECORD Station No. 2170B
Date Sept. 21/84 R.M. 57.0 Sequence No. 37
Collectors MJ Imlay, SN Moyer
Gear Camo, viewbox Elapsed Time
Drainage St. Francis Riv State Arkansas County Cross
Locality St. Francis River ca 1 mi below US Rt. 64 bridge.
Ecology Deep pool, small sandbar on E side (NO MOLLUSKS). Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis	1	
Pleurobema cordatum			Lep. laevissima	1	
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax		
Q. pustulosa			P. purpurea	2	
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Clay & silt. River ca 50 m wid, >6 ft deep over most of area, slow current (pool). List above records mussels from W side

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FIELD DATA RECORD Station No. 2170A
Date Sept. 21/84 R.M. 57.7 Sequence No. 38
Collectors MJ Imlay, SN Moyer
Gear Camo, viewbox Elapsed Time
Drainage St. Francis River State Arkansas County Cross
Locality St. Francis River, ¼ mi below US Rt. 64 bridge
Ecology Sandy shoal - sand all across river. River 50 M wide Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides	2	1
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis	14	
Pleurobema cordatum			Lep. laevissima	5	
P. coccineum			Ligumia recta		
Quadrula quadrula	1		Obliquaria reflexa		
Q. nodulata			Proptera capax	4	
Q. pustulosa			P. purpurea	2	
Q. metanevra			Truncilla truncata	1	
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa	2		Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Current fairly fast on E side - nearly a riffle. Area searched 100 x 75 ft (750 M²). P. capax lengths 9, 8, & 8 cm.

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FIELD DATA RECORD Station No. 2163
Date Sept. 19, 1984 R.M. 58.0 Sequence No. 39
Collectors AH Clarke
Gear Viewbox Elapsed time 0.6 hrs.
Drainage St. Francis River State Arkansas County Cross
Locality St. Francis Bay, just above US Hwy 64 bridge.
Ecology River 1-1½ ft deep, bottom deep sh. ft. mg sand. Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis		
Pleurobema cordatum			Lep. laevissima		
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax		
Q. pustulosa			P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes No mollusks in 2 careful transects. Not even a single shell on a wide, exposed sandbar. Possibly dries up at extreme low water.

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FIELD DATA RECORD Station No. 2180
Date Sept 21/84 R.M. 58.2 Sequence No. 40
Collectors M. Conley, S. N. Moyer
Gear Canoe, viewbox, dr Elapsed time
Drainage St. Francis River State Arkansas County Cross
Locality St. Francis River, 300 M above US Rt 64 bridge
Ecology Sand. Current moderate. Searched 100 x 100 ft. area (1000 M²) Notes (over)(

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis		
Pleurobema cordatum			Lep. laevissima		2
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax	7	
Q. pustulosa			P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes P. capax: lengths 12, 11, 11, 10, 10, 9, 8 cm (all live). River 60 M wide

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FIELD DATA RECORD Station No. 2180B

Date Sept. 26/84 R.M. 58.8 Sequence No. 41

Collectors MJ Imbs SN Moyer

Gear Canoe, minnow etc. Elapsed Time

Drainage St. Francis River State Arkansas County Cross

Locality St. Francis River 3/4 mi above US Hwy 64 bridge

Ecology River 50 M wide. Sand, fairly rapid. Search 100 x 10 ft area (1000 M²). Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa		
Plectomerus dombeyana			Leptodea fragilis	1	
Pleurobema cordatum			Lep. laevissima		
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax	2	
Q. pustulosa			P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes P. capax lengths 9 and 8 cm.

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FIELD DATA RECORD Station No. 2155

Date Sept 11/84 R.M. 91.0 Sequence No. W1

Collectors AH & JM Clarke !

Gear Canoe, water slower Elapsed Time 3.0 hrs.

Drainage White River State Arkansas County Monroe

Locality White River, Aberdeen, opposite boat landing (i.e. above E shore)

Ecology Mud & sandy mud. Colorful in 1-4' depth in 100 M long area. Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata	+		Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides	+	
F. undata			L. radiata siliquoidea		
Megalonaias gigantea	abundant		L. ventricosa	+	
Plectomerus dombeyana	+		Leptodea fragilis	+	
Pleurobema cordatum			Lep. laevissima		
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa	+	
Q. nodulata			Proptera capax		
Q. pustulosa	+		P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica	8		T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Quadrula cylindrica under overhanging trees. M. gigantea etc. v. abundant. Upstream end of Q. cylindrica bed marked with orange paint on tree. Voucher specimens of all species kept - finish thru shell when all re-examined.

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FIELD DATA RECORD Station No. 2159
Date Sept. 14/84 R.M. 91.0-.5 Sequence No. [illegible]
Collectors AH & JM Clarke, Mark E. Gordon
Gear Canoe, waterscopes Elapsed Time 1.0 hr.

Drainage White River State Arkansas County Monroe
Locality White River, 0-½ mi above Aberdeen, E. side
Ecology Sand. Sandy mud nr. bank. Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata	+		Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea	+		L. ventricosa	+	
Plectomerus dombeyana			Leptodea fragilis	+	
Pleurobema cordatum			Lep. laevissima		1
P. coccineum			Ligumia recta		
Quadrula quadrula	+		Obliquaria reflexa	+	
Q. nodulata			Proptera capax		
Q. pustulosa	+		P. purpurea	+	
Q. metanevra			Truncilla truncata		
Q. cylindrica	3		T. donaciformis		
Tritogonia verrucosa	+		Other Species		
			Viviparus subpurpurea	+	
Anodonta grandis			Campeloma	+	
Arcidens confragosus			Pleurocera canaliculatum	+	
Strophitus undulatus					

Notes Q. ~~tuberculata~~ cylindrica only opposite Aberdeen throughout a band extending 100 M above and 100 M below tree with orange paint.

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FIELD DATA RECORD Station No. 2157
Date Sept. 12/84 R.M. 91.3 Sequence No. #2
Collectors AH & JM Clarke
Gear Canoe, waterscopes Elapsed Time 2 hr.

Drainage White River State Arkansas County Monroe
Locality White River, east side, from above St. 2155 to ½ mi upstream, m A[illegible]
Ecology Notes (over)(

	Alive	Dead		Alive	Dead
Amblema plicata	+		Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides	+	
F. undata			L. radiata siliquoidea		
Megalonaias gigantea	+		L. ventricosa	+	
Plectomerus dombeyana	+		Leptodea fragilis	+	
Pleurobema cordatum			Lep. laevissima		
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa	+	
Q. nodulata			Proptera capax		
Q. pustulosa	+		P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica	1		T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes Local people call Q. cylindrica "cucumber" or "pickle back".
One taken in 3' depth. Photo taken of Q. cylindrica in Jud; this hand.
No mussels kept.

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FIELD DATA RECORD Station No. 2158
Date Sept. 14/84 R.M. 93.0-93.0 Sequence No. 45
Collectors AH & JM Clarke, Mark Gordon
Gear Canoe, water scopes Elapsed Time 2½ hrs.

Drainage White River State Arkansas County Monroe
Locality White River, 92.0-93.0 RM, 1-2 mi above Aberdeen
Ecology Sand. Collected both sides of river Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides	2	
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa	+	
Plectomerus dombeyana			Leptodea fragilis		
Pleurobema cordatum			Lep. laevissima		
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa	+	
Q. nodulata			Proptera capax		
Q. pustulosa			P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species.		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes No mussels on W side. Mussels v. rare on E side. L. ventricosa & O. reflexa on E side at RM 92.0.

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FIELD DATA RECORD Station No. 2156
Date Sept. 12/84 R.M. 92.0 Sequence No. 44
Collectors AH & JM Clarke
Gear Canoe, water scopes Elapsed Time 2 hrs.

Drainage White River State Arkansas County Monroe
Locality White River, west side, ca 1 mi above Aberdeen
Ecology Sand. Bottom shallow - 3' deep 100' from shore. Mussels rare. Notes (over)( )

	Alive	Dead		Alive	Dead
Amblema plicata			Actinonaias carinata		
Elliptio dilatata			Carunculina parva		
Fusconaia ebena			Cyprogenia aberti		
F. flava			Lampsilis anodontoides		
F. undata			L. radiata siliquoidea		
Megalonaias gigantea			L. ventricosa	1	
Plectomerus dombeyana			Leptodea fragilis		
Pleurobema cordatum			Lep. laevissima		
P. coccineum			Ligumia recta		
Quadrula quadrula			Obliquaria reflexa		
Q. nodulata			Proptera capax		
Q. pustulosa			P. purpurea		
Q. metanevra			Truncilla truncata		
Q. cylindrica			T. donaciformis		
Tritogonia verrucosa			Other Species		
Anodonta grandis					
Arcidens confragosus					
Strophitus undulatus					

Notes ♀ L. ventricosa photographed (4 photos). Tree trunk on opposite shore marked with orange paint.

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Mussel (Naiad) Study
St. Francis and White Rivers, Arkansas

1. OBJECTIVE.

The objective of this contract is to gather current data and prepare a report which will: (1) document the presence or absence of the live selected mussel (naiad) species within certain reaches of the St. Francis and White Rivers of Arkansas; (2) upon discovery of live selected species, describe with reasonable accuracy the number and locations of individuals within the selected reaches; (3) through interpretation of results, comment upon the advisability of transplant of individuals of selected species and; (4) recommend the extent of and specific procedures for any transplant activities deemed advisable.

2. GENERAL DESCRIPTION OF WORK.

The St. Francis River from immediately downstream of Madison, Arkansas to the U.S. Highway 64 will be examined for living individuals of Proptera (=Potamilus) capax, Cyprogenia aberti, and Quadrula cylindrica. This reach of approximately 37 kilometers (23 miles) is proposed for maintenance dredging and has, as recently as 1980 (Bates and Dennis 1983), supported populations of P. capax and C. aberti. Individual mussels will not be collected but merely counted; located as accurately as reasonably possible; verified as to selected species; subjected to gross measurements and sex determination. Immediately following notation of this data, individual mussels will be carefully returned to the substrate. The time required to tabulate the data with respect to individual mussels is expected to be sufficiently short that there should be no appreciable mortality.

The same type of examination will be conducted between miles 91 and 93 in the White River, Arkansas. Previous work (Bates and Dennis 1983) has reported Quadrula cylindrica as occurring within the White River.

Except as noted under paragraph, ASSISTANCE/DATA TO BE FURNISHED BY THE GOVERNMENT, the Contractor is charged to furnish all supplies, permits, equipment, and personnel necessary to conduct this work.

3. STUDY AREAS.

a. St. Francis River, St. Francis and Cross Counties, Arkansas

Commencing at river mile 36 downstream of Madison, Arkansas and proceeding upstream to river mile 59, upstream of the U.S. Highway 64 crossing.

b. White River, Monroe County, Arkansas

Commencing at river mile 91 and proceeding upstream to river mile 93.

4. PERSONNEL STANDARDS.

a. The Contractor shall utilize a systematic, interdisciplinary approach to conduct this study. Specialized knowledge and skills will be used during the course of the study to include expertise in biology, limnology, and malacology as required to produce an acceptable report.

b. The following minimal experience and academic standards shall apply:

(1) Principal Investigator(s) (PI). Individuals in charge of the conduct of this contract study and its end product shall meet the standards for biologist or limnologist. In addition, the individuals must have a publication record that demonstrates extensive experience in successful field project formulation, execution and technical monograph reporting. The Contracting Officer may also require suitable professional references to obtain evaluations of the adequacy of prior work.

(2) Biologist/Limnologist. Individuals must possess a B.A. or B.S. degree from an accredited college or university in biology or limnology. A Master's thesis or its equivalent in research publication is highly recommended, as is the M.A. degree. In addition, a minimum of five (5) years professional experience is required.

c. All operations shall be conducted under the supervision of qualified professionals in the discipline appropriate to the data that is to be discovered, described or analyzed. Vitae of personnel involved in project activities may be required by the Contracting Officer at anytime during the period of service of this contract.

d. The Contractor shall designate in writing the name of the Principal Investigator. Participation time of the Principal Investigator shall average a minimum of 20 hours per month during the period of service of this contract and he shall participate in the field work. In the event of controversy or court challenge, the Principal Investigator shall be available to testify with respect to report findings. The additional services and expenses would be at Government expense. When required, arrangements for these services and payment therefor will be made by representatives of either the Corps of Engineers or the Department of Justice.

5. SAMPLING ORDER.

Field work is to be completed for the St. Francis River reach prior to commencement of work on the White River reach. Should river conditions render this sequence inappropriate, the Contracting Officer shall advise the Contractor in writing of his determination to reverse the sequence.

6. SAMPLING METHODS.

a. St. Francis River: handpicking, Needham scraper, diving, brailing (in descending order of preference).

b. White River: handpicking, Needham scraper, brailing (in descending order of preference).

7. GENERAL PERFORMANCE SPECIFICATIONS.

a. The extent and character of the work to be accomplished by the Contractor shall be subject to the general supervision, direction, control and approval of the Contracting Officer. The Contracting Officer may have a representative of the Government present during any or all phases of the [illegible].

b. To conduct the field investigation, the Contractor will obtain all necessary permits, licenses, and approvals from all local, state and federal authorities. Should it become necessary in the performance of the work and services of the Contractor to secure the right of ingress and egress to perform any of the work required herein on properties not owned or controlled by the Government, the Contractor shall secure the consent of the owner, his representative, or agent, prior to effecting entry on such property.

c. The Contractor shall keep standard field records which may be reviewed by the Contracting Officer and/or his representative. These records shall include field notes, appropriate site survey forms, field maps and photographs necessary to successfully implement requirements of this contract. At the location of each individual or aggregate of selected species, the field records must minimally record: species discovered (scientific name), number of individuals by species, dimensions of substrate inhabited by the individuals, coordinates of location (from established permanent datum), substrate description, depth in substrate at which individual mussels were found, gross measurements of animal, presumed sex of animal, sampling method used, date, name of individual making the observations. Copies of all records shall be submitted to the Contracting Officer along with the draft report at no additional cost to the Government.

d. The Contractor, prior to the acceptance of the final report, shall not release any sketch, photograph, report or other material of any nature obtained or prepared under this contract without specific written approval of the Contracting Officer.

e. The Contracting Officer shall be immediately notified should individuals of a Federally classified endangered species, other than P. capax, be discovered within the selected reaches.

8. GENERAL REPORT REQUIREMENTS.

a. The report required by this contract shall be literate, comprehensive, and analytic in nature. Conduct of the work shall be described, sources of data shall be referenced, and primary data displayed for support of any arguments presented or recommendations.

b. The report shall include, but not necessarily be limited to, the following sections and items:

(1) Title Page. Title page shall provide: the task undertaken, location (county and state), date of report, Contractor's name, Contract number, name of author(s) and Principal Investigator, and the agency for which the report is being prepared.

(2) Abstract. The abstract shall define the objective(s), the results and the conclusion(s) of the study.

(3) Table of Contents.

(4) Introduction. The introduction shall define the objective(s), describe the project area(s), provide an appropriate map of the area(s), define the dates during which the study was conducted and appropriately acknowledge contributions to the study from firms, organizations or individuals not directly associated with the Contractor.

(5) Previous Research. Discussion of existing data and publications which are considered useful in deriving or interpreting relevant background data and which provide a context to discuss ecological requirements of selected species, threshold populations and transplant options and procedures.

(6) Study Methods. This section shall describe and defend the study strategy and methods chosen to gather necessary data and to utilize these data to address ecological requirements and population transplants of the selected species.

(7) Study Results. The data obtained shall be displayed and analyzed as to relevance with regard to ecological requirements and transplant options. Performance of the study strategy shall be addressed, as shall variance of results from those intuitively expected by the PI.

(8) Recommendations.

(9) References.

(10) Appendices (Maps, Correspondence, Contract).

c. The following instructions also shall apply to report preparation:

(1) Information shall be presented in textual, tabular, and graphic forms, whichever are most appropriate, effective and advantageous to communicate necessary information. All tables, figures and maps appearing in the report shall be of publishable quality.

(2) All measurements should be metric. If the Contractor's equipment is in the English system, then the metric equivalents should follow in parentheses.

(3) Black and white photographs are preferred except when color changes are important for understanding the data being presented. No instant type photographs may be used.

(4) Negatives of all black and white photographs and/or color slides of all plates included in the final report shall be submitted so that copies for distribution can be made.

(5) The report will first be submitted as a draft document. Should the Contracting Officer's review, additional (and clearly identified) draft versions shall be required. The Contractor shall submit twenty (20) copies of each required draft report and fifty copies of the final report plus one unbound, reproducible quality final report.

9. SCHEDULE.

The Contractor shall, unless delayed due to causes beyond his control and without his fault or negligence, complete all work and services under this contract within the following time limitations:

Activity	Completion Time (In days beginning with acknowledged date of receipt of notice to proceed)
Draft Report	35 days
Final Report	100 days

The Contractor shall make any required corrections after review by the Contracting Officer of the reports. In the event that any of the Government review periods (60 days) are exceeded and upon request of the Contractor, the contract period will be extended on a calendar day for day basis. Such extension shall be granted at no additional cost to the Government.

10. MEETINGS.

The Contracting Officer may request meetings with the Contractor to discuss study strategy, results or the draft report. Such meetings shall be at a location(s) named by the Contracting Officer. Two weeks advance notice shall be given to the Contractor and efforts shall be made to select mutually agreeable dates and times. Should such meetings be called, the Contractor shall be paid $_____ per (24 hour period) day and actual cost of commercial (coach) airfare.

11. ASSISTANCE/DATA TO BE FURNISHED BY THE GOVERNMENT.

The Government shall stand ready to provide the Contractor with:

a. Two (2) copies of the report entitled Mussel (Naiad) Survey--St. Francis, White, and Cache Rivers, Arkansas and Missouri; Final Report March 8, 1983; Bates and Dennis.

b. Two (2) copies each of the Whitmore, Princedale, and Clarendon 15 minute quadrangle maps.

SECTION G - CONTRACT ADMINISTRATION DATA

G-1. PAYMENT

G-1.1. Upon satisfactory completion of work by the Contractor, in accordance with the provisions of this contract, and its acceptance by the Contracting Officer, the Contractor will be paid the amount of money indicated in Block 25 of the order.

G-1.2. If the Contractor's work is found to be unsatisfactory and it is [illegible] the part of the Contractor or his employees [illegible] satisfactory condition, the Contractor will be liable for all costs in connection with correcting the unsatisfactory work. The work may be performed by Government forces or Contractor forces at the direction of the Contracting Officer. In any event, the Contractor will be held responsible for all costs required for correction of the unsatisfactory work, including payments for services, automotive expenses, equipment rental, supervision, and any other costs in connection therewith, where such unsatisfactory work as deemed by the Contracting Officer to be the result of carelessness, incompetent performance or negligence by the Contractor's employees. The Contractor will not be held liable for any work or type of work not covered by this contract.

G-1.3. Prior to such final payment under the contract, or prior to settlement upon termination of the contract, and as a condition precedent thereto, the Contractor shall execute and deliver to the Contracting Officer a release of all claims against the Government arising under or by virtue of this contract, other than such claims, if any, as may be specifically exempted by the Contractor from the operation of the release in stated amounts to be set forth therein.

SECTION H - SPECIAL PROVISIONS.

Wage determination of the Secretary of Labor applicable to this Request for Proposal No. is Federal Register Wage Determination Number