

809340143

Distribution and Host Species of the
Federally Endangered Freshwater Mussel,
Potamilus capax (Green, 1832),
in the Lower Wabash River, Illinois and Indiana

Kevin S. Cummings and Christine A. Mayer

Illinois Natural History Survey
Center for Biodiversity
Technical Report 1993 (1)

607 East Peabody Drive
Champaign, Illinois
61820

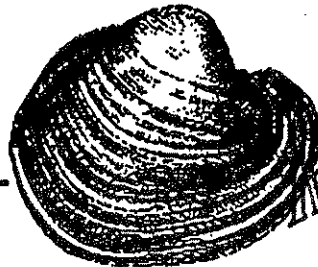
Final Report

15 March 1993

Prepared for

Illinois Department of Conservation
Division of Natural Heritage
524 South Second Street
Springfield, Illinois
62706

36 pp.



RECEIVED

JUN 21 1993

FISH & WILDLIFE SERVICE
FEDERAL AID

TABLE OF CONTENTS

	PAGE
LIST OF FIGURES	ii
LIST OF TABLES	iii
INTRODUCTION	1
METHODS	3
RESULTS & DISCUSSION	7
CONCLUSIONS & RECOMMENDATIONS	15
ACKNOWLEDGEMENTS	16
LITERATURE CITED	17
APPENDIX I	19
APPENDIX II	22
APPENDIX III	26

LIST OF FIGURES

	PAGE
Figure 1. Total range and present distribution of the fat pocketbook, <i>Potamilus capax</i> , in the Interior Basin	2
Figure 2. Distribution of the fat pocketbook, <i>Potamilus capax</i> , in the lower Wabash River	4
Figure 3. Glochidia of <i>Potamilus capax</i> , INHS 9180, St. Francis Floodway, Cross County, Arkansas	8

LIST OF TABLES

	PAGE
Table 1. List of fish species examined for glochidia in the lower Wabash River, 1992.....	6
Table 2. <i>Potamilus capax</i> size classes for Mink and Mackeys islands, Wabash River, 1991	9



Distribution and Host Species of the Federally Endangered Freshwater Mussel,
Potamilus capax (Green, 1832), in the Lower Wabash River, Illinois and Indiana

Kevin S. Cummings & Christine A. Mayer

Illinois Natural History Survey
Center for Biodiversity
Champaign, Illinois

ABSTRACT: A survey for additional populations of the federally endangered freshwater mussel, *Potamilus capax*, was conducted in the lower Wabash River in summer of 1991. To determine the host species, fishes were collected in the lower Wabash River in summer of 1992. Areas of suitable habitat (i.e. soft substrates around islands) from Mt. Carmel downstream to near the Ohio River were sampled for *P. capax*. Although no new localities were discovered above or below where *P. capax* was documented in recent studies, living mussels were found at Mink and Mackeys islands, Posey County, Indiana where only shells were found previously. Fishes were collected monthly from April through August 1992 and inspected for glochidia in order to determine the host species of *P. capax*. Five hundred ninety-nine fishes of 32 species were examined, and three species were found with encysted glochidia. A single glochidium identified as *P. capax* was found on a freshwater drum (*Aplodinotus grunniens*) collected in the month of June. The majority of glochidia examined were determined to be *Potamilus ohioensis*. Other species found included *Leptodea fragilis*, *Potamilus alatus*, *Truncilla sp.*, and unidentified members of the subfamily Anodontinae. *

INTRODUCTION

The fat pocketbook, *Potamilus capax* (Green, 1832) (Unionidae: Lampsilinae), was historically widespread in the Mississippi River drainage, and occurred from the Falls at St. Anthony, Minnesota, southeast to the lower Wabash and Ohio rivers, and west to the St. Francis River drainage of Arkansas. The fat pocketbook has undergone a marked reduction in range in the last 50 years, and is thought to be limited to three areas within its former range: the St. Francis River drainage in Arkansas, the lower Wabash and Ohio rivers in Illinois, Indiana, and Kentucky, and the Mississippi River in Missouri (Bates and Dennis, 1983; Sickel, 1987; USFWS, 1989; Cummings et al., 1990) (Fig. 1). Because of the drastic reduction in the overall range of the species, the fat pocketbook was listed as a Federally Endangered Species on 14 June 1976 (USFWS, 1976).

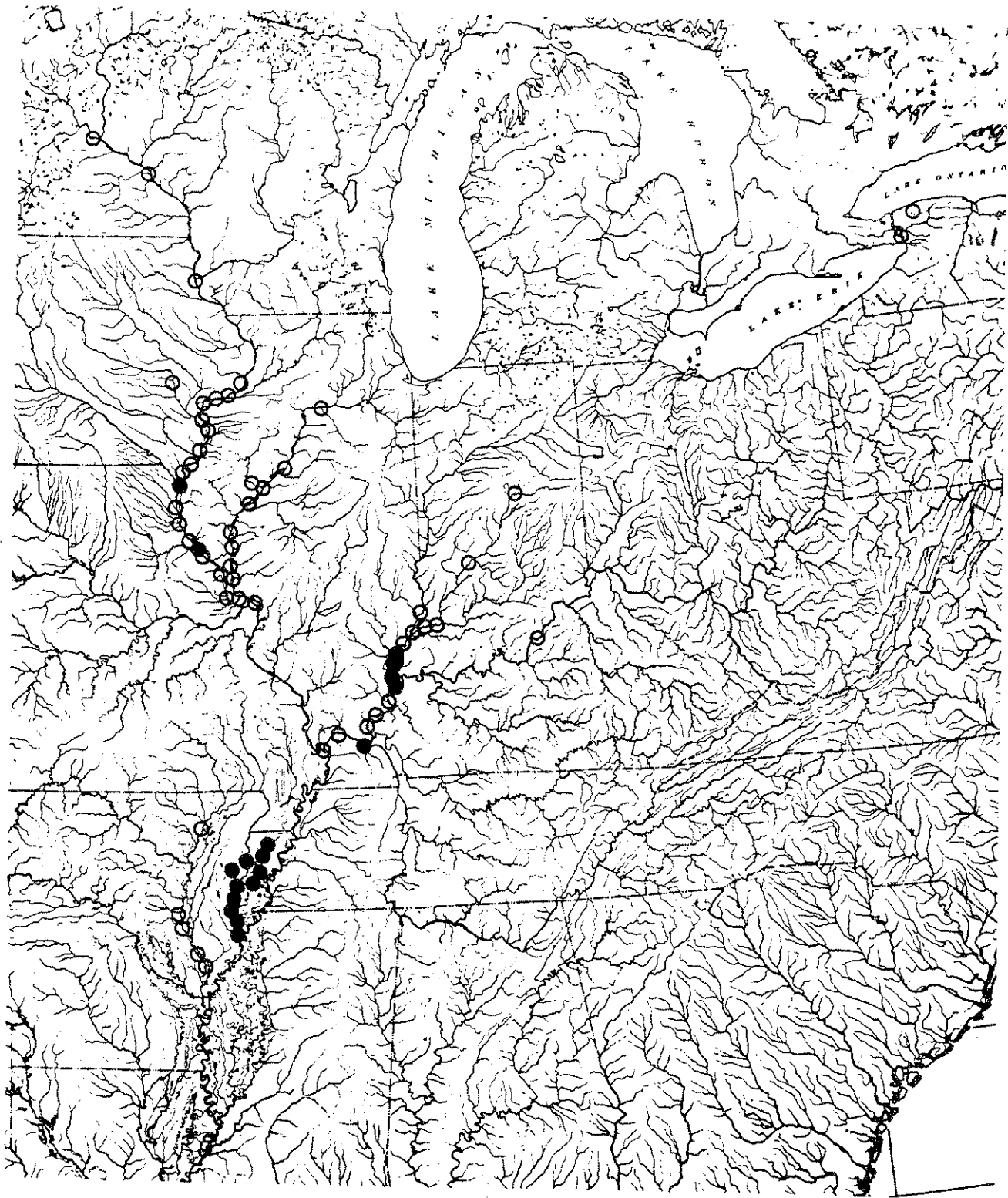


Figure 1. Total range and present distribution of the fat pocketbook, *Potamilus capax* (Green, 1832) in the Interior Basin. Open circles represent historic records, solid circles represent locations where live mussels were found or transplanted.

In 1987, during a survey of the unionid fauna of the Wabash River drainage, nine live *P. capax* were found in the lower part of the river. Both juveniles and adults were found indicating that a reproducing population was present. The fat pocketbook was considered to be relatively common among a total of 19 live species found; however, unionid diversity has been drastically reduced in the river below Mt. Carmel (Cummings et al., 1992) and very few mussels were collected.

The *P. capax* population of the lower Wabash River appears stable and is large relative to other sympatric mussels. The habitat for *P. capax* is slow to moderately flowing water around islands over a substrate composed of silt, mud, and sand. This report is a follow-up to a study of the distribution, status, and life-history of the fat pocketbook conducted in the lower Wabash River in 1989 (Cummings et al., 1990). The objectives of this study were to survey potential sites for *P. capax* at selected locations in the lower Wabash River and to collect and examine fishes for the presence of glochidia to determine the host(s) for *P. capax*.

METHODS

Mussel Sampling

Mussels were sampled in the lower Wabash River in August and September of 1991. Sites were chosen based on recent occurrence or likelihood of encountering live individuals of *P. capax*. Sampling was concentrated in the preferred habitat of *P. capax* (around islands in soft mud) from near the confluence of the White River (about 3 miles north of Mt. Carmel) downstream to Mink Island (just south of New Harmony) (Fig. 2). Specific islands investigated included:

1. unnamed islands at Grand Rapids, 1.75 miles north of Mt. Carmel, Wabash County, Illinois, T15S, R12W, sec 15/16.
2. Patoka Island, 0.5 miles southeast of Mt. Carmel, Gibson County, Indiana, T1S, R12W, sec. 28.
3. Coffee Island, Rochester, Wabash County, Illinois, T2S, R13W, sec. 14.
4. Mink Island, south of New Harmony, Posey County, Indiana, T5S, R14W, sec. 22/27.
5. unnamed island (=Capax Island), 3.5 miles southeast of New Haven, Ill., Posey County, Indiana, T8S, R15W, sec. 2.
6. Mackeys (=Hurricane) Island, Posey County, Indiana, T8S, R10E, sec. 13.

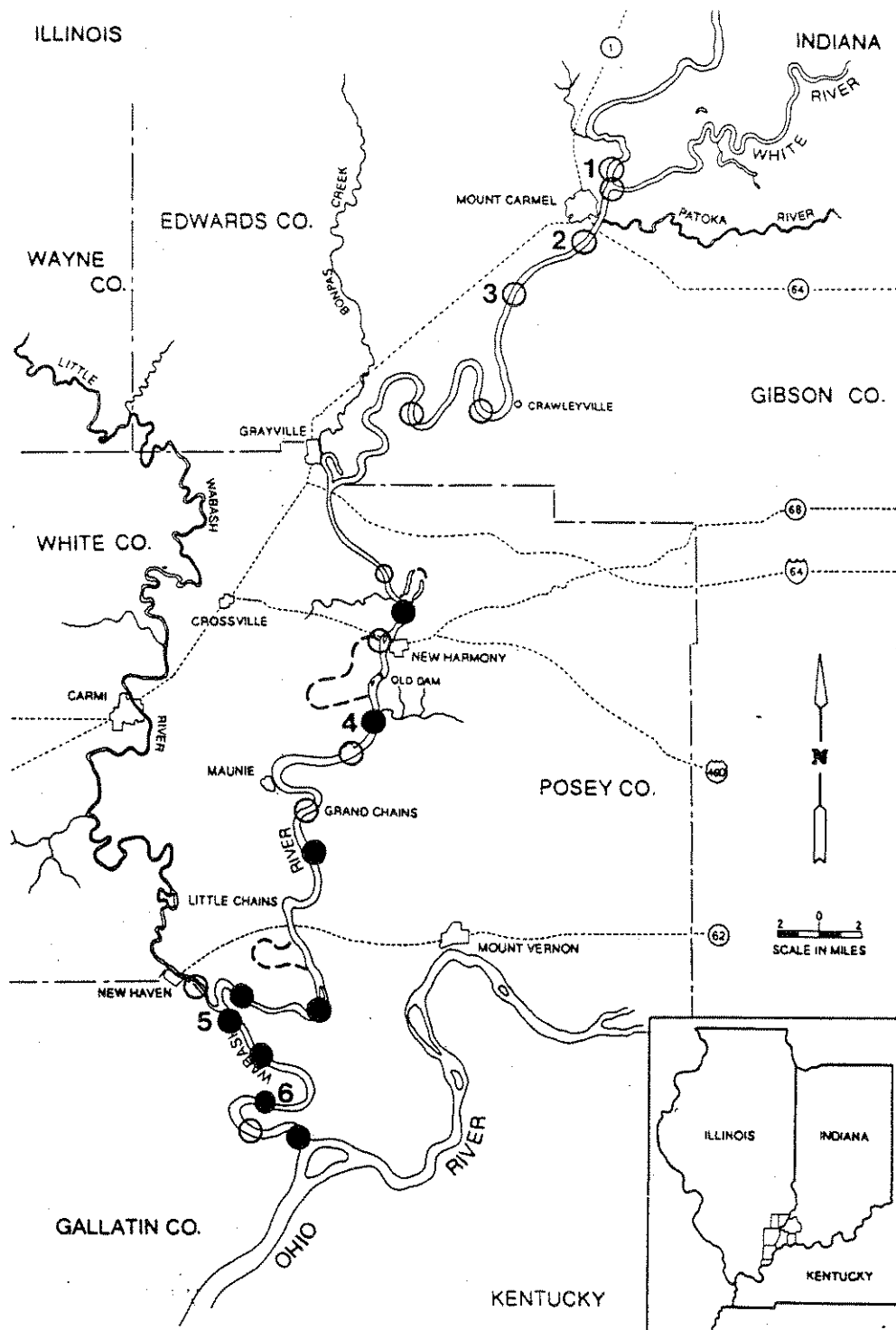


Figure 2. Distribution of the fat pocketbook, *Potamilus capax* (Green, 1832) in the lower Wabash River. Open circles represent locations of relict shells of *P. capax*, solid circles represent locations where live *P. capax* were found in 1987, 1989, and 1991. Numbers indicate sites sampled in 1991.

All live *P. capax* collected were measured to the nearest millimeter, photographed, and returned to the substrate. Additional data from Mink and Mackeys (=Hurricane) islands were provided by Ray Fisher, Illinois Department of Conservation (IDOC) - retired.

Fish Sampling

Fishes were collected monthly in the lower Wabash River at Capax Island from April through August 1992 in an attempt to identify the host(s) species for *P. capax*. This site was chosen because it was known to contain a relatively large population of fat pocketbooks. Collections were made with a 10' x 4' minnow seine on 16 April, 21 May, and 23 July and with a boat electroshocker on 16 April, 22 May, 26 June, and 28 August. All fishes (excluding endangered species) were preserved in 10% buffered formalin, returned to the laboratory, identified, counted, and measured (standard length). In the laboratory, opercular flaps were removed from each fish, and the gills and fins examined under a dissecting microscope. All fish species examined are listed in Table 1.

Identification of Glochidia

The ax-head shaped or ligulate glochidia of the genus *Potamilus* are unique and can be easily separated from all other genera in the family Unionidae found in the North America. Glochidia were identified to species using a key written by Cummings et al. (1990) and reproduced below. A detailed description of the glochidium of *P. capax* is also given.

Key to the Glochidia of *Potamilus* in the Wabash River Drainage.

- 1A. Glochidia large (over 300 um in height), hooks present, micropoints prominent on the ventral margin.....*Potamilus alatus*
- 1B. Glochidia small (under 200 um in height), with or without hooks, micropoints lamellar or much reduced.....2
- 2A. Glochidia with hooks, valves not equal in length, surface sculpture vermiculate, micropoints lanceolate and much reduced.....*P. capax*
- 2B. Glochidia without hooks, both valves equal in length, surface sculpture not vermiculate, micropoints lamellar.....*P. ohioensis*

Table 1. List of fish species examined for glochidia in the lower Wabash River, 1992.
(32 species, 599 individuals)

	# of Fish Examined	# Fish Infected (%)
LEPISOSTEIDAE (2)		
<i>Lepisosteus osseus</i>	1	
<i>Lepisosteus platostomus</i>	1	
HIODONTIDAE (1)		
<i>Hiodon alosoides</i>	1	
CLUPEIDAE (91)		
<i>Alosa chrysochloris</i>	1	
<i>Dorosoma cepedianum</i>	90	
CYPRINIDAE (198)		
<i>Cyprinella spiloptera</i>	72	
<i>Cyprinus carpio</i>	5	
<i>Ericymba buccata</i>	1	
<i>Hybognathus nuchalis</i>	9	
<i>Macrhybopsis storeriana</i>	1	
<i>Notropis atherinoides</i>	24	
<i>Notropis blennioides</i>	20	
<i>Notropis buchanaui</i>	4	
<i>Notropis ludibundus</i>	10	
<i>Phenacobius mirabilis</i>	1	
<i>Pimephales vigilax</i>	51	
CATOSTOMIDAE (79)		
<i>Carpionotus carpio</i>	2	
<i>Carpionotus cyprinus</i>	16	
<i>Carpionotus velifer</i>	58	2 (3%)
<i>Ictiobus bubalus</i>	3	
ICTALURIDAE (84)		
<i>Ictalurus furcatus</i>	6	
<i>Ictalurus punctatus</i>	77	1 (1%)
<i>Pylodictis olivaris</i>	1	
MORONIDAE (4)		
<i>Morone chrysops</i>	4	
CENTRARCHIDAE (23)		
<i>Lepomis cyanellus</i>	2	
<i>Lepomis humilis</i>	1	
<i>Lepomis macrochirus</i>	10	
<i>Lepomis megalotis</i>	3	
<i>Micropterus punctulatus</i>	5	
<i>Pomoxis nigromaculatus</i>	2	
PERCIDAE (6)		
<i>Stizostedion canadense</i>	6	
SCIAENIDAE (111)		
<i>Aplodinotus grunniens</i>	111	54 (49%)
TOTAL	599	56 (9%)

Potamilus capax (Green, 1832) - (Fig. 3 a-d). Glochidium small with a mean height of 172.10 ± 8.55 μm (range = 154 - 185 μm , N = 20). Ax-head shaped or ligulate, with lanceolate hooks at the lateral margins of the ventral flange (Fig. 3 a,b). The dorsal margin is straight to slightly curved, 55.90 ± 2.69 μm in length (range = 50 - 60 μm , N = 20), with small alae on either side of the hinge. Under low magnification, the surface appears smooth except near the dorsal end where it is slightly malleated or wrinkled. Under high magnification the surface sculpture is apparent and vermiculate (Fig. 3 d).

The ventral margin is slightly curved. The hooks are large in relation to the body size (Fig. 3 a,b). Micropoints are present on the ventral margin, but are extremely reduced and appear unorganized (Fig. 3 b). The valves are inflated and unequal at the ventral end with one side fitting inside the other (Fig. 3 a,c). A large lateral valve gape is present.

RESULTS & DISCUSSION

Distribution and Status

In 1989, a survey for *P. capax* was conducted at 14 sites from the confluence of the Wabash and Ohio rivers upstream to three miles north of New Harmony (Fig. 2). A total of 67 live *P. capax* was found at four of the sites, and fresh-dead shells were present at an additional site. Sixty-two of the 67 *P. capax* found were collected by hand, although a brail was used at all sites.

Most of the live *P. capax* were found around three islands. Two of the islands were adjacent to one another and are connected during periods of low flow. At this site (Capax Island), fat pocketbooks were relatively common in a narrowly defined area on the downward slope of the island and at the point where the slope met the stream bed. All were found in fine silt and mud, between 50-150 mm thick, overlying a stable sand substrate. Most were collected from depths of 25 to 150 cm in water currents of 0.00 - 0.33 meters per second.

Surveys were made at six islands in 1991 in order to determine if *P. capax* occurred in similar habitat throughout the lower Wabash River and to see if we could extend the known distribution for the species upstream (Fig. 2). A list of the sites visited and the species found is given in Appendix I.

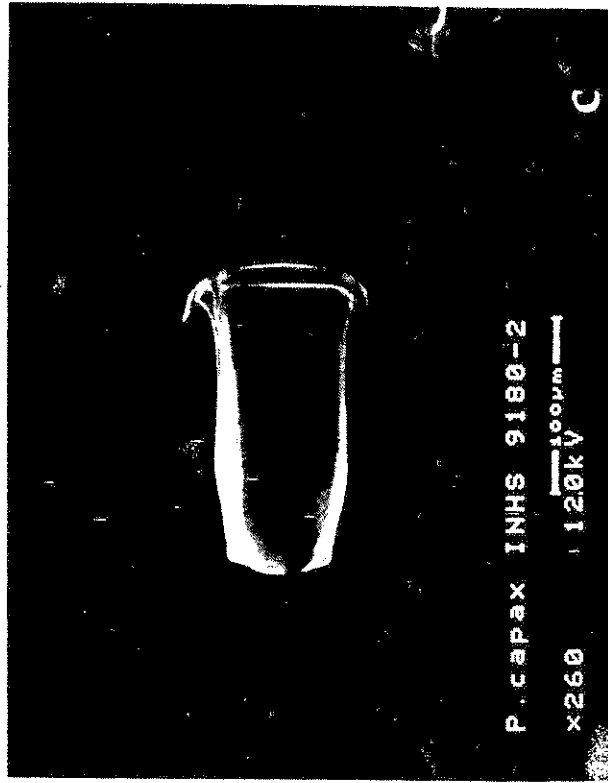
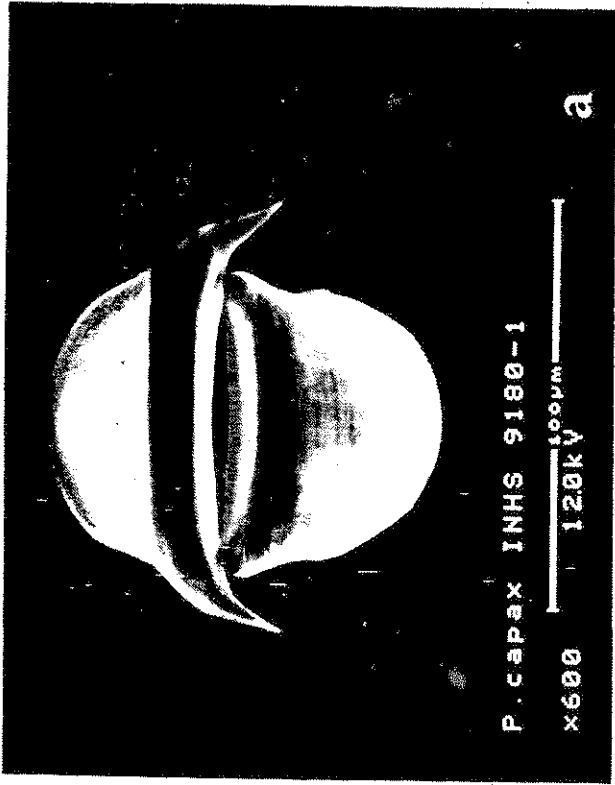


Figure 3. Glochidia of *Potamilus capax*, INHS 9180, St. Francis Floodway, Cross County, Arkansas.
(a) ventral view, (b) close-up the the ventral-lateral hook, (c) exterior valve, (d) surface sculpture.

No live fat pocketbooks were found upstream from where they were collected in 1989. However, live *P. capax* were present at Mink and Mackeys islands in Posey County, Indiana in August and September 1991. In August, six individuals were found on the west side of the island by IDOC biologist Ray Fisher. In September, an additional eight individuals were found in a pool on the west side of the island. The pool, separated from the river due to receding waters, measured approximately 200' long by 50' wide with a maximum depth of one foot. Substrate in the pool was mostly silt, mud, and sand. Another 46 individuals were found stranded by receding waters at Mackeys Island near the confluence with the Ohio River by Ray Fisher (IDOC) in August 1991. All *P. capax* were measured and returned to the river. A summary of the size classes for Mink and Mackeys islands is given in Table 2. The mussels ranged from 63 to 129 mm in length, with a mean of 87 mm. No juveniles were found in 1991 and the level of recruitment is unknown.

Table 2. *Potamilus capax* size classes for Mink and Mackeys islands, Wabash River, 1991.

Wabash River, W side of Mink Island, T5S, R14W, sec. 22/27, Posey County, Indiana, 29 August and 25 September 1991.						
60-69	70-79	80-89	90-99	100-109	110-119	120-129
	3	3	2	2	1	3
Wabash River, Indiana side of Mackeys (=Hurricane) Island, T8S, R10E, sec. 13 Posey County, Indiana, 27-28 August 1991.						
60-69	70-79	80-89	90-99	100-109	110-119	120-129
2	14	14	15	1		

From this information it appears that *P. capax* occurs in suitable habitat from the Ohio River upstream to just north of New Harmony, Indiana (Fig. 2). Efforts to locate a population above this point were unsuccessful. Factors limiting the upstream range of *P. capax* in the Wabash River are unclear but may be due to habitat constraints of the host species. Records for the freshwater drum, a possible primary host for *P. capax*, are rare above the confluence of the Wabash and White rivers and may explain the absence of the fat pocketbook above this point (Gerking, 1945; Smith, 1979). In addition, the substrate above the mouth of the White River is largely composed of gravel and islands are scarce.

Host Species and Reproduction

Recent work by Neves and co-workers (Zale and Neves, 1982; Neves et al., 1985; Yeager and Neves 1986; Neves and Widlak, 1988) has shown a striking example of host specificity as it relates to the higher classification of fishes and unionids. Their studies documented a strong relationship between subfamilies of mussels and orders or subclasses of fishes. Although there are exceptions, cypriniforms and siluriforms (Ostariophysi) most often serve as hosts for mussels in the subfamily Ambleminae, while perciforms are the most commonly recognized hosts for lampsilines. Salmoniforms are the primary host for members of the subfamily Margaritiferinae while anodontines appear to be the least selective in respect to host specificity.

Gravid Period

Members of the freshwater mussel genus *Potamilus* are in the subfamily Lampsilinae and are considered long term breeders or bradytictic. In bradytictic species the eggs are fertilized in the late summer, mature in the fall and winter, and are carried in the marsupium until the following spring or summer when they are released to infect the appropriate host(s).

Gravid females of the pink heelsplitter, *Potamilus alatus*, were found from fall through early winter in Pool 7 of the Mississippi River. Glochidia were released from late May to early July (Holland-Bartels and Kammer, 1989). Surber (1913) reported females of *Potamilus ohioensis* with mature glochidia from the Mississippi River near Fairport, Iowa during April, June, and September. He further stated that fishes encysted with glochidia for *P. ohioensis* could be found almost year round, and that the period of parasitism likely lasted from September to the following October. However, only 2% of fish taken from June to November had encysted glochidia of *P. ohioensis*.

Surber (1912) and Coker et al., (1921) reported females of *P. capax* with glochidia in June, July, August, and September in the Mississippi River. Females collected from the Mississippi River on 5 October and from the Wabash River on 8 August were reported to be gravid and possess mature glochidia (Ortmann, 1914). A gravid female was taken in the Cumberland River at its confluence with the Ohio River in December of 1987 (Sickel, 1987).

Mussel Hosts at Capax Island

During this study, 599 fishes of 32 species were collected from April through August 1992 in the lower Wabash River and inspected for glochidia. The fish fauna at the study site was

dominated numerically by Cyprinidae (33%) followed by Scienidae (19%), Clupeidae (15%), Ictaluridae (14%), and Catostomidae (13%). Individuals in the remaining five families made up only 6% of the fauna (Table 1). Fifty-six individuals (9%) of three species were infected with a total of 633 encysted glochidia. A month by month listing of the fish species, number collected, range and mean size, number infected, and the number and species of glochidia are given in Appendices II and III.

The three fish species and percent with glochidia were as follows: freshwater drum, *Aplodinotus grunniens* (Scienidae) (49%); highfin carpsucker, *Carpionodes velifer* (Catostomidae) (3%) and channel catfish, *Ictalurus punctatus* (Ictaluridae) (1%). Glochidial infestations ranged from one to 103, and averaged 11 per infected fish. Glochidia of *P. ohioensis* were the most common species found in April and *Truncilla sp.* was dominant in June. The three fish species with encysted glochidia are discussed in detail below.

Freshwater Drum - *Aplodinotus grunniens*

The freshwater drum is the known host for 11 species of mussels including three species currently placed in the genus *Potamilus* (*P. alatus*, *P. purpuratus*, and *P. ohioensis*) (Coker and Surber, 1911; Howard, 1913; Surber, 1913). Howard and Anson (1922) speculated on the drum as the host of *P. capax* and stated that "certain species of mussels in their parasitism are restricted to a single species or genus of hosts. A striking example of adaptation is that of *Aplodinotus grunniens* Raf. which is the sole known carrier of eight or more species of mussels" including *Potamilus alatus*, *P. purpuratus*, *P. capax* (probable), *P. ohioensis*, *Leptodea fragilis*, *Truncilla donaciformis*, *T. truncata*, and *Ellipsaria lineolata*. Other glochidia reported from freshwater drum include: *Megaloniais nervosa*, *Anodonta grandis*, *Arcidens confragosus*, and *Lampsilis higginsii* (Wilson, 1916; Surber, 1913; Hoggarth, 1992).

During this study, 54 of 111 (49%) freshwater drum examined were found with encysted glochidia. At least five different species were found on drum including: *Potamilus capax*, *P. alatus*, *P. ohioensis*, *Leptodea fragilis*, and *Truncilla sp.* The species of *Truncilla* were not positively identified to species but were thought to be *T. donaciformis*. All except *P. capax* have been previously verified as occurring on drum (Hoggarth, 1992).

The most common glochidia found were *Potamilus ohioensis*, and this species was restricted to freshwater drum in this study. Glochidia of *P. ohioensis* were found only on drum

collected in April and May. The greatest infestation occurred in April with 68% of the drum bearing glochidia. In April, 26 of 27 drum with encysted glochidia had from one to 61 *P. ohiensis* attached with a average of 16 per fish (Appendix III). Three of five infested drum collected in May contained glochidia of *P. ohiensis*.

The second most common species found on drum was *Truncilla*, encysted on 17 of the 18 infested fishes examined in June. Glochidia of *Truncilla* were found in April, June, July, and August, but were most common in June (Appendix III). *Leptodea fragilis* was the third most common species found, but were present on only six of 111 drum examined. Two glochidia of *Potamilus alatus* were found on drum, one in April and one in May. A single glochidium of *P. capax* was found on a drum (125.1 mm standard length) collected in June. Although this individual was the only evidence of *P. capax* found, it was completely encysted and there was no indication that it would be sloughed or rejected.

Highfin Carpsucker - *Carpionodes velifer*

We found three glochidia on two individuals of the highfin carpsucker in the May sample (Appendix III). They have not been identified to species at this time but are members of the subfamily Anodontinae. Glochidia of anodontines are usually attached externally on the fins, but are occasionally attached to gills. The only anodontines found in the lower Wabash River today are *Anodonta grandis*, *A. imbecillis*, *Arcidens confragosus*, and *Lasmigona complanata* (Cummings et al., 1992). A review of the literature suggests that catostomids are unlikely as hosts of the fat pocketbook. All reported glochidia found on suckers have been anodontines with the exceptions of *Megalonaias nervosa* found on *Carpionodes velifer* (Howard, 1914, Coker et al., 1921) and *Margaritifera falcata* found on *Catostomus tahoensis* (Murphy, 1942). The known catostomid-unionid relationships are as follows: *Catostomus commersoni* - *Anodonta cataracta*, *A. implicata*, *Alasmidonta marginata* (Wiles, 1975; Davenport and Warmuth, 1965; Howard and Anson, 1922); *Moxostoma macrolepidotum* - *Alasmidonta marginata*; *Hypentelium nigricans* - *Alasmidonta marginata* (Howard and Anson, 1922).

Channel Catfish - *Ictalurus punctatus*

A single individual out of 77 channel catfish examined was found with two encysted glochidia (Appendices II and III). Based on size and shape they are provisionally identified as *Quadrula quadrula*. Although common at the study site and a known feeder on mollusks (Forbes and Richardson, 1908) channel catfish are not likely hosts of *P. capax*. Channel catfish and other ictalurids are rarely reported as hosts of lampsilines, and are primarily

associated with amblemines. With the exceptions of *Anodonta grandis* reported from the yellow bullhead, *Ameiurus natalis*, and *Actinonaias ligamentina* and *Lampsilis siliquoidea* reported from the tadpole madtom, *Noturus gyrinus*, all glochidia found on catfish have been amblemines. Glochidia reported from channel catfish include *Megalonaias nervosa*, *Quadrula nodulata*, and *Q. pustulosa*. The other known ictalurid-unionid relationships are as follows: *Ameiurus nebulosus*, *Ameiurus melas* - *Megalonaias nervosa*, *Quadrula pustulosa*; *Noturus gyrinus* - *Megalonaias nervosa*; *Pylodictus olivaris* - *Megalonaias nervosa*, *Quadrula quadrula*, *Q. nodulata*, *Q. pustulosa*, *Elliptio dilatata* (Howard, 1913; 1914, Wilson, 1916; Coker et al., 1921; Howard and Anson, 1922; Hoggarth, 1992).

Other Fishes

The three fish species on which glochidia were found were among the top five most abundant fishes collected at the study site. Gizzard shad, *Dorosoma cepedianum*, and spotfin shiners, *Cyprinella spiloptera*, were ranked second and fourth in terms of abundance, but were devoid of glochidia. Gizzard shad have been reported as hosts to four species of mussels: *Anodonta grandis*, *Arcidens confragosus*, *Megalonaias nervosa*, and *Elliptio dilatata* (Hoggarth, 1992), and spotfin shiners are the known host of only one species, *Quadrula cylindrica* (Yeager and Neves, 1986). None of the five mussels listed above are common in the lower Wabash River today. Although no perciforms other than freshwater drum were found with glochidia, the sample size was small (N = 33) and additional effort should be placed on this group in trying to determine the host(s) for *P. capax*.

Incidence of Parasitism

Holland-Bartels and Kammer (1989) examined the reproductive period and host relationship of three species (*Amblema plicata*, *Lampsilis cardium*, and *Potamilus alatus*) in the Upper Mississippi River. They found that only 4% of nearly 2000 fishes collected had infestations, with a mean of three glochidia per fish. Twelve of the 33 species of fishes they examined were infested (7 Cyprinidae, 1 each of Esocidae, Catostomidae, Moronidae, Centrarchidae, and Percidae) but no species list was given. Of the perciforms examined, 24% were infested, with an average of six glochidia per fish. This high incidence of parasitism points to the importance of perciforms in mussel reproduction in general and lampsilines specifically.

In the North Fork Holston River, Neves and Widlak (1988) reported 14% of 4800 fishes collected with encysted glochidia (41 species in 7 families collected; 23 species in 4 families

with glochidia). Most infected fish had light infestations averaging from one to ten glochidia. Overall, 79% of lampsiline-infected hosts had ten or fewer glochidia attached compared with 47% for amblemine-infested hosts.

In trying to determine the host for *Lampsilis siliquoidea*, Trdan (1981) examined 18 species of fishes from eight families. He reported glochidial infestations on seven species (all perciforms). The percent infected ranged from 1.9 on bluegill to 11.1 on largemouth bass. The intensity of infestation ranged from one to 58 glochidia per fish; the mean number per host ranged from four to 18, and averaged a little over 13 for all hosts combined.

In this study, 56 of 599 individuals (9%) of three species were found with 633 encysted glochidia. The intensity of infestation ranged from one to 103 glochidia per fish, with an average of 11 for all hosts combined. The numbers of individuals and species of glochidia found approximate the relative abundance of adult mussels at Capax Island with the exception of two species: 1.) The fat pocketbook, one of the most common species found at the study site, was only found on one fish; 2.) The large number of *Truncilla* found is not consistent with the composition of the resident mussel fauna (Appendix D). Possible explanations for the lack of *P. capax* on the fish we examined are: 1.) We missed the release period during our monthly sampling period (April - August); 2.) *P. capax* releases glochidia during the fall or winter; 3.) *P. capax* did not release glochidia or reproduce in 1992.

Zale and Neves (1982) reported that *Medionidus conradicus* released glochidia almost throughout the year, beginning in September and lasting well into summer, stopping during embryogenesis in July and August. In order to resolve the host question for *P. capax*, additional collecting should be done throughout the year with more intensive collecting during the spring and summer. However, the size of the river and extreme fluctuations in water level make collecting fish difficult and manpower intensive. Although we found encysted glochidia on freshwater drum, other species like the sauger should still be investigated. Our sample size of perciforms other than drum may not be large enough to rule out the other species in this order as potential hosts.

CONCLUSIONS AND RECOMMENDATIONS

The *P. capax* population of the lower Wabash River appears stable and is fairly large relative to sympatric mussel species. We suggest that several steps be taken to insure its viability based on requirements of the species, and what we perceive to be actual and potential threats. Because the total area occupied is not large, disturbances to the lower Wabash River could have a major negative impact on *P. capax*.

1. Islands and their immediate surroundings must be protected, especially from dredging and channelizing operations. We also recommend that these types of operations be avoided on a large scale anywhere in the lower Wabash River.
2. Siltation and pollution are threats generated by agricultural runoff and urban/industrial waste. The increasing awareness of the problems associated with soil erosion and efforts to control it will undoubtedly be of benefit to *P. capax* and the entire aquatic community. We recommend that the appropriate governmental agencies insure that legally established water quality standards are met.
3. As stated in the recovery plan, monitoring at not more than 3-year intervals should be done to determine the viability of a population (USFWS, 1989). The Wabash River population should be placed on a monitoring schedule to check for changes in status and distribution.
4. The host species for *P. capax* appears to be the freshwater drum, *Aplodinotus grunniens*. However, only a single drum with one glochidia of *P. capax* was found in this study. Additional laboratory studies should be conducted to verify field observations. We recommend that additional work be done looking at freshwater drum and other perciforms throughout the year and that laboratory studies on transformation be conducted to verify field observations.
5. Before relocation projects are conducted, the Wabash River and Arkansas populations should be analyzed genetically to determine if differences exist. Genetic differences in the two populations could be a major consideration in future management of the species.

ACKNOWLEDGEMENTS

This study was supported by a grant from the U.S. Fish and Wildlife Service (USFWS), Region 3, under Section 6 of the Endangered Species Act. That grant was administered by the Illinois Department of Conservation (IDOC). We would especially like to thank Les Frankland and Ray Fisher of IDOC for their generous help in collecting and discussion on river ecology. Thanks to Glen Kruse and Mike Sweet (IDOC), Sue Lauzon (Illinois Endangered Species Protection Board), and Ron Refsnider (USFWS) for help in getting this project funded.

LITERATURE CITED

- Bates, J.M., and S.D. Dennis. 1983. Mussel (naiad) survey - St. Francis, White, and Cache Rivers, Arkansas and Missouri. Final Report. U. S. Army Engineer District, Memphis, Tennessee 89 pp. + appendices.
- Coker, R.E., and T. Surber. 1911. A note on the metamorphosis of the mussel *Lampsilis laevis*. Biological Bulletin 20:179-182.
- Coker, R.E., A.F. Shira, H.W. Clark, and A.D. Howard. 1921. Natural History and propagation of fresh-water mussels. Bulletin of the U.S. Bureau of Fisheries 37(893):1-181.
- Cummings, K.S., M.E. Retzer, C.A. Mayer, and L.M. Page. 1990. Life history aspects and status of the federally endangered fat pocketbook, *Potamilus capax* (Green, 1832) (Mollusca: Unionidae) in the lower Wabash River, Illinois and Indiana. Center for Biodiversity Technical Report 1990(1). Illinois Natural History Survey, Champaign, Illinois 37 pp.
- Cummings, K. S., C. A. Mayer, and L. M. Page. 1992. Survey of the freshwater mussels (Mollusca: Unionidae) of the Wabash River drainage. Final Report. Prepared for the Indiana Department of Natural Resources, Division of Fish & Wildlife. Illinois Natural History Survey, Center for Biodiversity Technical Report 1992(1b):iii + 201 pp.
- Davenport, D., and M. Warmuth. 1965. Notes on the relationship between the freshwater mussel *Anodonta implicata* Say and the alewife *Polombus pseudoharengus* (Wilson). Limnology and Oceanography 10(supplement):R74:R78.
- Forbes, S.A., and R.E. Richardson. 1908. The fishes of Illinois. Illinois State Laboratory of Natural History cxxi + 357 pp.
- Gerking, S.D. 1945. The distribution of the fishes of Indiana. Investigations of Indiana Lakes and Streams 3(1):1-137.
- Hoggarth, M.A. 1992. An examination of the glochidia-host relationships reported in the literature for North American species of Unionacea (Mollusca: Bivalvia). Malacology Data Net 3(1-4):1-30.
- Holland-Bartels, L.E., and T.W. Kammer. 1989. Seasonal development of *Lampsilis cardium*, *Amblema plicata plicata*, and *Potamilus alatus* (Pelecypoda: Unionidae) in the Upper Mississippi River. Journal of Freshwater Ecology 5(1):87-92.
- Howard, A.D. 1913. The catfish as a host for fresh-water mussels. Transactions of the American Fisheries Society 42:65-70.
- Howard, A.D. 1914. Some cases of narrowly restricted parasitism among commercial species of fresh water mussels. Transactions of the American Fisheries Society 44(1):41-44
- Howard, A.D., and B.J. Anson. 1922. Phases in the parasitism of the Unionidae. Journal of Parasitology 9(2):68-82.

- Murphy, G. 1942. Relationship of the fresh-water mussel to trout in the Truckee River. *California Fish and Game* 28(2):89-102.
- Neves, R.J., L.R. Weaver, and A.V. Zale. 1985. An evaluation of host suitability for glochidia of *Villosa vanuxemi* and *V. nebulosa* (Pelecypoda: Unionidae). *American Midland Naturalist* 113(1):13-19.
- Neves, R.J., and J.C. Widlak. 1988. Occurrence of glochidia in stream drift and on fishes of the upper North Fork Holston River, Virginia. *American Midland Naturalist* 119(1):111-120.
- Ortmann, A.E. 1914. Studies in najades (cont.). *Nautilus* 28(5):65-69.
- Sickel, J.B. 1987. Preliminary survey for endangered freshwater mussels at Cumberland Island Towhead, confluence of the Cumberland and Ohio Rivers, Livingston County, Kentucky. Report prepared for Donan Engineering, Inc. P.O. Box 528, 444 South Main St., Madisonville, Kentucky 42431. 9 pp.
- Smith, P.W. 1979. The fishes of Illinois. University of Illinois Press, Urbana, Illinois xxix + 314 pp.
- Surber, T. 1912. Identification of the glochidia of freshwater mussels. U.S. Bureau of Fisheries Document No. 771 10 pp + 3 plates.
- Surber, T. 1913. Notes on the natural hosts of fresh-water mussels. *Bulletin of the U.S. Bureau of Fisheries* 32:110-116 + 3 plates.
- Trdan, R.J. 1981. Reproductive biology of *Lampsilis radiata siliquoidea* (Pelecypoda: Unionidae). *American Midland Naturalist* 106(2):243-248.
- U.S. Fish and Wildlife Service. 1976. *Federal Register* 41:24064.
- U.S. Fish and Wildlife Service. 1989. A recovery plan for the fat pocketbook pearly mussel *Potamilus capax* (Green, 1832). U.S. Fish and Wildlife Service. Atlanta, Georgia 22 pp.
- Wiles, M. 1975. The glochidia of certain Unionidae (Mollusca) in Nova Scotia and their fish hosts. *Canadian Journal of Zoology* 53(1):33-41.
- Wilson, C.B. 1916. Copepod parasites of fresh-water fishes and their relations to mussel glochidia. *Bulletin of the U.S. Bureau of Fisheries* 34:333-374 + 15 plates.
- Yeager, B.L., and R.J. Neves. 1986. Reproductive cycle and fish hosts of the rabbit's foot mussel, *Quadrula cylindrica strigillata* (Mollusca: Unionidae) in the upper Tennessee River drainage. *American Midland Naturalist* 116(2):329-340.
- Zale, A.V., and R.J. Neves. 1982. Fish hosts of four species of lampsiline (Mollusca: Unionidae) in Big Moccasin Creek, Virginia. *Canadian Journal of Zoology* 60:2535-2542.

Appendix I. Bivalve collections in the lower Wabash River, 1991.
(L = live, D = dead, WD = weathered dead, SF = subfossil)

Site 1. Wabash River, unnamed islands at Grand Rapids, 1.75 mi N Mt. Carmel, Wabash County, Illinois, T15S, R12W, sec. 15/16, 29 August 1991, K.S. Cummings & C.A. Mayer

INHS 12341	<i>Cumberlandia monodonta</i>	2WD
INHS 12342	<i>Leptodea fragilis</i>	2L
INHS 12343	<i>Obliquaria reflexa</i>	2D
INHS 12344	<i>Potamilus ohioensis</i>	2L
INHS 12345	<i>Corbicula fluminea</i>	2L

Site 2. Wabash River, Patoka Island, 0.5 mi SE Mt. Carmel, Gibson County, Indiana, T1S, R12W, sec. 28, 29 August 1991, K.S. Cummings & C.A. Mayer

INHS 12356	<i>Potamilus ohioensis</i>	2L, gravid
INHS 12357	<i>Corbicula fluminea</i>	5L

Site 3. Wabash River, Coffee Island, at Rochester, Wabash County, Illinois, T2S, R13W, sec. 14, NE, 26 September 1991, K.S. Cummings & C.A. Mayer

INHS 13004	<i>Amblema plicata</i>	2L
INHS 13005	<i>Anodonta grandis</i>	1D
INHS 13006	<i>Arcidens confragosus</i>	1WD
INHS 13007	<i>Ellipsaria lineolata</i>	1WD
INHS 13008	<i>Elliptio crassidens</i>	1L, 2D
INHS 13009	<i>Fusconaia ebena</i>	1WD
INHS 13010	<i>Lampsilis cardium</i>	2L, gravid
INHS 13011	<i>Lasmigona complanata</i>	1D
INHS 13012	<i>Leptodea fragilis</i>	3L, gravid
INHS 13013	<i>Obliquaria reflexa</i>	4L
INHS 13014	<i>Obovaria olivaria</i>	2L, 2D
INHS 13015	<i>Potamilus alatus</i>	1D
INHS 13016	<i>Potamilus ohioensis</i>	1D
INHS 13017	<i>Quadrula cylindrica</i>	1SF
INHS 13018	<i>Quadrula nodulata</i>	1L
INHS 13019	<i>Quadrula quadrula</i>	4L
INHS 13020	<i>Tritogonia verrucosa</i>	3L
INHS 13021	<i>Truncilla donaciformis</i>	1L
INHS 13022	<i>Truncilla truncata</i>	2L
INHS 13023	<i>Corbicula fluminea</i>	16L

Site 4. Wabash River, Mink Island, W side of island, Posey County, Indiana, T5S, R14W, sec. 22/27, 25 September 1991, K.S. Cummings & C.A. Mayer

INHS 13401	<i>Anodonta grandis</i>	1D
INHS 13402	<i>Epioblasma triquetra</i>	1SF
INHS 13403	<i>Lampsilis cardium</i>	1D
INHS 13404	<i>Lampsilis teres</i>	2D
INHS 13405	<i>Lasmigona complanata</i>	1D
	<i>Leptodea fragilis</i>	8L
INHS 13406	<i>Obliquaria reflexa</i>	1D
INHS 13407	<i>Obovaria olivaria</i>	2D
INHS 13408	<i>Potamilus capax</i>	8L, 22D
INHS 13409	<i>Potamilus ohioensis</i>	9L, 1D
INHS 13431	<i>Quadrula nodulata</i>	1D
	<i>Quadrula quadrula</i>	6L
	<i>Tritogonia verrucosa</i>	1L
INHS 13410	<i>Truncilla donaciformis</i>	1D
INHS 13411	<i>Truncilla truncata</i>	1D
INHS 13412	<i>Corbicula fluminea</i>	1D

Site 4. Wabash River, below Mink Island, E bank Wabash River, Posey County, Indiana, T5S, R14W, sec. 27, NE, 25 September 1991, K.S. Cummings & C.A. Mayer

INHS 13114	<i>Amblema plicata</i>	1L
INHS 13115	<i>Elliptio crassidens</i>	1D
INHS 13116	<i>Lampsilis cardium</i>	2D
INHS 13117	<i>Leptodea fragilis</i>	1L, 1D
INHS 13118	<i>Obliquaria reflexa</i>	1L, 3D, 1WD
INHS 13119	<i>Obovaria olivaria</i>	19L, 3D
INHS 13120	<i>Potamilus alatus</i>	1D
INHS 13121	<i>Potamilus capax</i>	4D
INHS 13122	<i>Potamilus ohioensis</i>	1D
INHS 13123	<i>Quadrula pustulosa</i>	2L, 2D
INHS 13124	<i>Quadrula quadrula</i>	4L, 1D
INHS 13125	<i>Tritogonia verrucosa</i>	15L, 3D
INHS 13126	<i>Truncilla donaciformis</i>	3D
INHS 13127	<i>Truncilla truncata</i>	3D
INHS 13128	<i>Corbicula fluminea</i>	1D

Site 4'. Wabash River, rm 38.8, below Mink Island, W bank across from Harmonie State Park, White County, Illinois, T5S, R14W, sec. 27, NW, 25 September 1991, K.S. Cummings & C.A. Mayer

	<i>Amblema plicata</i>	1L
INHS 13433	<i>Obliquaria reflexa</i>	2D
INHS 13434	<i>Obovaria olivaria</i>	1D
INHS 13435	<i>Potamilus capax</i>	2D
	<i>Potamilus ohioensis</i>	1L
INHS 13436	<i>Quadrula cylindrica</i>	1SF

Site 5. Wabash River, 3.5 mi SE New Haven, Illinois, Capax Island, Posey County, Indiana, T8S, R15W, sec. 2, 30 August 1991, K.S. Cummings & C.A. Mayer

INHS 12346	<i>Anodonta grandis</i>	2L
INHS 12347	<i>Lasmigona complanata</i>	1D
INHS 12348	<i>Leptodea fragilis</i>	3L
INHS 12349	<i>Obovaria olivaria</i>	1L
INHS 12350	<i>Potamilus alatus</i>	1D
INHS 12351	<i>Potamilus capax</i>	3L, 24D
INHS 12352	<i>Potamilus ohioensis</i>	6L
INHS 12353	<i>Quadrula nodulata</i>	11WD
INHS 12354	<i>Truncilla donaciformis</i>	11WD
INHS 12355	<i>Corbicula fluminea</i>	2L

Site 6. Wabash River, Mackeys (=Hurricane) Island, Posey, Indiana, T8S, R10E, sec. 13, SE, 27 & 28 August 1991, R. Fisher

INHS 13104	<i>Amblema plicata</i>	1D
INHS 13129	<i>Anodonta grandis</i>	1D
INHS 13105	<i>Lampsilis cardium</i>	1D
INHS 13130	<i>Lampsilis cardium</i>	1D
INHS 13106	<i>Lampsilis teres</i>	1D
INHS 13107	<i>Leptodea fragilis</i>	1D
INHS 13108	<i>Obliquaria reflexa</i>	2D
INHS 13109	<i>Obovaria olivaria</i>	2D
INHS 13110	<i>Potamilus alatus</i>	1D
INHS 13111	<i>Potamilus capax</i>	15L, 22D
INHS 13131	<i>Potamilus capax</i>	31L, 15D, 6WD
INHS 13112	<i>Potamilus ohioensis</i>	2D
INHS 13132	<i>Quadrula nodulata</i>	1WD
INHS 13113	<i>Corbicula fluminea</i>	1D

Appendix II. Month by month listing of fish species, number collected, mean size, size range, and number infected from sites on the lower Wabash River, 1992.
(All measurements in millimeters)

1 mi N New Harmony, White Co., IL T4S, R14W, sec. 25. 16 April 1992 (Seine & Shock)

	# of Fish	Mean Size	Range	# Fish Infected
CLUPEIDAE				
<i>Dorosoma cepedianum</i>	55	123.6	60.0 - 262.0	-
CYPRINIDAE				
<i>Cyprinus carpio</i>	4	494.0	397.0 - 597.0	-
<i>Cyprinella spiloptera</i>	35	36.7	23.6 - 48.5	-
<i>Hybognathus nuchalis</i>	1	73.8	-	-
<i>Notropis atherinoides</i>	13	65.2	43.4 - 74.1	-
<i>Notropis blennioides</i>	8	41.0	32.2 - 53.3	-
<i>Notropis burchanani</i>	4	32.2	30.7 - 34.8	-
<i>Pimephales vigilax</i>	19	31.3	22.8 - 40.1	-
CATOSTOMIDAE				
<i>Carpodes cyprinus</i>	11	65.0	29.8 - 90.2	-
<i>Carpodes velifer</i>	42	66.2	26.3 - 195.0	-
ICTALURIDAE				
<i>Ictalurus punctatus</i>	39	75.3	42.9 - 523.0	-
CENTRARCHIDAE				
<i>Lepomis humilis</i>	1	32.9	-	-
SCIAENIDAE				
<i>Aplodinotus grunniens</i>	40	95.5	83.0 - 205.0	27 (68%)
TOTAL	272			27 (10%)

Mink Island, Harmonie State Park, Posey Co., IN T5S, R14W, sec. 27. 21 May 1992 (Seine & Shock)

	# of Fish	Mean Size	Range	# of Fish Infected
CLUPEIDAE				
<i>Dorosoma cepedianum</i>	19	132.9	86.5 - 290.0	-
CYPRINIDAE				
<i>Cyprinella spiloptera</i>	20	54.8	45.6 - 63.3	-
<i>Ericymba buccata</i>	1	47.6		-
<i>Hybognathus nuchalis</i>	3	71.0	66.5 - 75.8	-
<i>Notropis atherinoides</i>	10	60.4	49.5 - 72.1	-
<i>Notropis blennioides</i>	12	50.3	41.6 - 58.6	-
<i>Pimephales vigilax</i>	21	32.1	26.9 - 40.3	-
CATOSTOMIDAE				
<i>Carpionotus carpio</i>	1	390.0		-
<i>Carpionotus cyprinoides</i>	1	130.1		-
<i>Carpionotus velifer</i>	12	60.1	38.0 - 80.6	2 (17%)
<i>Ictalurus bubalus</i>	1	375.0		-
ICTALURIDAE				
<i>Ictalurus furcatus</i>	3	308.0	109.0 - 415.0	-
<i>Ictalurus punctatus</i>	10	178.7	55.6 - 385.0	-
MORONIDAE				
<i>Morone chrysops</i>	1	128.2		-
CENTRARCHIDAE				
<i>Lepomis macrochirus</i>	1	44.5		-
<i>Micropterus punctulatus</i>	1	103.1		-
<i>Pomoxis nigromaculatus</i>	1	185.0		-
PERCIDAE				
<i>Stizostedion canadense</i>	1	143.1		-
SCIAENIDAE				
<i>Aplodinotus grunniens</i>	17	136.9	88.6 - 302.0	5 (29%)
TOTAL	136			7 (5%)

3.5 mi SE New Haven, at Island, Posey, Co., IN T8S, R15W, sec. 2. 26 June 1992 (Shock).

	# of Fish	Mean Size	Range	# of Fish Infected
LEPISOSTEIDAE				
<i>Lepisosteus platostomus</i>	1	520.0		-
CLUPEIDAE				
<i>Dorosoma cepedianum</i>	6	123.1	100.2 - 185.0	-
CYPRINIDAE				
<i>Cyprinella spiloptera</i>	14	39.6	30.5 - 51.4	-
<i>Notropis atherinoides</i>	1	76.4		-
<i>Pimephales vigilax</i>	3	35.6	33.3 - 37.1	-
CATOSTOMIDAE				
<i>Carpiodes cyprinus</i>	4	108.9	80.7 - 141.1	-
ICTALURIDAE				
<i>Ictalurus punctatus</i>	18	90.5	65.2 - 245.0	1 (6%)
MORONIDAE				
<i>Morone chrysops</i>	1	153.8		-
CENTRARCHIDAE				
<i>Lepomis cyanellus</i>	1	67.2		-
<i>Lepomis macrochirus</i>	5	90.8	85.0 - 100.2	-
<i>Lepomis megalotis</i>	1	58.9		-
<i>Pomoxis nigromaculatus</i>	1	171.2		-
PERCIDAE				
<i>Stizostedion canadense</i>	5	181.0	152.1 - 200.0	-
SCIAENIDAE				
<i>Aplodinotus grunniens</i>	27	108.7	85.4 - 141.0	18 (67%)
TOTAL	88			19 (22%)

Below Mink Island, across from Harmonie State Park Boat Ramp, White Co., IL T5S, R14W, sec. 27. 23 July 1992 (Seine).

	# of Fish	Mean Size	Range	# of Fish Infected
CYPRINIDAE				
<i>Cyprinella spiloptera</i>	2	44.7	43.7 - 45.6	-
<i>Cyprinus carpio</i>	1	30.5		-
<i>Hybognathus nuchalis</i>	5	36.5	34.2 - 38.8	-
<i>Notropis ludibundus</i>	10	39.2	34.0 - 43.0	-
<i>Phenacobius mirabilis</i>	1	38.3		-
<i>Pimephales vigilax</i>	7	40.0	36.8 - 42.9	-
CATOSTOMIDAE				
<i>Carpiodes carpio</i>	1	90.0		-
ICTALURIDAE				
<i>Ictalurus punctatus</i>	9	82.4	30.5 - 111.5	-
SCIAENIDAE				
<i>Aplodinotus grunniens</i>	2	121.0	100.1 - 141.8	1 (50%)
TOTAL	38			1 (3%)

3.5 mi SE New Haven, at Island, Posey, Co., IN T8S, R15W, sec. 2. 28 August 1992 (Shock).

	# of Fish	Mean Size	Range	# of Fish Infected
LEPISOSTEIDAE				
<i>Lepisosteus osseus</i>	1	280.0		-
HIODONTIDAE				
<i>Hiodon alosoides</i>	1	205.0		-
CLUPEIDAE				
<i>Alosa chrysochloris</i>	1	245.0		-
<i>Dorosoma cepedianum</i>	10	120.6	56.7 - 230.0	-
CYPRINIDAE				
<i>Cyprinella spiloptera</i>	1	36.0		-
<i>Macrhybopsis storeriana</i>	1	51.5		-
<i>Pimephales vigilax</i>	1	44.2		-
CATOSTOMIDAE				
<i>Carpionodes velifer</i>	4	100.0	76.7 - 118.8	-
<i>Ictiobus bubalus</i>	2	290.0	285.0 - 295.0	-
ICTALURIDAE				
<i>Ictalurus furcatus</i>	3	305.1	170.3 - 455.0	-
<i>Ictalurus punctatus</i>	1	260.0		-
<i>Pylodictis olivaris</i>	1	265.0		-
MORONIDAE				
<i>Morone chrysops</i>	2	108.7	61.8 - 155.6	-
CENTRARCHIDAE				
<i>Lepomis cyanellus</i>	1	49.9		-
<i>Lepomis macrochirus</i>	4	95.7	69.5 - 127.2	-
<i>Lepomis megalotis</i>	2	72.5	56.2 - 88.8	-
<i>Micropterus punctulatus</i>	4	124.8	52.4 - 225.0	-
SCIAENIDAE				
<i>Aplodinotus grunniens</i>	25	175.7	106.6 - 310.0	2 (8%)
TOTAL	65			2 (3%)
<hr/>				
GRAND TOTAL	599			56 w/ glochidia (9.3 %) 1 w/ <i>P. capax</i>

Appendix III. Number and species of glochidia for each infected fish species by month in the lower Wabash River, 1992.

APRIL SAMPLE

Standard Length	<i>P. ohienis</i>	<i>L. fragilis</i>	<i>Truncilla</i>	<i>P. alatus</i>	?
<i>Aplodinotus grunniens</i>					
84.9	8	2	1		
86.6	2				
87.4	9				
88.3	2				
88.6	17				
89.6	4				
89.7		1			
89.7	7				
90.4	2				1
90.5	28				
90.6	1				
91.0	61				
91.2	11				
91.4	24				
91.6	3				
92.1	55				
92.6	15				
92.8	1			1	
96.2	35				
97.0	20	2	1		
99.4	58	8			
99.7	1				
101.2	12				
103.0	21	4			
106.7	5	2			
113.7	3				
205.0	1				
# fish infected	26	6	2	1	1
# glochidia	406	19	2	1	1
ave # glochidia	15.6	3.2	1.0	1.0	1.0
TOTAL No. of drum with glochidia= 27					
TOTAL No. glochidia = 429					

MAY SAMPLE

Standard Length	<i>P. ohiensis</i>	<i>P. alatus</i>	<i>Anodontinae</i>	?
<i>Carpiodes velifer</i>				
78.9			2	
80.6			1	
# fish infected			2	
# glochidia			3	
ave # glochidia			1.5	
<i>Aplodinotus grunniens</i>				
88.6	1			
95.9	1			
97.6				1
110.3	1			
265.0		1		
# fish infected	3	1		1
# glochidia	3	1		1
ave # glochidia	1.0	1.0		1.0
TOTAL No. of fish with glochidia= 7				
TOTAL No. glochidia = 8				

JUNE SAMPLE

Standard Length	<i>P. capax</i>	<i>Truncilla</i>	?
<i>Aplodinotus grunniens</i>			
85.4		1	
91.9		3	
95.5		6	
97.0		2	
99.7		1	
105.2		2	
105.3		1	
105.8		103	
107.3		2	
114.1		4	
114.1		2	
117.7		3	
120.8		4	
121.5		4	
125.0		4	
125.1	1		
126.6		6	
141.0		7	
# fish infected	1	17	
# glochidia	1	155	
ave # glochidia	1.0	9.1	
<i>Ictalurus punctatus</i>			
65.2			2
# fish infected		1	
# glochidia			2
ave # glochidia			2
TOTAL No. of fish with glochidia= 18			
TOTAL No. glochidia = 156			

JULY SAMPLE

Standard Length *Truncilla*

Aplodinotus grunniens

141.8	36
# fish infected	1
# glochidia	36
ave # glochidia	36

AUGUST SAMPLE

Standard Length *Truncilla*

Aplodinotus grunniens

144.2	1
210.0	1
# fish infected	2
# glochidia	2
ave # glochidia	1

R E C E I V E **D**
JUL 8 1993
FWRS