

FINAL REPORT

Results of a Biological Survey for  
*Leptodea leptodon* (Rafinesque, 1820)  
in the Missouri River in Southeastern  
South Dakota

A Report Prepared for the U.S. Fish and Wildlife Service  
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February 12, 1996

## SUMMARY

In late September and early October, 1995, a brail survey was carried out to determine the distribution of *Leptodea leptodon* (Rafinesque) in the Missouri River near Yankton and Vermillion, South Dakota. We did not find *L. leptodon* but useful information in three areas was nevertheless brought to light, viz.:

(1) *Leptodea leptodon* is unusual in that adults are deeply buried and are not available by brail. Subsequent investigations which seek to determine its abundance at its only known location in the research area, close below Gavin's Point Dam, can only be carried out with the help of a diver during a period of very low water, e.g. when flow at the dam is cut off.

(2) A survey of major museum holdings of *L. leptodon* shows that historical records exist for a few sites in the Great Lakes Drainage and for a moderately large number of sites throughout the Ohio-Mississippi-Missouri River System. Examination of those records indicates, however, that with the exception of one collection in the Green River, Kentucky (in a site where it is now extinct), it has not been found east of, or in, the Mississippi River since 1950. The desirability of a status survey is therefore indicated.

(3) There is need for systematic and taxonomic studies of *L. leptodon*. Gravid specimens should be sought and glochidia should be photographed with a scanning electron microscope so that the generic placement of the species can be more firmly established. Our examination of Rafinesque's original description indicates that the name *leptodon* is apparently not applicable to this species. Other early literature and type material, therefore, should be critically reexamined to determine what its specific name should be.

## 1. INTRODUCTION

*Leptodea leptodon* (Rafinesque 1820) (Mollusca: Unionidae), is a little known, rare, and possibly endangered species thought to be most abundant in the upper western portion of the Mississippi River System. Until recently it had never been found in the main stem of the Missouri River. In 1982, however, it was found there by Hoke (1983) who collected a pair of empty fresh valves at a site located 0.1 km east of Gavin's Point Dam near Yankton, South Dakota, near the (indefinite) Nebraska-South Dakota boundary.

Based on this record, the U.S. Fish and Wildlife Service awarded a contract to ECOSEARCH, Inc. to examine museum holdings of *L. leptodon* and to carry out a brail survey below Gavin's Point Dam and in adjacent reaches of the Missouri River to determine the distribution and abundance of *L. leptodon* there. Accordingly, a survey was done in late September and early October, 1995. The results of that work, including of a reevaluation of the taxonomy of this species, are given below.

**Acknowledgments:-** I am grateful to Dr. Jim Peterson of Vermillion, South Dakota for providing information and for making a boat available while our boat was not functional, to Teri Nelson of Corpus Christi, Texas, for field assistance, and to my wife Judith J. Clarke for help during all aspects of the work. Thanks are also expressed to Richard I. Johnson and Daniel L. Graf of the Department of Mollusks, Museum of Comparative Zoology at Harvard University; to Dr. Robert Hershler and Paul Greenhall of the Department of Invertebrates (Mollusks), Museum of Natural History, Smithsonian Institution; to Dr. John B. Burch and Ms. Louanne Reich of the Museum of Zoology, University of Michigan; and to Dr. David H. Stansbery and Ms. Kathy Borrer of the Museum of Natural History, The Ohio State University, for allowing access to collections under their care and/or for providing information.

## 2. MATERIALS AND METHODS.

Prior to beginning field work I examined the research holdings of *L. leptodon* in the Museum of Comparative Zoology at Harvard University (my *alma mater*) and the Smithsonian Institution (where I was previously curator of freshwater and terrestrial mollusks). Later I received lists of museum records of *L. leptodon* from the Museum of Zoology, University of Michigan and the Museum of Zoology, The Ohio State University and an updated list from the Smithsonian. The data recorded are presented below in the Discussion. I also reexamined some of the early literature on this species and concluded that a nomenclatorial problem, and possibly a taxonomic problem, also exists. These issues are also reviewed under Discussion.

Water levels were high in the Missouri River throughout most of the summer of 1995 so this survey was postponed several times in the hope that levels would become significantly reduced. By late September it became apparent that the field season was drawing to a close and that the work should be done then if we hoped to do it in 1995. Accordingly, between September 21 and October 7, the ECOSEARCH team located itself in Vermillion, South Dakota, and carried out the work.

As specified in the contract the survey was carried out by brailing. This was accomplished initially by use of a 14 foot outboard-powered boat and later a 17 foot boat with a depth finder and a larger outboard motor. The brail initially utilized was 10-foot long and was equipped with 16 drop chains bearing a total of 48 4-pronged brail hooks. During brail run 21 the brail was snagged and lost so for subsequent runs a more snag-resistant five foot brail with 24 brail hooks was used. The reach studied was that between Gavin's Point Dam above Yankton downstream to the area south of Vermillion, a distance of about 30 river miles. Landmarks and islands were numerous in this reach and we were able to define the locations of our brailing sites accurately by use of binoculars and detailed topographic maps. During the 18 days we spent in the area we carried out 53 brail runs and made site visits from shore (see attached data sheets).

### 3. RESULTS

During the field work brail runs were carried out in the Missouri River in both South Dakota and Nebraska waters. Twelve runs were located in the one-mile reach below Gavin's Point Dam above Yankton but the rest were distributed fairly evenly between that reach and the abrupt south-turning bend south of Vermillion, SD.

The results were disappointing. No *Leptodea leptodon* were found. Among other species only ten specimens, representing four species, were collected. Nine of these specimens, representing *Leptodea fragilis* (Say) (three live specimens and three pairs of fresh empty valves), *Potamilus alatus* (Say) (one live specimen and one pair of fresh empty valves), and *Lasmigona complanata* (Barnes) (one pair of fresh empty valves) were found in the one-mile reach below Gavin's Point Dam. The remaining specimen, a live *Anodonta grandis* Say, occurred east of St. Helena, Nebraska, about midway between the Dam and Vermillion. All empty specimens and one live *L. fragilis* were kept for further study but all other live specimens were promptly returned to the river near where they had been collected.

Shoreline searches were also done near the mouth of the Niobrara River in Lewis and Clark Lake (the lake formed above Gavin's Point Dam) but no unionids were found. That area was selected because, according to the results of a monitoring program by aircraft, it and the reach just below Gavin's Point Dam are the two most heavily-utilized fishing areas in the region, and good fishing usually indicates high general productivity. We also searched the James River at three sites within 20 miles of its mouth near Yankton, but also without finding unionids.

#### 4. DISCUSSION

##### A. The Taxonomy of "*Leptodea leptodon*".

I have translated Rafinesque's (1820) description of the "Subgenus *Leptodea*" and the "species *leptodon*" from the original French as follows:

Second Subgenus. *Leptodea*. "Leptode" [thin-shelled]

Teeth completely bilobed and thin : those of the right valve simple. Shell compressed. Ligament [wing] membranous. Lateral teeth thin and curved.

Fifth species. *Unio leptodon* (*Elliptio leptodon*.) Thin mussel.

Elliptical, very compressed, posteriorly elongated. Shell thin and fragile and almost smooth; periostracum brownish, nacre violaceous; pseudocardinal teeth bilobed, small, obtuse, thin, and tuberculous; lateral teeth thin and long. Height 1/2 and diameter 1/6 of the length and umbones located 1/3 of the distance from anterior to posterior.

Fairly common in the lower Ohio River. Most are small because their shells are so fragile that they are obviously easy prey for their enemies. Some, however, reach about 3 inches in length. The muscle scars are faint and the cavities between the hinge teeth are apparently confluent. Soft parts whitish.'

Variety 1. *Olivacea*. Periostracum olivaceous.

Variety 2. *Semi-radiata*. Olivaceous with small brown rays.'

Rafinesque goes on next to describe *Unio fragilis* (now known *Leptodea fragilis*) and follows with the statement:

'This species [*U. fragilis*] very much resembles the preceding [*U. leptodon*]' etc..

In my opinion Rafinesque's description does not apply to the species under investigation here but it may apply to the species known as *Potamilus ohioensis* (Raf.) (= *Proptera* (or *Potamilus*) *laevissima* (Say) of many authors) or possibly to the species *Hemistena lata* (Lea). Among the reasons for this conclusion are (1) the lateral teeth of "*L. leptodon*" are straight or very nearly so and would not have been described as curved; (2) *P. ohioensis* closely resembles *L. fragilis* whereas "*L. leptodon*" does not; (3) judging from the small numbers of specimens in museum collection lots (normally only one or two specimens), "*L. leptodon*" apparently was never common whereas *P. ohioensis* is a common species (but see below); (4) Rafinesque's rudimentary figures of "*U. leptodon*" do not resemble our modern concept of that species (or of *P. ohioensis*) but they do resemble *Hemistena lata* (Raf.), an uncommon to rare species which is often confused with *L. leptodon*; and (5) the existence of two varieties, one without small brown rays and one with them, is characteristic of *H. lata* but not of "*L. leptodon*" or *P. ohioensis*.

It should be pointed out that the comparative abundance of individual mussel species in multi-species communities may vary widely from decade to decade. In 1993 and 1994 ECOSEARCH, Inc. carried out a comprehensive survey of

mussel beds in the lower 543 miles of the Ohio River (Clarke, 1995), mostly by brail but also by hand collecting in shallow water. We did not find any *L. leptodon*, *P. ohioensis*, or *H. lata* there, nor did Williams and Schuster (1984) during their brail survey of the same area. Both of these studies demonstrated that substantial faunal changes have occurred during this century, with some species becoming nearly or entirely extinct in the Ohio River during this century. Examination of museum records (see below) also shows that with the exception of collections by D. H. Stansbery at Munfordville, KY in the Green River, no live specimens of "*Leptodea leptodon*" have been collected from east of the Mississippi River or the Lake Erie Drainage since 1950. The Munfordville beds have since been devastated because of cold, turbid, hypolimnetic discharges through the dam at Green River Lake (Clarke, 1983).

If I or some other malacologist concludes, after a thorough investigation, that the name *Leptodea leptodon* (Raf.) should be replaced, the next available name appears to be *Symphynota tenuissima* of Lea (1829). A firm decision on this matter should be postponed until Lea's type specimen at the Smithsonian Institution, and more rare literature (e.g. see Simpson, 1900: 575-576), can be examined. The glochidea of this species have never been seen and they should also be studied to confirm its generic affinities. This is especially important because some authors (e.g. Haas, 1969) consider *L. leptodon* to be the type species of the genus *Leptodea* (Rafinesque) whereas others (e.g. Thiele, 1935) consider *L. fragilis* as the type species). In this report we shall continue to use the name *Leptodea leptodon*, but interested readers should be aware that taxonomic and systematic problems exist with regard to this species.

#### B. *Leptodea leptodon* in South Dakota.

Hoke's (1983) record of *Leptodea leptodon* was based on one pair of fresh empty valves found by him among "almost fifteen hundred unionids examined at that site [1 km below Gavin's Point Dam]" during a period when water levels had undergone "a ten foot drop".

It has long been apparent that reaches close below dams are often excellent mussel habitats. Dams such as that at Gavin's Point which are designed to allow top runoff allow the warm phytoplankton-rich surface water above the dam to be skimmed off. The turbulence below causes that water to become reoxygenated and the phytoplankton to become mixed throughout the water column, both beneficial to unionids. Indeed the unionids we collected there all showed evidence of very rapid growth. Gavin's Point Dam is also the first dam encountered by fishes moving up the lower Missouri River. Fishes become greatly concentrated there thus making readily available the fish hosts needed by larval unionids to develop into adulthood and thereby leading to the formation of dense unionid communities.

The use of brails is often the most appropriate and cost effective method of carrying out mussel surveys in rivers because mussels there are normally oriented

with their shells gaped open in an upstream direction. Brailing in lakes is ineffective because mussels there are oriented in all directions. Recent experience (Buchanan, 1980 and M.A. Hoggarth, pers. comm.) has shown that *Leptodea leptodon* is unusual in that the adults are entirely, or almost entirely, buried just below the substrate surface. They almost certainly, therefore, cannot be collected by brailing. Further, the Missouri River reach below the Dam has numerous large boulders and the entire river reach surveyed has many sunken trees and, in some areas, large items of trash in it. All of this makes brailing very difficult and probably reduces its efficiency, which is only about 1% even under favorable circumstances. It is therefore not surprising that our brailing efforts were unsuccessful.

The Missouri River, because of its unstable and largely muddy bottom, has long been regarded as a very poor habitat for unionid mussels (see references cited in Hoke, 1983). Dr. James Peterson, of Vermillion, who has used a boat on the Missouri River for many years and is a keen observer of natural history, has informed me that freshwater mussels can be seen occasionally in the Yankton and Vermillion reach during periods of low water but that they are uncommon and scattered. As already indicated by Hoke (1983) the reach just below Gavin's Point Dam revealed more species than any of the other 11 regional sites from whence data were available. The literature indicates that *L. leptodon* is principally a riverine species only occurring as a rare element (comprising less than 0.1%) in rich and diverse mussel communities. It therefore appears likely that the short reach below Gavin's Point Dam may be the only area in the South Dakota portion of the Missouri River which contains *Leptodea leptodon*. The presence of that species there can only be confirmed through a thorough examination of the area on foot or by a diver during a period of very low water.

### C. The Distribution of *Leptodea leptodon*.

The following specimen-associated data are from the research collections of *Leptodea leptodon* in the four museums with the largest holdings of that species. They are the Museum of Comparative Zoology (abbreviated MCZ), The Ohio State Museum, Museum of Zoology (OSUM), the University Museums, University of Michigan (UMMZ), and the Smithsonian Institution, Museum of Natural History (USNM). Identifications of the specimens in the MCZ and USNM have been verified by the writer but those in the OSUM and UMMZ have not, but all are believed to be correct. Abbreviations used, in addition to those above, are: !, collected by; and v, valve(s). Four to six digit numbers following museum abbreviations are museum catalog numbers and one or two digit numbers following catalog numbers represent the number of specimens (if known). Dates of collection are inserted where known but all lots without dates were collected before 1950 (and many were before 1900).

### GREAT LAKES - ST. LAWRENCE RIVER DRAINAGE.

Lake Erie Drainage: Cleveland, Ohio (MCZ 315699); Buffalo, New York

(Robinson!, I. Lea Coll'n., USNM 86051, 4v).\*

## OHIO - MISSISSIPPI - MISSOURI RIVER SYSTEM.

### Ohio River System

**Ohio River:** near Marietta, Ohio (USNM 19255, 5); Cincinnati, Ohio (MCZ 158097; USNM 30030, 4v; USNM 86052, 18v; T.G. Lea!, I. Lea Coll'n., "paratypes ?", USNM 123359, 3v; and USNM 86052, 12v).

**Ohio River Tributaries:** Scioto River, "probably Chilicothe", Ohio (UMMZ 43860, not in coll'n.); and "Scioto River" (UMMZ 83032, 1). East Fork Little Miami River, Ohio: (G. Twitchell!, ca. 1900, OSUM 18498, 1). Little Miami River, Ohio: (Bartlett!, MCZ 315694). Licking River, KY (MCZ 315693). Wabash River: Terre Haute, IN (Daniels!, UMMZ 83033, 1; F.C. Baker!, MCZ 89381); Delphi, IN (Daniels!, USNM 149364, 2v); Lafayette, IN (J. Scovell!, 1907, USNM 676956, 1v; MCZ 302596; and Daniels!, Oct. 1897, UMMZ 83035, 1); Grayville, IL (F.M. Witter!, USNM 477061, 2v); and Grand Chain, Posey County, IN (Daniels!, Aug. 1901, UMMZ 83034, 8). White River (Wabash River tributary): canal, Indianapolis, IN (MCZ 196926). Green River, KY: Munfordville, Hart Co. (D.H. Stansbery, 1962, MCZ 315692); above US Rt. 31 bridge, Munfordville (D.H. Stansbery & J.J. Jenkinson!, Sept. 24, 1964, OSUM 12717, 1); and Greensboro (Boepple!, Dec. 26, 1908, USNM 677381, 2v). Cumberland River: Horseshoe Bottom, Russell Co. KY (Owen!, Aug. 26, 1948, UMMZ 172733, 3); Albany Landing, Cumberland Co., KY (UMMZ 83025, 1); Cloyd's Landing, KY (UMMZ 83026, 1); and Celena, Clay Co., TN (Aug. 25, 1939, UMMZ 134831, 1). Cumberland River Tributaries: Beaver Creek, ford above Rowena Ferry, Russell Co., KY (Owen!, Aug. 26, 1948, UMMZ 172746, 1); and Caney Fork, 5 mi SE of Carthage, Jasper Co. (W.J. Clench!, UMMZ 83038, 1). Tennessee River: Knox Co., TN (Walker Coll'n, MCZ 231202); and Muscle Shoals, AL (Smith!, UMMZ 83024, 1). Tennessee River Tributaries: Clinch River: Clinton, Anderson Co. (Barbour Coll'n., MCZ 46654) and Needham's Ford, TN (Adams!, UMMZ 83028, 1); Holston River: Knoxville, TN (N.W. Lermond!, MCZ 76883; and UMMZ 83022, 5); mouth of Holston River, Austin's [?] Grist Mill, Knox Co., TN (Barbour Coll'n., MCZ 46654); and Duck River, TN (MCZ 158089; UMMZ 83019, 2).

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\* Note: there are also several lots labeled Grand Rapids, Michigan (Lake Michigan drainage), but such records are believed to represent specimens from an old museum collection which was housed there, not from Grand Rapids itself. These lots are UMMZ 83041, 1; UMMZ 164019, (not in coll'n.); and USNM 149364, 2v ("I. Lea Coll'n").

Mississippi River, Eastern Tributaries:

Illinois River, IL: Peoria (Lewis!, I. Lea Coll'n., USNM 86054, 4v). Minnesota River: Big Stone Lake, Roberts Co., SD (Orier!, UMMZ 83037, 1 [identification questionable]); and mouth of Minnesota River, Mendota, MN (OSUM 56849, 1).

Mississippi River.

Davenport, Scott Co., IO (MCZ 16704; OSUM 56858, 2); Muscatine, (Bindette Slough), (F.M. Witter!, USNM 519428, 2v); Keokuk, IO (B. Shimek!, USNM 539800, 2v) and Mercer County, IL (MCZ 6019).

Mississippi River, Western Tributaries.

Iowa River System: Cedar River, Cedar Rapids (B. Shimek!, 1882, USNM 519426, 3v and USNM 519876, 2v). Iowa River: Iowa City, Iowa (Shimek Coll'n., USNM 505019, 9v and USNM 519425, 9v), (RE Call!, MCZ 6110), and (without further data, MCZ 16704 and UMMZ 83023, 1).

Meramec River System, MO: Meramec River: bridge at MO Rt. 19, 1.2 mi NW of Steelville, Crawford Co. (D.H. Stansbery & J.J. Jenkinson!, Sept., 19, 1984, OSUM 13885, 1v); bridge at MO Rt. H, 9.5 mi NE of Steelville (H. Kemper!, Aug. 1, 1971, OSUM 33601, 1); Allenton Access, 2.9 mi SSW of Eureka, Jefferson Co. (A.C. Buchanan & D.K. Scholl, Sept. 19, 1978, OSUM 54583, 2); and below RR bridge, 3.0 mi NE of Eureka, St. Louis Co. (G. Bogosian!, July 9, 1989, OSUM 30171, 2). Meramec River Tributaries, MO: Big River: MO Rt. PP bridge, 2.4 mi S of Eureka, Jefferson Co. (D.H. Stansbery & A.C. Buchanan, June 13, 1977, OSUM 4113, 1); MO Rt. W bridge, 1.0 mi NW of House Springs, Jefferson Co. (D.H. Stansbery & A.C. Buchanan, June 13, 1977, (OSUM 41128, 1). Bourbeuse River: just above its mouth, Franklin Co. (J.K. Neel, Oct. 10, 1962, OSUM 15412, 1). Big Piney River: Devil's Elbow, 17.4 mi SE of Rolla, Pulaski Co. (W.L. Pflieger & S. Olson, July 29, 1981, OSUM 56004, 1).

White River System. White River: Garfield, AR (R.E. Scammon!, Apr. 2, 1902, USNM 738510, 2v). White River Tributaries: James River, Galena, Stone Co. (Hinkley!, UMMZ 83030,3). Middle Fork Little Red River: bridge at AR Rt.9, Shirley, Van Buren Co. (E.R. & R.N. Kinser!, July 22, 1967, OSUM 22177, 1). [Spring River], Hardy, Sharpe Co. (Ferriss!, MCZ 315698 & UMMZ 83029, 1).

Red River System: Kiamichi River: Spencerville crossing, 8.5 mi NE of Hugo, Choctaw Co., OK (B.D. Valentine & class!, July 14, 1968, OSUM 20252, 1); Tuskahoma, Pushmataha Co., OK (UMMZ 83040, 2); bridge at US Rt. 271, 1.2 mi SE of Clayton, Pushmataha Co., OK (D.H. Stansbery!, Aug. 22, 1971, OSUM 32829, 1). Little River, 2.2 mi SE of Wright City, McCurtain Co., OK (B.A. Branson!, June 16, 1960, OSUM 48100, 1). Saline River, bridge at US Rt. 79, 2 mi NE of Saline, Cleveland Co. (C.B. Stein!, July 3, 1946, OSUM 18780, 1). Ouachita River, Arkadelphia, Clark Co., AR (UMMZ 83026, 4).

MISSOURI RIVER TRIBUTARIES.

**Gasconade River System:** Gasconade River: bridge between Vichy & Vienna, Maries Co., (C.B. Stein!, 1964, OSUM 13398, 5; & MCZ 254923); Hoehne farm, 3 mi N of Mt. Sterling, Gasconade Co. (D.H. Stansbery & J.J. Jenkinson!, Sept. 17, 1964, OSUM 13298, 9; and 5 mi N of Sterling (D.H. Stansbery!, 1964, MCZ 254924). Gasconade River Tributaries: Big Piney River, Devils Elbow, 17.4 mi SE of Rolla, Pulaski Co., MO (W.L. Pflieger & S. Olson, July 29, 1981, OSUM 56004,1).

## 5. CONCLUSIONS.

Despite an intensive brailing effort no specimens of *Leptodea leptodon* could be found in the 30-mile Missouri River reach from Gavin's Point Dam to the river bend south of Vermillion. This was believed to have been caused by several factors, chief among them being that living *Leptodea leptodon* are virtually completely buried in the substrate and cannot be collected by use of a brail. We believe that, because of a convergence of favorable limnological factors, the species probably does live close below Gavin's Point Dam, but the swift current and large water volume (52,000 cfs) passing over that area during normal discharge precludes careful bottom examination even by divers. It is recommended that cooperation be sought with the Army Corps of Engineers to shut off the dam for a brief period during a time most convenient to the COE (early March has been suggested by them) and that the search be conducted by a diver with scientific supervision by the writer.

A review of the early literature indicates that the name *leptodon* may not be applicable for this species. In addition the species may not even be a *Leptodea*. Further study is necessary to clarify these issues.

A compilation of museum records reveals that *Leptodea leptodon* has been collected from the Great Lakes Drainage and throughout the Ohio-Mississippi-Missouri River System but that apparently it has always been rare. This compilation also reveals that except for one locality in the Green River, Kentucky (at which we believe it has now been extirpated), **no specimens have been found east of the Mississippi River since 1950.** We therefore support the view that *L. leptodon* may be endangered.

If a comprehensive status survey of *Leptodea leptodon* is deemed advisable, we suggest that such a survey begin in the area where the most numerous recent findings of the species have been recorded, *viz.* the Meramec River System in Missouri. ECOSEARCH, Inc. already has a contract with the U.S. Fish and Wildlife Service to do a status survey for *Lampsilis abrupta* (Say) in the Meramec River in 1996 and searches for *L. leptodon* could also be carried out there for modest additional cost.

### Literature Cited

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# ECOSEARCH, INC.

Ecological Surveys and Research

## MISSISSIPPI DRAINAGE GENERAL MUSSEL SURVEY FORM

Station No. 2876, 2877  
 Kind of Samples Hand Collectives Coll. All 20 Clarke T Nelson Date Sept. 23, 1995  
 Location James River, north of Yankton, Yankton Co., S.D.

GPS-LOCATIONS-	2876 A <sup>A</sup>	2876 B <sup>B</sup>	2877 <sup>C</sup>	D
	12 mi N of Yankton -above diked up reach but still very muddy. Collected 1/2 hr.	Checked river at pull-off on Hwy 81 ca 15 mi N of Yankton. Very muddy. Coll. 1/2 hr.	at paved road crossing ca 4.0 mi west of Rt. 81 and S.D. Rt. 46 junction Muddy banks ca 10' wide exposed 3-7' across, not even fragments.	
<u>Amblema plicata</u>				
<u>Meg. gigantea</u>				
<u>Fusconaia flava</u>				
<u>F. ebena</u>				
<u>Quad. quadrula</u>				
<u>Q. nodulata</u>				
<u>Q. pustulosa</u>				
<u>Q. metanevra</u>				
<u>Cyclo. tuberc.</u>				
<u>Pl. cordatum</u>				
<u>El. crassidens</u>				
<u>E. dilatata</u>				
<u>Alas. marginata</u>				
<u>Las. costata</u>				
<u>Las. complanata</u>				
<u>Arc. confragosus</u>				
<u>An. grandis</u>				
<u>An. imbecillus</u>				

# ECOSEARCH, INC.

Ecological Surveys and Research

## MISSISSIPPI DRAINAGE GENERAL MUSSEL SURVEY FORM

Station No. SE-72(A-D)

Kind of Sample; Brail Coll. A.H. Zierke Date Sept. 20, 1935

Location Missouri R. <sup>above</sup> below Garrison Point Dam

Yankton, Yankton Co., S.D. 10-foot brail

GPS LOCATIONS	Site A Below boat ramp, 500' off N. shore, 1000 ft. from, 8' depth	Site B Far ACDE boat ramp (below A) ca 1 km below Dam, 100' from SWASRD	Site C Off a jet boat above A, 200' off S. Dam, 600' from, 12' deep	Site D opposite C, 75' off N. shore from Dam, 200' deep
<u>Amblema plicata</u>				
<u>Meg. gigantea</u>				
<u>Fusconaia flava</u>				
<u>F. ebena</u>				
<u>Quad. quadrula</u>				
<u>Q. nodulata</u>				
<u>Q. pustulosa</u>				
<u>Q. metanevra</u>				
<u>Cyclo. tuberc.</u>				
<u>Pl. cordatum</u>				
<u>El. crassidens</u>				
<u>E. dilatata</u>				
<u>Alas. marginata</u>				
<u>Las. costata</u>				
<u>Las. complanata</u>				
<u>Arc. confragosus</u>				
<u>An. grandis</u>				
<u>An. imbecillus</u>				

1 pr. fresh valves

# ECOSEARCH, INC.

Ecological Surveys and Research

## MISSISSIPPI DRAINAGE GENERAL MUSSEL SURVEY FORM

Station No. 2474 (E-14)

Kind of Samples Drill Coll. A H Clark Date Sept. 26, 1995  
E T Nelson

Location Yazoo River near Yankton, Yankton Co, S.D. 10' drill

GPS LOCATIONS	AE 2 mi below Convent Point Druggery off Neb. shore 15'-18' depth 1000' haul near current S.D. side	BF 1/2 mi above sharp river bend near Yankton, 100-150 off S.D. shore Bivalve sample just after 100' haul	G Mid channel at Green Island S.D. shore, west of Yankton, 1 mi west of BF sample Sample collected on 100 FT.	DH 200' off island S of South E, 1000' long 12'-14' depth Current S.D. side
<u>Amblema plicata</u>				
<u>Meg. gigantea</u>				
<u>Fusconaia flava</u>				
<u>F. ebena</u>				
<u>Quad. quadrula</u>				
<u>Q. nodulata</u>				
<u>Q. pustulosa</u>				
<u>Q. metanevra</u>				
<u>Cyclo. tuberc.</u>				
<u>Pl. cordatum</u>				
<u>El. crassidens</u>				
<u>E. dilatata</u>				
<u>Alas. marginata</u>				
<u>Las. costata</u>				
<u>Las. complanata</u>				
<u>Arc. confragosus</u>				
<u>An. grandis</u>				
<u>An. imbecillus</u>				

# ECOSEARCH, INC.

Ecological Surveys and Research

## MISSISSIPPI DRAINAGE GENERAL MUSSEL SURVEY FORM

Station No. 2878 (I-L)

Kind of Samples Brail Coll. A. H. Clark & T. Nelson Date Sept. 26, 1975

Location Missouri River, below Yankton, Yankton Co., S.D.

10-foot brail

GPS LOCATIONS	<u>AI</u> 300' off S.D. shore, 1/2 mi W + West channel about 1/2 mi off shore, sand empties, 1000' long, 12' deep	<u>BI</u> 2 1/2 mi ESE of mouth of James River, sand at base shore, 1000' long, 3' deep	<u>CI</u> 1/2 mi WSW of S.D. off rounded point on N. side, 10' deep, Dr. 4, 1000' x 10'	<u>DI</u> M. J. Linnel station 2 islands, 2 1/2 mi NE + NNE of S.D. shore, 1/2 mi - 12' deep 1000' long
<u>Amblema plicata</u>				
<u>Meg. gigantea</u>				
<u>Fusconaia flava</u>				
<u>F. ebena</u>				
<u>Quad. quadrula</u>				
<u>Q. nodulata</u>				
<u>Q. pustulosa</u>				
<u>Q. metanevra</u>				
<u>Cyclo. tuberc.</u>				
<u>Pl. cordatum</u>				
<u>El. crassidens</u>				
<u>E. dilatata</u>				
<u>Alas. marginata</u>				
<u>Las. costata</u>				
<u>Las. complanata</u>				
<u>Arc. confragosus</u>				
<u>An. grandis</u>				
<u>An. imbecillus</u>				

# ECOSEARCH, INC.

Ecological Surveys and Research

## MISSISSIPPI DRAINAGE GENERAL MUSSEL SURVEY FORM

Station No. 2578 (M-N)

Kind of Samples Brail Coll. AH Clarks Date Sept. 23, 1958  
W. T. Nelson

Location Missouri River, E and NE of St. Helena, Cedar Co., Neb.  
Ten-foot brail.

GPS LOCATIONS	A.M	300' B.N	C	D
<u>Amblema plicata</u> <u>Meg. gigantea</u> <u>Fusconaia flava</u> <u>F. ebena</u> <u>Quad. quadrula</u> <u>Q. nodulata</u> <u>Q. pustulosa</u> <u>Q. metanevra</u> <u>Cyclo. tuberc.</u> <u>Pl. cordatum</u> <u>El. crassidens</u> <u>E. dilatata</u> <u>Alas. marginata</u> <u>Las. costata</u> <u>Las. complanata</u> <u>Arc. confragosus</u> <u>An. grandis</u> <u>An. imbecillus</u>	Just above narrow in the river, 2 miles NE of St. Helena, with 300' off SD side. 12' deep; 600' run.	Off shallow water on E side of island 2 miles E of St. Helena, with 14' deep 1000' run		

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## MISSISSIPPI DRAINAGE GENERAL MUSSEL SURVEY FORM

Station No. 2879 (A-D)

Kind of Samples Brail Coll. A.H. Clarke  
E.T. Nelson Date Sept. 27, 1955

Location Missouri River, St. Helena, <sup>Calhoun Co.</sup> Mo. to Vermillion, S.D.

The Post Brail

GPS LOCATIONS	A	B	C	D
	E end of <u>St. Helena</u> "15.0 mi", 200' off N.W. shore, 600' long, depth 10-12 Drugged	2 mi E of <u>St. Helena</u> "20-500' off S.D. shore, 1000' long depth 10-12"	2 mi W of <u>St. Helena</u> "20-500' off S.D. shore, 1000' long depth 10-12"	2 mi W of <u>St. Helena</u> "20-500' off S.D. shore, 1000' long depth 10-12"
<u>Amblema plicata</u>				
<u>Meg. gigantea</u>				
<u>Fusconaia flava</u>				
<u>F. ebena</u>				
<u>Quad. quadrula</u>				
<u>Q. nodulata</u>				
<u>Q. pustulosa</u>				
<u>Q. metanevra</u>				
<u>Cyclo. tuberc.</u>				
<u>Pl. cordatum</u>				
<u>El. crassidens</u>				
<u>E. dilatata</u>				
<u>Alas. marginata</u>				
<u>Las. costata</u>				
<u>Las. complanata</u>				
<u>Arc. confragosus</u>				
<u>An. grandis</u>				
<u>An. imbecillus</u>				

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Ecological Surveys and Research

## MISSISSIPPI DRAINAGE GENERAL MUSSEL SURVEY FORM

Station No. 2579 (E-5)

Kind of Samples Basal Coll. T. Nelson Date Sept. 27 1955

Location Missouri River near Vermillion, Clay Co., S.D.

10-foot basal.

GPS LOCATIONS	AE 200' SW of 1st shore off 3rd bar marsh of Grand Coulee. Remnant of original tanks. Shaded only about 10%.	BF 200' off S.D. shore opposite west end of Grand I. in Clay Co., S.D. Shaded concrete depth 2-10'	CG S. of Vermillion, S.D. just above sharp S-turning bend. Basal just above level immediately in front of dam.	D
<u>Amblema plicata</u>				
<u>Meg. gigantea</u>				
<u>Fusconaia flava</u>				
<u>F. ebena</u>				
<u>Quad. quadrula</u>				
<u>Q. nodulata</u>				
<u>Q. pustulosa</u>				
<u>Q. metanevra</u>				
<u>Cyclo. tuberc.</u>				
<u>Pl. cordatum</u>				
<u>El. crassidens</u>				
<u>E. dilatata</u>				
<u>Alas. marginata</u>				
<u>Las. costata</u>				
<u>Las. complanata</u>				
<u>Arc. confragosus</u>				
<u>An. grandis</u>				
<u>An. imbecillus</u>				

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## MISSISSIPPI DRAINAGE GENERAL MUSSEL SURVEY FORM

Station No. 2450 (A-D)

Kind of Samples Bowl Coll. A. C. Clark L. T. Nelson Date Sept. 28, 1995

Location Missouri River below Sardinia Dam 5 feet from Yankton Co. S.D.

GPS LOCATIONS	A 1000 1200 ft from Sardinia Dam on left side Bowl Bowl Bowl	B 100 ft from off location Bowl Bowl Bowl	C 100 ft from side, opposite locations A & B 8 depth Bowl	D 300 ft from opposite point on left side below Dam Bowl Bowl
<u>Amblema plicata</u>				
<u>Meg. gigantea</u>				
<u>Fusconaia flava</u>				
<u>F. ebena</u>				
<u>Quad. quadrula</u>				
<u>Q. nodulata</u>				
<u>Q. pustulosa</u>				
<u>Q. metanevra</u>				
<u>Cyclo. tuberc.</u>				
<u>Pl. cordatum</u>				
<u>El. crassidens</u>				
<u>E. dilatata</u>				
<u>Alas. marginata</u>				
<u>Las. costata</u>				
<u>Las. complanata</u>				
<u>Arc. confragosus</u>				
<u>An. grandis</u>				
<u>An. imbecillus</u>				

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## MISSISSIPPI DRAINAGE GENERAL MUSSEL SURVEY FORM

Station No. 2880 (E-C)

Kind of Samples Brail Coll. A. H. Clarke Date Sept. 28, 1995  
2 T. Nelson

Location, Missouri River close to 2 below Gavens Point Dam, Yankton, Yankton  
Co., S.D. 5' brail

GPS LOCATIONS	A 50' off p. side of ramp below Dam, SD side, 1/2 mi (1 km) below Dam. Brail 1995 Sept 28	B 200' off rch. side 100' below E brail 1000-1500 Depth 10-12'	C 150-200' off Nth side, 1 mi below (E of) E, 10'-15' dam Brail SW 100' Fast current.	D
<u>Amblema plicata</u>				
<u>Meg. gigantea</u>				
<u>Fusconaia flava</u>				
<u>F. ebena</u>				
<u>Quad. quadrula</u>				
<u>Q. nodulata</u>				
<u>Q. pustulosa</u>				
<u>Q. metanevra</u>				
<u>Cyclo. tuberc.</u>				
<u>Pl. cordatum</u>				
<u>El. crassidens</u>				
<u>E. dilatata</u>				
<u>Alas. marginata</u>				
<u>Las. costata</u>				
<u>Las. complanata</u>				
<u>Arc. confragosus</u>				
<u>An. grandis</u>				
<u>An. imbecillus</u>				

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## MISSISSIPPI DRAINAGE GENERAL MUSSEL SURVEY FORM

Station No. 384/54-D

Kind of Sample Benthic Coll. AF 211 Clark Date Sept. 29, 1957

Location Missouri R., near Hankton, Hankton Co., S.D.

5-foot benthic

GPS LOCATIONS	A Below Hankton, S.D. Down 500' off river perman. S of Hankton 1/3' dip 1000 ft. long	B 300' off S of Hankton 1/3' dip perman. S of Hankton 1/3' dip 1000 ft. long	C 0.3 mi. S of Hankton S of crossing Hankton 500' off river S of Hankton 1/3' dip	D 500' off river perman. S of Hankton 1/3' dip 1000 ft. long
<u>Amblema plicata</u>				
<u>Meg. gigantea</u>				
<u>Fusconaia flava</u>				
<u>F. ebena</u>				
<u>Quad. quadrula</u>				
<u>Q. nodulata</u>				
<u>Q. pustulosa</u>				
<u>Q. metanevra</u>				
<u>Cyclo. tuberc.</u>				
<u>Pl. cordatum</u>				
<u>El. crassidens</u>				
<u>E. dilatata</u>				
<u>Alas. marginata</u>				
<u>Las. costata</u>				
<u>Las. complanata</u>				
<u>Arc. confragosus</u>				
<u>An. grandis</u>				
<u>An. imbecillus</u>				

# ECOSEARCH, INC.

Ecological Surveys and Research

## MISSISSIPPI DRAINAGE GENERAL MUSSEL SURVEY FORM

Station No. 331 (E-1)

Kind of Samples Bottom Coll. Alvin W. Clarke Date Sept 29, 1945

Location Missouri River near Hankston, Hankston Co., S.D. S-100-1000

GPS LOCATIONS	A E S. side of main channel E. of first bar channel off mouth of main channel near S. end of E. side of main channel 100 ft. from shore	B E Mid-channel between E. end of East Land and main channel 18 deep bottom	G E. end of S. side of main channel 100 ft. from shore 18 deep bottom	D 11 S. side of main channel 100 ft. from shore 18 deep bottom
<u>Amblema plicata</u>  <u>Meg. gigantea</u>  <u>Fusconaia flava</u>  <u>F. ebena</u>  <u>Quad. quadrula</u>  <u>Q. nodulata</u>  <u>Q. pustulosa</u>  <u>Q. metanevra</u>  <u>Cyclo. tuberc.</u>  <u>Pl. cordatum</u>  <u>El. crassidens</u>  <u>E. dilatata</u>  <u>Alas. marginata</u>  <u>Las. costata</u>  <u>Las. complanata</u>  <u>Arc. confragosus</u>  <u>An. grandis</u>  <u>An. imbecillus</u>				

# RESEARCH, INC.

Ecological Surveys and Research

## MISSISSIPPI DRAINAGE GENERAL MUSSEL SURVEY FORM

Station No. 2441 (I S)

Kind of Samples Brail Coll. W. S. S. Clarke Date Sept. 29, 1955

Location Missouri R near junction, S.D. 5-foot brail.

MUSSEL LOCATIONS	A N side of channel (S) long island S of channel - same R. just below bridge and SE of dam - 12 ft. diam. 500 ft. long	B N side of island just below mouth of dam - 12 ft diam. 500 ft. long	C	D
<u>Amblema plicata</u>				
<u>Meg. gigantea</u>				
<u>Mussonia flava</u>				
<u>F. ebena</u>				
<u>Quad. quadrula</u>				
<u>Q. nodulata</u>				
<u>Q. pustulosa</u>				
<u>Q. metanevra</u>				
<u>Cyclo. tuberc.</u>				
<u>Pl. cordatum</u>				
<u>El. crassidens</u>				
<u>E. dilatata</u>				
<u>Alas. marginata</u>				
<u>Las. costata</u>				
<u>Las. complanata</u>				
<u>Arc. confragosus</u>				
<u>An. grandis</u>				
<u>An. imbecillus</u>				

# ECOSEARCH, INC.

Ecological Surveys and Research

## MISSISSIPPI DRAINAGE GENERAL MUSSEL SURVEY FORM

Station No. 2882 (A-D)

Kind of Sample: Drift Coll. Alfred Clarke Date Sept. 30, 1995

Location Missouri R. near St. Helms Island, near Yankton Co. - Clark Co. boundary, SD and Cedar Co., Neb. S - (adj) tract.

GPS LOCATIONS	A	B	C	D
	Mid-channel between SD shore and small island, 4 mi E by ESE of St. Helms, Cedar Co. Neb. Depth 15'. 500-1000 ft. drag.	500' Off shallow embayment on NE side of St. Helms Island, 3.2 mi NNE of Bow Valley Mills, Neb. 10' deep. 1000' drag.	Downstream lim point on N side of R. (in Neb.) 2 mi W E of Bow Valley Mills, Neb. 12-14' deep. Drugged ca 60'. Snagged.	250' off SD shore opposite W end of small island N of Coot 1, 4.8 mi SSW of Meckling, S.D. 12-15' deep, 1000' drag.
<u>Amblema plicata</u>				
<u>Meg. gigantea</u>				
<u>Fusconaia flava</u>				
<u>F. ebena</u>				
<u>Quad. quadrula</u>				
<u>Q. nodulata</u>				
<u>Q. pustulosa</u>				
<u>Q. metanevra</u>				
<u>Cyclo. tuberc.</u>				
<u>Pl. cordatum</u>				
<u>El. crassidens</u>				
<u>E. dilatata</u>				
<u>Alas. marginata</u>				
<u>Las. costata</u>				
<u>Las. complanata</u>				
<u>Arc. confragosus</u>				
<u>An. grandis</u>				
<u>An. imbecillus</u>				

# ECOSEARCH, INC.

Ecological Surveys and Research

## MISSISSIPPI DRAINAGE GENERAL MUSSEL SURVEY FORM

Station No. 2882(E-H)

Kind of Samples Brail Coll. AH & JJ Clarke Date Sept. 30, 1995

Location Missouri River, near Goat Island, SW of Vermillion, Clay Co., S.D.,  
5-foot brail.

GPS LOCATIONS	<u>KE</u> 300' off S.D. shore opp. E end of small island N of Goat I., 4.6 mi. S of Meckling, S.D. Depth 12'-14', 800'- brail num.	<u>BF</u> Between another small island and N side of Goat I., in Neb., S.D. mi S by SSE of Meck- ling, S.D. 8' deep. 500' run, snagged.	<u>G</u> S. side of Goat I below a small island, 2 1/2 mi W of Cedar/Dixon Co. boundary, Neb. Brail 520' to 200' for Goat I. Depth 10'-8' 1000' run.	<u>BH</u> S. side of E point of Goat I. in mid channel, 1 mi W of Cedar/Dixon Co. boundary. Depth 15'-18'. 1000' run.
<u>Amblema plicata</u>				
<u>Meg. gigantea</u>				
<u>Fusconaia flava</u>				
<u>F. ebena</u>				
<u>Quad. quadrula</u>				
<u>Q. nodulata</u>				
<u>Q. pustulosa</u>				
<u>Q. metanevra</u>				
<u>Cyclo. tuberc.</u>				
<u>Pl. cordatum</u>				
<u>El. crassidens</u>				
<u>E. dilatata</u>				
<u>Alas. marginata</u>				
<u>Las. costata</u>				
<u>Las. complanata</u>				
<u>Arc. confragosus</u>				
<u>An. grandis</u>				
<u>An. imbecillus</u>				

# ECOSEARCH, INC.

Ecological Surveys and Research

## MISSISSIPPI DRAINAGE GENERAL MUSSEL SURVEY FORM

Station No. 2982 (I-L)

Kind of Samples brail Coll. AH & JJ Clarke Date Sept. 30, 1995  
 Location <sup>Missouri River</sup> Near (SW and S) of Vermillion, Clay Co., S.D. 5-foot brail.

GPS LOCATIONS	<u>AI</u> Between small island and Neb. shore, brailed across Cedar-Dixon Co. boundary. 14-16' depth, 800-1000 ft drag.	<u>BJ</u> 500' off Neb. shore, 0.8-0.6 mi W of sharp S-turning bend, 2 mi SW of Vermillion, S.D. 15-17' deep, 1000' run	<u>CK</u> 200' off (Neb) point of river bend 2 mi SW of Vermillion, S.D. 12-16' deep, 800-900 ft. drag.	<u>DL</u> 600' off S.D. shore between small islands 3.0 mi SW of Univ. of S.D. Vermillion, S.D. Depth 10 ft., 1000' drag.
<u>Amblema plicata</u>				
<u>Meg. gigantea</u>				
<u>Fusconaia flava</u>				
<u>F. ebena</u>				
<u>Quad. quadrula</u>				
<u>Q. nodulata</u>				
<u>Q. pustulosa</u>				
<u>Q. metanevra</u>				
<u>Cyclo. tuberc.</u>				
<u>Pl. cordatum</u>				
<u>El. crassidens</u>				
<u>E. dilatata</u>				
<u>Alas. marginata</u>				
<u>Las. costata</u>				
<u>Las. complanata</u>				
<u>Arc. confragosus</u>				
<u>An. grandis</u>				
<u>An. imbecillus</u>				

# ECOSEARCH, INC.

Ecological Surveys and Research

## MISSISSIPPI DRAINAGE GENERAL MUSSEL SURVEY FORM

Station No. 2882 (M)

Kind of Sample Brail Coll. AH & JJ Clarke Date Sept. 30, 1995

Location Missouri R., near Vermillion, Clay Co., S.D. Five foot brail.

MUSSEL LOCATIONS	<p style="text-align: center;">AM</p> <p>500' off S.D. shore below islands, 3.6 mi. SSW of University of S.D., Vermillion. 10' deep, 1000' drag.</p>	B	C	D
<u>Amblema plicata</u>				
<u>Meg. gigantea</u>				
<u>Fusconaia flava</u>				
<u>F. ebena</u>				
<u>Quad. quadrula</u>				
<u>Q. nodulata</u>				
<u>Q. pustulosa</u>				
<u>Q. metanevra</u>				
<u>Cyclo. tuberc.</u>				
<u>Pl. cordatum</u>				
<u>El. crassidens</u>				
<u>E. dilatata</u>				
<u>Alas. marginata</u>				
<u>Las. costata</u>				
<u>Las. complanata</u>				
<u>Arc. confragosus</u>				
<u>An. grandis</u>				
<u>An. imbecillus</u>				