

## NAIAD MOLLUSK POPULATIONS (BIVALVIA: UNIONIDAE) IN POOLS 7 AND 8 OF THE MISSISSIPPI RIVER NEAR LA CROSSE, WISCONSIN

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### ABSTRACT

Since 1969 over 7,000 naiad mollusks have been collected from nine major and numerous minor sites in a 26 river-mile (41.8 km) section of the Upper Mississippi River near La Crosse, Wisconsin. Of importance was the 1977 identification of a juvenile endangered *Lampsilis higginsii* (Lea, 1857), the present-day northern-most live Mississippi River record of this species. Pool 7 had 21 live species and five species represented by empty shells, while Pool 8 had 22 live species and 15 species represented by empty shells, a total of 38 species (25 live and 13 represented by empty shells). Live *Anodonta suborbiculata* Say, 1831, *Potamilus ohioensis* (Rafinesque, 1820), *Toxolasma parvus* (Barnes, 1823), and subfossil *Pleurobema rubrum* (Rafinesque, 1820) were added to the list of 36 species recorded prior to 1931. The present total for Pools 7 and 8 (all known records) includes 30 living species and 10 species represented by empty shells. The overall total of 40 species compares favorably with the 46 recorded from the most diverse area of the Mississippi at Prairie du Chien, Wisconsin, 63 river miles (100.8 km) south of La Crosse. After comparing all known records from sites near La Crosse, it becomes apparent that the area no longer supports an overall flourishing naiad fauna except for a few species that are abundant in localized areas such as Lake Onalaska [*Amblema p. plicata* (Say, 1817), *Lampsilis ventricosa* (Barnes, 1823), *L. radiata luteola* (Lamarck, 1819), and the *Anodonta grandis* Say, 1829, complex] and near Isle la Plume [*Truncilla donaciformis* (Lea, 1827)], *Toxolasma parvus* and *Pleurobema sintoxia* (Rafinesque, 1820), not common enough to be a regular part of the fauna in 1930, were found alive. *Anodonta imbecillis* Say, 1829, was often found in mud accumulated inside empty shells of other species.

Until recently the only known pre-1965 records of the naiad mollusk fauna of the La Crosse, Wisconsin, area of the Upper Mississippi River were the 28 species recorded in the Region III (present-day Pools 7, 8 and 9) of Ellis in 1930 (van der Schalie and van der Schalie, 1950) (Table 1). In 1907 Dr. Paul Bartsch of the U.S. National Museum (USNM), Smithsonian Institution, also conducted, but did not publish, a survey of mollusks of the Upper Mississippi River that included one site in the area now known as Pool 7 and six sites in the area now known as Pool 8. This part of the Mississippi River has been impounded since the construction of the nine-foot navigation channel in the mid-1930's (Fig. 1).

Unpublished records of Bartsch at USNM reveal 26 species for the present-day Pool 7 and 34 species for the present-day Pool 8, a total of 35 species. Ellis added *Anodonta imbecillis* Say, 1829, in 1930 to bring the pre-1965 total to 36 naiad species. Baker (1928) did not cite records of naiades from the La Crosse, Wisconsin, area.

In 1965 the Wisconsin Department of Natural Resources (Finke, 1966) conducted a mussel survey in five pools of the Upper Mississippi River bordering Wisconsin.

Finke found 14 species living in Pool 7, but no survey work was done in Pool 8. In 1977-1979 the Wisconsin Department of Natural Resources conducted another survey in the Wisconsin portion of the Mississippi and found living individuals of 15 species (450 specimens) and the empty shells of 4 additional species in Pool 7 (Thiel, 1981). Living individuals of 15 species (239 specimens) and the empty shells of 8 additional species were found in Pool 8.

Fuller (1978, 1980a, 1980b) conducted site specific surveys in 1977-1979 for the St. Paul District, U.S. Army Corps of Engineers, St. Paul, Minnesota, in areas that were likely to be dredged to maintain the nine-foot navigation channel. This included four sites in Pool 7 and nine sites in Pool 8. Fuller found 13 species (173 specimens) living in Pool 7 and 20 species (757 specimens) living in Pool 8.

Mathiak (1979) hand collected at several sites in the La Crosse area and found seven species in Pool 7 and eight species in Pool 8. Coon et al. (1977) also collected from Pool 8 in 1975, but their data does not specify the number of sites collected or number of species found in Pool 8.

The objectives of this study were to:

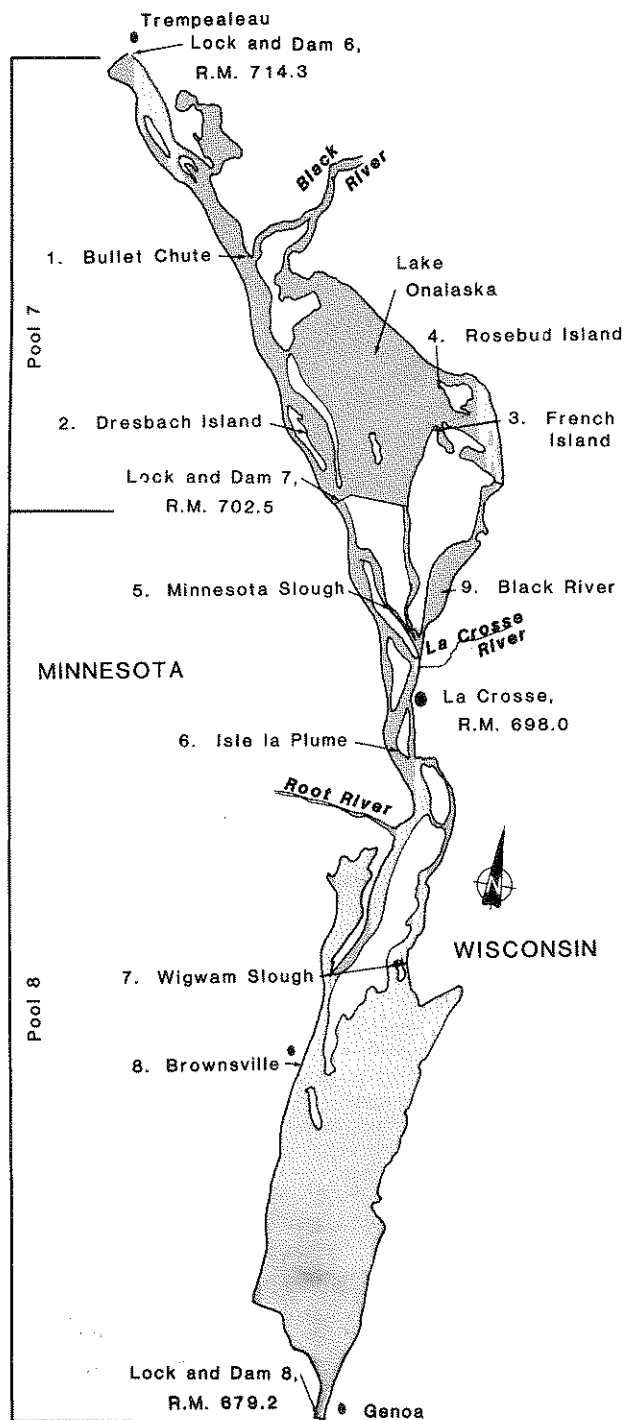


Fig. 1. Sampling sites in Mississippi River Pools 7 and 8, 1969–1981.

1. Determine diversity of naiad species (since 1969) that have lived or are now living in various areas of Pools 7 and 8, particularly in locations not studied before 1965 or examined by contemporary researchers.

2. Determine the presence or absence of the federally endangered *Lampsilis higginsii* (Lea, 1857) in these pools.

3. Compare existing records from Pools 7 and 8 with present populations, and cite possible causes for apparent changes in the species composition.

## GEOGRAPHIC DESCRIPTION

This study was conducted on the Mississippi River navigation Pools 7 and 8 near La Crosse, Wisconsin, from River Mile (R. M.) 682.7 to R. M. 708.6 (Fig. 1), a 26-river mile (41.8 km) segment of the Upper Mississippi River.

Pool 7 of the Mississippi River, just north of La Crosse, Wisconsin, extends from R. M. 702.5 (Lock and Dam 7) at Dresbach, Minnesota, upstream to R. M. 714.3 (Lock and Dam 6) at Trempealeau, Wisconsin. A prominent feature of Pool 7 is Lake Onalaska, a large shallow riverine lake that makes the pool the widest area of the Upper Mississippi (about 7.4 km). The lake covers a surface area of over 2,025 ha (Jackson et al., 1981). They reported that this area supports a large sport fishery and is part of the migratory route for many waterfowl species. The Black River of Wisconsin enters the pool through several braided channels, continuing through Lake Onalaska between Rosebud Island and French Island, ultimately emptying into Pool 8 at Onalaska, Wisconsin, and continuing to La Crosse.

Pool 8 of the Mississippi River extends from R. M. 679.2 (Lock and Dam 8) at Genoa, Wisconsin upstream to R. M. 702.5 (Lock and Dam 7) at Dresbach, Minnesota. Major tributaries of Pool 8 are the Black and La Crosse Rivers of Wisconsin (R. M. 698.2) and the Root River of Minnesota (R. M. 693.8). The five mile (8.0 km) navigable portion of the old Black River Channel has its own set of river miles. The city of La Crosse is adjacent to the Mississippi from approximately R. M. 693.7 to R. M. 701. The middle portion of Pool 8 is an extensive backwater system and the lower portion of the pool is wide, shallow, and slow moving, except for the navigation channel.

## METHODS

Most of the sites visited in this study prior to 1977 were hand collected, but after that date SCUBA diving and a 3 m crowfoot bar were used to supplement hand collections. The crowfoot bar, considered to be 0.7% efficient (Thiel, 1981), was generally dragged for a distance of about 170 m for each sample. At some sites all live specimens (and empty shells), except excess *Amblema p. plicata* (Say, 1817), were retained. In other instances only a few representative specimens of each species from a site were retained. A large number of specimens with soft parts were preserved in a solution of 75% ethanol, 5% glycerine, and 20% water. Some live specimens were temporarily transplanted prior to being used for studies by other researchers. The taxonomic nomenclature used in this study is taken from a December 1982 list used by The Ohio State University Museum of Zoology, Co-

lumbus, Ohio (Stansbery, 1982). Most of the species collection records are vouchered by specimens on deposit at The Ohio State University Museum of Zoology. A few specimens were placed at the Milwaukee Public Museum, Wisconsin; the Academy of Natural Sciences of Philadelphia, Pennsylvania; and at the Smithsonian Institution, Washington, DC.

## RESULTS

The nine major areas sampled during this study are shown in Figure 1. The results include relative abundance and diversity, and some observations on habitat characteristics.

### 1. Bullet Chute, Pool 7.

In 1965, Finke (1966) recorded a live, young *L. higginsii* from just below the mouth of Bullet Chute (Mississippi R. M. 708.6), a branch of the Black River. Several recent searches of the area have not revealed this endangered species, but a rare, live *Pleurobema sintoxia* (Rafinesque, 1820) was collected by SCUBA diving just north of the mouth of Bullet Chute. This species was not considered to be a regular part of the 1930 Ellis fauna (van der Schalie and van der Schalie, 1950). (Two 5-year old fresh-dead *P. sintoxia* were found on the Minnesota shoreline just west of Bullet Chute in 1982). Twelve other species were found living and two additional species were represented by empty shells, a total of 15 species. Since the Mississippi River appears to be in fair condition in Pool 7 (Jackson et al., 1981), and substratum conditions are similar to areas where *L. higginsii* is known to survive, possibly this rare species also still survives in the area.

### 2. Dresbach Island, Pool 7.

Finke (1966) found a live *L. higginsii* near R. M. 704 in the former main navigation channel of the Mississippi, just east of Dresbach Island. Searches in a number of areas within this channel by SCUBA diving and sampling with a crow-foot bar have not revealed this species here since 1966. The channel has some deep holes (7 m) along the riprapped banks of the series of islands between the channel and Lake Onalaska. These rocky areas serve as productive naiad habitat. The middle of the channel was characterized by a predominately sand substratum that supported moderate numbers of juvenile and adult naiades; of note were the brightly rayed and polished *Lampsilis ventricosa* (Barnes, 1823). Four live *Lasmigona complanata* (Barnes, 1823) represented the most unusual species in the area. Living individuals of 15 species and the empty shells of six additional species were found for a total of 21 naiad species in the channel east of Dresbach Island.

### 3. French Island, Lake Onalaska, Pool 7.

The northwest tip of French Island has been searched a number of times since 1969. This shallow (1 m) sandy area

has a variety of naiades, but the fauna is always dominated by *A. p. plicata*. *Lampsilis ventricosa* is abundant and the *Anodonta grandis* Say, 1829, complex is common. (See Starrett, 1971, for a discussion of the latter complex.) A large number of empty *A. imbecillis* and *Toxolasma parvus* (Barnes, 1823) wash up on the shoreline after storms. (The latter species was not considered a regular part of the 1930 Ellis fauna.) Many gastropod and sphaeriid species may be found in the same manner. One live rare *Tritogonia verrucosa* (Rafinesque, 1820) has been found, making a total of 18 living species. [*T. verrucosa* is considered uncommon in the Upper Mississippi River (Fuller 1978, 1980a, 1980b; Mathiak, 1979; Thiel, 1981; Ecological Analysts, Inc. 1981).]

### 4. Rosebud Island, Lake Onalaska, Pool 7.

Rosebud Island is about 1.5 km north of French Island. From mid-September to the end of October, 1977, live naiades were hand collected, from an area approximately 0.8 km long on the northwest tip of the island, R. M. 706.0, under contract with the St. Paul District, U.S. Army Corps of Engineers, St. Paul, Minnesota. Specimens were obtained in 0.3 m to 1.3 m of water, 5 m to 70 m off shore. There was an abundance of submerged aquatic vegetation at this site. The substratum was mostly firm sand with some gravel near the shore; other areas were a firm to soft silt and mud. *Lampsilis radiata luteola* (Lamarck, 1819) was generally buried vertically to almost its full length, but occasionally specimens of other species were found laying on the surface of the substrate.

Nearly 600 *L. ventricosa*, 253 *L. r. luteola*, and 130 *Fusconaia flava* (Rafinesque, 1820) were temporarily stored alive (up to 8 weeks) in wire cages submerged 16 cm in the substratum near the north shore of Lake Onalaska until they were needed for silt and sand bioassay studies conducted at the National Fishery Research Laboratory (Marking and Bills, 1980). Of interest were the results of this short-term transplantation project. Mortality rate in the holding cages was extremely low, about 1%. *Lampsilis* specimens burrowed into the substratum more readily than *F. flava*. Naiades used for bioassay studies had a mortality rate of 0.4% after a 48-hour acclimation period, prior to the bioassay studies, at the National Fishery Research Laboratory.

*Amblema p. plicata* was about three times as abundant as *L. ventricosa*, the second most common species found at this site. Several specimens of *A. p. plicata* were found with very weak or no "ridges". *Anodonta imbecillis* was often found in mud accumulated inside of empty shells of other species. Over 2,500 living naiad specimens (17 species) were examined. *Tritogonia verrucosa* (one) was the least common species found, although only single specimens were found of several other generally more common species.

### 5. Minnesota Slough—Railroad Bridge, Pool 8.

Observations while SCUBA diving below the railroad bridge (R. M. 699.8) in Minnesota Slough, just east of the main channel, revealed a seemingly suitable naiad habitat. Surprisingly, there was poor naiad species diversity in depths





to 7 m. Eight species were found alive and five others were represented only by empty shells. Live specimens were generally grouped together when on rock-gravel substratum. The most unusual find was one live adult *Magnonaias nervosa* (Rafinesque, 1820), but the fauna was dominated by *A. p. plicata*.

At the comparable railroad bridge site just to the west in the main channel, hand collecting yielded nine live species and six species represented by empty shells. A number of live juveniles, including 11 *Potamilus ohioensis* (Rafinesque, 1820), were found on a shallow sand-mud flat just upstream of the bridge. Fourteen live species and three species represented by empty shells, a total of 17 species, were found at these two railroad bridge sites.

#### 6. Isle la Plume, Pool 8.

A pre-dredging survey was conducted in 1977 for the City of La Crosse to determine the presence or absence of endangered naiades in the Mississippi River area adjacent to Isle la Plume (R. M. 695.7 to 696.1). The area above and below the site had been dredged extensively for fill in the previous 5 to 10 years. Only 11 species were found alive. Most of the 468 live specimens ranged from 2 mm to 15 mm in length. Ten species were found in small numbers, but the eleventh species, *Truncilla donaciformis* (Lea, 1827), was represented by 394 specimens and occurred at 52 of 65 sites surveyed with the crowfoot bar throughout the length and width of the area. Perhaps *T. donaciformis* is one of the first species to repopulate an area after it has been disturbed. Two species were frequently caught on the crowfoot hooks by their byssal threads: *T. donaciformis* had a clear byssus up to 15 cm long, and *P. ohioensis* had a black byssus up to 30 cm long. Only one live *A. p. plicata* was taken, and no endangered species were found on the predominantly sand substratum.

A search of the material dredged from the Upper Mississippi River near Isle la Plume revealed shells of an additional 16 species, although there was a paucity of specimens on the 45,000 cu m fill site. A total of 26 species were found in the dredged material. Most of these specimens were sub-fossil, indicating naiad species that formerly lived in the area. The subfossil *Alasmidonta marginata* Say, 1818, found here was not considered a regular part of the 1930 Ellis fauna (van der Schalie and van der Schalie, 1950). Twenty-seven species were found in the Isle la Plume area, but the present living naiad fauna appears to have declined by 59%.

A survey was also conducted in the nearby Bluff Slough by Havlik (1980a, 1981). Additional species records from the Bluff Slough site, including live *Anodonta suborbiculata* Say, 1831, and empty specimens of *L. complanata* and *L. r. luteola*, are included in Table 1. The Bluff Slough collection raises the total species found in the area to 30.

The results of the Isle la Plume survey indicated a number of changes in the distribution of naiades in the Mississippi River from that reported by Baker in 1928. Contrary to Baker's general observations, this survey revealed live naiades farther than 26 m from shore. Indeed, they were

found throughout the entire 275 m width of the channel. Baker also stated that records of mollusks in water more than 7.6 m should be viewed with suspicion. In this survey the greatest concentration of adult specimens, mainly *Obovaria olivaria* (Rafinesque, 1820), was found in water nearly 9.2 m deep near the Minnesota shore.

#### 7. Wigwam Slough, Pool 8.

Wigwam Slough, R. M. 691.2, in the backwaters of Pool 8, is an area characterized by a sand-gravel substratum, a strong current, and depths up to 3 m. Random sampling with SCUBA gear in March, 1981, revealed fairly diverse naiad populations with living individuals of 16 species and the empty shells of six additional species. A large number of *T. verrucosa* were found dead *in situ*. This seemed to suggest that siltation had not caused the demise of these specimens, but rather that non-point pollution had perhaps been responsible for this drastic decline of this species in Wigwam Slough. Two *M. nervosa* were found alive at this site. Additional survey work with a crowfoot bar did not add to the species recorded at this site.

In July, 1981, 60 live *T. verrucosa* from the Wisconsin River, Richland County, Wisconsin, marked on both valves with orange spray paint, were experimentally transplanted into Wigwam Slough about 15 m from shore in about 3 m of water. Prior to the transplant the site was marked with 4 large pieces of concrete placed on the substratum. As of November, 1981, these naiades appeared to have positioned themselves naturally in the substratum and no recently deceased specimens were found. However, in August, 1982, six of these specimens were dead, a 10% mortality rate. At least 5 to 10 years will be needed before researchers can determine if these specimens will reproduce and help re-establish the *T. verrucosa* population in Wigwam Slough.

#### 8. Brownsville, Minnesota, Pool 8.

Searches of a number of sites in the Brownsville, Minnesota, R. M. 688.5, area yielded living individuals of 15 species and the empty shells of two additional species. In August, 1977, a stressed living specimen taken from a fresh dredge material site was presented to me for identification by Terry Bills, Brownsville. This juvenile specimen represented the smallest live *L. higginsii* (22 mm) seen from the Mississippi River. [Since that time a live specimen, 19 mm in length, has been collected near Prairie du Chien, Wisconsin, above the mouth of the Wisconsin River, Mississippi R. M. 630.8, that may be *L. higginsii* (Stansbery, 1982 personal communication).] The Brownsville specimen still represents the present-day northern-most record of the endangered *L. higginsii* living in the main stem of the Mississippi River. More complete information on the dredging at Brownsville is provided in Whiting (1982).

One live *M. nervosa* was found in the Brownsville area in 1978, representing the first live specimen of the species above Lock and Dam 8 since 1931 (Finke, 1966; Mathiak, 1979; Fuller, 1980a; Thiel, 1981).

A number of naiad shells were found near Brownsville

in a shallow area just east of the main channel that also contained a number of muskrat houses. Below Brownsville, at the entrance to Venover Slough (R. M. 687.7), a large number of young naiades were found on a mud flat that was exposed during low water. Nine live *P. ohioensis* were found buried in packed sand just off shore (one to two m) at the Brownsville swimming beach, R. M. 689.1.

#### 9. Black River Mile 1.7, Clinton Street Bridge, Pool 8.

An intensive survey was conducted in 1978 above and below the Clinton Street Bridge at La Crosse for the Wisconsin Department of Transportation to determine the presence or absence of the endangered *L. higginsi* prior to the construction of a new bridge. The survey was accomplished by first conducting 49 crowfoot runs followed by SCUBA exploration of 16 potential and existing pier sites. A maximum of sixteen species (382 specimens) was recovered at one potential pier site (an area approximately 1.5 m wide and 7.6 m long).

A total of 2,197 living specimens (17 species) were found in the predominantly clay substratum. (Clay is rare in river bottoms in the La Crosse area.) *Amblema p. plicata* represented 75% of the live specimens recovered and clearly dominated the fauna. *Obliquaria reflexa* Rafinesque, 1820, and *Quadula quadrula* (Rafinesque, 1820), the next most common species, were well represented by 119 and 110 specimens respectively, but they comprised only 5% and 4% respectively of all specimens recovered. Many juveniles of a number of species were found. Two sub-fossil *L. higginsi* were ultimately recovered from this site.

One live *T. verrucosa* represented the least common species found. Seven species, represented by empty valves, were found by diving and increased the total species collected at the Clinton Street bridge site in 1978 to 24. Only one live specimen of *L. r. luteola* was collected even though 253 live specimens were collected several miles upstream in the Black River Channel as it flows through Lake Onalaska, Pool 7 (Site 4). A repeat dive at the bridge site in 1980 yielded another live *L. r. luteola*. This female specimen represented one of the largest specimens of the species ever deposited at The Ohio State University Museum of Zoology (150 mm long, 74 mm high, and 84 mm wide). A sub-fossil *Pleurobema rubrum* (Rafinesque, 1820), a new record for the La Crosse area, was found at the same time.

Several additional sites were investigated near Black River R. M. 5 in 1980. Live *L. complanata* and empty specimens of *Elliptio c. crassidens* (Lamarck, 1819) and *Elliptio dilatata* (Rafinesque, 1820) were found along with the usual dominance of *A. p. plicata*. This makes a total of 18 living species, with empty shells of nine additional species from the lower Black River. Since Bartsch found only 20 species in 1907 and Thiel (1981) duplicated seven of the Bartsch records (six living species and one species represented by empty shells), the 27 species found in this study represent the largest number ever recorded from the lower Black River.

Since the mid-1960's *Amblema p. plicata* has been commercially harvested intermittently from the Pool 8 seg-

ment of the Black River for the Japanese cultured pearl industry.

## DISCUSSION

From 1969 to 1981 over 7,000 naiad mollusks representing 38 species, 25 as living specimens and 13 as empty shells, have been collected in Pools 7 and 8 of the Upper Mississippi River near La Crosse, Wisconsin. Five of the 13 species represented by empty shells have been found alive by contemporary researchers (Table 1) as well as empty valves of *Cyclonaias tuberculata* (Rafinesque, 1820). In addition to the 35 species recorded prior to the 1930's I have added live *A. suborbiculata*, *P. ohioensis*, *T. parvus*, and sub-fossil *P. rubrum* for a total of 40 species. The present-day total of living individuals of 30 species and the empty shells of 10 additional species in the La Crosse area still duplicates and even exceeds the historic records, however the living diversity has decreased by 25%. The overall total of 40 species compares favorably with the 46 species recorded from the most diverse naiad fauna of the Mississippi River at Prairie du Chien, Wisconsin, 63 river miles (100.8 km) south of La Crosse in Pool 10 (Havlik and Stansbery, 1977; Havlik and Marking 1980; Havlik, 1981). Many species in the La Crosse area are found only in small numbers in comparison to the densities found at Prairie du Chien. The La Crosse fauna is clearly dominated by *A. p. plicata*, a commercial species that is not harvested in Pool 7 and only occasionally harvested in Pool 8.

Although living specimens have been found of several species not considered to be a regular part of the Ellis fauna, no live records of several species found by Ellis have been reported since the 1930's. Several species appear to be nearly extirpated from the La Crosse area.

The majority of this study was conducted after numbers of fresh-dead endangered *L. higginsi* were found in 1976 at Prairie du Chien, (Havlik and Stansbery, 1977). Segments conducted in 1977 (Rosebud Island) and in 1978 (Black River) revealed the presence of a diverse naiad fauna (17 species) living at each site and yet no living *L. higginsi*. An analysis of the Havlik and Stansbery (1977) species assemblage revealed that *O. olivaria* was one of the species living at Prairie du Chien and yet not found at the Rosebud Island or Black River sites. Further comparisons with data from Fuller (1978) confirmed that *O. olivaria* was also present at the *L. higginsi* site in the St. Croix River near Hudson, Wisconsin. After the 1978 discovery of living *M. nervosa* near Brownsville, Minnesota, a similar comparison of the fauna from all sites known to have living *L. higginsi* again revealed that *M. nervosa* generally lived in the same areas as *L. higginsi*. Since that time living *L. higginsi* apparently have not been found at any site in the Upper Mississippi, St. Croix or Wisconsin Rivers that did not also have either *O. olivaria* or *M. nervosa* (or both species) living at the same site (an area 2.25 sq m to 510 sq m) or in close proximity (within 0.4 km)

(Fuller, 1978, 1980a; Mathiak, 1979; Perry, 1979; Ecological Analysts, Inc., 1981; Thiel, 1981, personal communication).

Since *L. higginsii* is generally associated with populations of *O. olivaria* and/or *M. nervosa*, they apparently have similar habitat requirements. Historically they are all found in big river systems and are considered deep water species (Baker, 1928; Fuller, 1978, 1980a, 1980b). Since substrata in Pools 7 and 8 are often similar to those in the Prairie du Chien area where *L. higginsii* is known to survive, I suspect that water quality, biological characteristics or other factors are important for survival and reproduction. Research on water quality and on various contaminants using *O. olivaria* and *M. nervosa*, along with research on the more common congeneric species of *L. higginsii*, *L. ventricosa* and *L. r. luteola*, might provide some insights as to the habitat requirements of that endangered species. Although *O. olivaria* is found in small numbers in the Mississippi River upstream from Lock and Dam 8 (Mississippi R. M. 679.2) to the mouth of the St. Croix River (Mississippi R. M. 811.5), *M. nervosa* is almost extirpated from this same reach of the Upper Mississippi River (Fuller, 1978, 1980a, 1980b; Thiel, 1981). Likewise, there are no recent records of *L. higginsii* living in the main stem of the Mississippi River upstream of Brownsville, Minnesota to the mouth of the St. Croix River (Havlik, 1980b).

A cluster analysis of all naiad species found in Pool 10 of the Mississippi near the Prairie du Chien area (Thiel, 1982, personal communication) revealed that *O. olivaria* [as well as *Quadrula metanevra* (Rafinesque, 1820)] was more often found with *L. higginsii* than any other species, thus adding support to the above observations.

Since several other rare species such as *P. sintoxia* and *T. verrucosa* also still survive in Pools 7 and 8, the water quality in this area of the Upper Mississippi River should be maintained and even improved.

After comparing all known historical naiad mollusk records from the La Crosse area with modern species lists, it becomes apparent that the area no longer supports an overall flourishing naiad population except for a few species.

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