# Recovery Plan

# Pink Mucket Pearly Mussel
# <u>Lampsilis</u> <u>orbiculata</u>

## DISCLAIMER

THIS IS THE COMPLETED PINK MUCKET PEARLY MUSSEL RECOVERY PLAN. IT HAS BEEN APPROVED BY THE U.S. FISH AND WILDLIFE SERVICE. IT DOES NOT NECESSARILY REPRESENT OFFICIAL POSITIONS OR APPROVALS OF COOPERATING AGENCIES, AND IT DOES NOT NECESSARILY REPRESENT THE VIEWS OF ALL INDIVIDUALS WHO PLAYED A ROLE IN PREPARING THIS PLAN. THIS PLAN IS SUBJECT TO MODIFICATION AS DICTATED BY NEW FINDINGS, CHANGES IN SPECIES STATUS, AND COMPLETION OF TASKS DESCRIBED IN THE PLAN. GOALS AND OBJECTIVES WILL BE ATTAINED AND FUNDS EXPENDED CONTINGENT UPON APPROPRIATIONS, PRIORITIES, AND OTHER CONSTRAINTS.

THE RECOVERY PLANS FOR THE MUSSEL AND FISH SPECIES OF THE TENNESSEE RIVER VALLEY HAVE BEEN DEVELOPED ON A SPECIES-BY-SPECIES BASIS. FOR IMPLEMENTATION PURPOSES, THE PLANS WILL BE CONSOLIDATED ON A WATERSHED BASIS, AND THE NEEDS OF ALL LISTED SPECIES IN THAT SYSTEM WILL BE ADDRESSED.

This plan was prepared under contract by Steven Ahlstedt, Tennessee Valley Authority, Norris, Tennessee.

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RECOVERY PLAN FOR THE
PINK MUCKET PEARLY MUSSEL

<u>Lampsilis</u> <u>orbiculata</u> (Hildreth, 1828)

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CONTENTS



TABLE

CONTENTS
(continued)

Page

FIGURES



PHOTOGRAPH

PART I

INTRODUCTION

Freshwater mussels (naiades) are known to occur in every temperate and tropical climate with approximately one-half of the extant species living in North America. Eastern North America still contains the most diverse freshwater molluscan fauna known in the world. Stansbery (1970) reported that fauna numbers over a thousand species of bivalves and gastropods combined. The richest assemblages of freshwater mussels were reported from the Tennessee, Cumberland, and Ohio River systems.

Twenty-three freshwater mussels in the United States are listed as endangered by the U.S. Department of Interior. Almost all of these species were known from the Tennessee, Cumberland, and Ohio River systems. The pink mucket pearly mussel (*Lampsilis orbiculata*) was proposed as an endangered species in September 1975 (*Federal Register* 40(188):44329-44333) and listed in June 1976 (*Federal Register* 41(115):24062-24067).

Hildreth (1828) described *Unio orbiculatus* from the Muskingum River in Marietta and Washington Counties, Ohio. However, the description for *U. orbiculatus* by Hildreth (1828) does not fit that (the description) of *L. orbiculata*. The earliest name which fits the description of *L. orbiculata* is by Say (1831) in his description of *Unio abruptus*. *Unio abruptus* is undoubtedly the proper description

for L. orbiculata as reported by Binney (1858), Clarke (1982), and Bogan and Parmalee (1983). Another closely related endangered species, (Lampsilis higginsi (Lea, 1857)), is often confused with L. orbiculata; however, both are considered valid species (Havlik, 1980; USFWS, 1983; Clarke, 1982; Stansbery, Ohio State University-personal communication).

## DISTRIBUTION

### Historical

Historical records for L. orbiculata indicate this is strictly an Ohioan or Interior Basin species, found mainly in the Tennessee, Cumberland, and Ohio River drainage with occasional records from the Mississippi River drainage. Historically, L. orbiculata occurred in 25 river systems and was an extremely widespread in distribution (Table 1). This species has never been collected in large numbers from any one site or drainage and, therefore, it has usually been considered rare. Wilson and Clark (1914) reported L. orbiculata as being "fairly common" in their collections from the middle portion of the Cumberland River taking one to three specimens from each mussel bed. Ortmann (1919) reported this species as rare in the Monongahela River (only one specimen found) and in the Allegheny River (only a few specimens found). Further down the Ohio River Ortmann (1919) reported only two dozen L. orbiculata in the shell heaps of clam diggers. Ortmann (1925) also reported L. orbiculata as rarely occurring in the Tennessee River up to the lower Clinch River near Knoxville, Tennessee.

Table 1. Historical records for *Lampsilis orbiculata* prior to 1970 and subfossil specimens recorded to 1982.

| River | Source |
|---|---|
| Tennessee River | Hinkley (1904, 1906)<br>Ortmann (1918, 1919, 1925)<br>van der Schalie (1939)<br>Morrison (1942) archaeological specimens<br>Stansbery (1964, 1970, 1976)<br>Isom (1969, 1972)<br>Johnson (1980) |
| Flint River, Alabama | Johnson (1980) |
| Limestone Creek, Alabama | Ortmann (1925)<br>Johnson (1980) |
| Duck River | Johnson (1980) |
| Holston River | Lewis (1871)<br>Hickman (1937)<br>Johnson (1980) |
| French Broad River | Johnson (1980) |
| Clinch River | Ortmann (1918, 1919, 1925)<br>Cahn (1936)<br>Hickman (1937)<br>Stansbery (1973)<br>specimens collected mid-1960's<br>Johnson (1980) |
| Cumberland River | Call (1885)<br>Marsh (1885)<br>Wilson and Clark (1914)<br>Neel and Allen (1964)<br>Johnson (1980)<br>Sickel (1982) subfossil shells |
| Obey River | Shoup et al. (1941)<br>Johnson (1980) |
| Ohio River | Call (1885, 1896, 1900)<br>Sterki (1907)<br>Ortmann (1911, 1912, 1919, 1925)<br>Goodrich and van der Schalie (1944)<br>Parmalee (1960, 1967)<br>Stansbery (1962) |

Table 1. Continued.

| River | Source |
|---|---|
| Ohio River (continued) | Johnson (1980)<br>Taylor (1980) subfossil specimens |
| Allegheny River | Ortmann (1919)<br>Johnson (1980) |
| Monongahela River | Ortmann (1919)<br>Johnson (1980) |
| Elk River, West Virginia | Taylor and Hughart (1981) |
| Kanawha River, West Virginia | Stansbery (1972) archaeological specimens |
| Scioto River | Stansbery (1965) archaeological specimens<br>Johnson (1980) |
| Muskingum River | Hildreth (1828)<br>Ortmann (1918, 1919)<br>Bates (1970)<br>Stansbery (1970, 1974)<br>Johnson (1980) |
| White River, Indiana | Say (1817)<br>Call (1896, 1900)<br>Utterback (1917)<br>Ortmann (1919)<br>Goodrich and van der Schalie (1944)<br>Johnson (1980) |
| Wabash River, Indiana and Illinois | Say (1817)<br>Binney (1858)<br>Call (1896, 1900)<br>Baker (1906)<br>Ortmann (1919)<br>Goodrich and van der Schalie (1944)<br>Parmalee (1967)<br>Johnson and Baker (1973)<br>Johnson (1980) |
| Mississippi River, Illinois and Iowa | Pratt (1876)<br>Baker (1906)<br>Ortmann (1919, 1925)<br>Grier and Mueller (1922-23) |

Table 1. Continued.

| River | Source |
|---|---|
| Illinois River | Calkins (1874)<br>Baker (1906)<br>Danglade (1914)<br>Ortmann (1919)<br>Starrett (1971)<br>Johnson (1980) |
| Quachita River, Arkansas | Wheeler (1918)<br>Ortmann (1919) |
| Old River (Quachita River system) | Wheeler (1918) |
| Black River | Ortmann (1919) questionable specimens |
| Sac River, Missouri | Ron Oesch (personal communication)<br>1 relict specimen July 1969 |
| St. Francis River, Missouri | Ron Oesch (personal communication)<br>4 relict specimens May 1972 |

Additional records of *L. orbiculata* from the Ohio River include Call (1885, 1896, 1900), Simpson (1900, 1914), Sterki (1907), Goodrich and van der Schalie (1944), LaRoque (1967), and Taylor (1980, subfossil specimens). Archaeological specimens have been reported from the Kanawha and Scioto Rivers by Stansbery (1965, 1972). Hildreth (1828), Ortmann (1919), Stansbery (1974), and Bates (1970) reported *L. orbiculata* from the Muskingum River. In Indiana and Illinois, *L. orbiculata* was reported from the Wabash and White Rivers (Say, 1817; Call, 1896 and 1900; Baker, 1906). This species was also reported from the Mississippi River in Illinois and Iowa by Pratt (1876), Baker (1906), Simpson (1900), Grier and Mueller (1923); and the Illinois River by Calkins (1874), Baker (1906), Danglade (1914). West of the Mississippi River, this species has been reported from the Quachita, Old, and Black Rivers (Wheeler, 1918; Ortmann, 1919).

From the southern tributaries of the Ohio River system, *L. orbiculata* is reported from the Cumberland River by Call (1885), Marsh (1885), Simpson (1900, 1914), Wilson and Clark (1914), Neel and Allen (1964), and the Obey River (tributary to Cumberland) by Shoup et al. (1941). Numerous records of *L. orbiculata* were also reported from the Tennessee River (Hinkley 1904, 1906; Ortmann 1918, 1919, 1925; van der Schalie 1939; Stansbery 1964; Isom 1969, 1972). *Lampsilis orbiculata* has also been reported from numerous tributary streams to the Tennessee River including Limestone Creek, Alabama (Ortmann, 1925); Flint River, Alabama (Johnson, 1980); Duck River (Johnson, 1980); Holston River (Lewis, 1971; Hickman, 1937), French Broad River (Johnson, 1980); and the Clinch River (Ortmann, 1918, 1919, 1925; Cahn, 1936; Hickman, 1937; Stansbery, 1973 specimens collected mid-1960's; Johnson, 1980).

Based on this information, L. *orbiculata* had a widespread historical distribution where it was apparently rare throughout its range. Historical records for L. *orbiculata* prior to 1970 are summarized in Table 1.

## Present

*Lampsilis orbiculata* is presently known from 16 different rivers representing three major geographic regions (Figures 1 and 2, Appendix A, Table 1). Based on the number of locations where specimens have been found or observed, the greatest concentrations of L. *orbiculata* are reported from the Tennessee River (Yokley, 1972; TVA, 1978; Pardue, 1981; Leroy Koch (TVA) and James Sickel (Murray State University, personal communication); Cumberland River ( TVA, 1976; Parmalee et al. 1980; Koch, personal communication); Osage River (Grace and Buchanan, 1981; Oesch, personal communication); and the Meramec River (Buchanan, 1980; Oesch, personal communication).

Hundreds of fresh dead specimens of L. *orbiculata* have been observed by the author, Leroy Koch (personal communication), and Parmalee et al. (1980) from commercial sheller's cull and stockpiles located on the Tennessee and Cumberland Rivers. Juvenile L. *orbiculata*, less than five years of age, have been observed in the Tennessee River (Koch, personal communication), Paint Rock River (author), and the Meramec River (Buchanan, 1980) indicating that successful reproduction is occurring in these rivers.

Taylor (1983) reports that "a good-sized healthy population" of L. *orbiculata* exists in a small stretch of the Kanawha River below Kanawha Falls. Clarke (1982) also reported three live specimens found

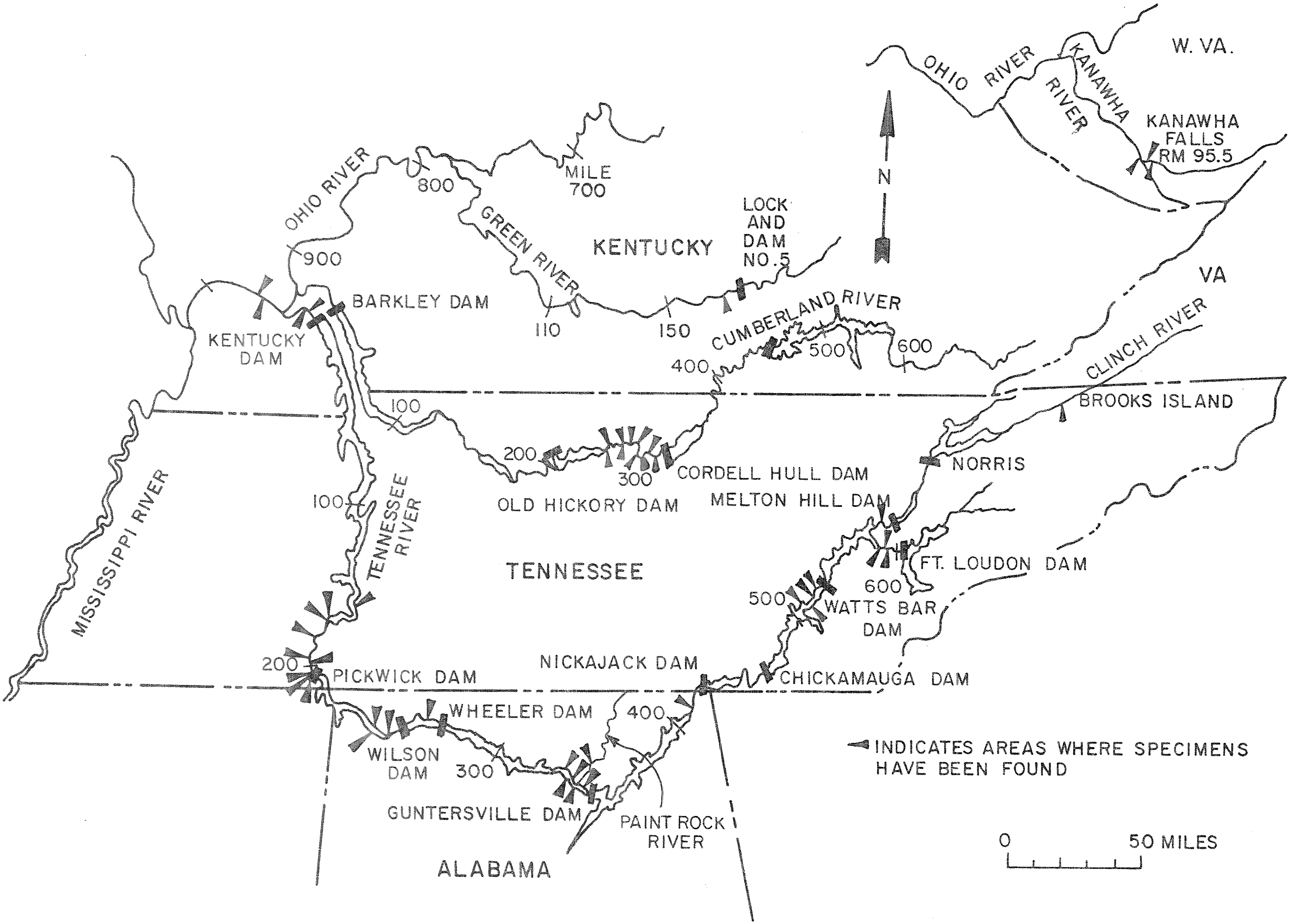



Figure 1: Tennessee, Cumberland and Ohio River Systems – Recent Locations for LAMPSILIS ORBICULATA (HILDRETH, 1828)

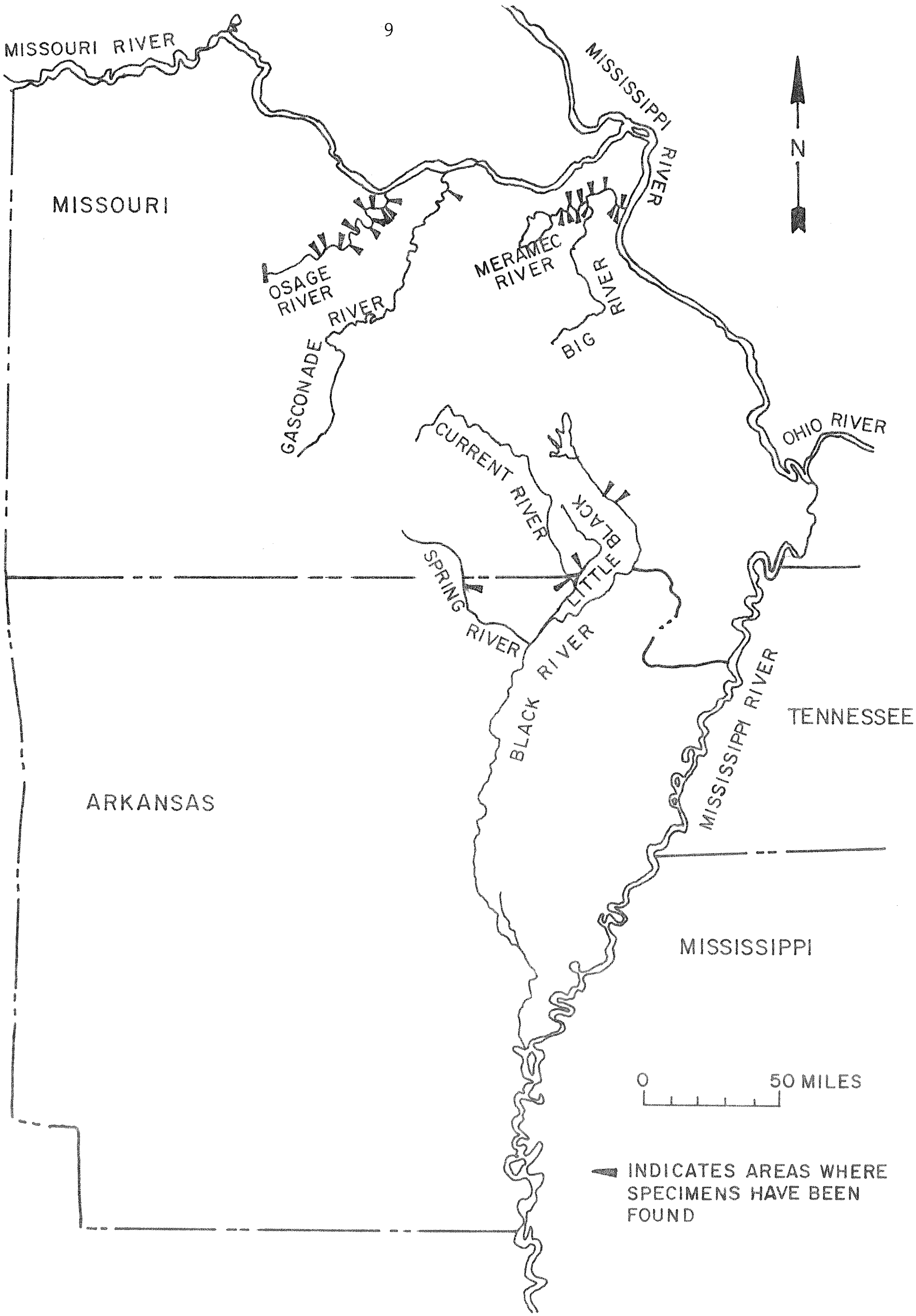



Figure 2 : Osage, Gasconade, Meramec, Big, Black, Little Black, Current, and Spring Rivers — Recent Locations for LAMPSILIS ORBICULATA (Hildreth, 1828)

during his survey of the Kanawha. In all probability, the Cumberland River has a reproducing population of *L. orbiculata* based on the number of specimens observed and aged by Parmalee et al. (1980), Koch (personal communication) and the author.

Lesser known populations of *L. orbiculata* are reported from the Clinch River, Tennessee upstream from Norris Dam and downstream from Melton Hill Dam (TVA; 1979, 1982); lower Ohio River (Koch and Jeff Pardue (TVA), personal communication); Green River, Kentucky (U.S. EPA, 1981; Sam Call, Kentucky Dept. of Natural Resources, personal communication); Big River, Missouri (Buchanan, 1980; Ron Oesch, personal communication); Black River, Missouri (Buchanan, 1980; Ron Oesch, personal communication); Little Black River, Missouri (Buchanan, 1979); Current River, Arkansas (Alan Buchanan, Missouri Dept. of Conservation, personal communication); and the Gasconade River (Stansbery and Oesch, personal communication). One fresh-dead specimen of *L. orbiculata* was found by the author in 1979 from the lower Little Tennessee River (Coytee Springs). This area is now impounded by Tellico Reservoir.

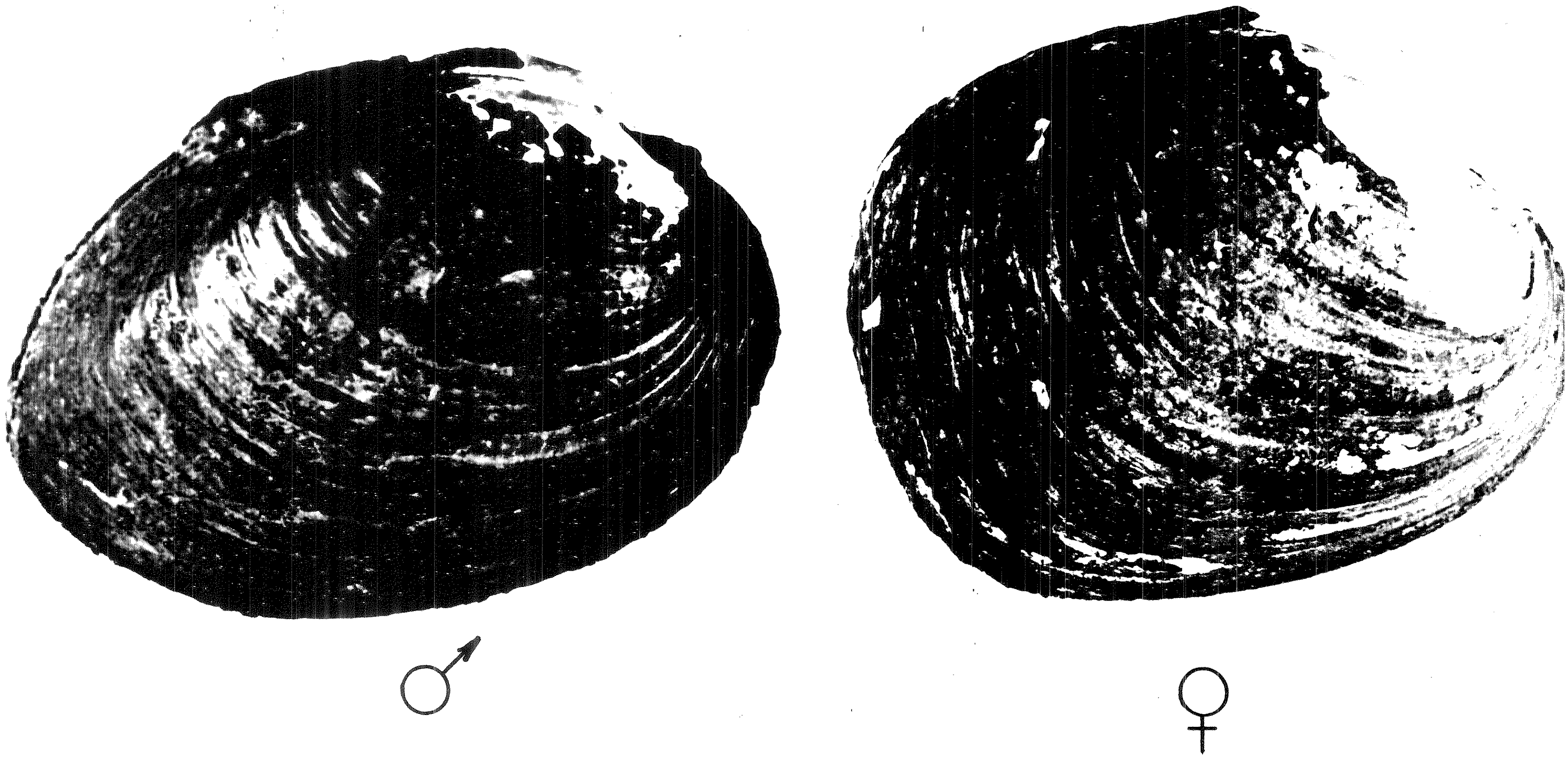
In view of the above information, *L. orbiculata* appears to have adapted to existence in the impounded Tennessee and Cumberland Rivers. The river-lake conditions in the upper reaches of these impoundments caused by discharges or releases through dams are apparently suitable for survival and propagation of *L. orbiculata*. The rare occurrence of *L. orbiculata* in smaller streams such as the Clinch River above Norris Dam and the Paint Rock River may result from sub-optimum habitat for this otherwise larger river species; however, conditions are apparently being met for the continued survival of this species.

# ECOLOGY AND LIFE HISTORY

Freshwater mussels (naiades), are benthic animals that usually remain buried in the substrate with only the most posterior margin of the shell and siphons exposed to the water column. Freshwater mussels are found in a variety of habitats ranging from mud and sand, between bedrock ledges, to rubble and gravel substrates. The majority of freshwater mussel species are normally found in riverine conditions in relatively firm rubble, gravel, and sand substrates swept-free of silt. Typically, most mussel species are found buried in the substrate in riffle and shoal areas.

*Lampsilis orbiculata* (see photo) is an Ohioan or Interior Basin species found in medium to large rivers (20 m wide or greater) in habitats ranging from silt to boulders, rubble, gravel, and sand substrates (Hickman, 1937; Yokley, 1972; Buchanan, 1980; Clarke, 1982). *Lampsilis orbiculata* is most often associated with larger rivers (Ohio, Tennessee, and Cumberland Rivers) in moderate to fast-flowing water, at depths ranging from 0.5 to 8.0 m. Ortmann (1919) collected this species from riffles with strong currents as did Bogan and Parmalee (1983). Buchanan (1980) reported *L. orbiculata* occurring at water depths ranging from 2.5 cm to 1.5 m in both standing and flowing water. The author has collected this species in the Tennessee and Cumberland Rivers at depths of 2.7 to 8.0 m in moderate to fast-flowing water.

The outward appearance of *L. orbiculata* is characterized by an elliptical, subovate, subquadrate shell attaining a size of approximately 105 mm long, 82 mm high, and 61 mm wide. Valves are inflated, thick, heavy, unsculptured, and gaping at the anterior-ventral base.



0 1 cm

<u>Lampsilis</u> <u>orbiculata</u>

Lampsilis orbiculata is sexually dimorphic. In males, the anterior margin of the shell is curved or rounded and the posterior end is somewhat pointed. In females, the anterior margin is rounded with the posterior-ventral area expanded, broad, and somewhat truncated to accommodate the marsupium (Hildreth, 1828; Simpson, 1914; Johnson, 1980). The posterior ridge is well defined in males and younger specimens being distinct along the dorsal margin. The surface of the shell is smooth except for wide, relatively dark, concentric growth rests. Beaks are located in the anterior portion of the shell, with young individuals marked with faint beak sculpture consisting of looped ridges. The outer covering of the shell (periostracum) can be glossy in younger specimens or dull in old individuals. Color is yellow to yellowish or greenish brown with wide, greenish rays present in younger specimens. Umbos are broad, moderately inflated, inclined forward, and project above the hinge line. The hinge line is long, full, and heavy.

The left valve consists of two large, triangular, pseudocardinal teeth of almost equal height separated by two curved lateral teeth with a short, medium width, flat interdentum. The right valve has one large triangular pseudocardinal tooth and one large, medium length, elevated, slightly curved lateral tooth. Anterior and posterior adductor muscle scars and pallial line are deep and well impressed. Nacre coloration is generally pink or salmon, to solid, irridescent, silvery white.

The life history of L. orbiculata is unknown; however, it is probably similar to that of most naiades (Figure 3). Males produce sperm which are discharged into the surrounding water and dispersed by water currents. Females downstream from the males obtain these

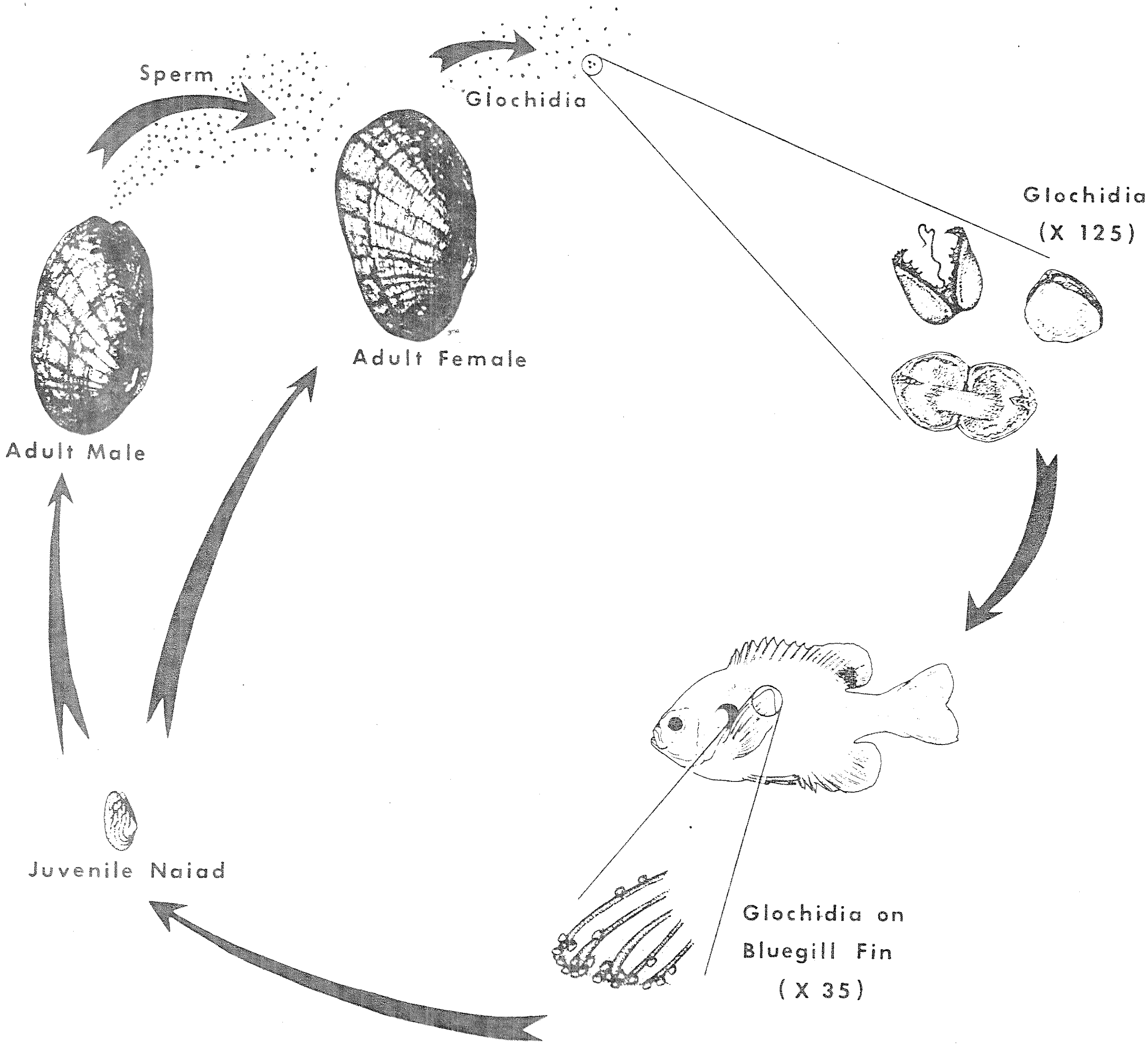



Figure 3. Typical naiad life cycle depicting the various stages. The life cycle for most species of naiades is very similar to that depicted here (Grace and Buchanan 1981).

sperm during feeding and respiration (Stein, 1971). Fertilization of the eggs occurs within the gills of the female. The fertilized eggs are retained in the posterior section of the outer gills, which are modified as brood pouches.

The family Unionidae are separated into two groups based on the length of time glochidia remain in the female (Ortmann, 1911). By Ortmann's definitions, bradytictic bivalves (long-term breeders) breed from midsummer through fall or early winter. Embryos develop in the female over winter and are released the following spring or summer. Tachytictic bivalves (short-term breeders) breed in early spring and release glochidia by mid- to late-summer of the same year. *L. orbiculata* is a bradytictic species becoming gravid in August with females having glochidia in September which are released (discharged) the following year in June (Ortmann; 1912, 1919).

The anatomy of *L. orbiculata* has been described by Ortmann (1911, 1912). Females of genus *Lampsilis* typically have a flap (mantle flap) which sets this group apart from other genera. The flap has numerous teeth along its edge and projects at the anterior end in a free lobe. An eye spot, typically found in most *Lampsilis* species, has been observed on the mantle flaps of *L. orbiculata* (Dave Stansbery, personal communication). The glochidia of *L. orbiculata* might be called bean-shaped and hookless. Hookless glochidia typically have a more spoon-shaped delicate shell, and are more frequently parasitic on the gill filaments of fish (Lefevre and Curtis, 1910; Coker and Surber, 1911). Ortmann (1911) reported that *L. orbiculata* glochidia are peculiar in that two sizes were observed, with the smaller glochidia more common.

Fish hosts for *L. orbiculata* are unknown. However, Surber (1913) reported the sauger as a host fish for another closely related endangered species, *Lampsilis higginsi*.

## REASONS FOR DECLINE AND CONTINUED THREATS

Many species of freshwater mussels, including *L. orbiculata*, have been totally eliminated from some river systems in the United States. Historically, *L. orbiculata* had a widespread distribution occurring in at least 25 rivers (Table 1). This species was never collected in large numbers from any one site or drainage and therefore has always been considered as uncommon or rare. Reasons for the decline of freshwater mussels in general are not totally understood, but due to the longevity of most mussel species--up to 50 years--and their rather sedentary nature, they are especially vulnerable to stream perturbations such as impoundments, siltation, and pollution.

### Impoundment

Possibly the single greatest factor contributing to the decline of freshwater mussels, not only in the Tennessee Valley, but other regions as well, is the alteration and destruction of stream habitat due to impoundments for flood control, navigation, hydroelectric power production, and recreation.

Since the early 1930's and 1940's, the Tennessee Valley Authority, Aluminum Company of America (Alcoa), and the U.S. Army Corps of Engineers have constructed 51 impoundments throughout the Tennessee and Cumberland River systems alone. Stream impoundments affect species

composition by eliminating those species not capable of adapting to reduced flows, altered temperature regimes, and anoxic conditions. Tributary dams typically have hypolimnial discharges that cause the stream below the dam (reservoir tailwater) to differ significantly from preimpoundment conditions and from upstream river reaches. Possible effects of hypolimnial discharges include: altered temperature regimes, extreme water level fluctuations, reduced turbidity, seasonal oxygen deficits, and high concentrations of certain heavy metals (TVA, 1980). Biological responses attributable to these environmental changes can include reductions in the fish and benthic macroinvertebrate communities (Isom, 1971). Hickman (1937) recorded numerous species of mussels and snails in the vicinity of the Norris Dam construction site prior to the impoundment of that reach of the Clinch River and predicted that the Norris Dam flood control project would have a deteriorating effect on the molluscan fauna. A. R. Cahn (1936) collected 45 mussel species including _L. orbiculata_ and nine river snail species in the dewatered riverbed following closure of Norris Dam. In a return visit to the area four months later, he could not find a single live mussel. Clarke (1981) warned that _Pleurobema plenum_, another federally listed endangered species, will survive in the Green River, Kentucky, only if its natural habitat is restored. _L. orbiculata_ is also found in the Green River (Call, personal communication). The completion of the Green River Dam in 1969 may eventually eliminate both species from that river system.

## Siltation

Silitation is another factor that has severely affected freshwater mussels. In rivers and streams, the greatest diversity and abundance of mussels are usually associated with gravel and/or sand substrates.

These substrates are most common in running water (Hynes, 1970). Increased silt transport into our waterways due to strip mining, coal washing, dredging, farming, logging, and road construction are some of the more obvious results of human alteration of the landscape. Hynes (1974) states that there are two major effects of inorganic sediments introduced into aquatic ecosystems. The first is an increase in the turbidity of the water with a consequent reduction in the depth of light penetration and the second is a blanketing effect on the substrate. High turbidity levels due to the presence of suspended solids in the water column have a mechanical or abrasive action that can irritate, damage, or cause clogging of the gills or feeding structures of mollusks (Loar et al. 1980). Additionally, high levels of suspended solids may reduce or inhibit feeding by filter feeding organisms, such as mussels, causing nutritional stress and mortality (Loosanoff, 1961). Freshwater mussels are long-lived and sedentary by nature; many species are unable to survive in a layer of silt greater than 0.6 cm (Ellis, 1936). Since most freshwater mussels are riverine species that require clean, flowing water over stable, silt-free rubble, gravel, and sand shoals, the smothering action of silt is often severe. Fuller (1977) reported that siltation associated with poor agricultural practices and deforestation of much of North America was probably the most significant factor impacting mussel communities. Mussel life cycles can be affected indirectly from siltation by impacting host-fish populations by smothering fish eggs or larvae, reducing food availability or filling of interstitial spaces in gravel and rubble substrate, thus eliminating spawning beds and habitat critical to the survival of young fishes (Loar et al. 1980).

Pollution

A third factor which must be considered is the impact caused by various forms of pollutants. An increasing number of streams throughout the United States receive municipal, agricultural, and industrial waste discharges. The damage suffered varies according to a complex of interrelated factors, which include the characteristics of the receiving stream and the nature, magnitude, and frequency of the stresses being applied. The degradation can be so severe and of such duration that the streams are no longer considered valuable in terms of their biological resources (Hill et al. 1974). These areas will not recover if there are residual effects from the pollutants, or if there is an inadequate pool of organisms for recruitment or recolonization (Cairns et al. 1971).

The absence of freshwater mussels can logically be an indication of environmental disruption only when and where their former presence can be demonstrated (Fuller, 1974). It is very rare that the composition and size of the mussel fauna can be quantitatively and/or qualitatively correlated with a specific disruption, be it chemical or physical (Ingram, 1956). However, some data are available concerning the adverse impacts of some pollutants on freshwater mussels along with other components of the ecosystem. Ortmann (1918) in his studies of the freshwater mussels in the upper Tennessee drainage reported numerous streams to be already polluted and the mussel fauna gone. These streams included the Powell River, for a certain distance below Big Stone Gap, Virginia (wood extracting plant); the North Fork Holston River for some distance below Saltville, Virginia (salt and plaster of Paris industries); French Broad River at Asheville, North Carolina; Big Pigeon River from

Canton, North Carolina, all the way to its mouth (wood pulp and paper mill); and the Tellico River below Tellico Plains, Tennessee (wood pulp and extracting mill). Williams (1969) in his study of the mussel fauna of the Green River reports an almost total elimination of the freshwater mussel fauna below Greensburg, Kentucky, due to oil brine pollution.

## DISCUSSION

All the aforementioned reasons for decline and continued threats have obviously impacted freshwater mussel communities in many streams. However, observations and sampling by various individuals using a variety of sampling techniques indicate that *L. orbiculata* still is geographically widespread and frequently is encountered in the Tennessee, Cumberland, and Meramec Rivers, and a small portion of the Kanawha River. The age distribution observed suggests that this species is reproducing in sections of each of these streams. Occasional specimens are also found in smaller streams (see Appendix, Table A-1) which suggest that *L. orbiculata* may persist at low population levels in these streams as well. Mainstream dams constructed on the Tennessee and Cumberland Rivers may have created habitat suitable for the survival and propagation of *L. orbiculata*. Clark (1976) reported that impoundments do not have the same effects on different species of mussels. Clark further reported that some species have benefitted from impoundment and are reproducing in large numbers. This has been observed by the author in the overbank areas of the Tennessee and Cumberland Rivers. Large numbers of *Quadrula metanevra*, *Quadrula quadrula*, and *Fusconaia ebena* as well as large concentrations of

*Anodonta grandis* have been observed in the impounded portions of the Tennessee and Cumberland Rivers. Other rivers may also be maintaining populations of *L. orbiculata* since some dams (especially mainstream dams) allow for riverine conditions.

# PART II

# RECOVERY

## A. Recovery Objectives

The ultimate objective of this recovery plan is to maintain and restore viable populations* of L. orbiculata to a significant portion of its historic range and remove the species from the federal list of endangered and threatened species. Based on the current widespread distribution of this species and the number of populations known, this species could now be considered for downlisting to threatened status. This species shall be considered recovered, i.e., no longer in need of federal Endangered Species Act protection, when the following criteria are met:

1. When two additional viable populations of L. orbiculata are found in any two rivers except the Tennessee, Cumberland, and Meramec Rivers. Both of these rivers will contain viable populations that are distributed such that a single event would be unlikely to eliminate L. orbiculata from the river system. Survey data must show at least five viable populations with each population having a minimum of two year-classes between 4 and 10 years of age as evidence of reproduction.
2. Additional mussel sanctuaries are established or expanded in river systems which contain known concentrations of L. orbiculata.
3. An education program is established for the public with major emphasis towards commercial mussel fishermen.
4. The species and its habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the populations.

*Viable population - A reproducing population that is large enough to maintain sufficient genetic variation to enable it to evolve and respond to natural habitat changes.

B. Step-Down Outline

Prime Objective: Delist

1. Conduct population and habitat surveys for L. orbiculta.
   1.1 Determine species' present distribution and status.
   1.2 Identify essential habitat and specific areas in need of protection.
2. Preserve populations and presently used habitat of L. orbiculata.
   2.1 Determine specific threats faced by the species.
   2.2 Continue to utilize existing legislation and regulations to protect the species and its habitat.
   2.3 Determine and implement protection strategies for areas identified in Task 1.2.
3. Develop education programs.

C. Narrative Outline

1. Conduct population and habitat surveys. Numerous freshwater mussel surveys since 1970 have documented the occurrence of L. orbiculata in at least 16 different rivers (Figures 1 and 2). Reproducing populations are known to occur in three of these rivers (Tennessee, Cumberland, and Meramec) and one young specimen (five years old) has been found in the Paint Rock River. Before L. orbiculata can be delisted, two additional reproducing populations in two separate rivers are required. Each river must contain two population centers of L. orbiculata with at least two year classes of four to ten years of age as evidence of a reproducing population.

Intensive dive/float freshwater mussel surveys and/or the use of a commercial mussel fishermen are recommended to locate specimens of L. orbiculata in the rivers known to support this species. Those streams which may contain reproducing populations of L. orbiculata in order of priority include the lower Ohio River below Owensboro, Kentucky; the Green River from Mumfordville, Kentucky, downstream to Lock and Dam No. 4; Osage River (Missouri); Black River (Arkansas); Kanawha River (West Virginia) below Kanawha Falls; and the Muskingum River, near Marietta, Ohio. When and if viable reproducing populations are found in two additional rivers (other than the Tennessee, Cumberland, or Meramec) the prime objective of this recovery plan will be satisfied.

1.1 Determine species' present distribution and status. Determine if lesser known populations described earlier are successfully reproducing.

1.2 Identify essential habitat and specific areas in need of protection. State protected mussel sanctuaries have been established for portions of the Tennessee, Cumberland, and Clinch Rivers. All three of these rivers have populations of L. orbiculata. Populations of this species in the State of Missouri are also protected to some extent since commercial mussel fishing is not allowed in the State. However, it is recommended that States be encouraged to establish or extend sanctuaries in areas with known concentrations of L. orbiculata. One such area highly recommended is the Kanawha River below Kanawha Falls, West Virginia.

2. Preserve populations and present habitat of L. orbiculata. All known populations of L. orbiculata and present habitat will continue to be protected by the Endangered Species Act until recovery objectives are met.

   2.1 Determine specific threats faced by the species. Many factors presently affect the species and its habitat, and other problems associated with future development are likely to occur. These negative impacts must be identified and remedied if recovery is to be reached.

   2.2 Continue to utilize existing legislation and regulations to protect the species and its habitat. Prior to and during implementation of this recovery plan the species will be protected by the full enforcement of existing laws and regulations.

   2.3 Determine and implement protection strategies for areas identified in Task 1.2.

3. Develop education programs. L. orbiculata is routinely taken by commercial mussel fisherman because it closely resembles another, more common commercially valuable species Actinonaias carinata (mucket). L. orbiculata has no value commercially and hundreds of specimens are killed and discarded. Commercial mussel fishermen should be educated to identify the more common endangered species and required to return those specimens unharmed to the river. A brief informative poster, pamphlet, or program is needed to point out basic problems, uniqueness

of river systems, rarity of the resources at risk, potential value of undistrubed systems, and penalities for its abuse. This material could help to eliminate some of the misconceptions about the value of preserving endangered species and their habitat. Educational efforts should also include all local, State, and Federal agencies, wildlife officers, and wildlife oriented clubs. These programs could also be developed for television and local newspaper coverage.

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# KEY TO IMPLEMENTATION SCHEDULE COLUMNS 1 AND 4

General Category (Column 1):

Information Gathering - I or R (research)

1. Population status
2. Habitat status
3. Habitat requirements
4. Management techniques
5. Taxonomic studies
6. Demographic studies
7. Propagation
8. Migration
9. Predation
10. Competition
11. Disease
12. Environmental contaminant
13. Reintroduction
14. Other information

Acquisition - A

1. Lease
2. Easement
3. Management agreement
4. Exchange
5. Withdrawal
6. Fee title
7. Other

Other - O

1. Information and education
2. Law enforcement
3. Regulations
4. Administration

Management - M

1. Propagation
2. Reintroduction
3. Habitat maintenance and manipulation
4. Predator and competitor control
5. Depradation control
6. Disease control
7. Other management

Priority (Column 4):

1 - Those actions absolutely necessary to prevent extinction of the species.

2 - Those actions necessary to maintain the species' current population status.

3 - All other actions necessary to provide for full recovery of the species.

Pink Mucket Pearly Mussel
Lampsilis orbiculata

Part III Implementation Schedule

| *1 General Category | Plan Task | Task Number | Priority | Task Duration | Responsible Agency *2 FWS Region | Responsible Agency *2 FWS Program | Responsible Agency *2 Other | Estimated Fiscal Year Costs *3 FY 1 | FY 2 | FY 2 | Comments/Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I1,2,3 | Determine species' present distribution and status. | 1.1 | 2 | 1 yr. | 3,4, 5 | SE | ADCNR, AGFC, ANHC, MDC, MDNR, KDFWR, KNPC, TWRA, THP, WVDNR, TVA, ODNR, IDC, and INPC | --- | --- | --- | *1. See general categories for Implementation Schedules. |
| I3 | Identify essential habitat and specific areas in need of protection. | 1.2 | 2 | 1 yr. | 3,4, 5 | SE | Same as above | --- | --- | --- | *2. Other agencies' responsibility would be of a cooperative nature or projects funded under a contract or grant program. In some cases contracts could be let to universities or private enterprises. |
| I9,10, 11,12, 14 | Determine specific threats faced by species. | 2.1 | 2 | 1 yr. | 3,4, 5 | SE | Same as above | --- | --- | --- | *3. Note: Task costs have not been estimated for this plan. This species' present/historic distribution coincides with that of other listed species. Thus, a task aimed at this species will benefit others. Rather than attempting to apportion the costs to each species, recovery tasks will be estimated at a later date when the plans are combined on a watershed basis for implementation. |
| O2,3,4 | Continue to utilize existing legislation and regulations to protect species. | 2.2 | 1 | Continuous | 3,4, 5 | SE,LE, ES | Same as above | --- | --- | --- | |
| M3,7 | Develop and implement protection strategies for areas developed under Task 1.2. | 2.3 | 2 | Unknown | 3,4, 5 | SE,ES | Same as above | --- | --- | --- | |

Pink Mucket Pearly Mussel
*Lampsilis orbiculata*

## Part III Implementation Schedule

| General Category | Plan Task | Task Number | Priority | Task Duration | Responsible Agency: FWS Region | Responsible Agency: FWS Program | Responsible Agency: Other | Estimated Fiscal Year Costs: FY 1 | FY 2 | FY 3 | Comments/Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | Develop and implement education programs. | 3 | 3 | Unknown | 3,4, 5 | SE,ES | Same as above | --- | --- | --- | |

Abbreviations:

SE - Endangered Species
LE - Law Enforcement
ES - Ecological Services
ADCNR - Alabama Department of Conservation and Natural Resources
AGFC - Arkansas Game and Fish Commission
ANHC - Arkansas Natural Heritage Commission
MDC - Missouri Department of Conservation
MDNR - Missouri Department of Natural Resources
KDFWR - Kentucky Department of Fish and Wildlife Resources
KNPC - Kentucky Nature Preserves Commission
TWRA - Tennessee Wildlife Resources Agency
THP - Tennessee Heritage Program
WVDNR - West Virginia Department of Natural Resources
TVA - Tennessee Valley Authority
ODNR - Ohio Department of Natural Resources
IDC - Illinois Department of Conservation
INPC - Illinois Nature Preserves Commission

# APPENDIX A

Table A-1: Recent records for Lampsilis orbiculata

Tennessee River - Leroy Koch (TVA-personal communication)

| Date | Location | No. Specimens |
|---|---|---|
| 1979-1981 | Below Pickwick Dam (TRM 206.7) | Est. 150 fresh dead observed |
| 1982 | Below Pickwick Dam (TRM 206.7) | 19 fresh dead |
| 1982 | Below Wilson Dam (TRM 259.4) | 13 fresh dead |
| 1982 | Below Guntersville Dam (TRM 349.0) | 11 fresh dead |
| July 1983 | Below Wilson Dam (TRM 255.8) | 3 live |

Tennessee River - Steven Ahlstedt (unpublished TVA field records)

| Date | Location | No. Specimens |
|---|---|---|
| Aug. 1980 | Below Southern RR tressel (TRM 591.3) | 2 live |
| Aug. 1981 | Long Island (TRM 417-417.2) | 2 live |
| 1976 | Below Watts Bar Dam (TRM 527.7-528.5) | 1 live |
| Sept. 1983 | Below Watts Bar Dam (TRM 528.8) | 1 live |
| Sept. 1983 | Below Watts Bar Dam (TRM 528.5) | 1 live |
| Sept. 1983 | Rhea Light (TRM 526.3) | 1 live |

Tennessee River - Pardue (1981)

| Date | Location | No. Specimens |
|---|---|---|
| 1978 | TRM 518.0 | Present-live |
| 1978 | TRM 518.5 | Present-live |
| 1978 | TRM 520.2 | Present-live |
| 1978 | TRM 520.3 | Present-live |
| 1978 | TRM 520.4 | Present-live |
| 1978 | TRM 520.7 | Present-live |
| 1978 | TRM 521.0 | Present-live |
| 1978 | TRM 521.3 | Present-live |
| 1978 | TRM 525.0 | Present-live |
| 1978 | TRM 527.4 | Present-live |
| 1978 | TRM 528.0 | Present-live |
| 1978 | TRM 528.1 | Present-live |
| 1978 | TRM 588.4 | Present-live |
| 1978 | TRM 592.2 | Present-live |

Tennessee River - James Sickel (Murray State University-personal communication)

| Date | Location | No. Specimens |
|---|---|---|
| Aug. 1981 | Haddox Ferry (TRM 12-17.0) | 5 fresh dead |

Tennessee River - TVA (1978)

| Date | Location | No. Specimens |
|---|---|---|
| 1978 | TRM 22.0 | 1 live |
| 1978 | TRM 164.9 | 1 live |
| 1978 | TRM 170.1 | 2 live |
| 1978 | TRM 183.0 | 1 live |
| 1978 | TRM 197.0 | 2 live |
| 1978 | TRM 203.0 | 1 live |
| 1978 | TRM 203.1 | 1 live |
| 1978 | TRM 251.0 | Present-live |
| 1978 | TRM 252.8 | Present-live |
| 1978 | TRM 334.3 | Present-live |
| 1978 | TRM 336.5 | Present-live |
| 1978 | TRM 336.6 | Present-live |
| 1978 | TRM 344.0 | Present-live |
| 1978 | TRM 345.6 | Present-live |
| 1978 | TRM 346.5 | Present-live |
| 1978 | TRM 518.0 | Present-live |
| 1978 | TRM 518.5 | Present-live |
| 1978 | TRM 520.2 | Present-live |
| 1978 | TRM 520.3 | Present-live |
| 1978 | TRM 520.4 | Present-live |
| 1978 | TRM 520.7 | Present-live |
| 1978 | TRM 520.8 | Present-live |
| 1978 | TRM 521.0 | Present-live |
| 1978 | TRM 521.3 | Present-live |
| 1978 | TRM 525.0 | Present-live |
| 1978 | TRM 527.4 | Present-live |
| 1978 | TRM 528.0 | Present-live |
| 1978 | TRM 528.1 | Present-live |
| 1978 | TRM 588.4 | Present-live |
| 1978 | TRM 592.5 | Present-live |

Tennessee River - Yokley (1972)

| Date | Location | No. Specimens |
|---|---|---|
| 1969-1972 | Below Pickwick Dam (TRM 200-205.2) | 1 live |
| 1969-1972 | TRM 152-174.2 | 2 live |

Paint Rock River, Alabama - TVA and USFWS (1983) - Charles Saylor (unpublished TVA field record)

| Date | Location | No. Specimens |
|---|---|---|
| July 1983 | PRRM 13.0 | 1 fresh dead (5 years old) |

Little Tennessee River, Tennessee - Steven Ahlstedt (TVA unpublished field records)

| Date | Location | No. Specimens |
|---|---|---|
| Oct. 1979 | Coytee Springs (LTRM 6.8) | 1 fresh dead |

Note: Now Tellico Reservoir

Clinch River - TVA (1979) - Steven Ahlstedt (TVA unpublished field records)

| Date | Location | No. Specimens |
|---|---|---|
| Aug. 1979 | Brooks Island (CRM 184.5) | 1 fresh dead |

Clinch River, Tennessee - TVA (1982) - Charles Saylor (TVA unpublished field records)

| Date | Location | No. Specimens |
|---|---|---|
| June 1982 | Below Melton Hill Dam (CRM 19.1) | 1 live |

Cumberland River - Leroy Koch (personal communication)

| Date | Location | No. Specimens |
|---|---|---|
| July 1982 | CRM 275-281 | 11 live |
| 1983 | CRM 272-297.7 | 110 live |

Cumberland River - Parmalee et al. (1980)

| Date | Location | No. Specimens |
|---|---|---|
| Sept. 1979 | Bartletts Bar (CRM 296.8) | 2 live |

Note: 150-200 fresh dead specimens observed in cull piles.

Cumberland River - TVA (1983)

| Date | Location | No. Specimens |
|---|---|---|
| Sept. 1983 | CRM 307.6-308.1 | 1 live |
| Sept. 1983 | CRM 307.4 | 1 live |
| Sept. 1983 | CRM 307.0 | 3 live |
| Sept. 1983 | CRM 306.2-306.5 | 1 live |
| Sept. 1983 | CRM 305.3-305.5 | 3 live |
| Sept. 1983 | CRM 305.3 | 3 live |

Cumberland River - TVA (1976)

| Date | Location | No. Specimens |
|---|---|---|
| Sept. 1976 | Mussel Cook-Out Camp (CRM 270) | Undetermined number of specimens observed |
| Sept. 1976 | Griffin Landing (CRM 275.4) | 1 live |
| Sept. 1976 | Cotton Bar (CRM 283.0) | 3 live |
| Sept. 1976 | Cotton Bar (CRM 284.3) | 3 live |
| Sept. 1976 | Below Rome Island (CRM 291.1) | 1 live |
| Sept. 1976 | Below Rome Island (CRM 293.0) | Undetermined number of specimens observed |
| Sept. 1976 | Below Rome Island (CRM 293.1) | 2 live |
| Sept. 1976 | Above Bartletts Island (CRM 296.8) | 3 live |
| Sept. 1976 | Bartletts Bar (CRM 297.0) | 3 live |
| Sept. 1976 | Rowlands Towhead (CRM 302.8) | 2 live |
| Sept. 1976 | Carters Island (CRM 305.3) | 2 live |

Lower Ohio River - Leroy Koch and Jeffrey Pardue (personal communication)

| Date | Location | No. Specimens |
|---|---|---|
| July 1980 | I-24 Bridge (ORM 940.7) | 1 fresh dead |
| July 1980 | Mussel Boat (ORM 944.2) | 2 fresh dead |

Green River, Kentucky - USEPA (1981)

| Date | Location | No. Specimens |
|---|---|---|
| 1981 | At Lock 5 (Butler County, Kentucky) | Unknown |

Green River, Kentucky - Kentucky Nature Preserves Commission Record (Sam Call record)

| Date | Location | No. Specimens |
|---|---|---|
| Oct. 1980 | Below U.S. Lock Number 5 | 2 fresh dead |

Kanawha River, West Virginia - Clarke (1982)

| Date | Location | No. Specimens |
|---|---|---|
| Sept. 1982 | Below Kanawha Falls (KRM 95.1-94.5) | 3 live |

Kanawha River, West Virginia - Taylor (1983)

| Date | Location | No. Specimens |
|---|---|---|
| Sept.-Nov. 1982 | Below Kanawha Falls (KRM 94.7) | 1 live |
| Sept.-Nov. 1982 | Below Kanawha Falls (KRM 92.8) | 1 live |
| Sept.-Nov. 1982 | Below Kanawha Falls (KRM 92.5) | 2 live |
| Sept.-Nov. 1982 | Below Kanawha Falls (KRM 91.8) | 2 live |
| Sept.-Nov. 1982 | Below Kanawha Falls (KRM 91.0) | 4 live |

Kanawha River, West Virginia - David Stansbery (Ohio State University-1980 personal communication)

| Date | Location | No. Specimens |
|---|---|---|
| Aug. 1969 | Below Kanawha Falls | 1½ dry shells |
| Sept. 1969 | Below Kanawha Falls | 1 dry shell |
| Oct. 1970 | Below Kanawha Falls | 1 dry shell |
| Nov. 1976 | Below Kanawha Falls | 1 live |
| Oct. 1979 | Below Kanawha Falls | 1 live |

Osage River, Missouri - Grace and Buchanan (1981), Ron Oesch (personal communication)

| Date | Location | No. Specimens |
|---|---|---|
| June-Sept. 1980 | ORM 80.8 | 1/2 weathered dead |
| Sept. 1980 | ORM 66.6 | 1 live |
| June 1980 | ORM 65.0 | 1 live |
| June 1980 | ORM 57.4 | 2 live |
| July 1980 | ORM 46.1 | 1 live, 1 subfossil |
| July-Aug. 1980 | ORM 40.5 | 1 live, 2½ subfossil |
| Aug. 1980 | ORM 37.0 | ½ subfossil |
| Aug. 1980 | ORM 26.9 | 1 live, 2 weathered dead, 5 subfossil |
| Aug. 1980 | ORM 23.7 | 1½ weathered dead, ½ subfossil |
| Aug. 1980 | ORM 22.2 | 2 subfossil |
| Aug. 1980 | ORM 21.5 | 4 live, 2 weathered dead, 5 subfossil |
| Aug. 1980 | ORM 17.6 | 3 live, 4½ weathered dead, 2 subfossil |
| Aug.-Sept. 1980 | ORM 13.6 | 2 live, 9 weathered dead, 2 subfossil |
| Sept. 1980 | ORM 10.3 | 2½ weathered dead |
| Sept. 1980 | ORM 5.6 | 1 dead, 1 weathered dead |

Osage River, Missouri - Ron Oesch (personal communication)

| Date | Location | No. Specimens |
|---|---|---|
| Sept. 1972 | Bagnell Dam to Miller County Line | 1 live |
| Feb. 1978 | ORM 11 | 1 live |

Meramec River, Missouri - Buchanan (1980), Ron Oesch (personal communication)

| Date | Location | No. Specimens |
|---|---|---|
| 1978 | MRM 4.9 | 1 live |
| 1978 | MRM 6.9 | 1 live |
| 1978 | MRM 10.5 | 1 live |
| 1978 | MRM 17.5 | 1 subfossil |
| 1978 | MRM 21.5 | 1 live |
| 1978 | MRM 23.8 | 1 subfossil |
| 1978 | MRM 28.4 | 1 live |
| 1978 | MRM 33.5 | 1 live |
| 1978 | MRM 37.7 | 1 live |
| 1978 | MRM 39.8 | 1 live |
| 1978 | MRM 48.8 | 1 live |
| 1978 | MRM 54.4 | 1 live |

Meramec River, Missouri - Ron Oesch (personal communication)

| Date | Location | No. Specimens |
|---|---|---|
| Aug. 1967 | Above Highway 141 Bridge | 1 live |
| Aug. 1968 | Above Bald Creek Road | 1 live |
| Aug. 1969 | Highway D to Times Beach | 1 relict |
| Apr. 1970 | Below Sappington Bridge | 3 fresh valves |
| June 1971 | Above Highway 185 Bridge | 1 live |
| May 1972 | At the Aboretum | 2 live, 4 valves |
| Aug. 1972 | At the Aboretum | 2 relict |
| May 1976 | Highway D to Highway 44 | 3 relict |
| Aug. 1977 | At Highway 44 Bridge | 1 live |
| July 1978 | Daniel Boone Camp | 1 live |
| Sept. 1978 | One Mile Above Highway 21 Bridge | 1 live |

Big River, Missouri - Buchanan (1980), Ron Oesch (personal communication)

| Date | Location | No. Specimens |
|---|---|---|
| 1978 | BRM 4.8 | 1 subfossil |

Black River, Missouri - Buchanan (1980), Ron Oesch (personal communication)

| Date | Location | No. Specimens |
|---|---|---|
| Aug. 1976 | At Leeper | 1 live |
| July 1971 | Markham Spring Rec. Area | 1 live |

Little Black River, Missouri - Buchanan (1979)

| Date | Location | No. Specimens |
|---|---|---|
| Aug. 1979 | LBRM 9.1 (Ripley County) | Live specimens observed |

Gasconade River, Missouri - Dr. David Stansbery (OSUM)

| Date | Location | No. Specimens |
|---|---|---|
| Sept. 1964 | Gasconade County, Missouri | 1 live |
| Aug. 1971 | Gasconade County, Missouri | 3 live |

Gasconade River, Missouri - Ron Oesch (personal communication)

| Date | Location | No. Specimens |
|---|---|---|
| Nov. 1970 | Near Mt. Sterling | 2 live |

Current River, Arkansas - Buchanan (personal communication)

| Date | Location | No. Specimens |
|---|---|---|
| Oct. 1982 | At Bridge 2.8 miles west of Success | 1 live |

Spring River, Arkansas - Alan Buchanan (personal communication)

| Date | Location | No. Specimens |
|---|---|---|
| Sept. 1983 | Highway 58 one-half mile SW of Williford, Sharp County | 1 live |

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