

## FRESHWATER MUSSELS (UNIONIDAE) OF THE WOLF RIVER IN WESTERN TENNESSEE AND MISSISSIPPI

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**ABSTRACT**—Freshwater mussels (Unionidae) were sampled in the Wolf River and its tributaries in Shelby and Fayette counties, Tennessee, and in Benton County, Mississippi. Twenty-five species were identified and the specific locations of 4,284 individuals were recorded. Mussels were abundant upstream from the Collierville, Tennessee sewage effluent, which also coincides with the extent of headcutting from earlier channelization. Downstream from this location, mussels were very rare in the river, but abundant in adjoining borrow pits. Some of the species we report are unique or rare in western Tennessee. One species, the Fat Mucket (*Lampsilis siliquoidea* (Barnes, 1823)) is reported nowhere else in Tennessee besides the Wolf River (although it may be a relic or extirpated species in Reelfoot Lake (Parmalee and Bogan, 1998), and three species, the Pink Heelsplitter (*Potamilus alatus* (Say, 1817)), the Plain Pocketbook (*Lampsilis cardium* (Rafinesque, 1820)), and the Spike (*Elliptio dilatata* (Rafinesque, 1820)) have not been reported to occur in western Tennessee. The Southern Hickorynut (*Obovaria jacksoniana* (Frierson, 1912)) has been reported in only one other Tennessee river and the Southern Rainbow (*Villosa vibex* (Conrad, 1834)) has been reported in only two other Tennessee rivers. Based upon available data from the Tennessee Wildlife Resources Agency listing of mussel status in Tennessee, three mussel species found in the Wolf River are of special concern, three are threatened, one is threatened or endangered, and one is endangered.

The freshwater mussel fauna of the United States, with almost 300 species, is one of the richest in the world. More than one-third of these are or were known to occur in Tennessee (Parmalee and Bogan, 1998). Unfortunately, we have not treated this resource well (Neves et al., 1997). As early as the late 19<sup>th</sup> and early 20<sup>th</sup> centuries there were reports of severe impacts upon mussels due to impoundment and pollution (Lewis, 1868; Ortmann, 1909). Our mussel fauna continues to face serious threats today (Neves, 1993), and some scientists believe that unless a major research and conservation effort is initiated immediately we will see the extinction of most of the North American freshwater mussel fauna in the next 25–50 years (Williams, 1999).

We undertook this survey of the Wolf River mussel fauna to document the composition and number of species present. We also wanted to determine mussel spatial distribution patterns that might coincide with environmental gradients, and to use these patterns to make more informed decisions regarding watershed development.

The Wolf River watershed lies within the Mississippi Alluvial Plain and the loess-covered Coastal Plain. It has a mean slope of 0.0–1.93 degrees (Mills and Wilson, 1997) with an area of 810 miles<sup>2</sup> (E.P.A., 1999). The Wolf River itself is approximately 85–90 miles long from its origin in Tippah County, Mississippi to its mouth on the Mississippi River at Memphis in western Shelby County, Tennessee. By 1964 the lower 22 miles of the Wolf River had been channelized by the Army Corps of Engineers, and erosion and headcutting are now negatively impacting the middle reach of the river.

The Wolf River and its floodplain lie within the Interior Basin or Mississippian unionioid faunal province (Parmalee and Bogan, 1998). Most freshwater mussel surveys in Tennessee have been made in the Cumberlandian province, i.e., the Tennessee and Cumberland River drainages, and there have been very few mussel surveys in western Tennessee. Before Manning's (1989) thorough study of the Hatchie River, in which he documented 33 taxa of unionacean mussels, the only other substantive works on western Tennessee mussels were those by Pilsbry and Rhoads (1896) and Ortmann (1926), in which four species were listed for the Wolf River. Kesler and Manning (1996) reported a new state record for the Wolf River, the Fat Mucket (*Lampsilis siliquoidea* (Barnes, 1823)), and gave shell length-frequency distributions and a length-age relationship for this species. The data we present here provide baseline documentation of the rich mussel fauna and its distribution in the Wolf River in western Tennessee and northern Mississippi.

### MATERIALS AND METHODS

We sampled mussels by hand in the Wolf River and associated borrow pits from Benton County, Mississippi, through Fayette and Shelby counties, Tennessee to near the river's mouth at the Mississippi River in downtown Memphis (Fig. 1). We developed our sampling techniques and field identification skills from October, 1994 to May, 1997 on 13 different occasions. The borrow pits we sampled were either connected directly to the river or received water during floods. We also sampled the North



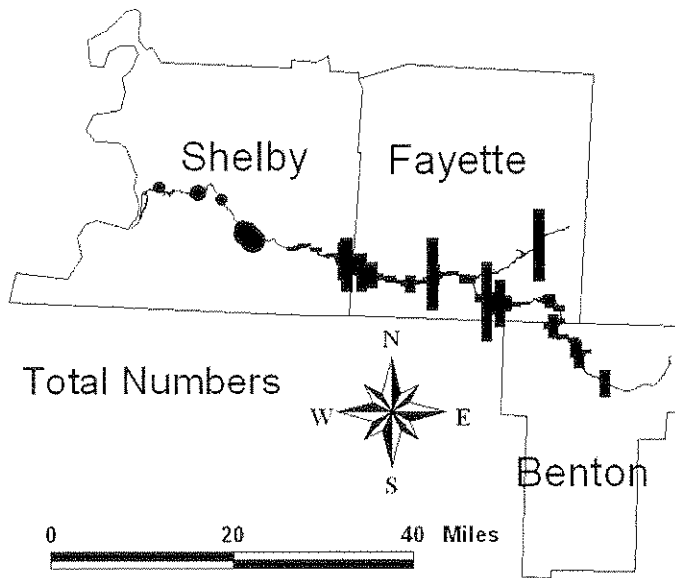


FIG. 1. Numbers (4,284) and locations (441) of the unionid mussels collected in Shelby and Fayette Counties, Tennessee and Benton County, Mississippi from September 1997–1999. The bars represent mussels found in the river proper. The highest bar represents 293 individuals, while the lowest bar represents only one individual. The size of the dots refer to the total number of individuals collected in borrow pits along the river, the largest representing 152 individuals.

Fork of the Wolf River north of LaGrange, Tennessee. From September 1997, to September 1999, specific longitude and latitude coordinates of individual mussels were recorded using a global positioning system unit (Garmin GPS II) on 31 different days at 128 locations. These data were plotted using ArcView. No longitude-latitude data were recorded at locations where no mussels were found. Before September, 1997, only species identities, numbers, and general locations were recorded.

Species were identified using Parmalee and Bogan (1998) and voucher specimens were placed in the Ohio State Museum, Ohio State University. We followed Turgeon et al. (1998) for all common and scientific names. We report here only live individuals.

## RESULTS AND DISCUSSION

The 25 unionid species found in the Wolf River and its floodplain are listed in Table 1. Within the Wolf River, most mussels were found in stable silt deposits along stream banks. The mussel species richness in the Wolf River is 0.76 times that of the larger, unchannelized Hatchie River, also in western Tennessee (Manning, 1989). This value increases to about 0.83 when one considers that Manning (1989) split three species that we did not. Given that our study is the first complete survey of the Wolf River, we cannot comment on how many species have been lost due to habitat alteration, sedimentation, Asian clam (*Corbicula fluminea*, Muller, 1774) colonization, and pollution.

The total number of individuals for which specific GPS location data were collected and the number of locations recorded are listed in Table 2. We have not reported the numbers of individuals sampled or their locations before GPS data were gathered because we re-sampled some of the same locations to re-

TABLE 1. Unionid mussels found in the Wolf River and its floodplain in Tennessee and Mississippi.

<i>Anodonta suborbiculata</i> (Say, 1831)	flat floater
<i>Arcidens confragosus</i> (Say, 1829)	rock pocketbook
<i>Elliptio dilatata</i> (Rafinesque, 1820)	spike
<i>Fusconaia flava</i> (Rafinesque, 1820)	Wabash pigtoe
<i>Lampsilis cardium</i> (Rafinesque, 1820)	plain pocketbook
<i>Lampsilis siliquoidea</i> (Barnes, 1823)	fat mucket
<i>Lampsilis teres</i> (Rafinesque, 1820)	yellow sandshell
<i>Leptodea fragilis</i> (Rafinesque, 1820)	fragile papershell
<i>Ligumia subrostrata</i> (Say, 1831)	pondmussel
<i>Obovaria jacksoniana</i> (Frierson, 1912)	southern hickorynut
<i>Potamilus ohioensis</i> (Rafinesque, 1820)	pink papershell
<i>Potamilus purpuratus</i> (Lamarck, 1819)	bleufer
<i>Potamilus alatus</i> (Say, 1817)	pink heelsplitter
<i>Pyganodon grandis</i> (Say, 1829)	giant floater
<i>Quadrula nodulata</i> (Rafinesque, 1820)	wartyback
<i>Quadrula pustulosa</i> (I. Lea, 1831)	pimpleback
<i>Quadrula quadrula</i> (Rafinesque, 1820)	mapleleaf
<i>Strophitus undulatus</i> (Say, 1817)	creeper
<i>Toxolasma parvum</i> (Barnes, 1823)	lilliput
<i>Tritogonia verrucosa</i> (Rafinesque, 1820)	pistolgrip
<i>Toxolasma texasensis</i> (I. Lea, 1857)	Texas lilliput
<i>Unio merus tetralasmus</i> (Say, 1831)	pondhorn
<i>Utterbackia imbecillis</i> (Say, 1829)	paper pondshell
<i>Villosa lienosa</i> (Conrad, 1834)	little spectaclecase
<i>Villosa vibex</i> (Conrad, 1834)	southern rainbow

place our earlier findings with more accurate GPS data. The total number of mussels counted at each of the 128 locations is presented in Fig. 1.

The bar in Fig. 1 on the North Fork of the Wolf River marks the location of a small tributary to the North Fork where 269 mussels were counted. While mussels were abundant in this small stream, no native mussels or *C. fluminea* were found in the North Fork upstream or downstream from the mouth of this tributary. This suggests to us that the stream is a refugium; mussels living there have avoided unsuitable conditions in the mainstem of the North Fork of the Wolf River. Because five species were encountered in this small stream, one of which we found nowhere else (*Unio merus tetralasmus* (Say, 1831)), such streams would seem to be important source pools for repopulating impacted reaches of larger waterways.

There was an abrupt reduction in numbers in the mainstem of the Wolf River at the eastern edge of Shelby County (Fig. 1). This dramatic reduction in abundance coincides with the upper extent of headcutting due to stream channelization that was completed by 1964. Downstream from this point we observed the characteristics of an area recently headcut as described by Hartfield (1993), i.e., extensive bank erosion; wide, degraded channels; meander cutoffs; uniform, shallow flows; numerous whole trees within the channel; loose, unstable sediments; and perched tributaries. Mussels cannot tolerate such stream degradation. We have found very few mussels in the Wolf River downstream from the extent of current headcutting to the lower reaches of the river. Our results are similar to those of Hartfield (1993) who observed the decline or disappearance of mussels due to headcutting in Mississippi and Louisiana.

TABLE 2. Number of mussels and the number of locations in the Wolf River for which longitude–latitude coordinates were recorded from September, 1997 to September, 1999.

Species	Number of individuals	Number of locations
<i>Q. pustulosa</i>	1871	82
<i>P. purpuratus</i>	752	84
<i>T. verrucosa</i>	477	59
<i>P. grandis</i>	343	25
<i>V. lienosa</i>	230	20
<i>L. siliquoides</i>	277	46
<i>F. flava</i>	80	20
<i>L. teres</i>	57	24
<i>T. parvus &amp; texasensis</i>	49	9
<i>L. fragilis</i>	34	19
<i>A. suborbiculata</i>	24	6
<i>L. cardium</i>	15	7
<i>U. imbecilis</i>	14	10
<i>P. ohioensis</i>	14	2
<i>U. tetralasmus</i>	10	2
<i>S. undulatus</i>	8	5
<i>E. dilatata</i>	4	3
<i>L. subrostrata</i>	4	1
<i>V. vibex</i>	4	1
<i>O. jacksoniana</i>	3	3
<i>A. confragosus</i>	1	1
<i>P. alatus</i>	1	1
<i>Q. nodulata</i>	1	1
<i>Q. quadrula</i>	1	1

The abrupt drop in mussel numbers also coincided with the first sewage outfall of Collierville, Tennessee. Unknown amounts of raw sewage were illegally discharged into the Wolf River for 10–15 years by the city of Collierville (Commercial Appeal, 1998), and this unregulated pollution has likely degraded conditions for mussels downstream. The negative effects of headcutting were thus combined with the effect of Collierville's effluent. Hopefully, now that water-treatment regulations are being enforced and the Corps of Engineers has begun the initial studies for a project intended to halt the river's headcut (United States Army Corps of Engineers, 1995; G.E.C., Inc., 1999), mussels will be able to recolonize this portion of the river.

The Fig. 1 dots in Shelby County west of Germantown Road represent mussels found in borrow pits along the river. No mussels were found in the river adjacent to these borrow pits. We hypothesize that the unstable sediment conditions in this previously channelized lower section of the river make an inhospitable environment for mussels (Hartfield, 1993).

What follows are comments about each species in the order of their abundance. The most commonly encountered species was the Pimpleback (*Quadrula pustulosa* (I. Lea, 1831)) (Table 2). This species has a wide distribution within Tennessee and also was widely distributed within the Wolf River (Fig. 2). This species was reported (as *Unio turgidus*) to be in the Wolf River by Pilsbry and Rhoads (1896). *Quadrula pustulosa* also was one of the two most common species encountered by Manning (1989) in the Hatchie River. According to Parmalee and Bogan (1998),

*Q. pustulosa* occurs in medium-sized to large rivers throughout Tennessee. We did not find *Q. pustulosa* downstream from the area of active headcutting in eastern Shelby County. However, this species was very abundant from the headcutting area upstream to the Wolf's headwaters in Benton County, Mississippi. This species, especially in middle reaches of the river between Batemen Bridge and Moscow, Tennessee, often had shells that were elongated posteriorly.

The second most common species sampled was the Bleufer (*Potamilis purpuratus* (Lamarck, 1819)). Unlike *Q. pustulosa*, the distribution of *P. purpuratus* in Tennessee is confined to the direct tributaries to the Mississippi River and Reelfoot Lake (Parmalee and Bogan, 1998). Within the Wolf River proper, we found *P. purpuratus* from Benton County to between Houston Levee Road and Germantown Road in Shelby County, and again in the mainstem of the Wolf River to within six miles of its mouth on the Mississippi River (Fig. 2). Given the abundance of *P. purpuratus* in our study, it is not surprising that Ortmann (1926) also reported this species as occurring in the Wolf River. Very large individuals of this species were found in borrow pits, one reaching 229 mm in length. This is much longer than the maximum shell length of about 170 mm reported by Parmalee and Bogan (1998).

We found a single Pink Heelsplitter (*P. alatus* (Say, 1817)) individual in the middle section of the river between Collierville/Arlington and Houston Levee roads. Both *P. purpuratus* and *P. alatus* require the freshwater drum (*Aplodinotus grunniens*) as a fish host (Watters, 1994), and we cannot explain the rarity of *P. alatus* in the Wolf River. According to Parmalee and Bogan (1998), *P. alatus* has not been reported from Reelfoot Lake or any of the direct tributaries to the Mississippi River in western Tennessee, although we (DM, NVT) found it in the Hatchie River in 1999.

The Pistolgrip (*Tritigonia verrucosa* (Rafinesque, 1820)) was the third most commonly encountered species. *Tritigonia verrucosa* was found in the mainstem of the river, but never in borrow pits or extremely slow-moving water. It was mostly found in the middle stretch of the river between Batemen Bridge and Moscow, Tennessee (Fig. 2). As with the two species above, *T. verrucosa* was reported by Ortmann (1926) (as *Quadrula verrucosa*) to occur in the Wolf River.

About as equally abundant as *Tritigonia verrucosa* was the Giant Floater (*Pyganodon grandis* (Say, 1829)), which was found at only 24 locations. Almost all of these were found in borrow pits, old cut-off sections of the river, and a small tributary to the North Fork of the Wolf River (Fig. 2). This tendency towards a lentic habitat is consistent with other studies (Cummings and Mayer, 1992). Manning (1989) distinguished two species of *Pyganodon* (formerly *Anodonta*), i.e., *grandis* and *corpulenta*. Turgeon et al. (1998) recognized only one species, *P. grandis*. While we did observe both the *corpulenta* form and the more compressed, elongated shell of the *grandis* form, we did not distinguish between these two morphotypes.

The fifth most abundantly encountered species was the Little Spectaclecase (*Villosa lienosa* (Conrad, 1834)). Over half of the 230 individuals were counted in a small tributary to the North Fork of the Wolf River (Fig. 2), an area that was severely logged in the summer of 1997. We found this species was most often along shaded riverbanks, and we became curious about how logging would affect the *V. lienosa* of this small stream. One hundred nineteen individuals were marked, measured for length, and returned to this stream as part of a growth study. This species is

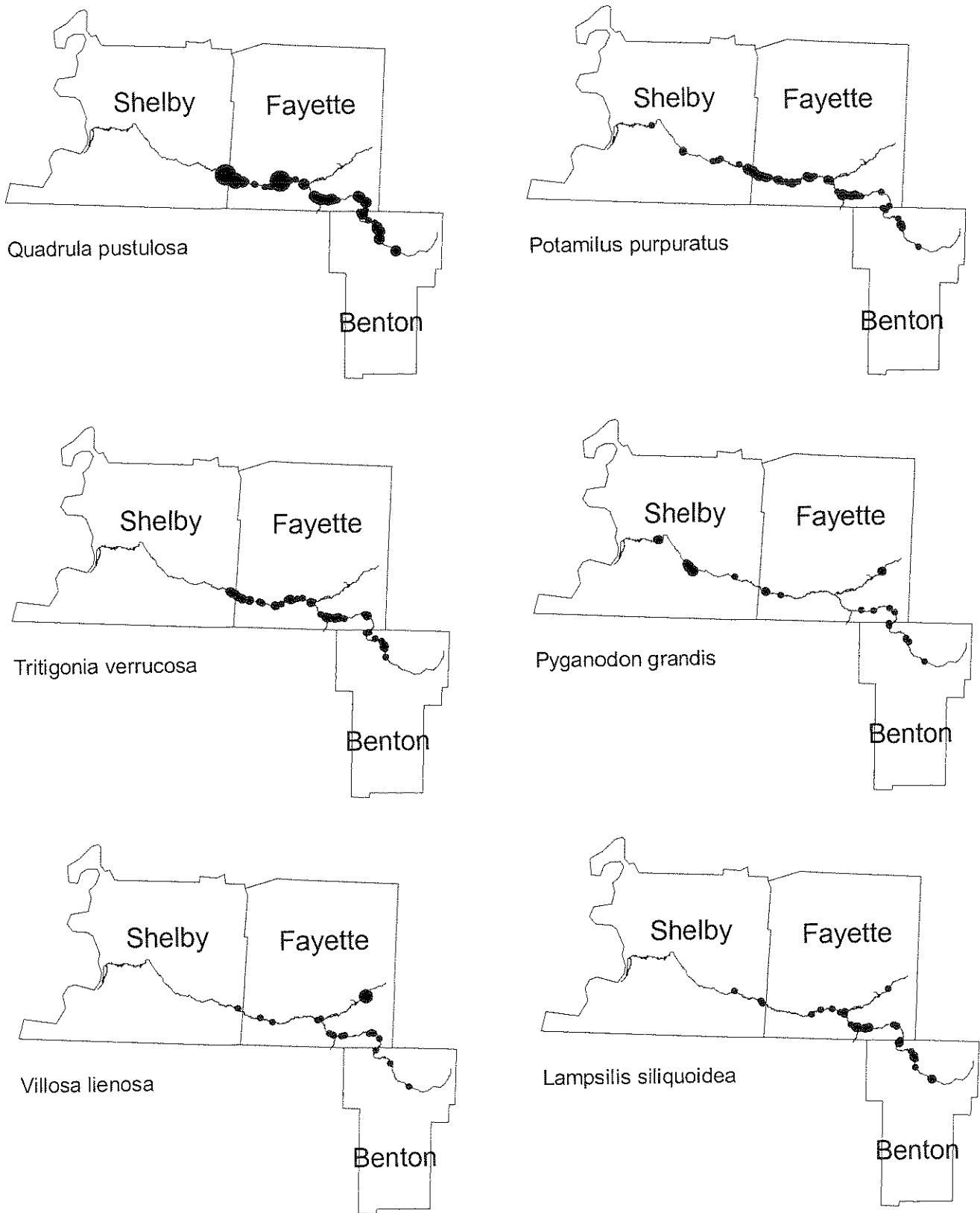


FIG. 2. Distribution of *Quadrula pustulosa*, *Potamilus purpuratus*, *Tritigonia verrucosa*, *Pyganodon grandis*, *Villosa lienosa*, and *Lampsilis siliquoidea*. The size of the dots represents the number of individuals collected at each location: 1–5 individuals •, 6–50 individuals •, 51–100 individuals •, 101–200 individuals ●

State listed as threatened or possibly endangered (Anonymous, 1994). Besides occurring in the Wolf River, *V. lienosa* occurs in the Hatchie River in small numbers (Manning, 1989) and the Obion River (Starnes and Bogan, 1988). It may still occur in the Red and Stones rivers in Tennessee, although its occurrence there is based on museum collections (Jenkinson and Kokai, 1977). Ray and Hamilton (1999) did not find *V. lienosa* in the Red River or one of its tributaries, Sulfur Fork Creek.

The Fat Mucket (*Lampsilis siliquoidea*) provides an interesting example of the Wolf River's uniqueness within Tennessee. While *L. siliquoidea* occurs throughout the Mississippi River Basin from western New York to Minnesota, throughout the interior of Canada, and south to Arkansas, it does not occur in the Tennessee and Cumberland River Basins. The Wolf River contains the only extant population of *L. siliquoidea* reported in Tennessee (Kesler and Manning, 1996), although we found a living individual in the Tusculum River (McNairy County, Tennessee) on October 5, 1997. Within the Wolf River *L. siliquoidea* is widespread (Fig. 2).

The Wabash Pigtoe (*Fusconaia flava* (Rafinesque, 1820)), Yellow Sandshell (*Lampsilis teres* (Rafinesque, 1820)), Lilliput (*Toxolasma parvum* (Barnes, 1823)), Fragile Papershell (*Leptodea fragilis* (Rafinesque, 1820)), and Flat Floater (*Anodonta suborbiculata* Say, 1831) were encountered about equally. However, their distributions differed; *Anodonta suborbiculata* was found exclusively in borrow pits, while the other species were found in the river channel.

*Fusconaia flava* was found throughout the middle and upper reaches of the Wolf River (Fig. 3). While *F. flava* is State listed as "threatened" (Anonymous, 1994), it seems to be doing well in the Wolf River.

*Lampsilis teres* was found in the middle reach of the Wolf River and in borrow pits (Fig. 3). While never locally abundant, it was found in 19 locations. It seemed to be doing quite well in one borrow pit, reaching a length of 150 mm, longer than the 130–140 mm length reported by Parmalee and Bogan (1998).

*Toxolasma parvum* is easily confused, especially in the field, with the Texas Lilliput (*Toxolasma texasensis*), and we have plotted the distribution of these species together in Fig. 3. While *T. parvum* occurs throughout Tennessee, *T. texasensis* has been reported only in the Hatchie River and at Reelfoot Lake (Parmalee and Bogan, 1998). While *T. parvum* is listed as of special concern (Anonymous, 1994), it seems to be doing well in the Wolf River.

The Fragile Papershell (*Leptodea fragilis*), while recorded at 19 locations, was rare at each location (Fig. 3), and the maximum number collected at any one station was six individuals. One individual from a borrow pit was 165 mm long, exceeding the 150–160 mm length mature individuals of this species reach (Parmalee and Bogan, 1998). The unique fish host of *L. fragilis* is the freshwater drum (*Aplodinotus grunniens*) (Watters, 1994). This fish also is the unique host to other mussel species found in the Wolf River, including the Bleufer (*P. purpuratus*), the Pink Heelsplitter (*P. alatus*), and the Pink Papershell (*P. ohiensis*), (although the white crappie also is reported as a host for *P. ohiensis* (Wilson, 1916)).

The Flat Floater (*Anodonta suborbiculata*) was a borrow pit or oxbow species, always being found in very soft sediment (Fig. 3). It was never found in the river channel. This distribution is consistent with that reported by Parmalee and Bogan (1998).

The Plain Pocketbook (*Lampsilis cardium*) was only occasionally encountered. Both the Tennessee Wildlife Resources Agency (TWRA; Anonymous, 1994) and Williams et al. (1993)

give the status of this species as of special concern, and it has not been reported in any other western Tennessee location. We found this species from Benton County, Mississippi to just above the Collierville, Tennessee sewage outfall in Shelby County (Fig. 3). According to Houpp (1993) *L. cardium* and *L. siliquoidea* are intolerant to sedimentation. While the high sediment load of the Wolf River (Madhavan, 1989; Neff and Hearnshurger, 1994) may negatively impact this species, there remains uncertainty regarding whether or not increased sedimentation is a cause of recent mussel declines (Box and Mossa, 1999). Given that *L. cardium* seems to be tolerant of poor or polluted water conditions unsuitable for many mussel species (Parmalee and Bogan, 1998), we are curious about why it is not more common in the Wolf River.

The Paper Pondsshell (*Utterbackia imbecillis*), while not common, was widely distributed (Fig. 4). This small species is thin shelled and may suffer high mortality from fish and mammal predators. Shell piles of *Corbicula fluminea* on the riverbank are common, although no *U. imbecillis* shells were found among these.

We found the Pink Papershell (*Potamilus ohiensis*), with one exception, in a borrow pit connected to the Wolf River that was constructed in 1987 (Fig. 4). Individuals in this pit were large, (lengths up to 165 mm), which is longer than the approximately 140 mm maximum length reported by Parmalee and Bogan (1998). The one individual not found in the borrow pit was found in Fayette County in sandy-silt sediment where the Wolf River is divided into several small channels. We are very curious why *P. ohiensis* seems to be limited to the borrow pit in Shelby County, and are concerned about its long-term viability within the Wolf River's floodplain. Manning (1989) found only one or two dead *P. ohiensis* (formerly *Leptodea laevisissima*) at just one location in the Hatchie River. Like *P. purpuratus*, which is found widely in the Wolf River, *P. ohiensis* requires the Freshwater Drum (*Aplodinotus grunniens*) to complete its life cycle (Watters, 1994). Unlike *P. purpuratus*, *P. ohiensis* also may use the White Crappie (*Pomoxis annularis*) (Wilson, 1916) as a fish host.

We found the Pondhorn (*Unio merus tetralasmus*) in only one location, a small tributary to the North Fork of the Wolf River (Fig. 4). In Tennessee this species has been reported from the Hatchie (Manning, 1998) and Forked Deer River systems (Parmalee and Bogan, 1998), backwaters of Reelfoot Lake (Najarian, 1955), and a small tributary of the Tennessee River (Brown and Pardue, 1980). Watters (1994) list only the Golden Shiner (*Notemigonus crysoleucas*) as a fish host for *U. tetralasmus*. Perhaps this mussel's distribution in the Wolf River is limited by the availability of adequate fish hosts.

The Creeper (*Strophitus undulatus*) was only rarely encountered (Fig. 4), although it has a broad geographic distribution (Parmalee and Bogan, 1998). It is listed by TWRA as of special concern (Anonymous, 1994). Another rarely encountered species was the Spike (*Elliptio dilatata*). This species was locally abundant in only one location (Fig. 4): cold, relatively fast-flowing current in Benton County, Mississippi. While found in the entire Mississippi River drainage, this species has not been reported before in western Tennessee (Parmalee and Bogan, 1998).

The Pondmussel (*Ligumia subrostrata*) was found in only one location, a borrow pit in Memphis. This species is listed as of special concern by TWRA (Anonymous, 1994), and in western Tennessee it is found only in Reelfoot Lake (Najarian, 1955) and the Hatchie River (Manning, 1989). Given its ability to adapt to newly created ponds and channels (Parmalee and Bogan, 1998), we expected to find this species in more locations.

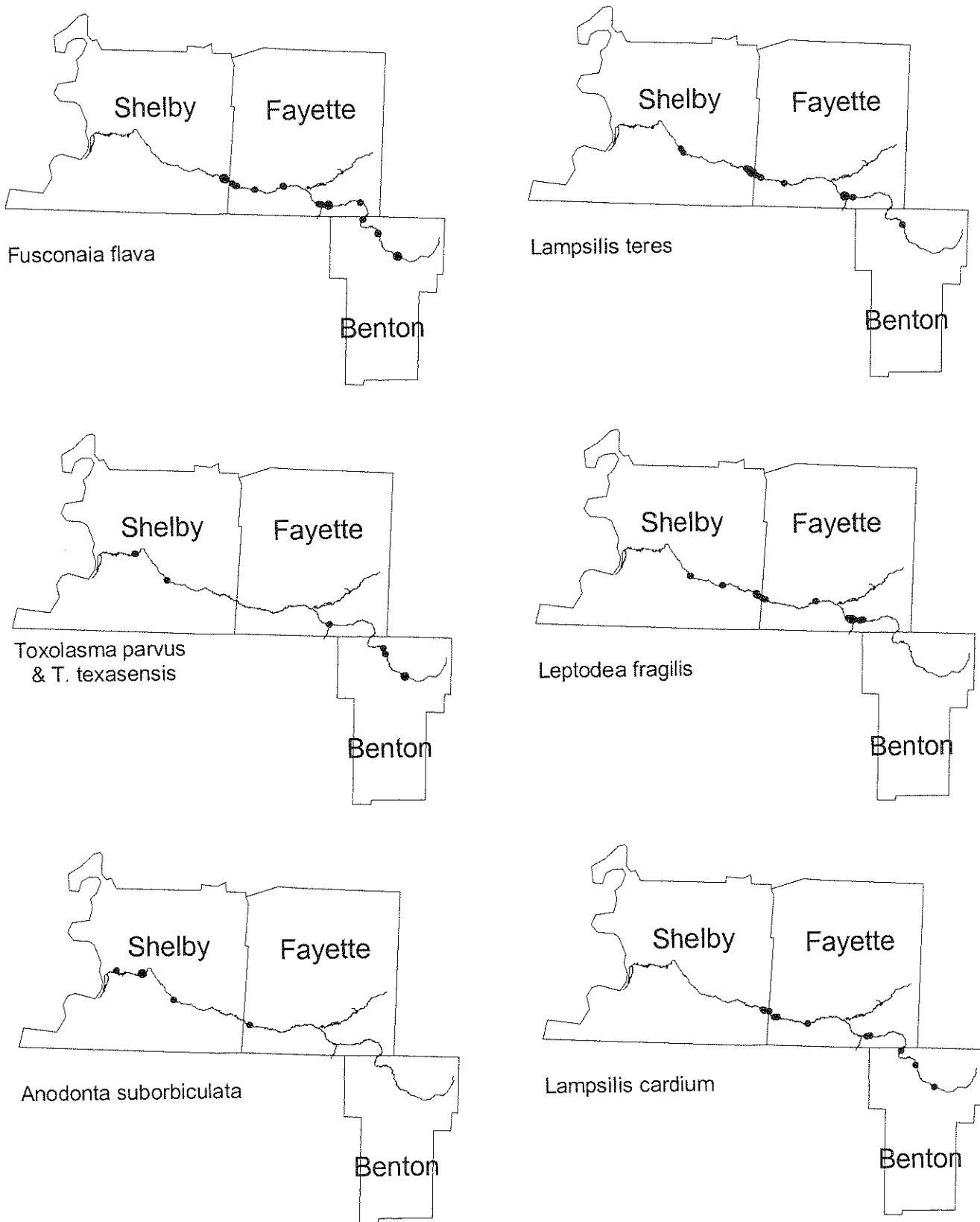


FIG. 3. Distribution of *Fusconaia flava*, *Lampsilis teres*, *Toxolasma parvus* and *T. texasensis*, *Leptodea fragilis*, *Anodonta suborbiculata*, and *Lampsilis cardium*. The size of the dots represents the number of individuals collected at each location: 1–5 individuals •, 6–50 individuals •, 51–100 individuals •, 101–200 individuals ●

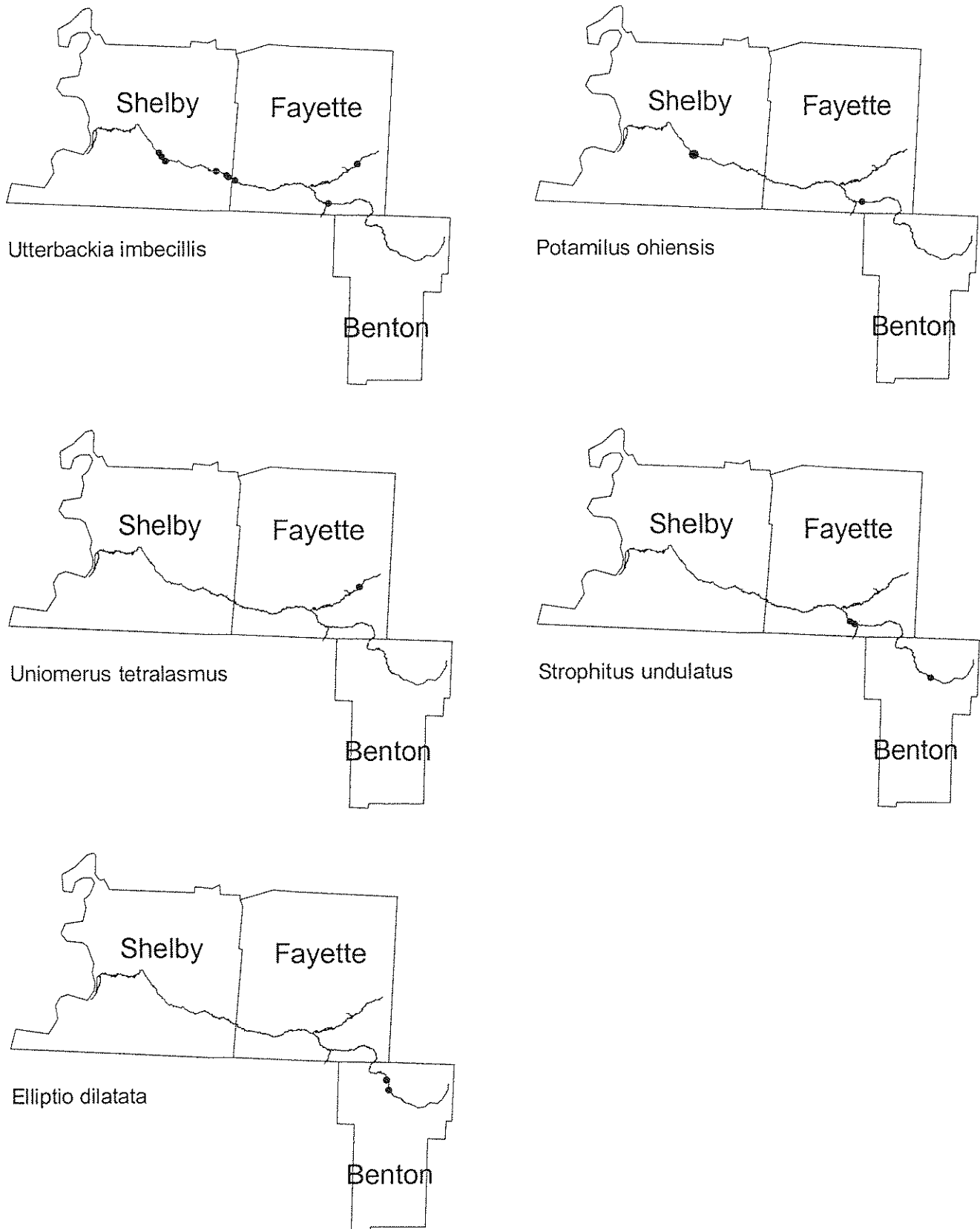


FIG. 4. Distribution of *Utterbackia imbecillis*, *Potamilus ohiensis*, *Uniomerus tetralasmus*, *Strophitus undulatus*, and *Elliptio dilatata*. The size of the dots represents the number of individuals collected at each location: 1–5 individuals •, 6–50 individuals ◐, 51–100 individuals ◑, 101–200 individuals ◒



The Southern Rainbow (*Villosa vibex*) occurred in only one location in one of the farthest upstream locations sampled in Benton County, Mississippi. It has been reported in only two other Tennessee locations, the Hatchie River in western Tennessee (Manning, 1989) and the Conasauga River in Polk County in southeast Tennessee, although this population may be extirpated (Parmalee and Bogan, 1998). The general distribution for *V. vibex* is the Gulf Coast drainage (Parmalee and Bogan, 1998).

Another uncommon species, which has been reported in only one other Tennessee location, was the Southern Hickorynut (*Obovaria jacksoniana*). We found no individuals of this species before initiating GPS coordinate recording in 1997, after which we found only three individuals. Except for the Hatchie River, where only six specimens were found (Manning, 1989), and a section of southeastern Missouri, this species is known from Alabama west to eastern Texas (Parmalee and Bogan, 1998). Williams et al. (1993) list this species as of special concern, TWRA classifies this species as threatened, and Withers and Christie (1997) list *Obovaria jacksoniana* global status as imperiled to vulnerable and state status as critically imperiled. Because we found this rare species in a section of the Wolf River immediately upstream from the current location of the headcutting nickpoint, we feel this species is at significant risk in the Wolf River.

We found a single Rock Pocketbook (*Arcidens confragosus*) upstream from the headcutting nickpoint. The area in which this individual was found had been sampled three times before on other occasions. Finding this large, distinctive individual on a fourth sampling effort demonstrates the heterogeneity of mussel distribution and the need for intensive, repetitive sampling. This species is found from Minnesota to Louisiana and as far west as eastern Texas (Parmalee and Bogan, 1998). It is thought to be adaptable to a variety of habitats (Parmalee and Bogan, 1998), yet it is apparently extirpated from Reelfoot Lake (Manning unpublished) and is fast disappearing from the Hatchie where only one specimen was found by the authors in 1999. It is a mystery why we have found only a single large individual of this species in the Wolf River.

The Wartyback (*Quadrula nodulata*) was collected in the middle stretch of the Wolf River in Fayette County, and was represented by only one verified specimen. This species also was represented by a single individual in the Hatchie River (Manning, 1989). Given the large variability of *Q. pustulosa* in the Wolf River, *Q. nodulata* could have been under-reported by us.

We found only one Mapleleaf (*Quadrula quadrula*). This individual was in a borrow pit near the lower end of the Wolf River in very soft sediment. *Quadrula quadrula* has been reported in western Tennessee in the Hatchie (Manning, 1989), the Loosahatchie and North Fork Obion rivers (Starnes and Bogan, 1988), and Reelfoot Lake in considerable abundance (Hoff, 1943). It also is found in middle Tennessee and the entire Mississippi drainage (Parmalee and Bogan, 1998). According to Klippel and Parmalee (1979), *Q. quadrula* is an adaptable species, and we are curious why only one individual was encountered. Its fish host, the Flathead Catfish (*Pylodictis olivaris*) (Watters, 1994), was not found in the Wolf River by Medford and Simco (1971) and this might explain its current absence.

*Species of Special Concern*—Given the declines in freshwater mussels nationally, we are concerned about the future of all the mussel species in the Wolf River. We are particularly concerned about those species that occur in only one or two locations, are very rare, or have been classified as threatened on a regional or statewide basis. One species about which we are

most concerned is the Southern Hickorynut (*O. jacksoniana*). As already described, this species has been classified by others as of special concern (Williams et al., 1993), and threatened (TWRA; Anonymous, 1994). The Tennessee Department of Environment and Conservation lists *O. jacksoniana* as critically imperiled in the state (Withers and Christie, 1997). We found only three individuals of this species in a section of the Wolf River currently threatened by headcutting. Given this species has been reported in only one other Tennessee location, we feel the potential is high for extirpation of *O. jacksoniana* in both the Wolf River and Tennessee.

The Southern Rainbow (*V. vibex*) is another species about which we are concerned. Withers and Christie (1997) classify *V. vibex* as imperiled in the state, and we found only four individuals at one location in the upper reaches of the Wolf River in Benton County, Mississippi.

There were four species in our survey that were represented by only one individual. These were the Rock Pocketbook (*A. confragosus*), Wartyback (*Q. nodulata*), Mapleleaf (*Q. quadrula*), and Pink Heelsplitter (*P. alatus*). While certainly at risk in the Wolf River due to their rarity, these species appear to be doing well elsewhere in the state. Given the overlap of *P. alatus* and *P. purpuratus*, their potential for interbreeding, and the difficulty in distinguishing males of these species, *P. alatus* may be more common in the Wolf River than we are reporting.

While the Plain Pocketbook (*L. cardium*) was found at seven locations, it was never locally abundant. All individuals were old and highly eroded. The taxonomy of this species is confused, and this species also could be assumed to be *L. ovata* (Parmalee and Bogan, 1998). Withers and Christie (1997) list *L. ovata* as imperiled in the state.

While the Fat mucket (*L. siliquoidea*) was abundant and widely distributed in the Wolf River, its extirpation from the Wolf River would almost certainly mean its loss from the state. Withers and Christie (1997) list *L. radiata*, a possible synonym for *L. siliquoidea*, as critically imperiled in the state.

Other species, while regionally common, were found at one or two unique locations. The Pink Papershell (*P. ohioensis*) occurred in only one borrow pit, with the exception of a single individual, and Parmalee and Bogan (1998) list *P. ohioensis* as being threatened in the state. Destruction of this borrow pit could easily mean the extirpation of *O. ohioensis* in the Wolf River. We only found the Pondhorn (*U. tetralasmus*) in a small tributary to the North Fork of the Wolf River, and the Spike (*E. dilatata*) in cool, fast-flowing water in the upper Wolf River of Benton County, Mississippi. If these habitats are degraded we would likely see the extirpation of these species in the Wolf River also.

*Summary*—The distribution of mussels in the Wolf River shows the effects of human activities. The abrupt decline in mussel abundance in eastern Shelby County, which coincides with a sewage effluent and the extent of headcutting, marks a change from an unimpacted, natural river to a degraded one. Borrow pits along the lower reaches of the river and small tributaries in its upper reaches serve as source pools for eventual recolonization by mussels. These refugia are thus valuable resources in need of protection. As pointed out by Neves et al. (1997), "The legislative goal of equal treatment under the law continues to elude the non-charismatic creatures of America's heritage."

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## LITERATURE CITED

- ANONYMOUS. 1994. TWRA Proc. 94-17, Proclamation of endangered and threatened wildlife in Tennessee. TWRA.
- BOX, J. B., AND J. MOSSA. 1999. Sediment, land use, and freshwater mussels: prospects and problems. *J. N. Am. Benthol. Soc.*, 18:99-117.
- BROWN, R. N., AND W. J. PARDUE. 1980. *Uniomereus tetralasmus* (Say, 1830) (Pelecypoda: Unionidae), a new distribution record for a freshwater mussel collected from the lower Tennessee River drainage. *J. Tennessee Acad. Sci.* 55:108.
- COMMERCIAL APPEAL. 1998. January 11.
- CUMMINGS, K. S., AND C. A. MAYER. 1992. Field guide to freshwater mussels of the midwest. Manual 5. Illinois Nat. Hist. Sur. Champaign, Illinois.
- E.P.A. web site: <http://www.epa.gov/surf2/hucs/08010210/>.
- G.E.C., Inc. 1999. Wolf River environmental restoration project engineering and environmental technical report. Contract No. DACW66-97-D-0049.
- HARTFIELD, P. 1993. Headcuts and their effect on freshwater mussels. Pp. 131-141 in Conservation and management of freshwater mussels (K. S. Cummings, A. C. Buchanan, and L. M. Koch, eds.). Proc. UMRCC Symp., St. Louis, MO. Upper Mississippi River Conservation Committee, Rock Island, Illinois.
- HOFF, C. C. 1943. Some records of sponges, branchiobdellids, and molluscs from the Reelfoot Lake Region. *J. Tennessee Acad. Sci.*, 18:223-227.
- HOUPE, R. E. 1993. Observations on long-term effects of sedimentation on freshwater mussels (Mollusca: Unionidae) in the North Fork of Red River, Kentucky. *Trans. Kentucky Acad. Sci.*, 54:93-97.
- JENKINSON, J. J., AND F. L. KOKAI. 1977. *Villosa lienosa* (Conrad, 1834). Pp. 82-83 in Ohio. Bull. Amer. Malac. Union, Inc., for 1977.
- KESLER, D. H., AND D. MANNING. 1996. A new mussel record for Tennessee: *Lampsilis siliquoidea* (Mollusca: Unionidae) from the Wolf River. *J. Tennessee Acad. Sci.*, 71:90-94.
- KLIPPEL, W. E., AND P. W. PARMALEE. 1979. The naiad fauna of Lake Springfield, Illinois: an assessment after two decades. *The Nautilus*, 93:189-197.
- LEWIS, J. 1868. Remarks on the mollusks of the Valley of the Mohawk. *Am. J. Conchology*, 4:241-245.
- MADHAVAN, K. 1989. A study on soil erosion in western Tennessee. *J. Tennessee Acad. Sci.*, 64:19-25.
- MANNING, D. 1989. Freshwater mussels (Unionidae) of the Hatchie River, a tributary of the Mississippi River, in west Tennessee. *Sterkiana*, 72:11-18.
- MEDFORD, D. W., AND B. A. SIMCO. 1971. The fishes of the Wolf River, Tennessee and Mississippi. *J. Tennessee Acad. Sci.*, 46:121-123.
- MILLS, H. H., AND M. D. WILSON. 1997. A statistical analysis of Tennessee topography using digital elevation models: a quantitative evaluation of physiographic-province boundaries. *J. Tennessee Acad. Sci.*, 72:45-50.
- NAJARIAN, H. H. 1955. Notes on aspidogastrid trematodes and hydracarina from some Tennessee mussels. *J. Tennessee Acad. Sci.*, 30:11-14.
- NEFF, R. A., AND S. M. HEARNSBERGER. 1994. Total suspended particulate solids at five sites on the Wolf River. *Rhodes College Sci. J.*, 12:17-28.
- NEVES, R. J. 1993. A state-of-the-unionids address. Pp. 1-10 in Proc. UMRCC symp., conserv. manage. freshwater mussels. (K. S. Cummings, A. C. Buchanan, and L. M. Koch, eds.). Upper Mississippi River Conserv. Comm.
- NEVES, R. J., A. E. BOGAN, J. D. WILLIAMS, S. A. AHLSTEDT, AND P. W. HARTFIELD. 1997. Status of aquatic mollusks in the Southeastern United States: a downward spiral of diversity. Pp. 43-85 in Aquatic fauna in peril the Southeastern Perspective. (G. W. Benz and D. E. Collins, eds.). Southeast Aquatic Res. Inst. Special Publication 1. Chattanooga, Tennessee.
- ORTMANN, A. E. 1909. The destruction of the fresh-water fauna in western Pennsylvania. *Proc. Am. Philos. Soc.*, 48:90-110.
- . 1926. Unionidae from the Reelfoot Lake region in west Tennessee. *The Nautilus*, 39:87-94.
- PARMALEE, P. W., AND A. E. BOGAN. 1998. The freshwater mussels of Tennessee. Univ. Tennessee Press, Knoxville.
- PILSBRY, H. A., AND S. N. RHOADS. 1896. Contributions to the zoology of Tennessee. No. 4, Mollusks. *Proc. Acad. Nat. Sci.*, Philadelphia, 47:487-506.
- RAY, R. A., AND S. W. HAMILTON. 1999. The mussel fauna, past, present, and future, of Sulfur Fork Creek and lower Red River, Tennessee, and laboratory transformation of glochidia. First Symp. Freshwater Mollusk Conserv. Soc. March 17-19, 1999. Chattanooga, Tennessee. [Abstract].
- STARNESE, L. B., AND A. E. BOGAN. 1988. The mussels (Mollusca: Bivalvia: Unionidae) of Tennessee. *Amer. Malac. Bull.*, 6:19-37.
- TURGEON, D. D., J. F. QUINN JR., A. E. BOGAN, E. V. COAN, F. G. HOCHBERG, W. G. LYONS, P. M. MIKKELSEN, C. F. E. ROPER, G. ROSERBERG, B. ROTH, A. SCHELTEMA, M. J. SWEENEY, F. G. THOMPSON, M. VECCHIONE, AND J. D. WILLIAMS. 1998. Common and scientific names of aquatic invertebrates from the United States and Canada: Mollusks, 2<sup>nd</sup> ed. Am. Fish. Soc. Spec. Pub.
- US ARMY CORPS OF ENGINEERS. 1995. Wolf River, Memphis, Tennessee, Reconnaissance Report.
- WATTERS, G. T. 1994. An annotated bibliography of the reproduction and propagation of the Unionoidea (primarily of North America). *Ohio Biol. Sur. Miscellaneous Contrib.* No. 1.
- WITHERS, D. I., AND W. M. CHRISTIE. 1997. Rare invertebrates list. Tennessee Dept. Environ. Cons., Div. Natural Heritage. <http://www.state.tn.us/environment/nh/tninvert.html>
- WILLIAMS, J. D., M. L. WARREN JR., K. S. CUMMINGS, J. L. HARRIS, AND R. J. NEVES. 1993. Conservation status of the freshwater mussels of the United States and Canada. *Fisheries*, 18:6-22.
- WILLIAMS, J. D. 1999. Conservation status of freshwater mussels. First Symp. Freshwater Mollusk Cons. Soc. March 17-19, 1999, Chattanooga, Tennessee. [Abstract]
- WILSON, C. B. 1916. Copepod parasites of fresh-water fishes and their economic relations to mussel glochidia. *Bull. US Bureau Fish.* [Document 824], 34:331-374.