

A Qualitative Freshwater Mussel (Bivalvia: Unionidae) Survey of the Lamine and Blackwater River Basins, Missouri

Authors: McMurray, Stephen E., Scott Faiman, J., and Bruenderman, Sue A.

Source: Freshwater Mollusk Biology and Conservation, 15(1) : 45-59

Published By: Freshwater Mollusk Conservation Society

URL: <https://doi.org/10.31931/fmbc.v15i1.2012.45-59>

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

A QUALITATIVE FRESHWATER MUSSEL (BIVALVIA: UNIONIDAE) SURVEY OF THE LAMINE AND BLACKWATER RIVER BASINS, MISSOURI

Stephen E. McMurray¹ & J. Scott Faiman

Missouri Department of Conservation, Resource Science Center,
1110 S. College Avenue, Columbia, Missouri 65201 U.S.A.
¹phone: (573) 882-9909; email: Stephen.McMurray@mdc.mo.gov

Sue A. Bruenderman

Kentucky Department for Environmental Protection, Division of Water,
200 Fair Oaks Lane, Frankfort, Kentucky 40601 U.S.A.

ABSTRACT

From 2003 to 2006 freshwater mussels (Bivalvia: Unionidae) were qualitatively surveyed in the Lamine River basin, a Missouri River tributary in west central Missouri. Timed searches (average time/site = 1.9 hr) were conducted to ascertain the distribution, diversity and abundance of unionids in the basin. A total of 45 sites were sampled and 5287 individuals from 27 species were observed, including *Ligumia recta*, a Missouri Species of Conservation Concern. The invasive *Corbicula fluminea* was observed live at nearly all sampling locations throughout the basin. Overall average Catch per Unit Effort (CPUE, live individuals/person hr) was 54.7 and ranged from 0 to 417.6. *Amblema plicata* was the most abundant species, with 2989 individuals recovered at 34 sites, representing 56.5% of the live mussels collected. *Leptodea fragilis* and *Potamilus alatus* were the most widely distributed species, each occurring at 36 sites. The Lamine basin unionid fauna (30 historic, 27 extant species) is more diverse than that of prairie streams in the Missouri River system and is similar to Ozark rivers. Given the anthropogenic impacts occurring in the basin, the Lamine River basin has a diverse freshwater mussel fauna. A number of species rich mussel assemblages were observed in the mainstem Lamine River. Continuing with management objectives to maintain water quality, improve aquatic habitat, and work with private landowners to stabilize streambanks and improve riparian zones will be necessary to maintain the diversity of freshwater mussels in the Lamine River basin.

KEY WORDS Freshwater Mussels, Qualitative Survey, Lamine River, Blackwater River, Missouri

INTRODUCTION

With less than 25% of the fauna considered stable (Williams et al., 1993), native freshwater mussels (Mollusca: Bivalvia: Unionidae and Margaritiferidae) are one of the most endangered groups of animals in North America (Stein et al. 2000). In Missouri, 10 species are listed as state endangered, 9 of which are also either federally endangered or candidate species; 19 other species are considered Missouri Species of Conservation Concern (SOCC). With 42% of the statewide fauna considered to be SOCC, freshwater mussels rank second only to crayfish in terms of imperilment in Missouri (MDC 2011). Documenting the distribution and diversity of freshwater mussels is a key aspect of their conservation (NNMCC 1998, MDC 2008).

Previous survey efforts in the Lamine River basin have documented 30 species, including 2 SOCC: *Anodonta suborbiculata* Say, 1831, and *Ligumia recta* (Lamarck, 1819) (Utterback, 1915–1916, 1917; Oesch, 1995) (Table 1). Utterback (1915–1916, 1917) docu-

mented 21 species from the Blackwater River portion of the basin, but unfortunately included few specific details about collection locations or species distributions. Oesch (1995) reported 30 species from 10 locations in the basin, adding 9 species to the fauna that had not been previously reported: *Fusconaia flava* (Rafinesque, 1820), *Obliquaria reflexa* Rafinesque, 1820, *Pleurobema sintoxia* (Rafinesque, 1820), *Potamilus alatus* (Say, 1817), *Potamilus ohioensis* (Rafinesque, 1820), *Quadrula pustulosa* (Lea, 1831), *Truncilla donaciformis* (Lea, 1828), *Truncilla truncata* Rafinesque, 1820, and *Venustaconcha ellipsiformis* (Conrad, 1836). Other than these limited survey efforts, little was known of the diversity and distribution of freshwater mussels in the Lamine River basin. This survey was conducted to document the distribution, diversity and abundance of unionid mollusks, in particular SOCC, in the Lamine River Basin.

The Lamine River is the 3rd largest free-flowing river in Missouri (Brown et al., 1992), and together with

its largest tributary (Blackwater River), the basin drains approximately 6863 km² of the Central Plains Aquatic Subregion (Sowa et al., 2005) in west central Missouri (Figures 1 and 2). This subregion was largely glaciated during the Pleistocene Epoch, and is characterized by low, rolling plains. Surface runoff is the primary source of water to typical streams within the subregion, and stream discharge fluctuates widely from extremely low base flow conditions to relatively high peak discharges following rain events (Sowa et al., 2005, 2007). The Lamine River is an Ozark border stream (Pflieger, 1989), and is unique because it straddles the border between the largely glaciated Central Dissected Till Plains and unglaciated sections of the Ozarks (Sowa et al., 2005). Tributary streams from the west tend to be of a lower gradient and primarily turbid, with sand and silt substrates, while tributaries from the south and east tend to be clear with gravel substrates similar to Ozark streams (Sowa et al., 2005).

Historically the basin was dominated by tallgrass prairie to the west, transitioning to oak and mixed-hardwood forested areas in the east (Sowa et al., 2005). Presently, landuse in the basin is largely agricultural, either row crops or pasture, with only a few remnants of native prairie remaining (MDNR, 2008). There are a number of sizeable communities in the basin, each of which has numerous permitted point source discharges. Threats and impacts to the basin's mussel fauna include point source pollution discharges, channelization, head cutting, nonpoint source runoff, gravel mining operations, and invasive species (Brown et al., 1992). Brown et al. (1992) considered aquatic habitat quality to be fair throughout the Lamine River portion of the basin, however lack of riparian corridor and areas of intensive streambank erosion were prevalent in select areas. Fortunately, approximately 92% of the mainstem Lamine River remains unmodified (Brown et al., 1992). In contrast, many streams in the Blackwater River portion of the basin, including the Blackwater River mainstem itself, have been extensively channelized (S.E. McMurray, pers. obs.).

METHODS

Freshwater mussels were qualitatively sampled by experienced personnel with timed searches at 45 locations from 2003 to 2006 (total search time = 86.1 person hr, average time/site = 1.9 person hr) (Fig. 1 and 2, Appendix A). Timed, qualitative searches were conducted to maximize species richness and optimize our ability to detect rare species (Strayer et al., 1997; Vaughn et al., 1997). Search time at each location was dependent upon stream size and the amount of area that could be searched. Sampling locations were chosen in the field based on availability and quality of

habitat (e.g., stable substrates, suitable flow) and signs of mussel assemblages (e.g., shell material on gravel bars, live animals observed), and were accessed via public or private accesses, bridge crossings, or boat. These sites included new as well as previously surveyed locations. Additional collections of shell material, previously unreported, were made between 1995 and 1999 by Missouri Department of Conservation (MDC) staff.

Depending upon water clarity and depth mussels were surveyed visually with snorkeling or view scopes or with tactile searches, in all available habitats. All mussels were identified, counted, and returned to the substrate; shell material was also collected from each location. Length measurements (anterior to posterior margins) were made from all mussels collected from 4 assemblages in the Lamine River (locations 4, 10, 22, 27), 1 assemblage in Muddy Creek (location 28), and 1 assemblage in Spring Fork (location 37) (Figures 1 and 2). Nomenclature largely follows Turgeon et al. (1998), except where accepted taxonomic changes have occurred. Conservation status follows Williams et al. (1993) and the Global Rank and State Rank of each species observed follow MDC (2011) and NatureServe (2010). The Global Rank is an assessment of global imperilment primarily based on the number of occurrences worldwide, and range from G1 (Critically Imperiled) to G5 (Secure) (MDC, 2011; NatureServe, 2010). The State Rank is a measure of imperilment primarily based on the number of occurrences of a species in Missouri, and as with Global Ranks ranges from S1 (Critically Imperiled) to S5 (Secure) (MDC 2011).

RESULTS

We observed 5287 individuals representing 27 species at the 45 locations surveyed in the basin (Appendix A). Average Catch per Unit Effort (CPUE, live individuals/person hr) for all survey locations was 54.7, ranging from 0 to 417.6. *Amblema plicata* was by far the most dominant species collected with 2989 individuals occurring at 34 of 45 sites (75.5%), representing 56.5% of live mussels collected (Table 2). *Leptodea fragilis* and *Potamilus alatus* were the most commonly encountered species, each occurring at 36 locations. Including *A. plicata*, 12 species had relative abundance values greater than 1.0%. A majority of the species observed (n=15) had relative abundance values less than or equal to 1.0% (Table 2). The invasive species *Corbicula fluminea* (Müller, 1774) was observed live at nearly all sampling locations throughout the basin, but counts of individuals were not made.

At the 6 locations where length measurements were collected the most dominant species observed,

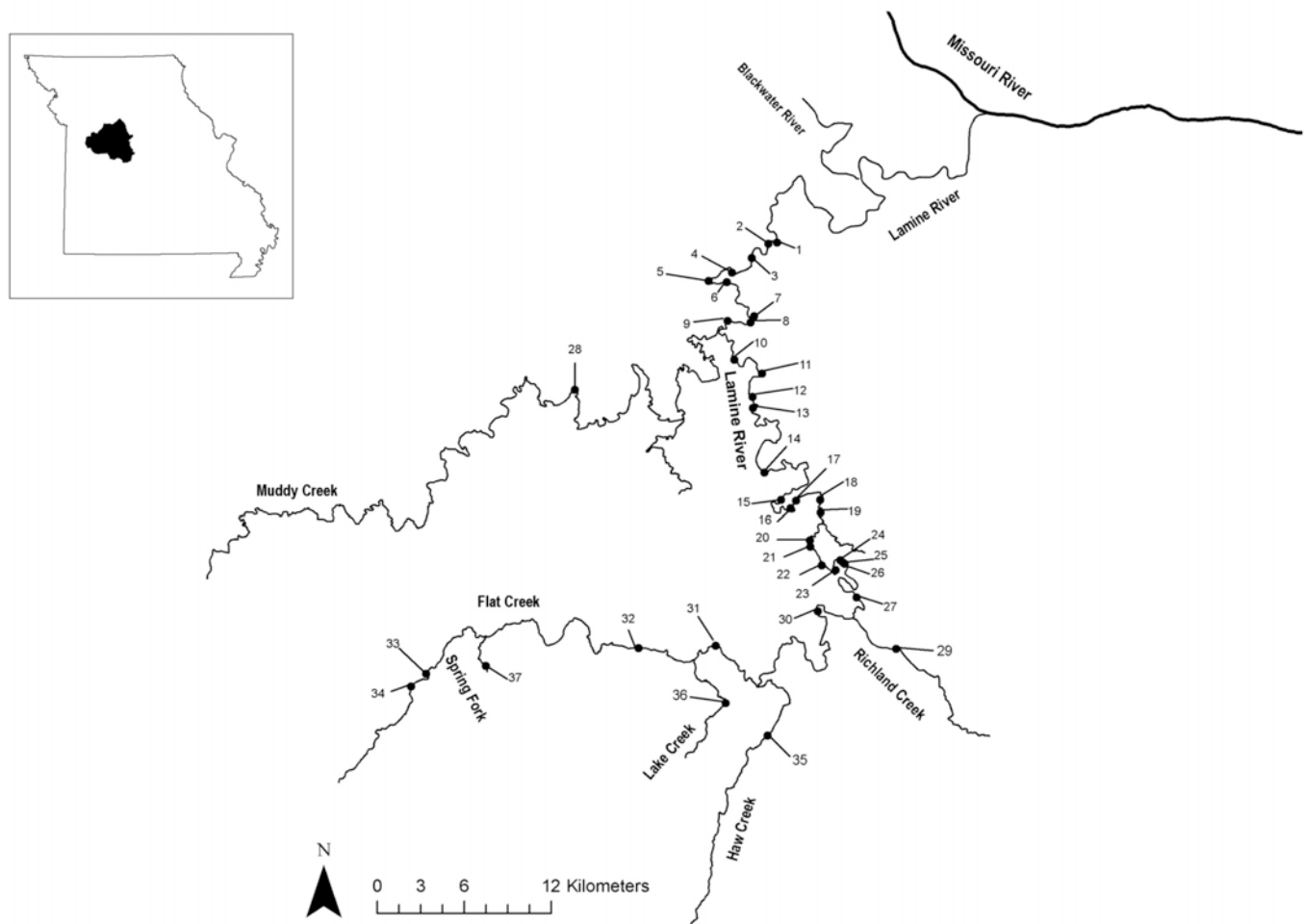


FIGURE 1

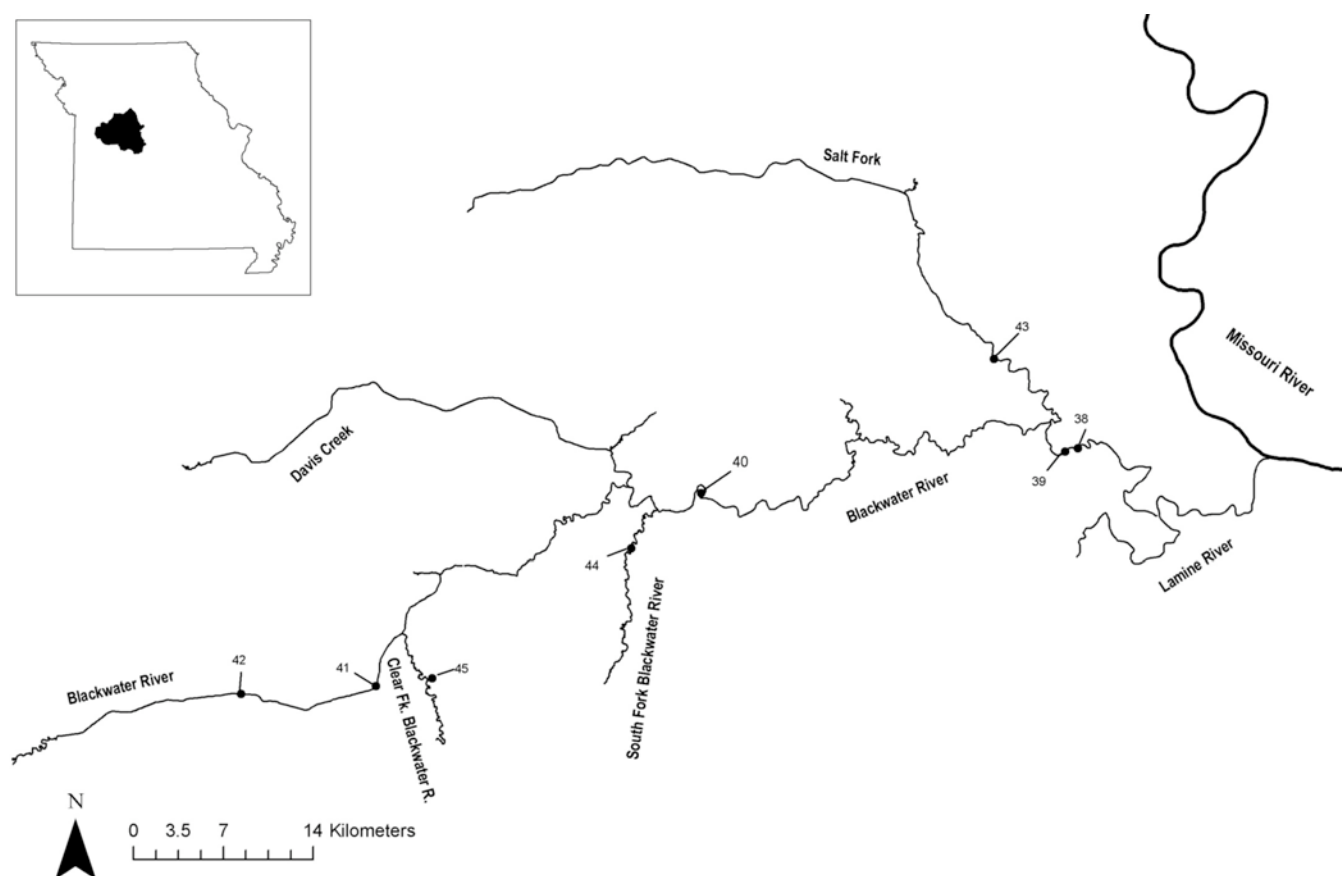
Qualitative freshwater mussel survey sites in the Lamine River, Missouri, 2003 – 2006. Inset shows the location of the basin in Missouri.

Amblema plicata, ranged from 25 – 156 mm in shell length ($n = 146$, $\bar{x} = 108.4 \pm 32.3$ mm). With the exception of *Lampsilis cardium* ($n = 28$, 57 – 159 mm, $\bar{x} = 126.4 \pm 30.0$), *Obliquaria reflexa* ($n = 37$, 27 – 82 mm, $\bar{x} = 64.4 \pm 12.2$), and *Quadrula quadrula* ($n = 70$, 29 – 127 mm, $\bar{x} = 97.329 \pm 23.9$) the most abundant species observed were largely represented by larger, and therefore older, individuals (Figure 3).

Nearly all of the 27 species observed during this survey effort were found in the Lamine River mainstem, with 3 species (*Ligumia recta*, *Ellipsaria lineolata* and *Venustaconcha ellipsiformis*) restricted to the mainstem of that river. *Megaloniais nervosa* (Rafinesque, 1820) was only found live in the Lamine River mainstem, but was represented by shell material from a single location in Muddy Creek, a Lamine River tributary. *Ligumia subrostrata* (Say, 1831), *Pyganodon grandis* (Say, 1829),

and *Toxolasma parvum* (Barnes, 1823) were only represented by shell material in the mainstem Lamine River, but were found live in other portions of the basin. *Uniomerus tetralasmus* (Say, 1831) was the only species that did not occur in the Lamine River mainstem; it was restricted to the South Fork Blackwater River and Flat Creek.

Most of the species observed in the present survey were S4 or S5 species (Apparently Secure or Secure, respectively) (MDC 2011). A single Missouri SOCC, *Ligumia recta*, was represented by a total of 4 live individuals at 4 locations in the Lamine River mainstem. Weathered and subfossil shell material was collected at an additional 9 locations also in the Lamine River mainstem. Globally, *L. recta* is a G5 (Secure) species, but is an S2 (Imperiled) species in Missouri (MDC 2011, NatureServe 2010).

**FIGURE 2**

Qualitative freshwater mussel survey sites in the Blackwater River, Missouri, 2003 – 2006. Inset shows the location of the basin in Missouri.

DISCUSSION

With a fauna of 30 species, freshwater mussel diversity in the Lamine River basin is similar to Ozark streams in the Missouri River system, such as the Sac River (39 species; Hutson & Barnhart, 2004; MDC, unpubl.), Pomme de Terre River (31 species, Hutson & Barnhart, 2004), and Gasconade River (43 species; Buchanan, 1994; Bruenderman et al., 2001; MDC, unpubl. data). In contrast, the Lamine River basin is much more diverse than prairie rivers in the Missouri River system such as the Platte River (12 species, MDC, unpubl. data) and Grand River (19 species, MDC, unpubl. data). This is reflective of the ichthyofauna of these systems, with Ozark rivers being more diverse than their prairie counterparts (Pflieger, 1997).

The dominant species in the Lamine River basin, *Amblema plicata*, is relatively common and widely distributed in the Midwest (Cummings & Mayer, 1992) and in Missouri (Oesch, 1995). *Amblema plicata* is a habitat generalist, appears to be tolerant of a wide

range of water quality, and therefore may become a dominant species in many river systems (Oesch, 1995). *Amblema plicata* has been found to be the dominant species in other river systems with varying degrees of impacts similar to those observed in the Lamine River basin (i.e., high sediment loads, hydromodification). Ahlstedt & Jenkinson (1991) reported that *A. plicata* represented >54% of the mussels collected in the lower St. Francis River (Missouri and Arkansas). Hutson & Barnhart (2004) reported that *A. plicata* represented 43% of the mussels collected in the Pomme de Terre River (Missouri). Wentz et al. (2009) reported that *A. plicata* represented >55% of the mussels collected in the Tyronza River (Arkansas).

While qualitative visual or tactile searches without excavation tend to oversample large or sculptured species and underestimate smaller species and individuals (Obermeyer, 1998), Christian et al. (2005) concluded that visual and tactile searches by experienced personnel could reveal recruitment when it was

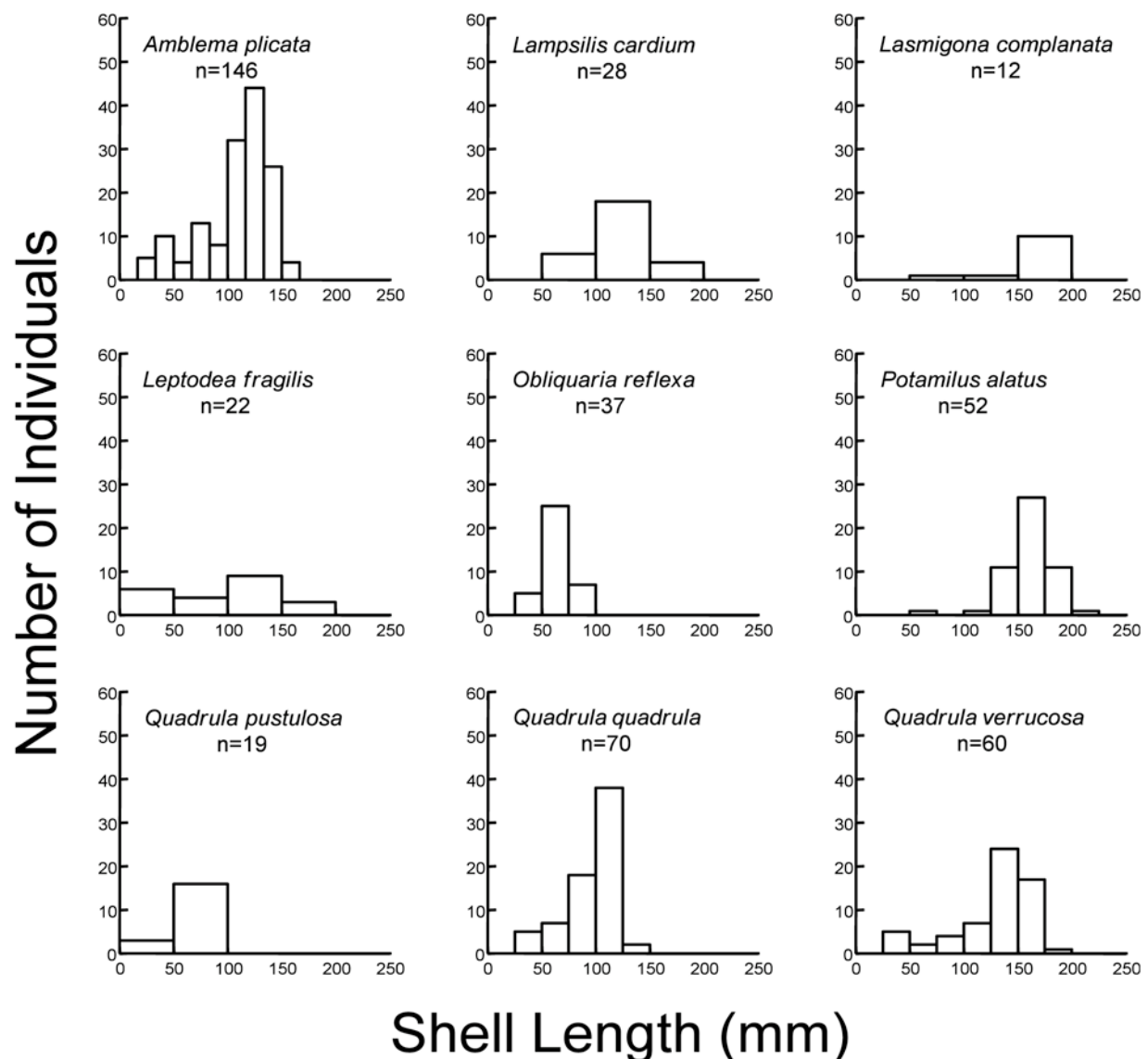


FIGURE 3

Size frequencies of 9 of the most abundant species collected from 6 locations in the Lamine River basin, Missouri, 2003 – 2006.

occurring. Few small juveniles (< 20 mm total shell length) were observed in the samples that were measured, and our size frequency distributions indicated unimodal recruitment patterns in the 9 most abundant species in the basin. This paucity of juveniles could be due to a lack of recent recruitment. However, given the intrinsic variability in freshwater mussel recruitment, even sporadic patterns of recruitment can sufficiently maintain populations (Neves & Widlak, 1987; Payne et al., 1997).

Three species previously reported to occur in the basin were not observed in the present survey.

Utterback (1915–1916, 1917) reported *Cyclonaias tuberculata* (Rafinesque, 1820) and *Lasmigona costata* (Rafinesque, 1820) as “fairly abundant” and *Anodonta suborbiculata* as “scarce”. Based on Utterback (1915–1916, 1917) Oesch (1995) also reported each of these species from the Blackwater River portion of the basin prior to 1920, but no more recent collections were noted. These species have apparently been extirpated from the basin, presumably due to the extensive modification of the Blackwater River.

Corbicula fluminea was common and abundant throughout the basin, and it has been demonstrated

that increased ammonia levels following large-scale die-offs of *C. fluminea* are detrimental to native mussels (Cooper et al., 2005). No *Dreissena polymorpha* Pallas, 1769, were observed in the Lamine River basin. However, *D. polymorpha* occurs in the Missouri River basin and several reservoirs in Missouri (MDC, unpubl. data). Private watercraft can move freely between the Lamine and Missouri rivers, and other infested waterbodies, and therefore could aid in the dispersal of this invasive species into the Lamine River system.

Notwithstanding the anthropogenic impacts occurring in the basin, the Lamine River basin has a diverse freshwater mussel fauna, and a number of species rich mussel assemblages were observed in the mainstem Lamine River. Continuing with management objectives proposed by Brown et al. (1992) to maintain water quality, improve aquatic habitat, and work with private landowners to stabilize streambanks and improve riparian zones will be necessary to maintain the diversity of freshwater mussels in the Lamine River basin.

ACKNOWLEDGEMENTS

We thank T. Barnes, M. Bayless, W. Gorlinsky, J. Guyot, J. Hundley, E. Rahm, and N. Stanek (MDC) for their assistance in the field. We thank T. Bixler (MDC) with assistance constructing Figures 1 and 2. Previously unreported additional collections of shell material reported herein were made by L. Trial (MDC-retired) and S. Zezula (NRCS, formerly of MDC). M.C. Barnhart (Missouri State University); J. Fantz (MDC); A.D. Roberts and B. Simmons (US Fish and Wildlife Service) and two anonymous reviewers provided reviews and improved this manuscript.

LITERATURE CITED

- Ahlstedt, S.A. & J.J. Jenkinson. 1991. Distribution and abundance of *Potamilus capax* and other freshwater mussels in the St. Francis River system, Arkansas and Missouri, U.S.A. *Walkerana* 5(14): 225-261.
- Brown, D.J., Turner, W.M., & R.J. Dent, Jr. 1992. *Lamine River basin management plan*. Missouri Department of Conservation, Fisheries Division. Jefferson City, Missouri.
- Bruenderman, S.A., Faiman, J.S., & A.C. Buchanan. 2001. Survey for endangered and other unionid species in the upper Gasconade River basin, Missouri. *Final Report completed for U.S. Fish and Wildlife Service, Columbia, Missouri. Missouri Department of Conservation, Jefferson City*. 97 pp.
- Buchanan, A.C. 1994. A survey of the freshwater mussels of the lower Gasconade River. *Report for the U.S. Army Corps of Engineers, Kansas City District, Missouri. Missouri Department of Conservation, Jefferson City*. 64 pp.
- Christian, A.D., Harris, J.L., Posey, W.R., Hockmuth, J.F., & G.L. Harp. 2005. Freshwater mussel (*Bivalvia: Unionidae*) assemblages of the lower Cache River, Arkansas. *Southeastern Naturalist* 4(3): 487-512.
- Cooper, N.L., Bidwell, J.R., & D.S. Cherry. 2005. Potential effects of Asian clam (*Corbicula fluminea*) die-offs on native freshwater mussels (Unionidae) II: porewater ammonia. *Journal of the North American Benthological Society* 24(2): 381-394.
- Cummings, K.S. & C.A. Mayer. 1992. Field Guide to Freshwater Mussels of the Midwest. *Illinois Natural History Survey Manual* 5. 194 pp.
- Hutson, C. & M.C. Barnhart. 2004. Survey of endangered and special concern mussel species in the Sac, Pomme de Terre, St. Francis, and Black River systems of Missouri, 2001 – 2003. *Final Report completed for U.S. Fish and Wildlife Service, Columbia, Missouri. Missouri Department of Conservation, Jefferson City*. 379 pp.
- Missouri Department of Conservation [MDC]. 2008. *Missouri mussel conservation and management plan*. Missouri Department of Conservation, Resource Science Division, Columbia, Missouri. 52 pp.
- Missouri Department of Conservation [MDC]. 2011. *Missouri species and communities of conservation concern checklist*. Missouri Department of Conservation, Jefferson City. 55 pp.
- Missouri Department of Natural Resources [MDNR]. 2008. *Watershed information sheet: Lamine River basin – 10300103*. Water Protection Program, Water Quality Monitoring and Assessment Section. Available at: <http://www.dnr.mo.gov/env/wpp/watersheds/info/ws-10300103.htm> (Accessed: 3 November 2008).
- National Native Mussel Conservation Committee [NN-MCC]. 1998. National strategy for the conservation of native freshwater mussels. *Journal of Shellfish Research* 17(5): 1419-1428.
- NatureServe. 2010. *NatureServe Explorer: An online encyclopedia of life [web application]*. Version 7.1. NatureServe, Arlington, Virginia. Available at: <http://www.natureserve.org/explorer>. (Accessed: 1 July 2011).
- Neves, R.J. & J.C. Widlak. 1987. Habitat ecology of juvenile freshwater mussels (*Bivalvia: Unionidae*) in a headwater stream in Virginia. *American Malacological Bulletin* 5(1): 1-7.

- Obermeyer, B.K. 1998. A comparison of quadrats versus timed snorkel searches for assessing freshwater mussels. *American Midland Naturalist* 139: 331-339.
- Oesch, R.D. 1995. *Missouri Naiades: A Guide to the Mussels of Missouri*. Missouri Department of Conservation, Jefferson City. 271 pp.
- Payne, B.S., Miller, A.C., & R. Whiting. 1997. Designing a riverine mussel survey. Pp. 151-156, [In:] Cummings, K.S., Buchanan, A.C., Mayer, C.A., & T.J. Naimo (eds.). *Conservation and Management of Freshwater Mussels II: Initiatives for the Future. Proceedings of a UMRCC Symposium, 16 – 18 October 1995, St. Louis, MO. Upper Mississippi River Conservation Committee, Rock Island, IL.* 293 pp.
- Pflieger, W.L. 1989. Aquatic Community Classification System for Missouri. Aquatic Series No. 19, *Missouri Department of Conservation, Jefferson City.* 188 pp.
- Pflieger, W.L. 1997. *The Fishes of Missouri*. Missouri Department of Conservation, Jefferson City. 372 pp.
- Sowa, S.P., Annis, G., Morey, M.E., & D.D. Diamond. 2007. A GAP analysis and comprehensive conservation strategy for riverine ecosystems of Missouri. *Ecological Monographs* 77(3): 301-334.
- Sowa, S.P., Diamond, D.D., Abbitt, R., Annis, G., Gordon, T., Morey, M.E., Sorensen, G.R., & D. True. 2005. A gap analysis for riverine ecosystems of Missouri. *Final Report, submitted to the USGS National Gap Analysis Program. Missouri Resources Assessment Partnership, University of Missouri, Columbia.* 238 pp + appendices.
- Stein, B.A., Kutner, L.S., & J.S. Adams, J.S. (eds.). 2000. *Precious Heritage: the Status of Biodiversity in the United States*. Oxford University Press, New York. 399 pp.
- Strayer, D.L., Claypool, S., & S.J. Sprague. 1997. Assessing unionid populations with quadrats and timed searches. Pp. 163-169, [In:] Cummings, K.S., Buchanan, A.C., Mayer, C.A., & T.J. Naimo (eds.). *Conservation and Management of Freshwater Mussels II: Initiatives for the Future. Proceedings of a UMRCC Symposium, 16 – 18 October 1995, St. Louis, MO. Upper Mississippi River Conservation Committee, Rock Island, IL.* 293 pp.
- Strayer, D.L. & D.R. Smith. 2003. A guide to sampling freshwater mussel populations. *American Fisheries Society, Monograph 8, Bethesda, Maryland.* 110 pp.
- Turgeon, D.D., Quinn, Jr., J.F., Bogan, A.E., Coan, E.V., Hochberg, F.G., Lyons, W.G., Mikkelsen, P.M., Neves, R.J., Roper, C.F.E., Rosenberg, G., Roth, B., Scheltema, A., Thompson, F.G., Vecchione, M., & J.D. Williams. 1998. Common and scientific names of aquatic invertebrates from the United States and Canada: mollusks. *American Fisheries Society Special Publication 26, Bethesda, Maryland.* 526 pp.
- Utterback, W.I. 1915-1916. The naiades of Missouri. *American Midland Naturalist* 4(3): 41-53; 4(4): 97-152; 4(5): 181-204; 4(6): 244-273; 4(7): 311-327; 4(8): 339-354; 4(10): 32-464.
- Utterback, W.I. 1917. Naiad geography of Missouri. *American Midland Naturalist* 5(1): 26-30.
- Vaughn, C.C., Taylor, C.M., & K.J. Eberhard. 1997. A comparison of the effectiveness of timed searches vs. quadrat sampling in mussel surveys. Pp. 157-162, [In:] Cummings, K.S., Buchanan, A.C., Mayer, C.A., & T.J. Naimo (eds.). *Conservation and Management of Freshwater Mussels II: Initiatives for the Future. Proceedings of a UMRCC symposium, 16 – 18 October 1995, St. Louis, MO. Upper Mississippi River Conservation Committee, Rock Island, IL.* 293 pp.
- Wentz, N.J., Harris, J.L., Farris, J.L., & A.D. Christian. 2009. Mussel inventory and population status of the federally endangered *Potamilus capax* (Green 1832) in the Tyronza River, Arkansas. *Journal of the Arkansas Academy of Science* 63: 169-176.
- Williams, J.D., Warren, Jr., M.L., Cummings, K.S., Harris, J.L., & R.J. Neves. 1993. Conservation status of freshwater mussels of the United States and Canada. *Fisheries* 18(9): 6-22.

TABLE 1

Freshwater mussel (Bivalvia: Unionidae) species reported from the Lamine River basin, Missouri, from Utterback (1915–1916, 1917, “Blackwater River Basin”), Oesch (1995), and present survey.

Scientific Name	Global Rank/ State Rank ^A	Utterback (1915–1916, 1917)	Oesch (1995)	Present Survey
<i>Amblema plicata</i>	G5/S5	×	×	×
<i>Anodonta suborbiculata</i> ^B	G5/S2	×	×	
<i>Cyclonaias tuberculata</i>	G3/S4	×	×	
<i>Ellipsaria lineolata</i>	G4-5/S4	×	×	×
<i>Elliptio dilatata</i>	G5/S4	×	×	×
<i>Fusconaia flava</i>	G5/S4		×	×
<i>Lampsilis cardium</i>	G5/S4-5	×	×	×
<i>Lampsilis siliquioidea</i>	G5/S4-5	×	×	×
<i>Lampsilis teres</i>	G5/S4	×	×	×
<i>Lasmigona c. complanata</i>	G5/S4	×	×	×
<i>Lasmigona costata</i>	G5/S4	×	×	
<i>Leptodea fragilis</i>	G5/S4	×	×	×
<i>Ligumia recta</i> ^B	G5/S2	×	×	×
<i>Ligumia subrostrata</i>	G5/S4	×	×	×
<i>Megaloniaias nervosa</i>	G5/S4	×	×	×
<i>Obliquaria reflexa</i>	G5/S4		×	×
<i>Pleurobema sintoxia</i>	G4-5/S4		×	×
<i>Potamilus alatus</i>	G5/S5		×	×
<i>Potamilus ohiensis</i>	G5/S4		×	×

TABLE 1

(cont.)

<i>Pyganodon grandis</i>	G5/S5	×	×	×
<i>Quadrula pustulosa pustulosa</i>	G5/S4		×	×
<i>Quadrula quadrula</i>	G5/S4	×	×	×
<i>Quadrula verrucosa</i>	G4-5/S4-5	×	×	×
<i>Strophitus undulatus</i>	G5/S4	×	×	×
<i>Toxolasma parvus</i>	G5/S4	×	×	×
<i>Truncilla donaciformis</i>	G5/S4		×	×
<i>Truncilla truncata</i>	G5/S4		×	×
<i>Unio merus tetralasmus</i>	G5/S4	×	×	×
<i>Utterbackia imbecillis</i>	G5/S4	×	×	×
<i>Venustaconcha ellipsiformis</i>	G4/S4		×	×
Corbiculidae				
<i>Corbicula fluminea</i>				×
Total Native Species (30)		21	30	27 ^C

^A Source: MDC (2008), NatureServe (2010)

^B Missouri Species of Conservation Concern (MDC 2011)

^C Includes previously unreported shell collections made by Missouri Department of Conservation staff, from 1995 – 1999

TABLE 2

Number collected, number of occurrences (live and dead) and percentage of sites, and relative abundance of fresh-water mussels collected in the Lamine River basin, Missouri presented in order from highest to lowest relative abundance.

Species	Number Collected Live	Number of Occurrences (%)	Relative Abundance (%)
<i>Amblema plicata</i>	2989	34 (75.5)	56.5
<i>Potamilus alatus</i>	431	36 (80.0)	8.2
<i>Quadrula quadrula</i>	385	32 (71.1)	7.3
<i>Lampsilis siliquioidea</i>	278	10 (22.2)	5.3
<i>Quadrula verrucosa</i>	183	33 (73.3)	3.5
<i>Lampsilis cardium</i>	169	32 (71.1)	3.2
<i>Obliquaria reflexa</i>	162	27 (60.0)	3.1
<i>Quadrula p. pustulosa</i>	159	31 (68.9)	3.0
<i>Leptodea fragilis</i>	85	36 (80.0)	1.6
<i>Lasmigona c. complanata</i>	80	29 (64.4)	1.5
<i>Ligumia subrostrata</i>	77	9 (20.0)	1.5
<i>Megaloniaias nervosa</i>	61	12 (26.7)	1.2
<i>Elliptio dilatata</i>	52	16 (35.6)	1.0
<i>Pyganodon grandis</i>	35	9 (20.0)	0.7
<i>Truncilla donaciformis</i>	22	28 (62.2)	0.4
<i>Utterbackia imbecillis</i>	22	13 (28.9)	0.4
<i>Truncilla truncata</i>	21	21 (46.7)	0.4
<i>Lampsilis teres</i>	18	24 (53.3)	0.3
<i>Pleurobema sintoxia</i>	18	11 (24.4)	0.3
<i>Potamilus ohiensis</i>	12	22 (48.9)	0.2

TABLE 2
(cont.)

<i>Ellipsaria lineolata</i>	8	8 (17.8)	0.2
<i>Fusconaia flava</i>	6	11 (24.4)	0.1
<i>Strophitus undulatus</i>	6	9 (20.0)	0.1
<i>Ligumia recta</i>	4	13 (28.9)	0.1
<i>Toxolasma parvus</i>	2	8 (17.8)	0.0
<i>Uniomereus tetralasmus</i>	1	2 (0.04)	0.0
<i>Venustaconcha ellipsiformis</i>	1	3 (0.07)	0.0

APPENDIX A

Number and collecting location CPUE (live individuals/hr) of freshwater mussels collected from the Lamine River basin, Missouri. For shell material, FD = Fresh Dead, WD = Weathered Dead, and SF = Subfossil.

Genus/Species	Collecting Location											
	1	2	3	4	5	6	7	8	9	10	11	12
<i>Amblema plicata</i>	WD	29	81	94	84	WD	74	763	SF	74	19	433
<i>Ellipsaria lineolata</i>				1		WD	1	2			SF	
<i>Elliptio dilatata</i>					FD	WD	SF	1			1	
<i>Fusconaia flava</i>								1			1	
<i>Lampsilis cardium</i>		2	WD	9	6	FD	10	6	SF	7	5	8
<i>Lampsilis siliquioidea</i>												
<i>Lampsilis teres</i>		1	WD	1				1				2
<i>Lasmigona c. complanata</i>			1	1			2	11		3	1	6
<i>Leptodea fragilis</i>	WD		2	9	1	WD	2	6	1	6	1	2
<i>Ligumia recta</i>					WD	WD	1	FD				SF
<i>Ligumia subrostrata</i>												
<i>Megaloniaias nervosa</i>		5		WD				WD	SF		8	8
<i>Obliquaria reflexa</i>	WD	3	8	18	WD	WD		28		8	WD	5
<i>Pleurobema sintoxia</i>						WD		WD				1
<i>Potamilus alatus</i>	1	1	9	7	8	WD	12	101		9	2	12
<i>Potamilus ohioensis</i>						FD	WD	1			SF	FD
<i>Pyganodon grandis</i>			WD									
<i>Quadrula pustulosa</i>	WD	4	1	7	2	WD	3	10	WD	4	3	10
<i>Quadrula quadrula</i>	WD	6	18	26	6	WD	16	20	WD	6	3	27
<i>Quadrula verrucosa</i>					1	WD	1	1				
<i>Strophitus undulatus</i>												
<i>Toxolasma parvus</i>	5		9	4	8	WD	1	5		6	8	6
<i>Truncilla donaciformis</i>	WD	WD	1	1	FD	WD	WD	WD		4	1	1
<i>Truncilla truncata</i>				WD	FD		WD	2		4	WD	1
<i>Unio merus tetralasmus</i>												
<i>Utterbackia imbecillis</i>			WD				1					FD
<i>Venustaconcha ellipsiformis</i>												
Live Totals:	6	51	130	178	116	0	124	959	1	131	53	522
Person Hours:	1.0	2.0	2	4	1.67	0.83	1.33	2.92	0.5	1.17	2.0	1.25
CPUE:	6	25.5	65	44.5	69.6	0	93	328.8	2	112.3	26.5	417.6

APPENDIX A

(cont)

Genus/Species	13	14	15	16	17	18	19	20	21	22	23	24
<i>Amblema plicata</i>	163	79	5	1	WD	2	126	6	154	48	14	5
<i>Ellipsaria lineolata</i>	2						1			1		
<i>Elliptio dilatata</i>	3	47	WD	SF	WD	SF				WD		SF
<i>Fusconaia flava</i>	1	3	WD		WD	SF						WD
<i>Lampsilis cardium</i>	8	19	1	FD	FD	SF	18	5	1	5	9	
<i>Lampsilis siliquoidea</i>		1										WD
<i>Lampsilis teres</i>	1	6	WD	WD			WD	1	1			WD
<i>Lasmigona c. complanata</i>	2	2				1	6	1	11	2	4	1
<i>Leptodea fragilis</i>	2	2	FD	FD		1		1	14	6	3	WD
<i>Ligumia recta</i>		2	SF	SF			1			SF		SF
<i>Ligumia subrostrata</i>												SF
<i>Megaloniais nervosa</i>	9	29	SF			SF						WD
<i>Obliquaria reflexa</i>	8	7	FD	FD	WD	SF	18	1	15	3	1	
<i>Pleurobema sintoxia</i>	6	10	WD			WD				1		SF
<i>Potamilus alatus</i>	11	31	1	WD	WD	2	61	3	19	43	8	4
<i>Potamilus ohiensis</i>	1	WD	1	1	WD		1			FD		WD
<i>Pyganodon grandis</i>									FD			
<i>Quadrula pustulosa</i>	22	26	WD	FD		SF	5		1	WD	1	WD
<i>Quadrula quadrula</i>	32	10	FD	3		SF	25	1	27	7		WD
<i>Quadrula verrucosa</i>		3										
<i>Strophitus undulatus</i>			WD	FD								
<i>Toxolasma parvus</i>	10	20	WD	1		SF	3	6	3	12	3	2
<i>Truncilla donaciformis</i>	1	WD	FD	FD				FD	4	3	FD	FD
<i>Truncilla truncata</i>	2	1	FD	1					3	3		WD
<i>Uniomerus tetralasmus</i>												
<i>Utterbackia imbecillis</i>			FD	FD					FD	WD	FD	WD
<i>Venustaconcha ellipsiformis</i>										WD		
Live Totals:	284	298	8	7	0	6	265	25	253	134	43	12
Person Hours:	3.75	4.67	1.07	1.0	0.5	1.0	2.0	1.67	2.67	3.12	0.67	0.83
CPUE:	75.7	63.6	7.5	7	0	6.0	132.5	15.0	94.9	43.0	64.5	14.4

APPENDIX A

(cont)

Genus/Species	25	26	27	27	28	29	30	31	32	33	34	35
<i>Amblema plicata</i>	146	16	19	38	5		39	7	WD	465		
<i>Ellipsaria lineolata</i>												
<i>Elliptio dilatata</i>				WD			WD		SF			
<i>Fusconaia flava</i>					WD		SF					
<i>Lampsilis cardium</i>	1	6	6	17	3	FD	2	3	1	10		
<i>Lampsilis siliquioidea</i>							WD	2	WD	236	WD	
<i>Lampsilis teres</i>			SF	2	1		WD		WD			
<i>Lasmigona c. complanata</i>	2		3	5	1		3	1	1	7		
<i>Leptodea fragilis</i>	2	5	4	10	FD		1	1	WD	1		
<i>Ligumia recta</i>		WD	WD									
<i>Ligumia subrostrata</i>							WD	2	FD	69		
<i>Megalonaias nervosa</i>	2											
<i>Obliquaria reflexa</i>	3	1	3	31			1					
<i>Pleurobema sintoxia</i>				WD			WD					
<i>Potamilus alatus</i>	26	2	7	14	WD		30	1	WD	6		
<i>Potamilus ohioensis</i>	2		WD	4			WD					
<i>Pyganodon grandis</i>								1	FD	28		
<i>Quadrula pustulosa</i>	5		5	12	9		1	13	SF	10		
<i>Quadrula quadrula</i>	1		11	50			8		1	76		
<i>Quadrula verrucosa</i>				WD	FD		WD		WD			
<i>Strophitus undulatus</i>				WD	FD		WD	2				
<i>Toxolasma parvus</i>	5	4	5	6	41		5	SF	SF	3		
<i>Truncilla donaciformis</i>		2	3	1	WD		WD					
<i>Truncilla truncata</i>		1	1	1	WD		1		WD			
<i>Unio merus tetralasmus</i>										1		
<i>Utterbackia imbecillis</i>							WD	FD	WD	21		
<i>Venustaconcha ellipsiformis</i>		1	SF									
Live Totals:	195	38	67	191	60	0	91	33	3	933	0	0
Person Hours:	0.53	1.42	4.0	1.5	3	0.67	2	3.25	3.0	6.67	0.75	0.53
CPUE:	365.6	26.8	16.8	127.3	20	0	45.5	10.2	1	140.0	0	0

APPENDIX A

(cont)

Genus/Species	36	37	38	39	40	41	42	43	44	45	Live Totals
<i>Amblema plicata</i>		WD									2989
<i>Ellipsaria lineolata</i>											8
<i>Elliptio dilatata</i>											52
<i>Fusconaia flava</i>		SF									6
<i>Lampsilis cardium</i>		1									169
<i>Lampsilis siliquoidea</i>		39						SF		SF	278
<i>Lampsilis teres</i>			SF			WD	1	FD	WD	WD	18
<i>Lasmigona c. complanata</i>		1	WD					1	SF	WD	80
<i>Leptodea fragilis</i>		1	FD	SF		WD		1		WD	85
<i>Ligumia recta</i>											4
<i>Ligumia subrostrata</i>		WD					1		1	4	77
<i>Megaloniais nervosa</i>											61
<i>Obliquaria reflexa</i>		WD									162
<i>Pleurobema sintoxia</i>											18
<i>Potamilus alatus</i>		WD	FD			WD		WD			431
<i>Potamilus ohioensis</i>			WD			1	SF	FD	WD		12
<i>Pyganodon grandis</i>		5	WD						WD	1	35
<i>Quadrula pustulosa</i>		5									159
<i>Quadrula quadrula</i>				WD		WD	WD	5			385
<i>Quadrula verrucosa</i>											6
<i>Strophitus undulatus</i>									FD	FD	2
<i>Toxolasma parvus</i>		WD		WD						2	183
<i>Truncilla donaciformis</i>		WD	FD					WD			22
<i>Truncilla truncata</i>		WD									21
<i>Unio merus tetralasmus</i>									FD		1
<i>Utterbackia imbecillis</i>											22
<i>Venusta concha ellipsiformis</i>											1
Live Totals:	0	52	0	0	0	1	2	7	1	7	5287
Person Hours:	0.53	1.33	0.67	0.83	3.0	1.33	1.33	2.2	2.0	2.0	86.1
CPUE:	0	39.0	0	0	0	0.8	1.5	3.2	0.5	3.5	