10-14-2004

Survey of endangered and special concern mussel species in the Sac, Pomme de Terre, St. Francis, and Black River systems of Missouri, 2001-2003

Christian Hudson
Missouri State University

M. Christopher Barnhart
Missouri State University

Endangered Species Grant Final Report
Grant No. E-1-36
(*A Survey of endangered and Special Concern Mussel Species in the St. Francis and Black Rivers in Southeast Missouri*)
Grant Period: 7/1/01 – 6/30/04

Survey of endangered and special concern mussel species in the Sac, Pomme de Terre, St. Francis, and Black River systems of Missouri, 2001-2003

Prepared by: Christian Hutson, M.S.
Research Specialist

and

Chris Barnhart, Ph.D.
Professor of Biology

Date Prepared: October 14, 2004

Project Leader: _____
Stephen E. McMurray
Missouri Department of Conservation

Acknowledgements

We would like to express our thanks to the generous and talented people who assisted us in this study. Bryan Simmons and Jason Gunter were essential members of the field crew. Their endurance, mechanical skills, and attention to detail were outstanding. Melissa Shiver and Nathan Eckert also made valuable contributions to the fieldwork. We thank Bob Holmes and Bill Goodman (SMSU) for modifying and repairing our boat and trailer. Sue Bruenderman, Al Buchanan and Scott Faiman of MDC and Andy Roberts of USFWS provided guidance and insight from their vast knowledge of mussels and Missouri rivers. Rick Horton, Ron Dent, Tim Banek, and Ron Bullard from MDC and Charlie Meeks from the Cedar County Republican provided important background information pertaining to the Sac River Basin and Stockton Dam. Conservation Agent Joni Bledsoe gave us valuable landowner contacts without which Sac River access would have been even more problematic than it was. Mark Boone and Paul Cieslewicz of MDC provided important information pertaining to the St. Francis and Black River basins. Andy Roberts, Paul McKenzie, and Charlie Scott of the Columbia Field Office of USFWS made this study possible by facilitating financial support. We thank DeeCee Darrow and Stephen McMurray (MDC) for their valuable editorial comments on the reports. Funding for the project was provided by the U.S. Fish and Wildlife Service through the Cooperative Endangered Species Conservation Fund and by the Fisheries Division and Resource Science Division of the Missouri Department of Conservation.

Table of Contents

St. Francis River system

Distribution maps - other species

Black River system

Distribution maps - other species

Introduction

Native mussels of the order Unionoida are the most imperiled major taxonomic group of aquatic animals in the United States. Presently, 70 mussel species are listed as federally threatened or endangered and 19 others as candidates for listing (USFWS website), and many workers believe that more than half of the North American species are in jeopardy (Master et al. 2000). The factors that have led to this situation are manifold (Strayer et al.2004). However, in Missouri and elsewhere, the construction of dams and reservoirs over the past century has had perhaps the most serious negative impact on the biota of rivers and on mussels in particular (Coker 1929, Watters 1996, Vaughn and Taylor 1999). The downstream effects of dams on unionids could possibly be moderated if they were better understood. Each of the four rivers surveyed in the present study has been impounded by at least one major dam, and we hope that the data presented in this report will help in assessing the biological impacts of these structures, in addition to the principle goal of documenting the distribution of species of concern.

Mussels have no doubt suffered significant population declines and range restriction in Missouri during the last century (Utterback 1915, Oesch 1984, Roberts and Bruenderman 2000, Bruenderman et al. 2001). At least one species, the Ozark-endemic Curtis Pearly mussel (*Epioblasma florentina curtisi*), has not been found since 1993 and could be globally extinct. On the other hand, the federally endangered winged mapleleaf, *Quadrula fragosa*, which had not been recorded in Missouri since the time of W. I. Utterback, was recently discovered in the Bourbeuse River (Roberts and Barnhart, unpublished data) and confirmed by genetic analysis (Dr. Jeanne Serb, University of Alabama, personal communication). Several other species of conservation concern have major population strongholds in Missouri, including the federally endangered scaleshell and pink mucket, federal candidate sheepnose, Neosho mucket, and spectaclecase, and other widespread but increasingly rare species such as snuffbox, rabbitsfoot, and salamander mussel. For this reason, Missouri's mussel fauna is of national significance.

The abundance and diversity of unionid mussels in Missouri are greatest in the larger rivers that drain the Ozarks region and in the rivers and artificial channels of the Southeast Lowlands (Utterback 1915, Oesch 1984). Surveys have documented the mussel fauna of these regions within the past decade in the Spring River in the upper Arkansas system (Obermeyer et al. 1997), the Meramec system (Roberts and Bruenderman 2000), selected streams in Southeast Missouri (Buchanan 1996), the St. John's basin and New Madrid Floodway (Barnhart 1998), the Gasconade River (Buchanan 1994, Bruenderman et al. 2001), and the lower Osage River (Ecological Specialists 2003). However, some major river basins have never been systematically surveyed, such as the Sac River (Osage River system), and the James River (White River system). Others, such as many of the smaller tributary streams of the White River system, have not been examined for over 20 years.

The primary objective of the present surveys was to determine the status of federal and state-listed and associated mussel species, and the unionid assemblage as a whole. A

related objective was to determine whether reproduction and recruitment were occurring in these rivers. Because most mussel species are long-lived with lifespans of decades, presence of adult populations does not necessarily indicate a viable population at a site. Evidence of recruitment is one of the most useful measures for determining the long-term health of a mussel community (Payne et al. 1997). Finally, we hoped to document the abundance and diversity of the mussel communities in relation to dams and impoundments. Patterns of operation of these dams, particularly Stockton Dam on the Sac River, may potentially be modified to reduce negative impacts on endangered species.

Methods

Site Selection and Access

We used 7.5' U.S. Geological Service topographical maps to identify areas of steep relief and rocky bluffs along the river. Such areas are usually associated with stable benthic habitat, which is a life requirement for unionids. We then conducted reconnaissance trips to determine areas of high priority for sampling. During these trips, we chose most of the sites that would later be sampled. We also later identified other areas for sampling while motoring to our survey sites on collecting trips.

Sites for sampling were selected based primarily upon three criteria: 1) presence and abundance of live mussels, 2) stable and diverse habitat, and 3) maintaining a reasonably uniform spacing of sites along the surveyed length of the rivers. When selecting sites, we took note of live mussels or shell material, as well as areas where the habitat appeared generally suitable for mussels. We searched for stable and sheltered substrate, with a variety of particle sizes including fines as well as cobble and boulder, and both shallow and deep water. Not all sites were chosen for favorable habitat conditions, however. Certain sites were selected as representative of large areas of unfavorable habitat, including unstable reaches with ongoing erosion of the banks. Likewise, within sites, we took care to ensure that all available habitats were surveyed, including areas of unstable substrate, solid bedrock, and/or high percentages of clay.

A portion of our sample sites in the St. Francis and Black Rivers were previously surveyed in other studies from 1965-1984. The UTM coordinates for these sites were obtained from the MDC Mussel Database (Microsoft Access). These sites were located using a handheld GPS (global positioning system) unit as well as detailed maps generated using ESRI Arcview 3.2a software. We were able to compare previous records of species composition, relative abundance, and CPUE (catch per unit effort) at these sites with our results.

We gained access to the river via public boat ramps when these were available. Privately owned access points were used only with landowner permission. We traveled to most sites using a 16-foot aluminum johnboat equipped with a 30-horsepower jet unit. A

wider workboat equipped with a 65-horsepower jet unit was provided by USFWS for the Black River segment of the study. The jetboats allowed us to navigate shallow sections of river. We frequently traveled 3-6 river miles to reach our sample sites and commonly encountered shallow areas as well as submerged boulders and logs. Many of these areas would not have been traversable using an ordinary outboard motor. Use of a jet unit is highly recommended for future surveys.

Sampling Methods

Sampling was qualitative. We did not randomly distribute our search effort over surveyed areas, and did not attempt to quantify mussel abundance through quadrat sampling. We recorded the catch rate per unit effort (CPUE, mussels per person-hour) which is related, in part, to the abundance of mussels in the searched area. However, it must be emphasized that CPUE also depends on other factors, including the skill and effort of the searcher and the search conditions. We sought to find as many mussel species as possible during timed searches. Two surveyors performed timed searches for live mussels at each survey site until no additional species were found for at least one person-hour. Generally we collected or counted all mussels encountered within approximately 300 m of river during each sampling effort. We examined all major habitat and substrate types at each site, because some species have peculiar habitat preferences (e.g. flat floaters and paper pondshell in soft sediments).

We snorkeled or used a surface air supply (Brownie Third Lung, Pioneer 275). Mussels were collected by hand. Visibility was generally quite good (2-3 m) and mussels were usually located by sight. We avoided sampling on days when high water from rain or dam operation impaired visibility. Certain sites, such as those located in sloughs or backwater areas, had zero visibility because of depth and turbidity. Groping was our sole search technique in these habitats.

At most sites we collected every mussel that was found for subsequent examination and measurement. These specimens were placed in net bags and taken to shore, where they were sorted and examined in shallow water. Each specimen was identified to species. Up to 20 individuals of each species were measured, aged, sexed and assessed for reproductive status (i.e., whether or not females were brooding glochidia in the marsupial gills). This sample often comprised all individuals of that species encountered at a site. If more than 20 specimens of a species were found, a sub-sample was chosen to represent the size distribution of the total catch. That is, if large individuals were more common in the sample, we measured more large individuals.

Maximum length was determined by measuring the distance from the anterior to posterior end to the nearest millimeter. Ages were estimated by counting the most distinct and regularly spaced external growth lines, assuming that each of these represented one year's growth. The first few years of old specimens with eroded umbos were sometimes inferred by comparison with younger individuals. Gender was determined by examining shell characters (sexually dimorphic species) or internal gills for gravidity. Gravidity was checked by gently prying open valves and examining for inflated gills. Catch per unit

effort (CPUE) at each sample site was determined by dividing total number of collected mussels by total search time (person-hours).

In addition to live specimens, we also gathered shells along the shore and from the streambed. Dead specimens of species not represented by live individuals were classified as fresh-dead, weathered-dead, or sub-fossil. Fresh-dead individuals were those in which soft anatomy had not fully decomposed. Weathered-dead shells had some luster to the nacre and relatively intact periostracum. Sub-fossil shells had chalky and lusterless nacre and the periostracum had peeled off considerably. The rate at which shell material decomposes following death of a mussel depends on variety of factors, including whether the shell was above or below the substrate, whether the shell was not in the water or immersed, species of mussel, and shell thickness. In general, weathered shells are thought to represent mussels that have been dead for less than a year and sub-fossil shells are those that have been dead for more than year (Buchanan 1980). However, relatively well-preserved shells approximately 500 years of age were also collected (see results).

At each site, we recorded date, location, names of collectors, area sampled, sampling methods, total sampling effort, number of living specimens of each species found, and species represented by shell material only. Qualitative descriptions were recorded of the specific habitat in which each special concern mussel species was found. Substrate particle size composition was estimated visually using a modified Wentworth scale.

Areas where mussels were found were photographed and sketched at most sites. We estimated length and width of beds (areas of high concentration of mussels) when possible. These details of site descriptions are not included in this report, but are on file at Southwest Missouri State University in Springfield, Missouri.

Sac and Pomme de Terre Rivers, 2001-2002

Summary- Sac and Pomme de Terre Rivers

Native freshwater mussels (Unionoida) were surveyed in the Sac and Pomme de Terre River systems of the Missouri-Osage River system. The Sac is the largest tributary of the Osage River and drains 1,981 square miles. Stockton Dam impounds the upper portion of the Sac system. The river is severely affected downstream by flow fluctuations from the dam. Releases varied between 100 and 5,000 cubic feet per second, often on a daily basis, depending on hydropower demand. These fluctuations cause extensive bank erosion and channel instability. The Pomme de Terre River watershed encompasses approximately 840 square miles. Pomme de Terre Dam impounds 18.3 river miles in the upper portion of the system, and Truman dam impounds 20 river miles in the lower portion of the system. Releases from Pomme de Terre Dam do not greatly fluctuate and downstream impacts appear to be moderate.

We surveyed 50 sites were (35 in the Sac system and 15 in the Pomme de Terre) between August 2001 and September 2002. Sampling effort averaged 2.7 hours per site and totaled 139.1 person-hours (91.1 person-hours in the Sac and 48 in the Pomme de Terre). We collected 12,393 individual mussels, representing 35 living species. The peak number of species per site was 21. Catch per unit effort ranged from 1 to 286 individuals per person-hour with an average of 89.1 individuals per person-hour.

The most abundant species in the Sac system (as percent of the total) were the purple wartyback (25%), Wabash pigtoe, pimpleback (~9% each), threeridge, washboard, butterfly (~8% each), mucket, monkeyface, plain pocketbook, pistolgrip, and threehorn wartyback (~4% each). Species of conservation concern (S = Missouri conservation rank) that were recovered from the Sac River include the federally endangered pink mucket (S1), the salamander mussel (S1) (a major range extension), black sandshell (S1-S2), elktoe and flat floater (both S2), and rock pocketbook and spectacle case (both S3). This is the first documentation of live pink muckets in the Sac River. The spectaclecase (federal candidate) appears to have been nearly extirpated from the Sac over the past few decades by the effects of Stockton dam. Dead shells in life position were frequently observed but only 2 live specimens were recovered.

The most abundant species in the Pomme de Terre system were the threeridge (43%), plain pocketbook (10%), purple wartyback (7%), ellipse and pimpleback (6%) and deertoe (4%). Species of conservation concern that were recovered from the Pomme de Terre River include the black sandshell (S1-S2), elktoe and flat floater (both S2), and rock pocketbook and (S3).

Very little recent population recruitment was evident in the Sac River system. Recruitment of some species was observed in the Pomme de Terre system. Overall, the results indicate that these rivers of the upper Osage River system are significant but impaired refuges for mussel SCC and deserve further attention and management efforts to preserve this fauna.

Background information- Sac and Pomme de Terre Rivers

The Osage River basin comprises over 14,000 square miles and contains one of the most diverse and abundant freshwater mussel faunas in the Midwest. Historically, 47 unionid species have been reported from the basin (Scammon 1906, Utterback 1916, Murray and Leonard 1962, Stansbery 1974, Grace and Buchanan 1981, Oesch 1984, Buchanan 1996, Horton and Hutson 2001). A 1980 survey of mussels in the lower Osage identified 34 extant species (Grace and Buchanan 1981) including the federally endangered pink mucket, the state endangered elephant ear and ebonyshell, and other SCC including spectaclecase, black sandshell, hickorynut, rock pocketbook, and elktoe. Mussels in the upper Osage basin (i.e., above Bagnell dam) have never before been systematically surveyed.

The Sac and Pomme de Terre are two large tributaries of the Osage River above Bagnell Dam. The Sac drains 1,981 square miles, and the Pomme de Terre drains 828 square miles. The Sac River drains portions of both the Ozark Highland and Osage Plains zoogeographical regions as described by Funk (1968). The basin includes portions of Barton, Cedar, Christian, Dade, Greene, Lawrence, Polk, St. Clair and Vernon Counties. Land is mainly used for pasture and grazing, with only relatively small areas of forest, row crop and urban land.

The Sac flows in a generally northerly direction for 120 miles to its confluence with the Osage River and Truman Reservoir. The total length of all the streams in the Sac watershed is 2,510 miles, 839 of which are perennial. Major tributaries include Little Sac River, Turnback Creek, Sons Creek, Horse Creek, Cedar Creek Coon Creek, Turkey Creek, Brush Creek, and Bear Creek. Tributary streams ranged from clear with predominantly chert gravel/cobble streambeds to turbid with silt, sand and gravel streambeds. Stockton Dam has impounded a total of 39 miles of the upper Sac River. Downstream, Truman Reservoir inundates about 8 miles of the lower Sac River and occasionally floods the lower portions of Coon Creek, Brush Creek, Turkey Creek, and Cedar Creek (Horton and Hutson, 2001).

Cursory fieldwork at a few sites in the Sac River before 2001 showed a diverse mussel fauna including at least 35 species (Horton and Hutson 2001). A single valve identified as the federally endangered pink mucket, *Lampsilis abrupta*, was collected below Stockton Dam 30 years ago, but no live individuals were found (Oesch 1984 and personal communication 2002). Eighty-nine species of fish have been identified from the Sac River basin. Overall, fish populations appeared healthy, but declines in several species are apparent and it is possible that some species were lost from the watershed (Horton and Hutson, 2001). According to Pflieger (1997), reservoir construction and habitat loss have been significant factors leading to fish population declines.

The Pomme de Terre River is in the Ozark Highland zoogeographical region as described by Funk (1968). The Pomme de Terre originates near Marshfield in Webster County, Missouri and flows northward to Pomme de Terre Lake. It resumes its path northward from Pomme de Terre Dam into Benton County where it is one of the major tributaries to Truman Reservoir. The Pomme de Terre watershed includes portions of Benton, Hickory, Dallas, Polk, Greene, and Webster Counties. Forests generally dominate stream corridors in the lower portion of the watershed, while stream corridors in the upper portion of the watershed primarily consist of grassland. Most grassland is used for cattle pasture and/or hay production (Groshens et al.1999).

The total length of all the streams in the basin is 714 miles. Major tributaries of the Pomme de Terre include Little Pomme de Terre River (north), Little Pomme de Terre River (south), and Lindley Creek. Stream channels in the region generally consist of a series of well-defined riffles and pools and possess substrates consisting of coarse gravel, rubble, boulders and bedrock (Pflieger 1997). Pomme de Terre Dam has impounded 18.3 miles of the Pomme de Terre River. Combined, Pomme de Terre and Truman reservoirs

inundate 59.6 river miles, or 46% of the former Pomme de Terre River channel (129 miles) (Groshens et al.1999).

The most recent previous mussel collections in the Pomme de Terre River apparently took place in the late 1970's. At least 34 species of mussels are known to occur in the Pomme de Terre River basin (Klippel et al. 1978, Oesch 1994, Groshens et al.1999) (Table 1). Eighty-three species of fish have been collected in the Pomme de Terre watershed after 1940 (Groshens et al.1999). The Niangua darter (federally threatened, state endangered), inhabits the upper segments of Pomme de Terre River drainage (Pfleiger 1997, Groshens et al.1999).

Dams and impoundments have reduced and fragmented much of the habitat of the Osage basin over the past 70 years. Major dams include Bagnell (completed in 1930), Pomme de Terre (completed in 1961), Stockton (completed in 1970) and Truman (completed in 1978). The design and operation of Stockton Dam, a hydropower facility, has been controversial and may negatively impact the unionid fauna. At the time Stockton Dam was designed, the Corps of Engineers miscalculated the channel carrying capacity of the Sac River by more than 50%. Output from the dam during power generation is excessive for the size of the channel, and the extremes of flow have caused extensive erosion, alteration of fish fauna, destruction of archeological resources, and other impacts (Anon. 1982, Zeigler 1994, Lopinot et al. 1998). In contrast to Stockton Dam, Pomme de Terre Dam is not a hydropower facility and is managed for flood control and recreation.

Results and Discussion- Sac and Pomme de Terre

We conducted 15 reconnaissance trips to determine areas of high priority for sampling. During these trips, we traveled the entire unimpounded length of the both the Sac and Pomme de Terre Rivers and chose most of the sites that would later be sampled. We also later identified other areas for sampling while motoring to our survey sites on collecting trips (see methods). Access to the Sac River was problematic at best. Only two public boat ramps were available. Therefore, we gained access primarily from streamside landowners or via highway “right-of-ways”. In contrast, the Pomme de Terre River had relatively abundant public access sites.

The survey was conducted between August 2001 and September 2002. We surveyed 35 sites in the Sac system, including 32 sites in the Sac mainstem and 3 sites in tributary streams (Horse Creek, Bear Creek and the Little Sac River). The mainstem sites were distributed over 42.2 river miles between Sac River Mile (SRM) 11.3-53.5. We surveyed 15 sites in the Pomme de Terre system, including 11 sites in the mainstem below the Pomme de Terre Dam, 3 in the mainstem above the dam and 1 site in a tributary stream (Lindley Creek). The mainstem Pomme de Terre sites were distributed over 77.2 river miles between Pomme de Terre River miles (PDTRM) 22.6-99.8 (Figure 1, Appendix A).

Total search effort was 139 person-hours, 91 person-hours in the Sac system and 48 in the Pomme de Terre. We collected 12,393 living mussels, 9,124 from the Sac and 3,269 from the Pomme de Terre. We found 35 living species, 33 in the Sac system and 31 in the Pomme de Terre. Overall CPUE was 100 mussels/person-hour in the Sac River, and 72.5 mussels/person-hour in the Pomme de Terre River. Sampling effort, species and numbers collected at each site appear in Appendix B. Seven SCC were found alive in the Sac system. These species were *Lampsilis abrupta, Alasmidonta marginata, Anodonta suborbiculata, Arcidens confragosus, Cumberlandia monodonta, Ligumia recta* and *Simpsonaias ambigua.* Four of these were also found in the Pomme de Terre system (*Alasmidonta marginata, Anodonta suborbiculata, Arcidens confragosu,* and *Ligumia recta*).

Diversity and abundance in the Sac system

We collected a total of 9,124 live unionids in 91.1 person-hours of effort in the Sac system. We collected 33 living species (Table 2). The most abundant species in our total sample were the purple wartyback (25% of live specimens), pimpleback (9.3%), Wabash pigtoe (8.9%), washboard (8.3%), threeridge (8.3%) and butterfly (7.5%) (Table 2, Figure 2). The most generally distributed species in our sample were threeridge (83% of sites), pink heelsplitter (77%), pimpleback (74%), purple wartyback, plain pocketbook, and threehorn wartyback (each of the latter three species was present at 71% of the sites).

The most rarely encountered species in the Sac system were the pink mucket, salamander mussel (new record for the basin), elktoe, rock pocketbook, and pink papershell. Each of these species was represented by only single live specimens. Other relatively rare species included Ozark shell (n=2), pondmussel (n=3), spectaclecase (n=3), and flat floater (n=6, new record for the Sac system). One species, the yellow sandshell, was not found live in the Sac and was represented by only one weathered dead shell (Table 2, Appendix B-Tables 1-2).

According to a hyperbolic regression model, the number of individuals collected at each Sac River site explained 90% of the variation in number of species among sites (Figure 3, Appendix B-Tables 1-2). The predicted number of species per site (i.e. the asymptote) is 21, and 564 specimens must be collected to recover 90% of of this number.

Most (29/33) species we collected in the Sac system were found in the Sac River mainstem. Four species, the salamander mussel, pond mussel, creeper and giant floater were only collected in tributaries of the Sac. Two species were new records for the Sac, the salamander mussel and the flat floater.

The abundance of unionids in the Sac is apparently higher than in some rivers of similar size in southern Missouri, and species diversity is also high. For example, a recent survey of Meramec River unionids found average CPUE=22 and 40 living species (Roberts and Bruenderman 2000) and a survey of the Gasconade River found CPUE=46 and 35 living species (Bruenderman et al. 2001). These values compare to CPUE=100 and 33 living species in the Sac (present study). It is likely that other living species are

present. Six additional species have been reported previously from the Sac, including northern broken-ray *Lampsilis reeveiana brittsi*, paper pondshell (*Utterbackia imbecillis*), fawnsfoot (*Truncilla donaciformis*), yellow sandshell (*Lampsilis teres*), lilliput (*Toxolasma parvus*) and slippershell (*Alasmidonta viridis*) (Table 1). Thus the fauna may be expected to total at least 39 species. The kidneyshell was reported in the Sac, Niangua, and Meramec by Oesch (1995), but has not been confirmed in these drainages or any others of the north slope of the Ozarks by more recent surveys, and it appears probable that those reports were misidentifications (Ron Oesch, personal communication 2002).

Subfossil shells in the Sac River

During our survey we discovered two areas in which "sub-fossil" mussels were eroding out of clay cut banks. Shells were collected and a total of 15 species were identified (Table 3). Remarkably, the majority of these shells were in excellent condition. Many specimens were articulated and retained most of their periostracum, and the nacre was somewhat lustrous. These shells might be classified as "weathered-dead" and not "sub-fossil" according to the classification used by Buchanan (1980). The deposits containing these shells and the shells themselves have been radiocarbon dated in conjunction with archaeological investigations. They appear to be approximately 500 years old (Neal Lopinot & Jack Ray, SMSU, personal communication 2001). Dead shells of similar appearance are commonly found in drift in the Sac, and it should be noted that such shells may be ancient yet could easily be mistaken for recent shells. These well-preserved shell deposits also present the possibility of investigating the pre-settlement mussel fauna of the Sac River.

Diversity and abundance in the Pomme de Terre system

We collected a total of 3,269 live unionids in 48 person-hours of effort in the Pomme de Terre. We collected 31 living species (Table 4). The six most abundant species in our samples were the threeridge (43% of live specimens), plain pocketbook (10.4%), purple wartyback (6.9%), ellipse and pimpleback (5.9% each) and deertoe (4%) (Table 4, Figure 4). The most generally distributed species in our sample were the threeridge, pink heelsplitter, and plain pocketbook (each occurring at 93.3% of sites), and the deertoe, pistolgrip, fragile papershell and threehorn wartyback (each occurring at 80.0% of sites). Three species were new records for the Pomme de Terre, the lilliput (*Toxolasma parvus*), flat floater (*Anodonta suborbiculata*) and rock pocketbook (*Arcidens confragosus*).

The number of specimens collected at each Pomme de Terre site explained 80% of the variation in number of species among sites (Figure 5, Appendix B Tables 3-4). The regression coefficients were similar to those calculated for the Sac (cf. Figures 4, 5).

The most rarely encountered unionid species in the Pomme de Terre system, each less than 0.1% of the total catch, were the lilliput (n=1), yellow sandshell (n=1 dead shell), giant floater (n=2), rock pocketbook (n=2), and creeper (n=3) (Table 4, Appendix B Tables 3-4). Other species that have previously been reported in the Pomme de Terre,

but were not found during this survey are the northern brokenray, slippershell, fawnsfoot and the pink papershell (references in Table 1).

Comparison with previous surveys

One other study of mussels in the Pomme de Terre River is available and is significant because it occurred in 1976, just prior to the flooding of the lower river by Truman Lake (Klippel et. al. 1978). Workers from the Illinois State Museum collected 1,436 mussels at 15 sites on the lower reaches of the river from Pomme de Terre Dam to near the confluence with the Osage River. The purpose of the study was to compare the extant mussel assemblage of the Pomme de Terre River with archeological records from Rogers Shelter (a prehistoric rock shelter). The collections included muskrat midden piles, fresh shell taken from gravel bars and shallow riffles, and quantitative collections made by sieving substrate at 5 of the 15 sites. Most of the sites (4 of 5 quantitative sites, 6 of 10 midden sites) are presently impounded by Truman Reservoir.

The most abundant species in the Illinois State study were deertoe (20.7%), threeridge (18.9%), ellipse (12.2%), pimpleback (9.6%) and mucket (6.3%). Midden shells comprised 43% of the collection and contained high proportions of deertoe and ellipse. Considering only the quantitative samples, the most abundant species were the threeridge (32.8% of live specimens), pimpleback (14.4%), mucket (9%), spike (8.8%) and purple wartyback (4.6%). These lists can be compared to our relative abundance results (Table 4, Figure 4). One striking difference is the abundance of mucket, which was a common species in the Illinois State survey, but comprised less than 0.5% of our sample. Elktoe were also more numerous in 1976 (20/1,436=1.39%) than in the present study (5/3,269=0.15%). These differences might reflect real changes in relative abundance, but it must be noted that the 1976 survey sites were mainly downstream of our sites and the collection included midden shells that probably biased the species proportions. One similarity in the two surveys was the dominant size class of the threeridge, at 100-120mm. Sizes of other species were not reported.

Longitudinal distribution in the Sac River

Flow in the Sac is dominated by Stockton Dam, which is operated as an on-demand hydropower facility. Releases fluctuate between 100 and 5000 cubic feet per second, depending on power demand. As described previously, these flow fluctuations have had serious impacts on the river channel, and they appear to have affected the mussel fauna as well. The fauna upstream of Caplinger Mill Dam has low CPUE, low species diversity, and little if any recruitment. This section contains long stretches of unstable substrate, intensive bank erosion, and riparian corridor loss that appear to be direct results of the flow extremes from Stockton Dam.

CPUE and diversity in the Sac increased abruptly below Caplinger Mill Dam (SRM 38) (Figures 6-7). Caplinger Mill Dam is a low head dam located about 15 miles below Stockton. This dam noticeably impounds the river for about 5 miles upstream. The river flows over the dam even during periods of low release from Stockton. Mussel abundance

and diversity were very low in the 5 miles immediately above Caplinger Mill where the river is relatively deep and slow with silty substrate, conditions that are unfavorable for most mussel species. The dam probably also presents an obstacle to host fish movement upstream, which may reduce recruitment of mussels from the more numerous downstream populations.

Below Caplinger Mill, mussel diversity was generally high, but abundance changed with distance in an interesting pattern (Figure 6). Abundance increased immediately below the dam (SRM 37.2) and then decreased gradually to a minimum between SRM 37.2-31.5. A number of species, including mucket, washboard, monkeyface, and plain pocketbook, decreased in abundance over this 6-mile reach. It is difficult to identify habitat trends that could account for this longitudinal change. Some of the sites in this reach appeared to have good habitat. Species diversity was generally high, and some rare species, including black sandshell and one of the two live *Cumberlandia monodonta* (Spectaclecase), were found in this reach.

Below SRM 31.5, mussel abundance abruptly increased more than 18-fold, peaking at SRM 28.4, and generally remained high between this point and the lower impounded region of the river (Figure 6). The increased abundance at SRM 28.4 was partly due to the appearance of large numbers of Wabash pigtoe. This species was practically absent from the first 6 miles below Caplinger Mill as well as further upstream. Mucket, washboard, threeridge, and butterfly also became more abundant.

Riverside bluffs are common downstream of SRM 31.5. In these areas, cobble and boulders make up a large proportion of the substrate on the bluff bank while sand dominates the substrate on the floodplain bank. High-density mussel beds were often located in the transition zone between areas of boulders/cobble and sand. These stretches of favorable habitat often ranged from 200-600 m long with depths of 0.5-5m (during low-flow periods). Mussel populations in these areas were extremely large and should be considered for quantitative sampling in future surveys.

Recruitment in the Sac system

Our data suggest very low recruitment of mussels in the Sac system. We found only a few young individuals (2-5 yr) of purple wartyback (n=3), pimpleback (n=3), mapleleaf (n=1), monkeyface (n=1), white heelsplitter (n=1), pistolgrip (n=2), creeper (n=1), deertoe (n=2), threehorn wartyback (n=2) fragile papershell (n=1) (Figure 10, Appendix C, Tables 1-4). No young individuals were collected in the section of river upstream of Caplinger Mill. It should be noted that qualitative sampling is biased towards collecting older, larger mussels (Negus 1966). Individuals less than 50 mm in length are difficult to find without excavation and sieving of the substrate, which we did not perform (Miller et al. 1993, Strayer et al. 1997). Therefore, the length-class distributions from our samples (Figures 10,11, Appendix C) almost certainly underestimate numbers of smaller individuals. However, our search techniques were adequate for finding at least some percentage of younger (2-5 yr) specimens for more common species (see Appendix C). The low occurrences of young mussels in our samples cannot be entirely explained by

sampling bias. Even populations of abundant species, such as purple wartyback, appear to be composed mainly of very old individuals, perhaps predating Stockton Dam. Study of age distributions may be advisable to determine historical patterns of recruitment.

Longitudinal distribution in the Pomme de Terre River

Sites upstream of Pomme de Terre Dam (PDTRM 73.2 to 99.8) had lower CPUE and species diversity than most of the downstream sites (Appendix B Table 3, Figures 8-9). However, the river above the lake is much smaller than that below the dam, and CPUE and species diversity are generally lower in smaller streams.

Below the lake, the Pomme de Terre River is controlled by reservoir releases. However, the flow pattern and environmental effects are very different from those in the Sac. Flows generally change on a weekly or monthly basis and, in contrast to the operation of Stockton Dam, there are no daily flow extremes. Although the dam was designed and authorized to generate electricity, it is not used for this purpose. The reservoir is part of the Osage River Basin flood protection program and provides recreational use.

The mussel fauna in the Pomme de Terre River does not appear to be severely affected below the dam. Mussel diversity and CPUE varied but did not generally increase or decrease with distance below the dam (PDTRM 22.6 to 41.4) (Figures 8, 9). The stream habitat in this area is relatively uniform, consisting of typical riffle-pool sequences with a variety of substrate types. Stream corridors are heavily forested and bank erosion is minimal. The larger CPUE below the dam, compared to the 3 sites above the lake, was partly due to increased species diversity and the appearance of large numbers of threeridge below the dam. Only one specimen of threeridge was collected upstream of Pomme de Terre Dam, but this species dominated the downstream collections. Pimpleback, plain pocketbook, deertoe, pistolgrip, and spike also were much more abundant in the downstream section.

Recruitment in the Pomme de Terre system

At least a few young individuals of most species were recovered in the Pomme de Terre, suggesting that some level of recruitment is occurring. We collected 70 young individuals (0-5 yr) of 14 different species: deertoe (n=24), threeridge (n=17), fragile papershell (n=10), spike (n=4), round pigtoe (n=3), fatmucket (n=2), paper pondshell (n=1), pimpleback (n=1), pistolgrip (n=2), plain pocketbook (n=1), purple wartyback (n=1), threehorn wartyback (n=1), ellipse, (n=1), white heelsplitter (n=1) (Figure 11, Appendix C Table 5, 6).

Species of Concern in the Sac and Pomme de Terre systems

One federally listed species and 6 state-listed species were recovered from the Sac and Pomme de Terre systems. Distribution maps for these and other species encountered during our study appear in Figures 12-47. Specific river miles, age estimates, and lengths of all specimens collected are reported in Appendix C.

Pink Mucket, *Lampsilis abrupta*

The pink mucket, listed as federally endangered in 1976, has a global ranking of G2 and a state ranking of S2 (MDC 2004b). Its historical distribution includes the Tennessee, Ohio, and Cumberland River basins with occasional records from the Mississippi River drainage (USFWS 1985). In Missouri, it has been reported from the lower reaches of the Osage, Gasconade and Meramec rivers (Buchanan 1980, Grace and Buchanan 1981), and from the St. Francis, Sac, Black, and Little Black rivers (Grace and Buchanan 1981, Oesch 1984). However, there are no previous records of live individuals of this species from the Sac River. The only previous evidence was a single dead shell collected below Stockton Dam.

In our survey, two live female pink muckets were collected in the Sac River. The first was found at site #CH01103 in St. Clair County (SRM 21.0) on August 22, 2001 (Figure 12 and Appendix B-Table 1). This site is approximately 0.33 mi downstream of Blackjack Conservation Access. The area contains some of the best mussel habitat encountered in the basin. Bank stability was good (forested and rocky, with a riparian corridor greater than 100 m) adjacent to the bluff, but poor on the floodplain side which had a narrow (11-25 m category) riparian corridor. Less than 10% of the stream was shaded. The specimen was collected at the beginning of a run directly downstream of a shallow bend (riffle) and adjacent to a large cobble pile on the outside of the bend. Water depth was approximately 1 m although depths vary with dam operation. The banks of the outside bend are littered with large boulders from the steep bluff above. The mussel bed was estimated to be 200 m in length and contains areas of very stable and diverse substrate. We also found a weathered dead shell of pink mucket at site #CH01118 in Cedar County (Figure 12 and Appendix B).

In July of 2003, a second female pink mucket was collected at site #CH01121. This area is located at SRM 36.7 at the Highway N Bridge near Caplinger Mill. The channel substrate was a mixture of sand, gravel, pebbles, cobble and boulders. Water depth was approximately 4-5 f and flow was moderate. The specimen was not brooding when collected, but became gravid while at SMSU. She was returned to the site of collection on 14 August 2003.

L. abrupta was one of the rarest mussels encountered during this survey. Due to its scarcity, this species may be in danger of becoming extirpated from the Sac River system in the near future.

Black sandshell, *Ligumia recta*

The black sandshell has a state rank of S1-S2 and a global rank of G5 (MDC 2004b). It has a large range and occurs throughout the Mississippi River system from New York to Minnesota, south to Oklahoma and east to the Alabama River basin, the Red River of the North, and the St. Lawrence River basin (Parmalee and Bogan 1998). In Missouri, it is known from the Black, Osage, White, Gasconade, Mississippi, Salt, Des Moines, Platte, Neosho, Meramec, Blackwater and St. Francis river basins (Utterback 1915, 1917; Oesch 1984; Barnhart 1999).

In our survey, a total of 119 living black sandshells were collected at 15 sites in the Sac River and 11 sites in the Pomme de Terre River (Table 2, 4, Figure 13). In the Sac River, this species was collected live at 43% of our survey sites, but was found live only at sites downstream of Caplinger Mill. In total, 71 live *L. recta* were collected in the Sac River with a relative abundance of 0.76%, we would often find 4-10 live individuals at a survey site (Appendix B). This species was collected in a variety of habitats, but was most common in substrates with high amounts of coarse sand, even in areas without high densities of other unionids. Weathered-dead shells of this species were found at 9 additional sites upstream of Caplinger Mill. The black sandshell is apparently extirpated from this region of the Sac River, but it is still a regular member of the mussel assemblage in the section of river downstream of Caplinger Mill.

In the Pomme de Terre River, black sandshell was collected live at 73% of our survey sites and was generally distributed throughout the portion of the river between Pomme de Terre Dam and Truman Reservoir. A total of 48 live *L. recta* were collected with a relative abundance of 1.47%. The number of individuals collected at each site varied from 1-12. The majority of the *L. recta* were collected from PDTRM 26.7-33.6 in substrates with high amounts of coarse sand with cobble and boulders in shallow water. Although rare, this species does not appear to be in danger of extirpation from the Sac or Pomme de Terre.

Elktoe, *Alasmidonta marginata*

The elktoe has a global rank of G4 and a state rank of S2 (MDC 2004b). It is a widespread species, but records are sporadic throughout its range (Cummings and Mayer 1992). The historical distribution of *A. marginata* was the upper Mississippi, Ohio, Cumberland, Tennessee, Michigan, and upper St. Lawrence drainages (Burch 1975). Utterback (1915, 1917) reported this species from the Mississippi, Gasconade, and Jack's Fork rivers and from the Osage, Meramec, Neosho, Black and St. Francis river basins. More recently, this species was collected from the Whitewater, Black, St. Francis, Cuivre, Salt, Gasconade, Sac, Pomme de Terre, Current, James, Elk, Spring, and North Fork of the White rivers (Oesch 1984).

Elktoe was a rare species in the present survey. We collected 6 live elktoe at 1 site in the Sac River, and 3 sites in the Pomme de Terre River (Table 2, 4, Figure 14). In the Sac River, this species was collected live at SRM 28.4 (Vilhaur Bluff) upstream of State

Highway W. Only 1 specimen was collected with a relative abundance of 0.01%. The specimen was highly eroded and its age was estimated at roughly 20 yrs. The collection site was above average in mussel density and diversity for this stream. The specimen was collected in a shallow run over a sand/gravel/cobble substrate. A bluff is located on the left upstream bank. Bank stability was good on this side, but poor on the right upstream bank. This area was cattle-trodden and bordered by a relatively thin (11-25 m) riparian corridor.

In the Pomme de Terre River, elktoe was collected live at 20% of our survey sites. A total of 5 live *A. marginata* were collected with a relative abundance of 0.15%. One of the survey sites was located upstream of Pomme de Terre Dam at PDTRM 99.8 (our uppermost site). In this region, the Pomme de Terre is essentially a headwater stream. The specimen came from a narrow, shallow riffle with a substrate of gravel/cobble. The flow was moderate and water depth was less than 0.5 m. The other specimens were collected downstream of Pomme de Terre Dam at PDTRM 29.4-33.6. The substrates at these sites include high percentages of gravel/cobble, with some boulders and bedrock. The flow was moderate to high (regulated by the dam) and depths ranged from 0.5-2 m. One weathered dead elktoe was also collected from this region of the river. Additional sampling of headwater reaches is needed to definitively assess the status of this species in the Pomme de Terre system.

Flat Floater, *Anodonta suborbiculata*

The flat floater has a global rank of G5 and a state rank of S2 (MDC 2004b). It has a large historical range with occurrences reported throughout the Mississippi River floodplain, but has probably been decimated by loss of connected wetlands along major rivers. Presently, this species can be described as locally abundant in the remaining floodplain lakes, sloughs and oxbows of the Mississippi and Ohio rivers and their tributaries (Cummings and Mayer 1992). In Missouri, it has been reported from the Missouri, St. Francis and Osage river basins.

In our survey, the flat floater was a rare species. We collected 11 live specimens at 1 site in the Sac River and 1 site in the Pomme de Terre River (Tables 2, 4 - Figure 15). In the Sac River, 6 live flat floaters were collected with a relative abundance of 0.07%. The site (SRM 39.2, 1.5 miles upstream of Caplinger Mill) is a very large bend (Horseshoe Bend) that was cut-off by the USACE and is unique in the Sac River. There is negligible flow in this area and the habitat resembles a lake. The water level is very deep (~5 m) and the substrate consists of silt with decaying woody debris. The banks are stable as there is no flow to cause erosion. The only other species collected at this site were the pink heelsplitter (n=1) and the washboard (n=1). All of the specimens were quite large (120-180 mm) making them easy to feel in the deep silt. With approximately 2.5 mi of this unique habitat, it seems reasonable to infer that a large population of flat floaters may occur in Horseshoe Bend.

In the Pomme de Terre River, 5 live flat floaters were collected with a relative abundance of 0.15%. The site (PDTRM 38.9) is a side channel that appently only receives flow

during periods of high water. On the particular day we surveyed this area there was no flow through this side channel. The water depth was less than 0.5 m, but the depth of the mud was greater than 0.5 m. The collected specimens were buried under 6-12 inches of mud. This site was also the only place that we collected live paper pondshell (*Utterbackia imbecillis*). Localized populations of flat floaters might occur in similar habitats elsewhere the Pomme de Terre system, but no other survey sites contained muddy side channels.

Rock Pocketbook, *Arcidens confragosus*

The rock pocketbook has a global rank of G4 and a state rank of S3 (MDC 2004b). Its range includes the Mississippi River and major tributaries from Minnesota to Louisiana, as well as several other Gulf river systems from Texas to Alabama (Clarke 1981, Parmalee and Bogan 1998). In Missouri, it has been reported from the Missouri River (south of St. Louis), lower Meramec River, St. Francis River, Little Black River and Osage River (Buchanan 1980, Oesch 1984, Buchanan 1996). Rock pocketbooks appear to be more common in man-made agricultural ditches in southeast Missouri (Ahlstedt and Jenkinson 1987, Roberts et al. 1997, Barnhart 1998).

In our survey, the rock pocketbook was a very rare species. We collected a total of 3 live rock pocketbooks at 1 site in the Sac River and 1 site in the Pomme de Terre River (Tables 2, 3, Figure 16). In the Sac River, we collected 1 older individual (age estimate of 16 years) at SRM 45.2. It was collected under a substrate of cobble and boulders with silty sand as well as numerous weathered dead shells. The site is located upstream of Caplinger Mill Dam and contains a sharp bend with a water depth of 1-3 meters and slow current. We found no other evidence of this species, live or dead, in the Sac River system.

In the Pomme de Terre River, we collected 2 rock pocketbooks at PDTRM 23.5. Both individuals were collected from the beginning of a run in moderate current at a water depth of approximately 1 meter. The substrate consisted of silt, sand, gravel and pebbles with numerous fresh-dead and weathered-dead shells. This site is only a few river-miles from the impounded water of Truman Reservoir. We found no other evidence of this species, live or dead, in the Pomme de Terre River system. The rarity of live specimens suggests that this species could soon become extirpated from the Sac and Pomme de Terre River systems.

Salamander Mussel, *Simpsonaias ambigua*

The salamander mussel has a global rank of G3 and a state rank of S1 (MDC 2004b). It had a large range encompassing the Ohio River system, north to Michigan, west to Iowa, south to Arkansas, and east to Tennessee (Parmalee and Bogan 1998). Buchanan (1980) reported this species from a single site in the Bourbeuse River. It was also reported from the lower 40 miles of the Meramec River (Environmental Science and Engineering, 1987, MDC 2002). The salamander mussel is the only unionid species known to utilize an

amphibian as a host. The host is the mudpuppy (*Necturus maculosus*), which has external gills for glochidial attachment (Clarke 1985, Barnhart et. al. 1998).

We collected one living salamander mussel from Bear Creek, a small tributary of the Sac River (Tables 2, 3 - Figure 17). The survey site was approximately 13 miles upstream of Bear creek's confluence with the Sac River (SRM 52.1). The specimen was found in shallow (12 in) water with little flow under a large flat rock in silt/sand substrate. Bedrock was common throughout the survey site and seemed to help stabilize the substrate. The salamander mussel has not been previously reported from the Missouri River basin and this find represents a major range extension for this species. We only surveyed one site in Bear Creek and no dead specimens were found. No mudpuppies were observed during our survey. More surveys are needed to assess the S*impsonaias ambigua* population in the Sac River system. A genetic comparison with other populations is also advisable.

Spectaclecase, *Cumberlandia monodonta*

The spectaclecase is ranked S3 in Missouri and G2/G3 globally (MDC 2004b). The distribution for this species includes the Cumberland and Tennessee River systems and the Mississippi River drainages from Minnesota to Pennsylvania south to the Gulf of Mexico (Burch 1975, Parmalee and Bogan 1998). Possibly the largest population in North America exists in Missouri in the Meramec and Gasconade River systems (Buchanan 1980, Baird 2000). It also occurs, although not abundantly, in the Osage, Salt, and Auxvasse rivers and in Joachim Creek (Utterback 1917, Oesch 1984, Buchanan 1980). Utterback (1917) reported it form the Mississippi River, northwest Missouri lakes, and the Osage and Platte river basins.

In our survey, we collected 3 living spectaclecase mussels from 2 sites in the Sac River (SRM 27.9 and 32.5) and numerous weathered-dead specimens from 6 other sites (SRM 11.3, 23.8, 33.5, 43.0, 45.2, 46.8) (Tables 2, 3 - Figure 18). The live specimens were collected from very rocky (cobble and boulder) riffles in swift current. They were apparently very old and had heavily eroded periostracum. Weathered dead specimens, still oriented in their living positions, were often observed crowded into small spaces under or between boulders. However, these spaces were often filled with sand and/or silt. Weathered dead specimens were also found in other atypical microhabitats, but were thought to be "wash-downs" from upstream areas. The extreme rarity of live specimens, combined with the large number of dead shells observed, suggests that this species has been drastically reduced post-impoundment and will soon be extirpated from the Sac River system.

Threats in the Sac and Pomme de Terre systems

Threats specific to unionids observed during our survey included the following:

- Bank/channel/substrate instability. Erosion is probably the greatest threat to the continued existence of mussels in the Sac River and to a lesser extent the Pomme de Terre River. The daily flow extremes from Stockton Dam have produced long stretches of unstable substrate, intensive bank erosion, and riparian corridor loss. This is especially true for the portion of the Sac River upstream of Caplinger Mill. However, these effects are seen throughout the entire reach of the Sac River between Stockton Dam and Truman Reservoir.

- Cattle with unrestricted access: We often encountered cattle in the riparian corridors and in the rivers. Thin-shelled mussels can be crushed by these animals. Trampling can destabilize in-stream substrate and cause bank erosion.

- Poaching: It is legal in Missouri, with a recreational fishing permit, to take up to five freshwater mussels per day (Wildlife Code of Missouri, Rule 3CSR10-6.610). Commercial harvest is illegal. During our survey, we encountered direct evidence of poaching in the Sac River near Blackjack Conservation Access. In September 2001 we found a large mesh bag containing over 60 live washboard mussels (Photo 5). We returned these mussels to the river and contacted MDC Conservation Agent Joni Bledsoe. Hubbs (2000) reported that Tennessee shell buyers paid as much as $5.50/lb live and $ 8.50/lb open for 5" washboards for use in the cultured pearl industry. Sac River washboard shells typically weigh approximately 1 kg. Therefore, the specimens we recovered could have been worth well over $1000. It should be noted that the Sac River is not widely used by recreational anglers, and there is very limited access. During our survey, we often went for days or weeks without encountering other people on the river. Consequently, it would not be difficult for poachers to avoid observation.

Threats to water quality in the Sac River system (Horton and Hutson 2001):

- Sac River basin copper, nickel, zinc, chromium, phosphorus, pH, dissolved oxygen and ammonia levels exceeded established criteria in less than 10 percent of the observations by the EPA.

- Increased urban development is a concern in the Little Sac River portion of the Sac River basin. Population increases in the Springfield metropolitan area are the primary reason for increased nutrification and algal growth in the Little Sac watershed. Occasionally high phosphate, nitrate and sulfate levels are likely due to localized agricultural practices, overflow from the Northwest Treatment Plant, or leachate from the Springfield landfill (Sparks and Pavlowsky, 2000).

- Reports of pollution and fish kills have increased in recent years. This may be the result of increased pollution events, increased environmental awareness and activism, better monitoring by state and federal agencies, or a combination of these factors.

- Several wastewater treatment facilities in the basin have historically violated their discharge permits. These problems are likely to increase as population increases continue to occur. Water quality concerns associated with point sources were listed in the Missouri Water Quality Basin Plan (MDNR 1996).

- Livestock is the most significant source of non-point pollution in the Sac River basin (MDNR 1996). The basin as a whole is one of the top cattle and hay producing areas in Missouri. Pastured cattle and fertilization for hay production and subsequent nutrient runoff may contribute to the nutrification of watershed streams. Total effect from livestock in the basin was estimated to be 3,850,000 population equivalency (MDNR 1985). Confined animal feeding operations (CAFOs) are increasing throughout the basin, and corporate hog feeding operations are increasing north and west of Stockton Lake (Kevin Hess, MDNR, pers. comm. 2001).

- Sediment yield by streams in the Sac River basin is 0.3-1.0 tons/acre/year, primarily from sheet and rill erosion. Helicopter video taken in 2000 revealed localized streambank erosion problems throughout the watershed (Anderson 1980).

- There is one permitted gravel-mining operation in the basin. There are also many small-localized areas where landowners have apparently removed gravel from, or re-arranged, gravel bars to use on farm roads and/or to prevent bank erosion. Another type of rock mining that is significant in the Sac River basin is limestone quarrying. Coal mining affects the Horse and Cedar creek drainages, with the potential for acid mine drainage to reduce water quality. In the past, mining of lead, zinc, and iron was conducted in the Sac River basin. Most of this mining activity has ceased, but old mine shafts and mine tailings can be found and may create water quality problems with leaching of materials or by providing avenues for mixing of surface waters with groundwater. (MDNR 1996).

Threats to water quality in the Pomme de Terre River Basin (Groshens et al. 1999).

- Discharges from the City of Buffalo's wastewater treatment facility negatively impacted 4.5 miles of Lindley Creek (Groshens et. al. 1999).

- Fifty-four National Pollution Discharge Elimination System (NPDES) permits were active in the Pomme de Terre watershed in 1998. Sixty-five percent of the NPDES permits are located in the Middle and Upper Pomme de Terre Hydrologic Units (Groshens et. al. 1999).

- The Missouri Department of Natural Resources states that six sizeable wastewater discharges exist in the watershed (excluding discharges directly into Pomme de Terre Lake) (MDNR 1996).

- There were fifteen known active gravel removal operations in the watershed in 1998 (Groshens et al. 1999).

- Most streams are impacted by runoff from livestock grazing. Cattle have free access to streams in most cases. The MDNR (1994) stated that "there has been a trend of increasing numbers of dairy cattle in the southern portion of the basin (Osage River Basin). Many of these dairies are not adequately managing animal wastes and it is running off into spring branches and streams."

- Groshens et al. (1999) felt that erosion was accelerated in the Pomme de Terre River below Pomme de Terre Dam. Certainly the effects appear much less severe than in the Sac below Stockton (personal observation).

- Ryck (1974) reported that "Low temperature discharges through Pomme de Terre Dam have a detrimental effect on the fishery in the tailwaters."

Management Recommendations- Sac and Pomme de Terre systems

"Annual Water Level Management Recommendations" were developed by MDC for input to the USACE on Pomme de Terre Lake level management and dam releases beginning in 1985 (Groshens et al. 1999). The management objectives of the recommendations were to 1) improve spawning habitat in the Pomme de Terre River for walleye and white bass from March 10-April 30, 2) improve walleye and white bass fishing during the spring spawning run below Pomme de Terre Dam, 3) increase recreational opportunities for fishing and canoeing in the Pomme de Terre River during summer, 4) improve spawning habitat for prey fishes such as gizzard shad and sport fishes in Pomme de Terre Lake from April 1-June 15, and 5) reduce bank erosion along the Pomme de Terre River during evacuation of flood waters beyond lake elevation 841 ft. msl. The plan has been generally followed, except where exceptionally high inflows and/or high water in downstream reservoirs necessitated deviations. Relative to Stockton Dam, Pomme de Terre Dam appears to be operated in a manner that is less detrimental to mussels.

Stockton Dam's operation appears to be highly damaging to the Sac River in general and to mussels in particualar. An intensive examination of watershed activities in this section of river should be conducted to identify and correct risks to aquatic resources. Certain sites in this reach are potentially good candidates for augmentation (release of artificially propagated juveniles). The Sac River Basin supports many species, including the federally endangered pink mucket and at least 6 species of Missouri SCC. This basin also contains one of the only areas in Missouri where the salamander mussel (S1) has

been recently documented. Priority should be given to the section of the Sac River downstream of Caplinger Mill Dam (SRM 38) for watershed improvement projects.

Taking into consideration the damaging effects of dam operation on the Sac River mussel population, immediate action should be taken to conserve the remaining mussel resources and restore lost habitat. Accomplishing this will necessitate the cooperation of several entities including: state and federal agencies, non-governmental institutions, private landowners, and the general public. Both the Sac and the Pomme de Terre river basins support a diversity of other aquatic organisms, some of which are in decline such as the federally threatened/state endangered Niangua darter (*Etheostoma nianguae*). Recovery actions for these animal groups are comparable to those required for mussels. Suggested conservation measures would include the following:

1. Investigate the possibility of altering the operation of Stockton Dam for the purpose of reducing daily flow extremes and approximating a natural flow regime. Without this measure, erosion rates are not likely to change and habitat restoration in the Sac River cannot be achieved. Before the construction of Stockton Dam, the Sac River rose and receded relatively slowly, allowing banks to dry out slowly and remain stable. Out-of-bank flows occurred, allowing the floodplain to absorb much of the energy of floodwaters and relieve pressure on stream banks. Post-impoundment river levels change drastically and are regulated to prevent out of bank flows. Water levels rise and fall quickly. As this occurs the banks do not have time to dry out, and saturated banks, without the support of the water column, are more susceptible to mass wasting. Additionally, "hungry water" exiting Stockton Dam may be responsible for increased erosion and bank failure. The term "hungry water" refers to water that is relatively sediment-free, with more erosive power. Any sediment carried into the streams above the dam has been deposited in Stockton Lake. Additionally, extended periods of bank-full flows occur. Extended bank-full flows, of relatively sediment-free water, are very erosive and exacerbate mass wasting.

2. Protect existing mussel populations and restore habitat. Partnerships should be formed with government and non-government natural resource agencies, private landowners, and businesses to promote proper land use practices. Strategies for accomplishing this goal are outlined in the National Strategy for the Conservation of Native Freshwater Mussels. (NNMCC 1999).

3. Identify new mussel beds and monitor select mussel beds that possess significant populations, are highly diverse, and demonstrate evidence of recruitment. Much of the diversity and abundance of unionids is found in mussel beds, which are isolated and patchily distributed. Long-term sampling of these areas is necessary to assess population status and recruitment and to document the success of water restoration projects. Then, perhaps, threats to habitat can be identified before the river is negatively impacted.

4. Augment populations of the pink mucket by artificial propagation and release of juveniles at suitable sites. Repeat the process for state endangered species as

propagation techniques for these species are refined. Threatened species can greatly benefit from artificial propagation, which can potentially stabilize existing populations and restore lost populations. However, the success of this process depends on the identification of suitable habitat that is not in danger of degradation.

5. Survey additional areas in all tributaries and headwater reaches of the Sac and Pomme de Terre rivers to determine the status of mussel populations. Little emphasis was placed on smaller tributaries in this survey or in many other surveys. It is probable that undocumented species exist in these tributaries. For example, the salamander mussel was collected from a Sac River tributary that had not previously been surveyed.

6. Work with the Missouri Department of Natural Resources to monitor water quality, improve water quality, and ensure compliance with discharge permits.

7. Develop a surveillance program to stop illegal harvest of commercially valuable species in the Sac River. Work with Conservation Agents to increase monitoring efforts at particularly vulnerable areas such as portions in close proximity to Blackjack Conservation Area in St. Clair County.

8. Inform the public of the significant natural resources that exist in the Sac and Pomme de Terre river basins, their status, and the threats that face them. Increasing public awareness can help encourage landowners and others to participate in conservation efforts.

Table 1. Mussel species reported from the Sac and Pomme de Terre River systems. Species names considered to be synonomies (Oesch 1984) are not listed. Sources: 1=Oesch 1984, 2=Horton and Hutson 1999, 3=Klippel et al. 1978, 4=present study. Conservation ranks from MDC 2004a.

	Species	Common Name	Global Rank	State Rank	Sac	Pomme deTerre
1	*Actinonaias ligamentina*	Mucket			1, 2, 4	1, 3, 4
2	*Alasmidonta marginata*	Elktoe	G4	S2?	1, 2 ,4	1, 3, 4
3	*Alasmidonta viridis*	Slippershell			1, 2	1, 3
4	*Amblema plicata*	Threeridge			1, 2 ,4	1, 3, 4
5	*Anodonta suborbiculata*	Flat floater			4	4
6	*Arcidens confragosus*	Rock pocketbook	G4	S3	2, 4	4
7	*Cumberlandia monodonta*	Spectacle case	G2G3	S3	2, 4	
8	*Cyclonaias tuberculata*	Purple wartyback			1, 2, 4	1, 3, 4
9	*Ellipsaria lineolata*	Butterfly			1, 2, 4	1, 3, 4
10	*Elliptio dilatata*	Spike			1, 2, 4	1, 3, 4
11	*Fusconaia flava*	Wabash pigtoe			1, 2, 4	1, 3, 4
12	[A]*Fusconaia ozarkensis*	Ozark pigtoe			4	1, 4
13	*Lampsilis abrupta*	Pink mucket	G2	S2	1, 2, 4	
14	*Lampsilis cardium*	Plain pocketbook			1, 2, 4	1, 3, 4
15	*Lampsilis siliquoidea*	Fatmucket			1, 2, 4	1, 4
16	*Lampsilis teres*	Yellow sandshell			1, 2, 4	3, 4
17	*Lasmigona complanata*	White heelsplitter			1, 2, 4	1, 3, 4
18	*Lasmigona costata*	Fluted shell			1, 2, 4	1, 3, 4
19	*Lampsilis reeveiana brittsi*	Northern brokenray			1	1
20	*Leptodea fragilis*	Fragile papershell			1, 2, 4	1, 3, 4
21	*Ligumia recta*	Black sandshell	G5	S1S2	1, 2, 4	1, 3, 4
22	*Ligumia subrostrata*	Pondmussel			1, 4	4
23	*Megalonaias nervosa*	Washboard			1, 2, 4	1, 4
24	*Obliquaria reflexa*	Threehorn wartyback			1, 2, 4	1, 3, 4
25	*Pleurobema sintoxia*	Round pigtoe			1, 2, 4	1, 3, 4
26	*Potamilus alatus*	Pink heelsplitter			1, 2, 4	1, 3, 4
27	*Potamilus ohiensis*	Pink papershell			1, 4	1
28	[B]*Ptychobranchus occidentalis*	Ouachita kidneyshell	G3G4	S2S3	1	
29	*Pyganodon grandis*	Giant floater			1, 2, 4	1, 4
30	*Quadrula metanevra*	Monkeyface			1, 2, 4	1, 3, 4
31	*Quadrula pustulosa*	Pimpleback			1, 2, 4	1, 3, 4
32	*Quadrula quadrula*	Mapleleaf			1, 2, 4	1, 3, 4
33	*Simpsonaias ambigua*	Salamander mussel			4	
34	*Strophitus undulatus*	Squawfoot			1, 2, 4	1, 3, 4
35	*Toxolasma parvus*	Lilliput			1	4
36	*Tritogonia verrucosa*	Pistolgrip			1, 2, 4	1, 3, 4
37	*Truncilla donaciformis*	Fawnsfoot			1, 2	1, 3
38	*Truncilla truncata*	Deertoe			1, 2, 4	1, 3, 4
39	*Utterbackia imbecillis*	Paper pondshell			1	4
40	*Venustaconcha ellipsiformis*	Ellipse			1, 2, 4	1, 3, 4

[A] *Fusconaia ozarkensis* (Call, 1887) is defined solely by shell morphology and may or may not be a valid taxon.

[B]*Ptychobranchus occidentalis* reported by Oesch (1984) in northern drainages, including the Sac, are probably misidentifications (Ron Oesch, personal communication 2002)

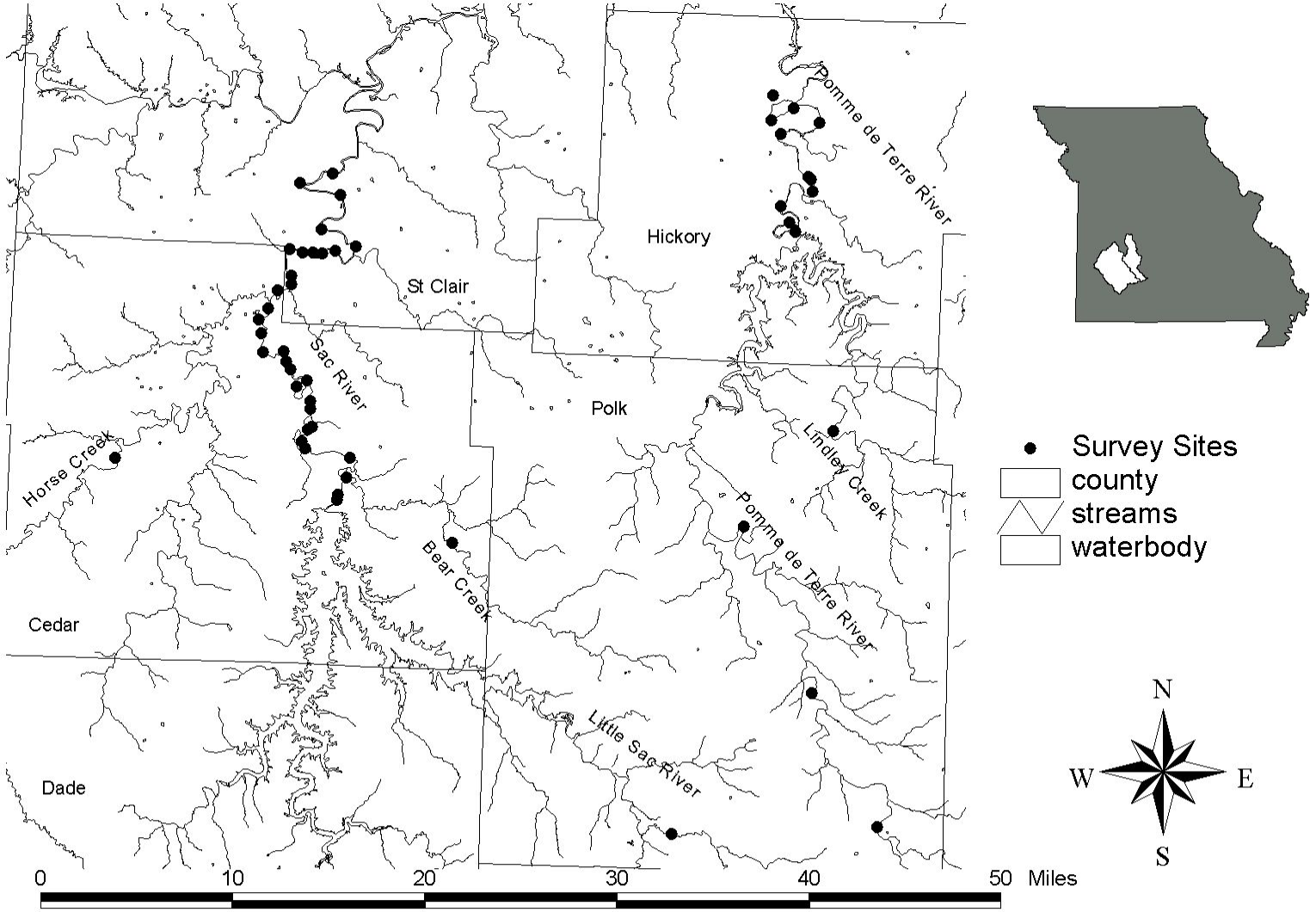

Figure 1. Distribution of 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

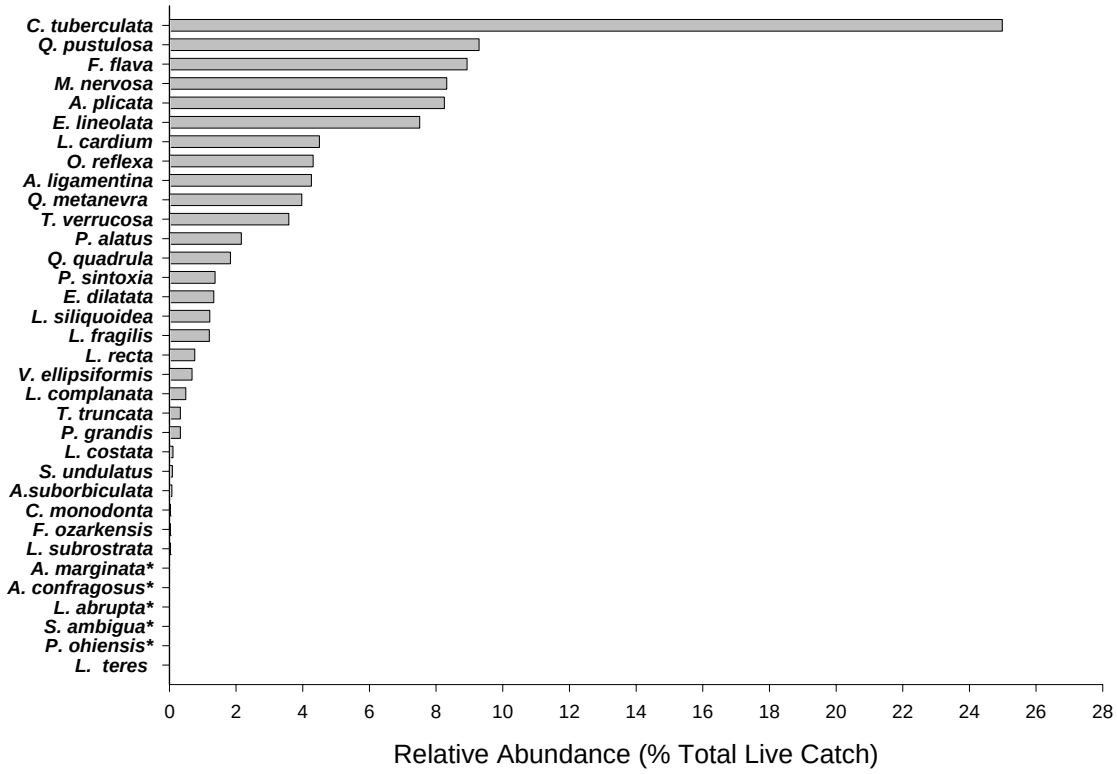

Figure 2. Relative abundance of species collected in the Sac River (see Table 2).

Table 2. Summary of sampling data for 34 unionid species collected in the Sac River system. Total sampling effort was 91.1 person hours at 35 sites. Total live catch was 9,124 individuals.

	Species	Number of Live Individuals	Relative abundance (percent of total live catch)	Number of sites with live or fresh-dead individuals	Percent of sites with live or fresh-dead individuals
1	*Cyclonaias tuberculata*	2280	24.99	25	71.4
2	*Quadrula pustulosa*	848	9.29	26	74.3
3	*Fusconaia flava*	815	8.93	19	54.3
4	*Megalonaias nervosa*	759	8.32	24	68.6
5	*Amblema plicata*	753	8.25	29	83.0
6	*Ellipsaria lineolata*	685	7.51	21	60.0
7	*Lampsilis cardium*	411	4.50	25	71.4
8	*Obliquaria reflexa*	393	4.31	25	71.4
9	*Actinonaias ligamentina*	389	4.26	21	60.0
10	*Quadrula metanevra*	362	3.97	21	60.0
11	*Tritogonia verrucosa*	327	3.58	21	60.0
12	*Potamilus alatus*	197	2.16	27	77.1
13	*Quadrula quadrula*	167	1.83	21	60.0
14	*Pleurobema sintoxia*	125	1.37	21	60.0
15	*Elliptio dilatata*	121	1.33	24	60.0
16	*Lampsilis siliquoidea*	111	1.21	8	22.9
17	*Leptodea fragilis*	109	1.20	23	65.7
18	*Ligumia recta*	69	0.76	15	42.9
19	*Venustaconcha ellipsiformis*	62	0.68	4	11.4
20	*Lasmigona complanata*	45	0.49	18	51.4
21	*Truncilla truncata*	30	0.33	6	17.1
22	*Pyganodon grandis*	30	0.33	1	2.9
23	*Lasmigona costata*	10	0.11	8	22.9
24	*Strophitus undulatus*	8	0.09	2	5.7
25	*Anodonta suborbiculata*	6	0.07	1	2.9
26	*Cumberlandia monodonta*	3	0.03	2	5.7
27	*Fusconaia ozarkensis*	2	0.03	2	5.7
28	*Ligumia subrostrata*	3	0.03	2	5.7
29	*Alasmidonta marginata*	1	0.01	1	2.9
30	*Arcidens confragosus*	1	0.01	1	2.9
31	*Lampsilis abrupta*	1	0.01	1	2.9
32	*Simpsonaias ambigua*	1	0.01	1	2.9
33	*Potamilus ohiensis*	0	0.01	1	2.9
34	*Lampsilis teres*	0	0.00	0	0

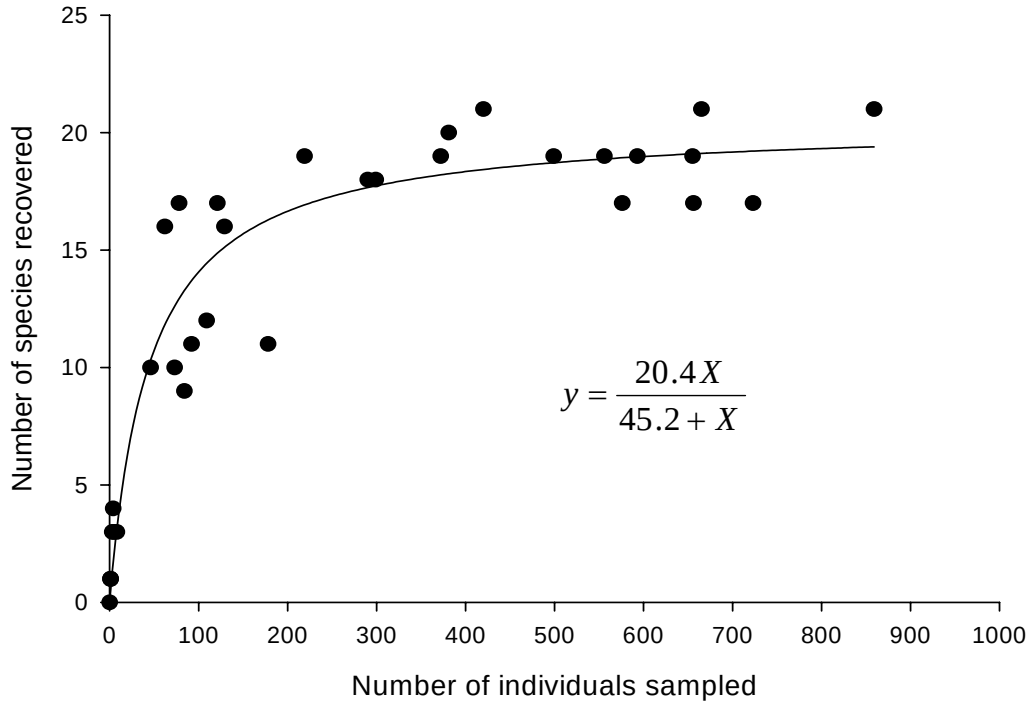

Figure 3. Number of species recovered versus sample size at sites in the Sac River system. Hyperbolic regression: $p<0.001$, $R^2 = 0.90$.

Table 3. Sub-fossil species collected from eroding cut banks in the Sac River.

Scientific Name	Common Name
Actinonaias ligamentina	mucket
Alasmidonta marginata	elktoe
Amblema plicata	threeridge
Ellipsaria lineolata	butterfly
Elliptio dilatata	spike
Fusconaia flava	Wabash pigtoe
Lampsilis cardium	plain pocketbook
Lampsilis siliquoidea	fatmucket
Lasmigona complanata	white heelsplitter
Lasmigona costata	fluted shell
Ligumia recta	black sandshell
Pleurobema sintoxia	round pigtoe
Quadrula metanevra	monkeyface
Quadrula pustulosa	pimpleback
Tritogonia verrucosa	pistolgrip
Truncilla truncata	deertoe

Table 4. Summary of sampling data for 32 unionid species collected in the Pomme de Terre River. Total sampling effort was 48 person hours at 15 sites. Total live catch was 3,269 individuals.

	Species	Number of Live Individuals	Relative abundance (percent of total live catch)	Number of sites with live or fresh-dead individuals	Percent of sites with live or fresh-dead individuals
1	*Amblema plicata*	1404	42.95	14	93.3
2	*Lampsilis cardium*	339	10.37	14	93.3
3	*Cyclonaias tuberculata*	225	6.88	9	60.0
4	*Venustaconcha ellipsiformis*	193	5.90	9	60.0
5	*Quadrula pustulosa*	193	5.90	11	73.3
6	*Truncilla truncata*	129	3.95	12	80.0
7	*Elliptio dilatata*	124	3.79	8	53.3
8	*Tritogonia verrucosa*	108	3.30	12	80.0
9	*Potamilus alatus*	76	2.32	14	93.3
10	*Megalonaias nervosa*	68	2.08	9	60.0
11	*Leptodea fragilis*	67	2.05	12	80.0
12	*Obliquaria reflexa*	63	1.93	12	80.0
13	*Lampsilis siliquoidea*	51	1.56	9	60.0
14	*Ligumia recta*	48	1.47	11	73.3
15	*Pleurobema sintoxia*	46	1.41	10	66.7
16	*Fusconaia flava*	31	0.95	8	53.3
17	*Lasmigona complanata*	25	0.76	7	46.7
18	*Quadrula metanevra*	18	0.55	4	26.7
19	*Actinonaias ligamentina*	12	0.37	5	33.3
20	*Utterbackia imbecillis*	7	0.21	1	6.7
21	*Fusconaia ozarkensis*	7	0.21	4	26.7
22	*Quadrula quadrula*	6	0.18	2	13.3
23	*Alasmidonta marginata*	5	0.15	3	20.0
24	*Anodonta suborbiculata*	5	0.15	1	6.7
25	*Lasmigona costata*	5	0.15	2	13.3
26	*Ellipsaria lineolata*	5	0.15	4	26.7
27	*Strophitus undulatus*	3	0.09	2	13.3
28	*Arcidens confragosus*	2	0.06	1	6.7
29	*Pyganodon grandis*	2	0.06	2	13.3
30	*Lampsilis teres*	1	0.03	1	6.7
31	*Toxolasma parvus*	1	0.03	1	6.7
32	*Ligumia subrostrata*	0	0.00	0	0

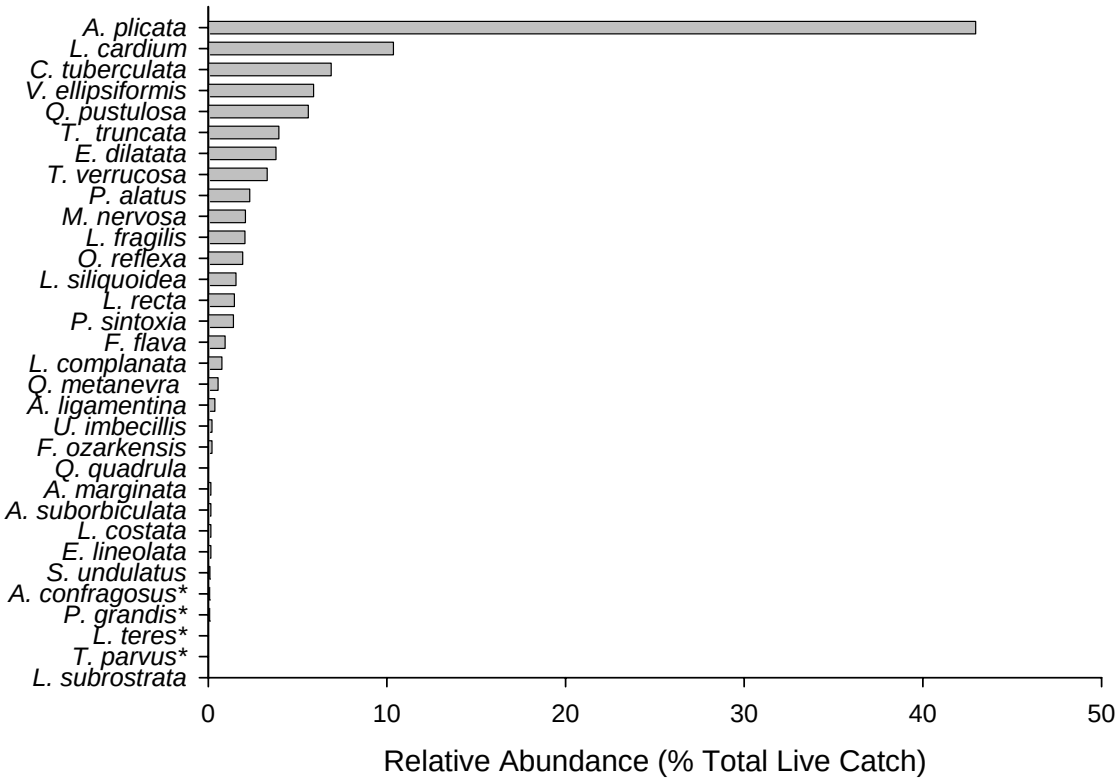

Figure 4. Relative abundance of species collected in the Pomme de Terre River (see Table 4).

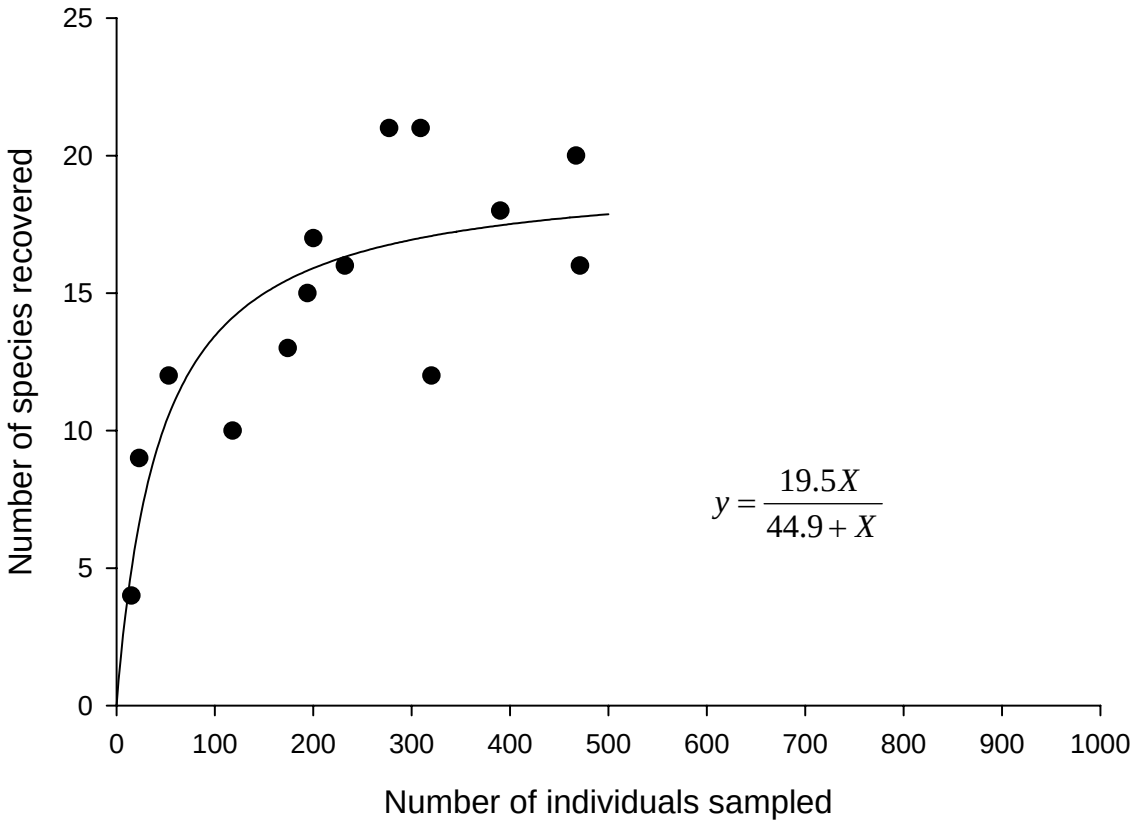

Figure 5. . Number of species recovered versus sample size at sites in the Pomme de Terre River. Hyperbolic regression: $p<0.001$, $R^2 = 0.675$.

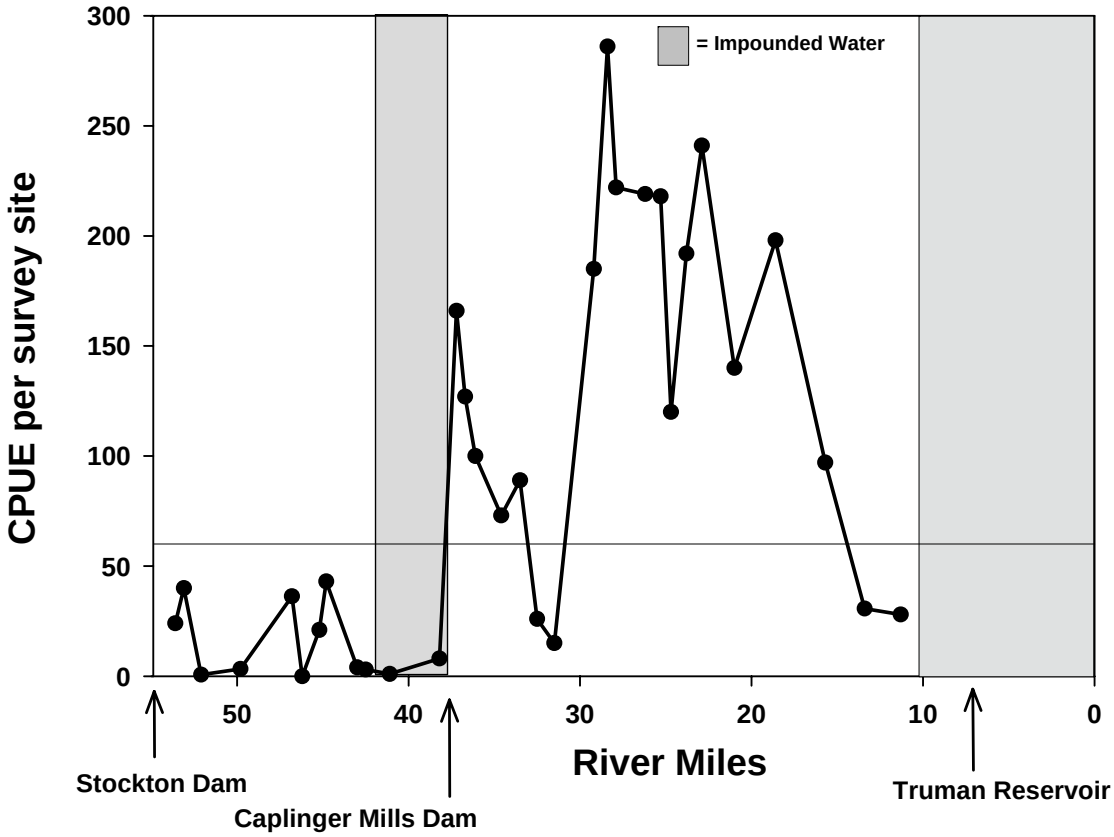

Figure 6. Longitudinal distribution of catch per unit effort (CPUE) at survey sites in the Sac River system.

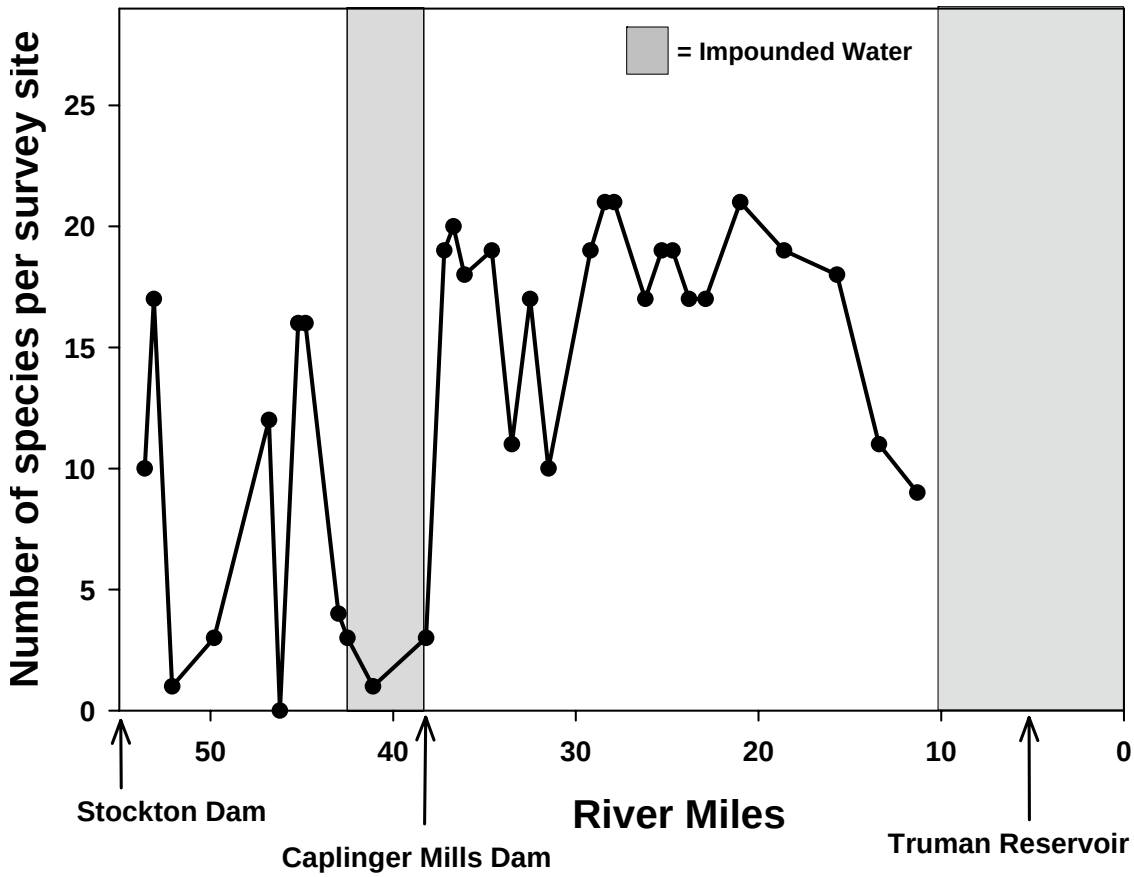

Figure 7. Longitudinal distribution of species counts at survey sites in the Sac River system

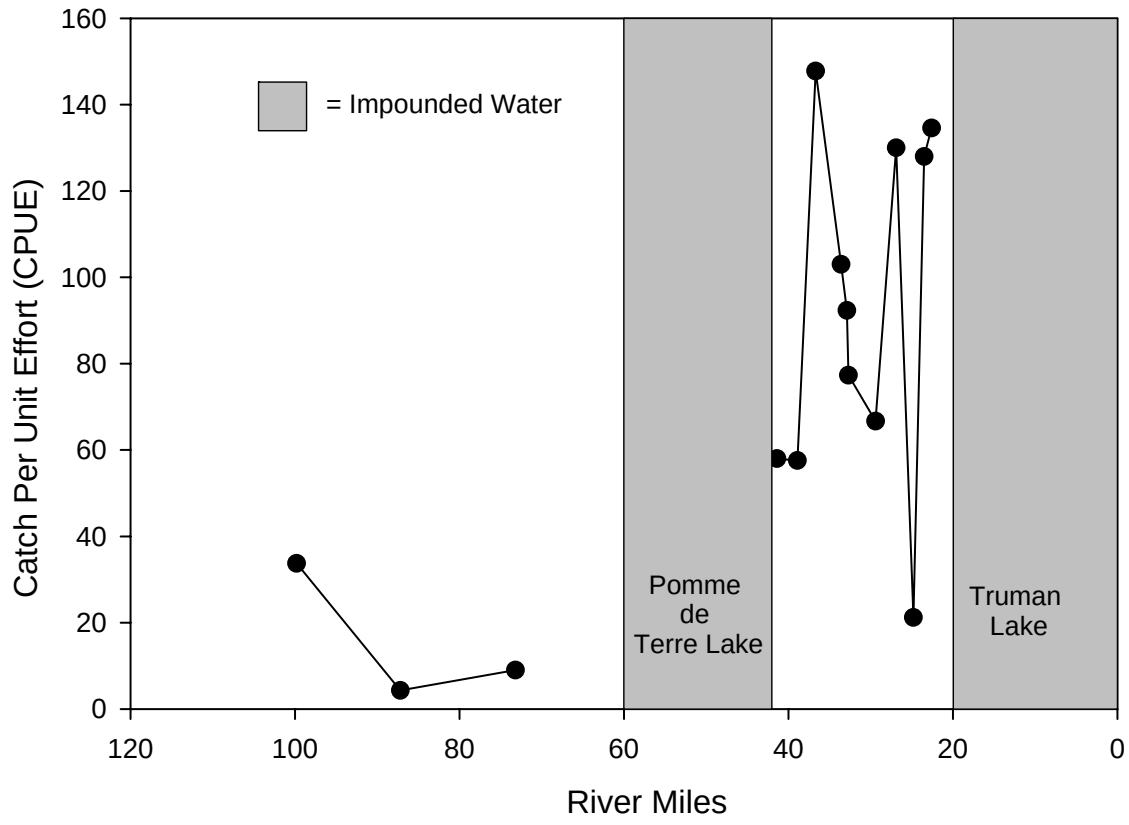

Figure 8. Longitudinal distribution of catch per unit effort (CPUE) at survey sites in the Pomme de Terre River.

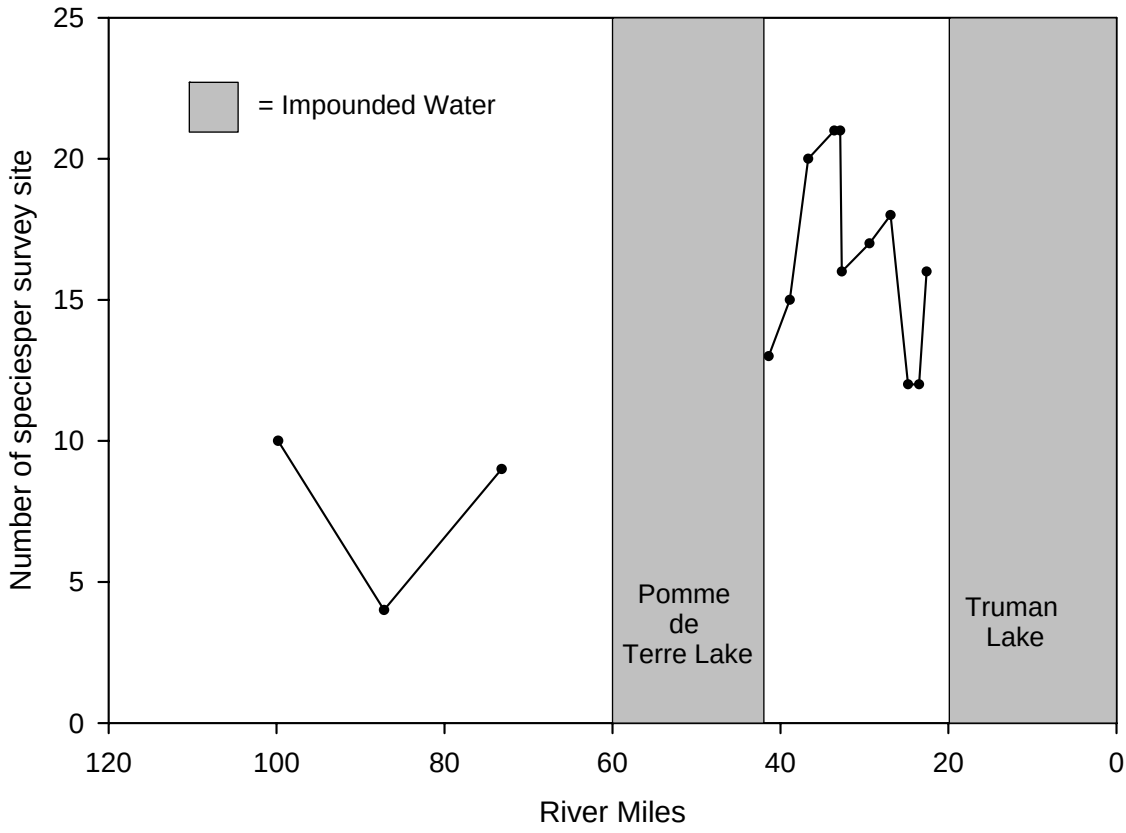

Figure 9. Longitudinal distribution of species counts at survey sites in the Pomme de Terre River.

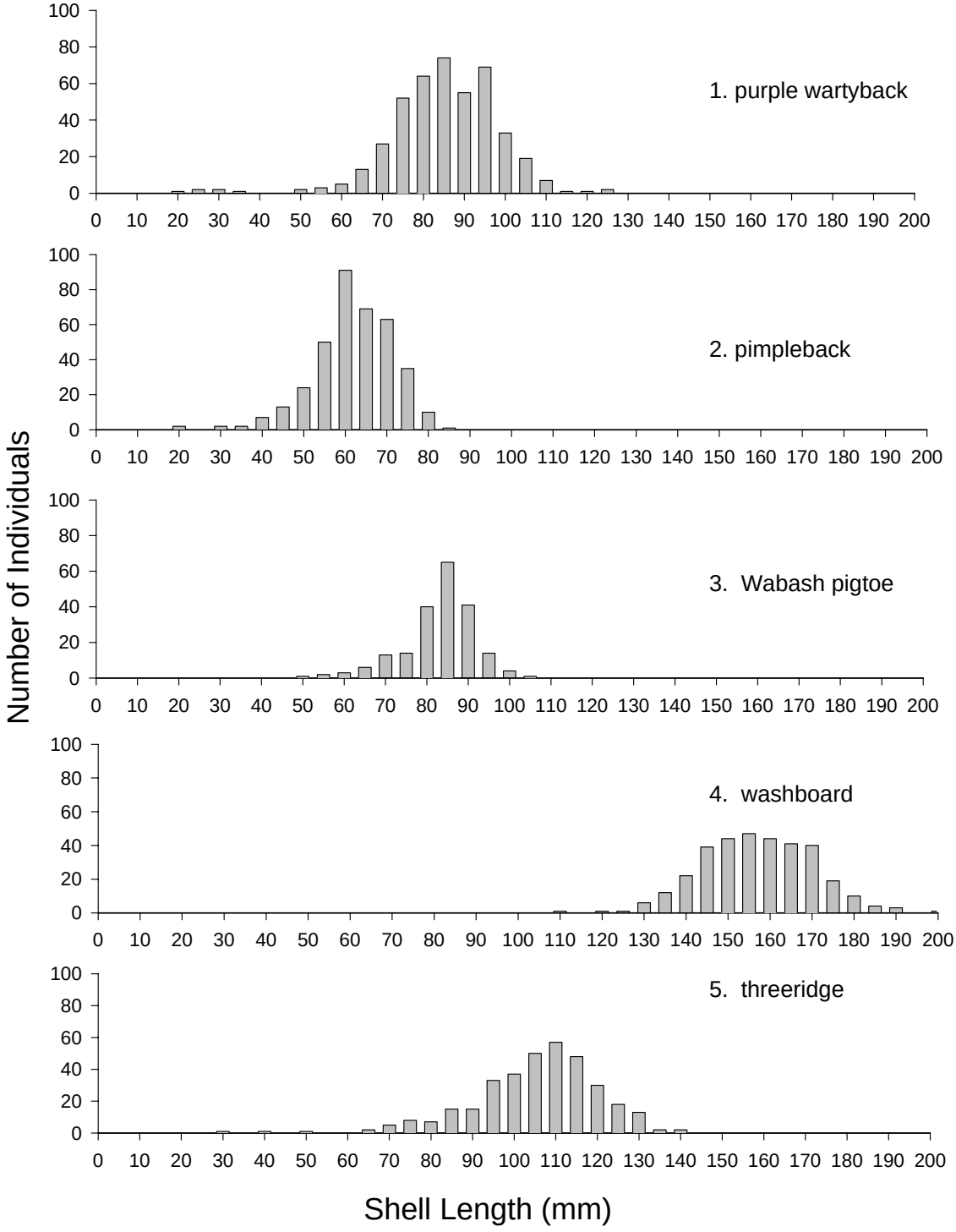

Figure 10. Length frequencies of the 10 most abundant species in the Sac River system.

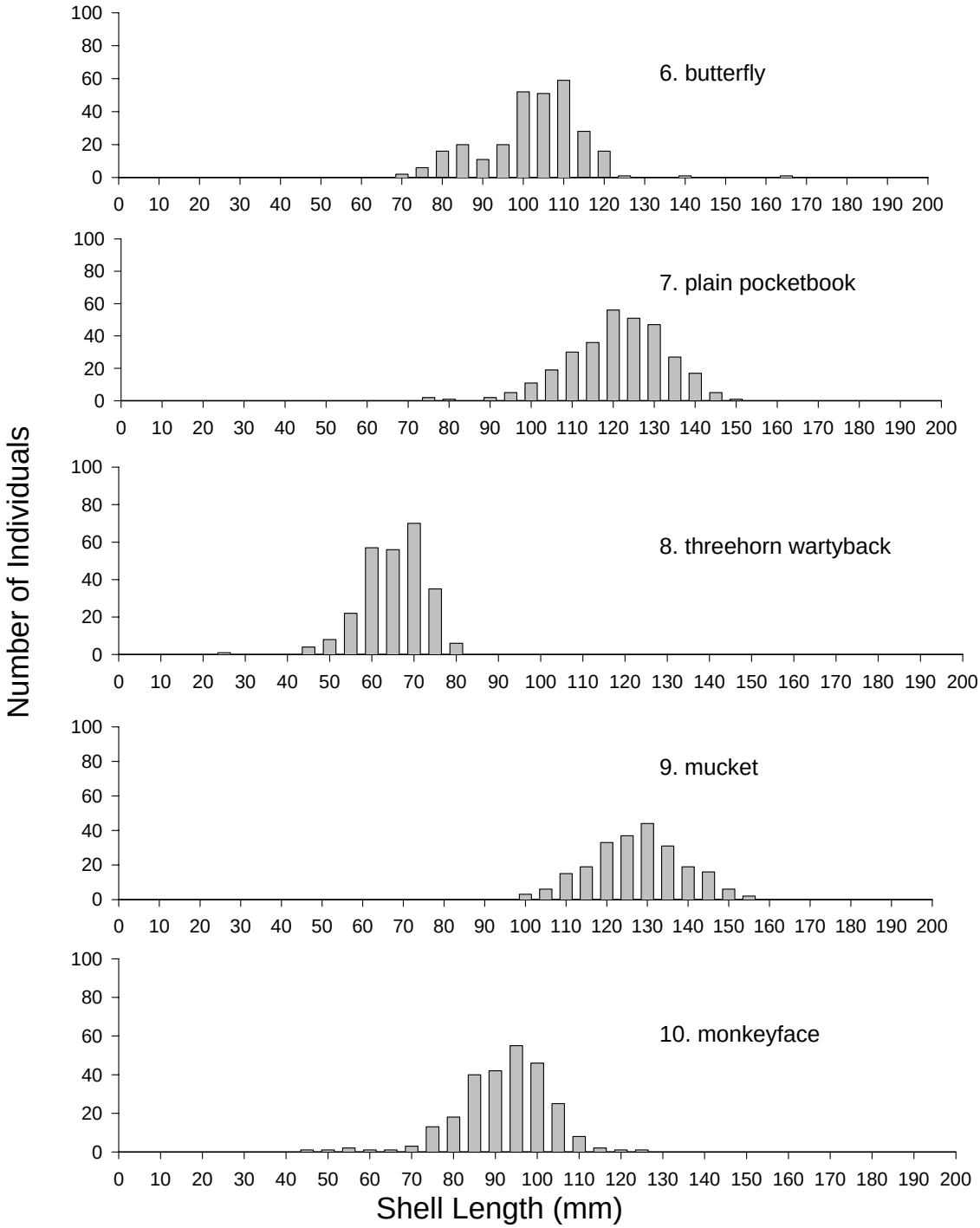

Figure 10, continued.

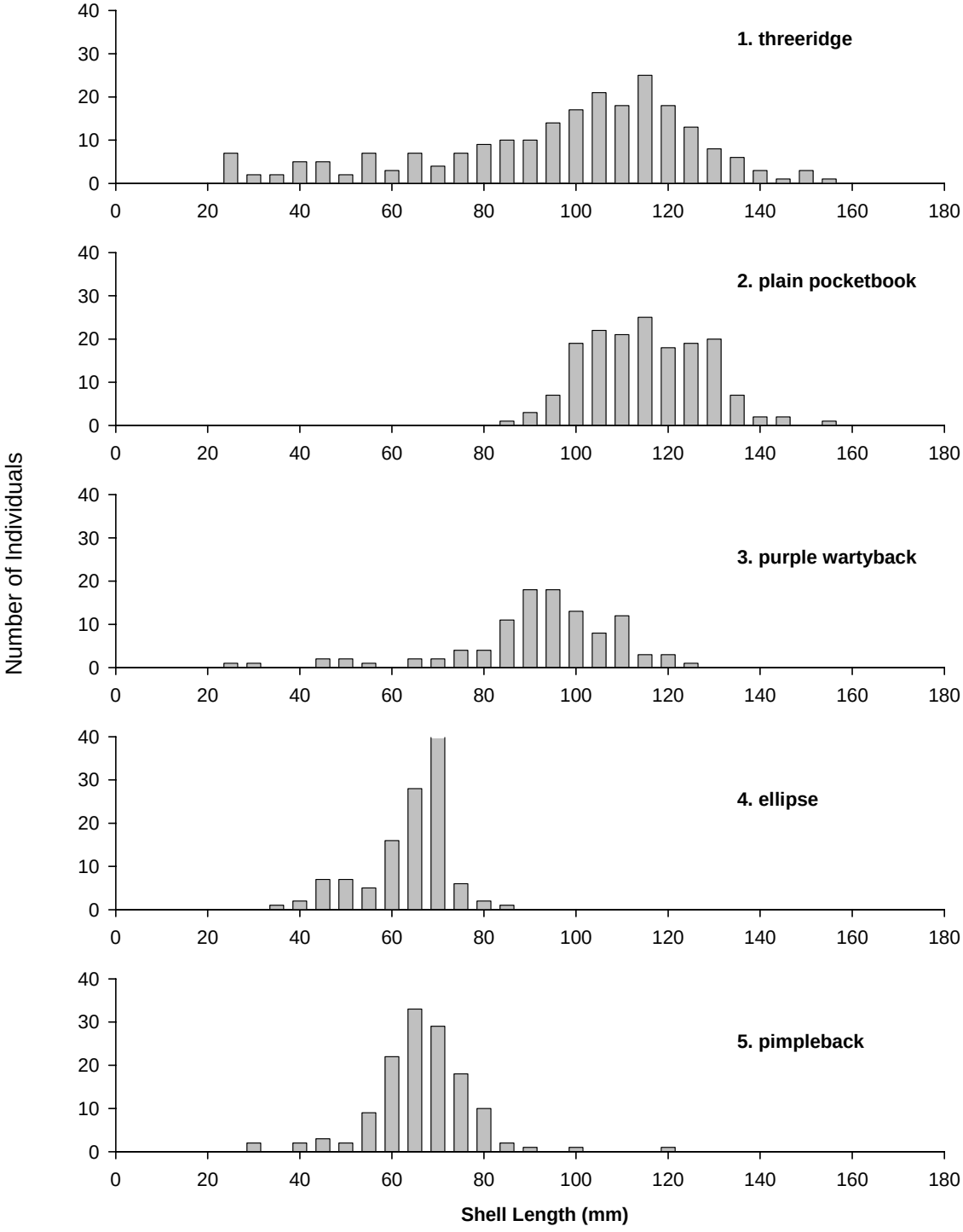

Figure 11. Length frequencies of the 10 most abundant species in the Pomme de Terre River, Missouri, 2001-2002

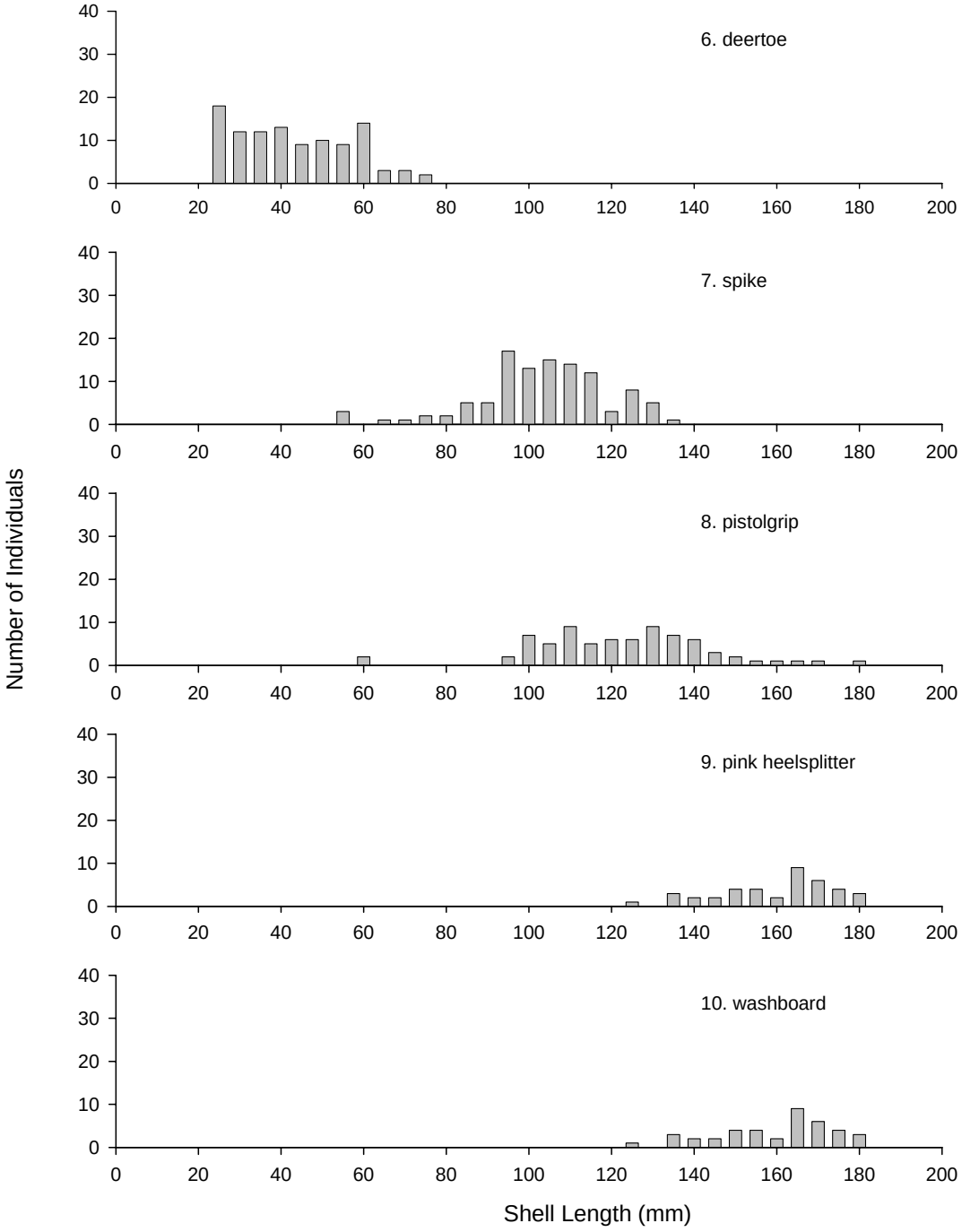

Figure 11, continued.

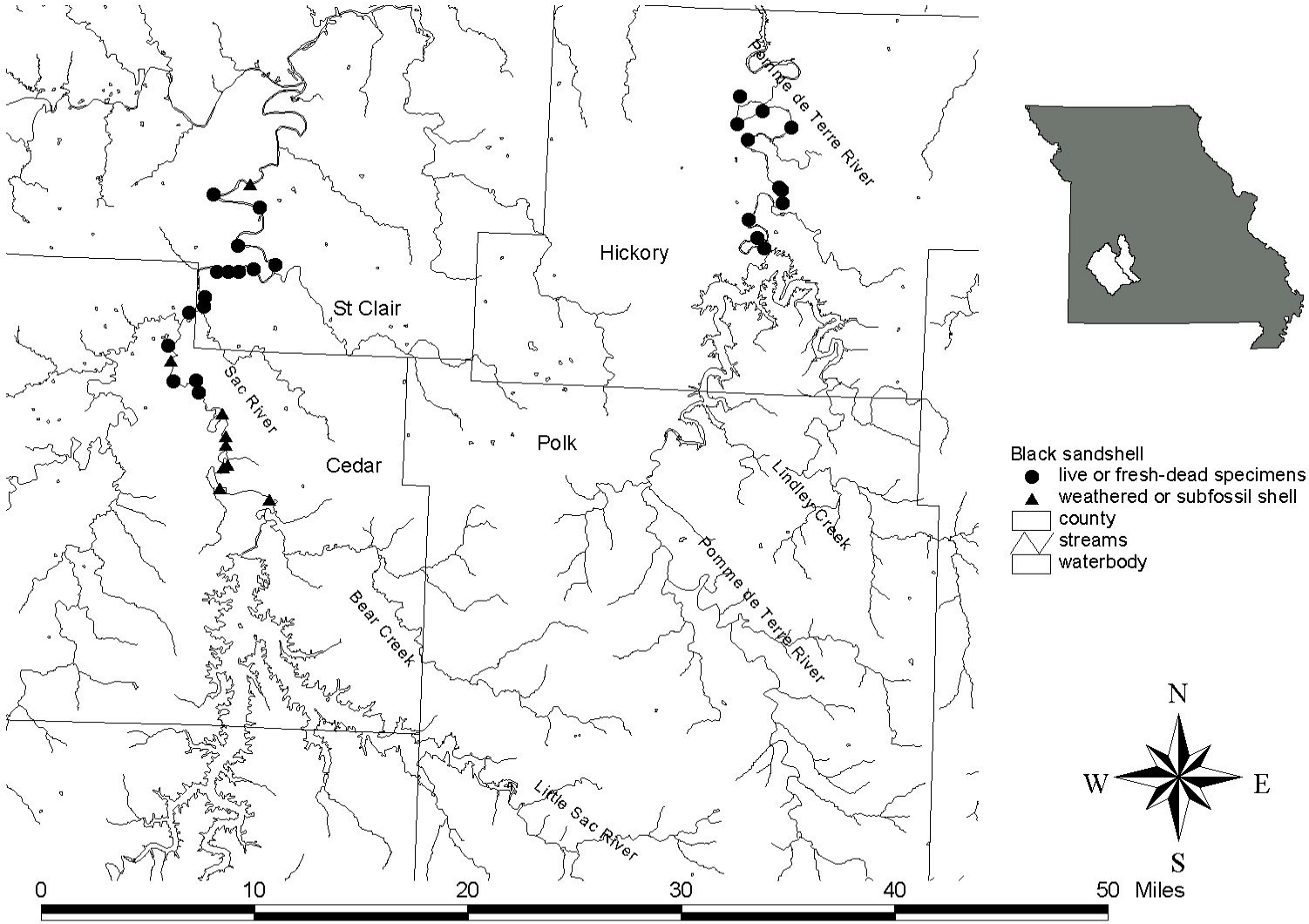

Figure 13. Distribution of the black sandshell at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

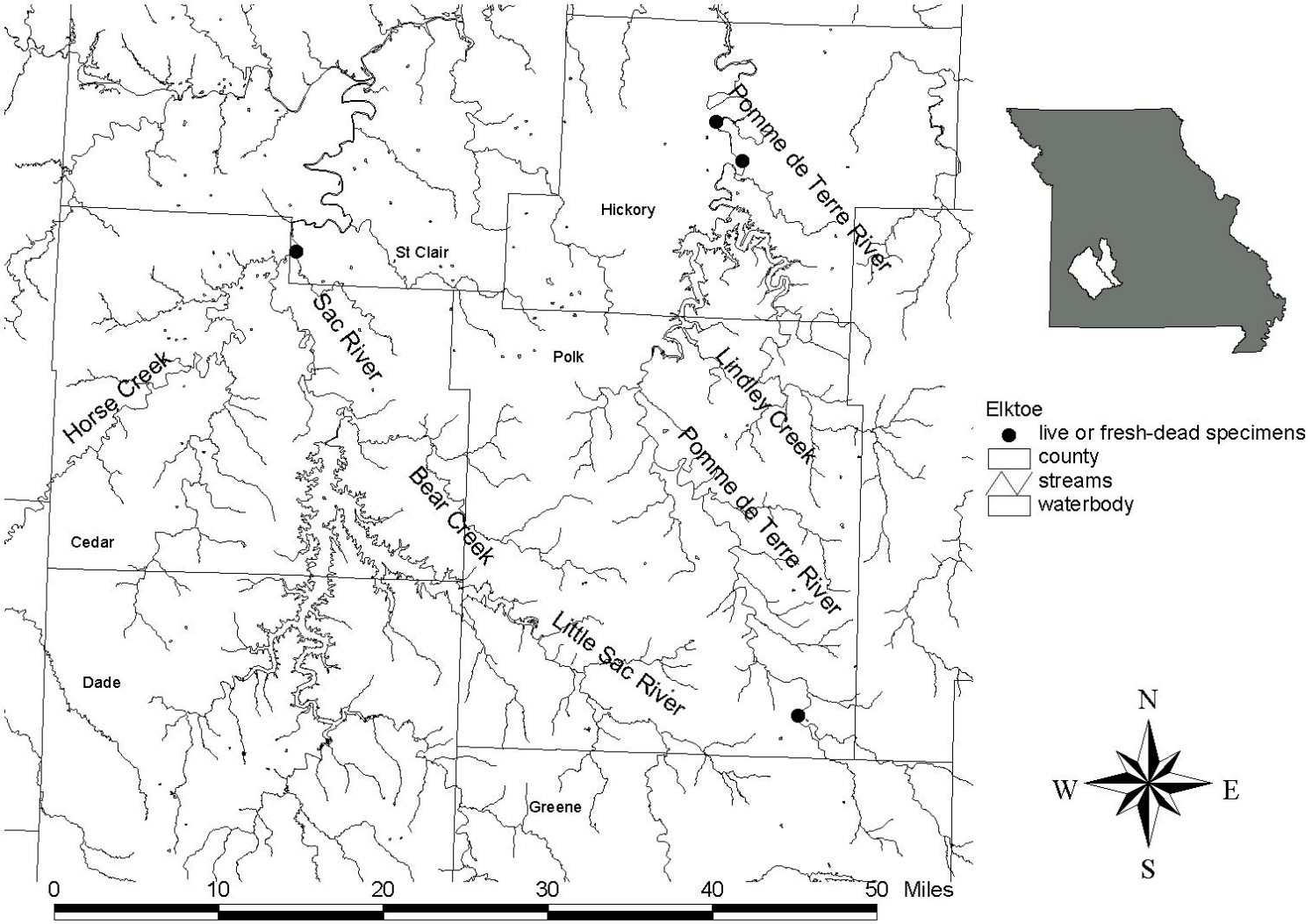

Figure 14. Distribution of the elktoe at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

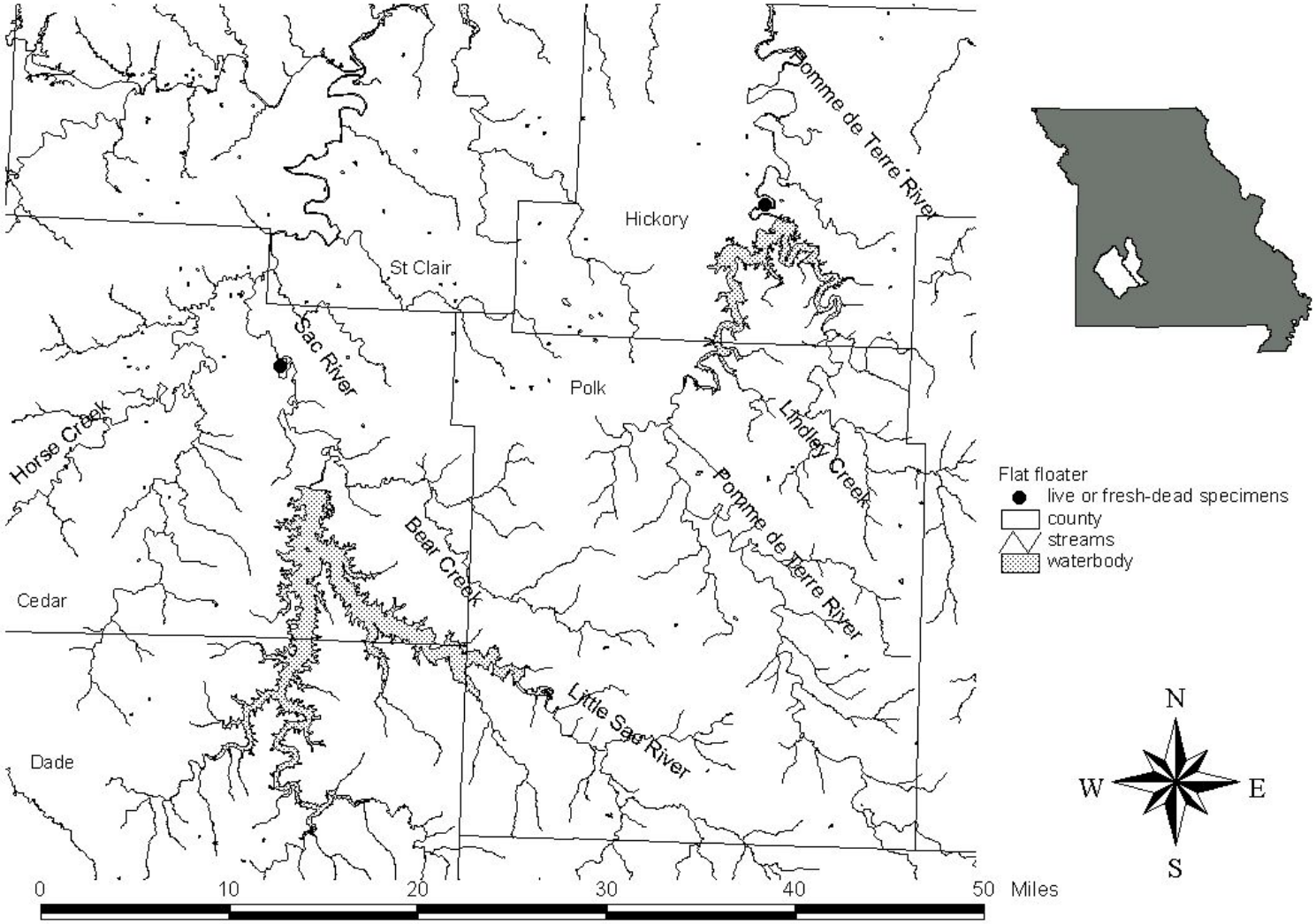

Figure 15. Distribution of the flat floater at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

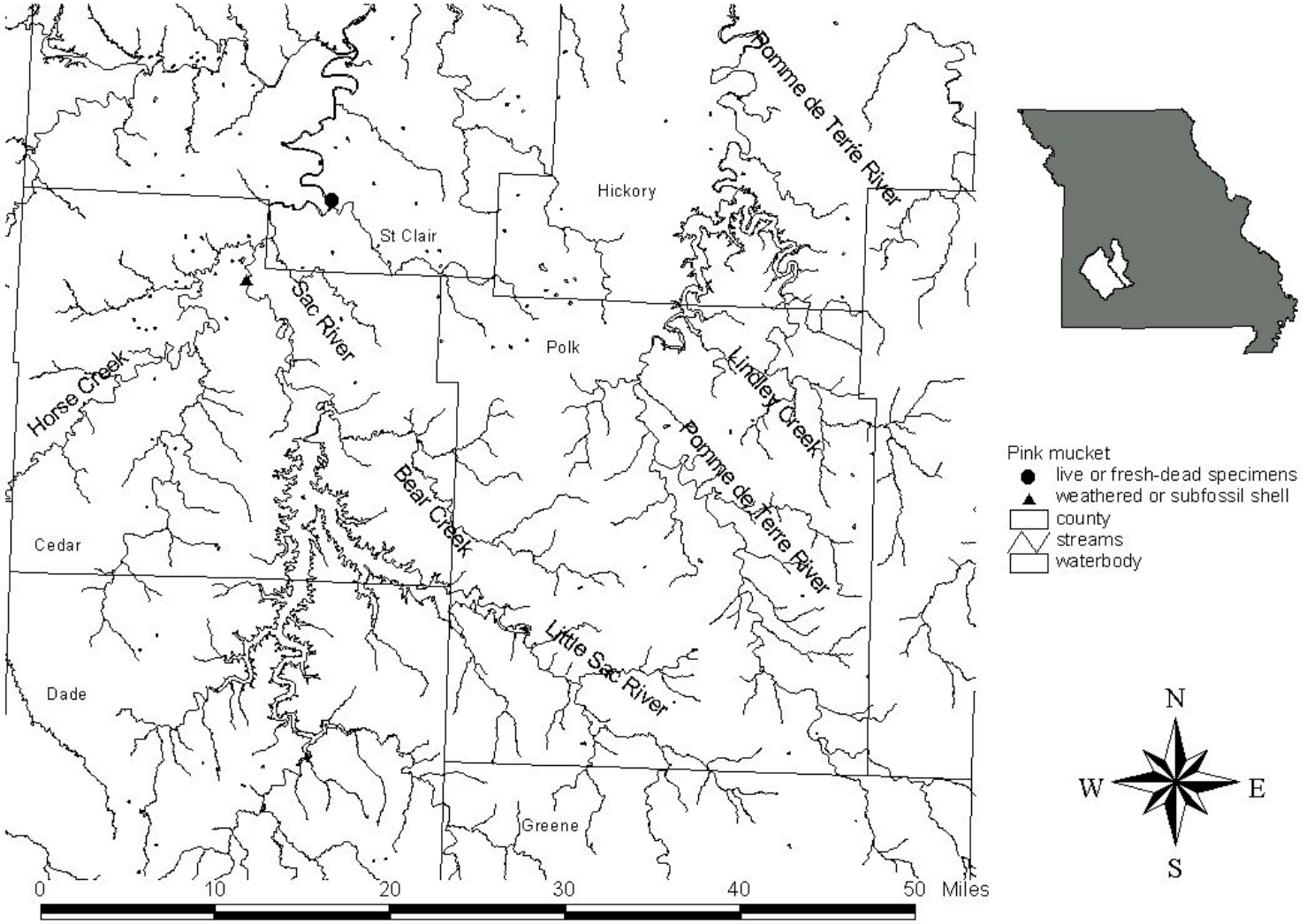

Figure 12 Distribution of the pink mucket at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

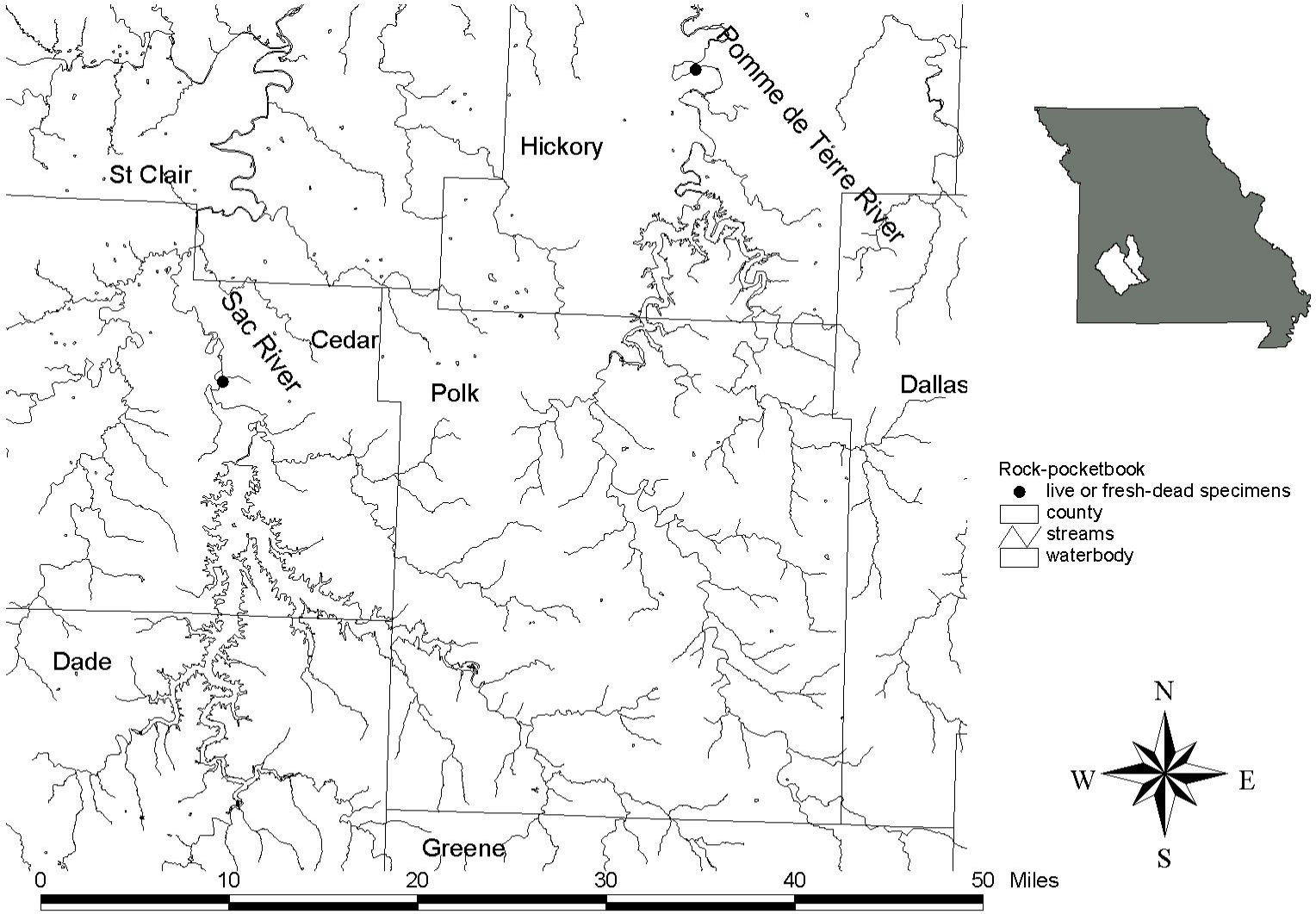

Figure 16. Distribution of the rock-pocketbook at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

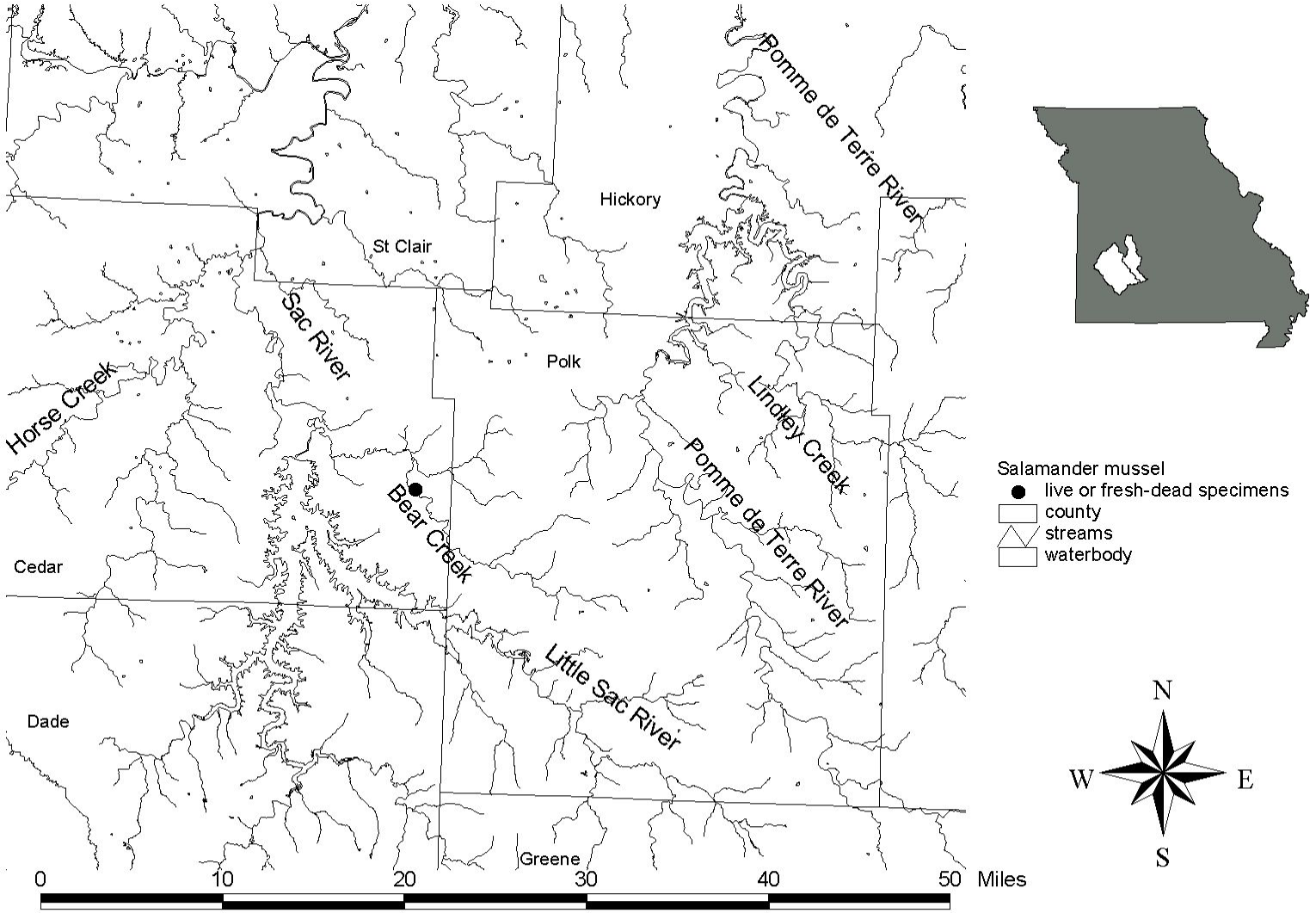

Figure 17. Distribution of the salamander mussel at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

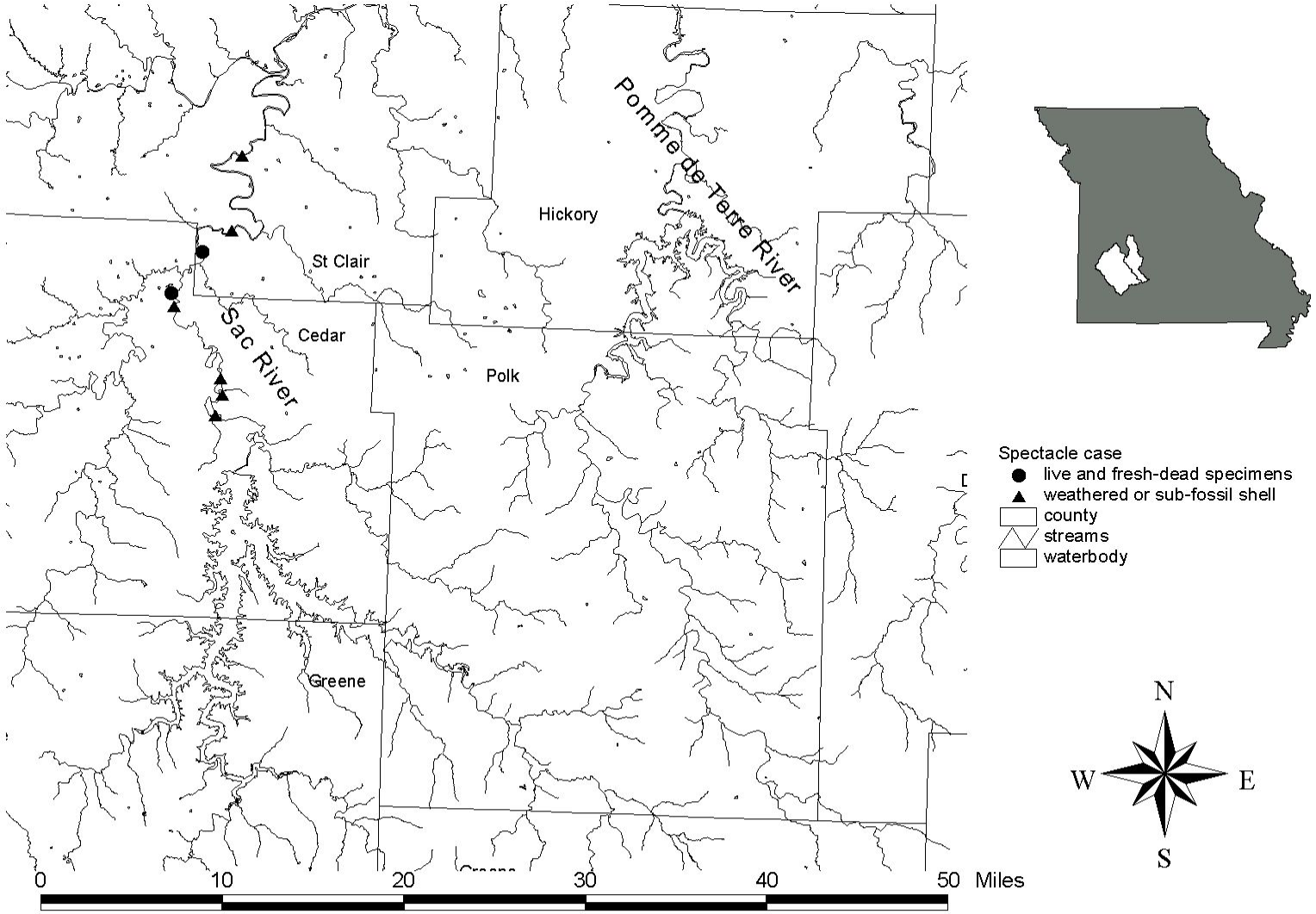

Figure 18. Distribution of the spectacle case at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

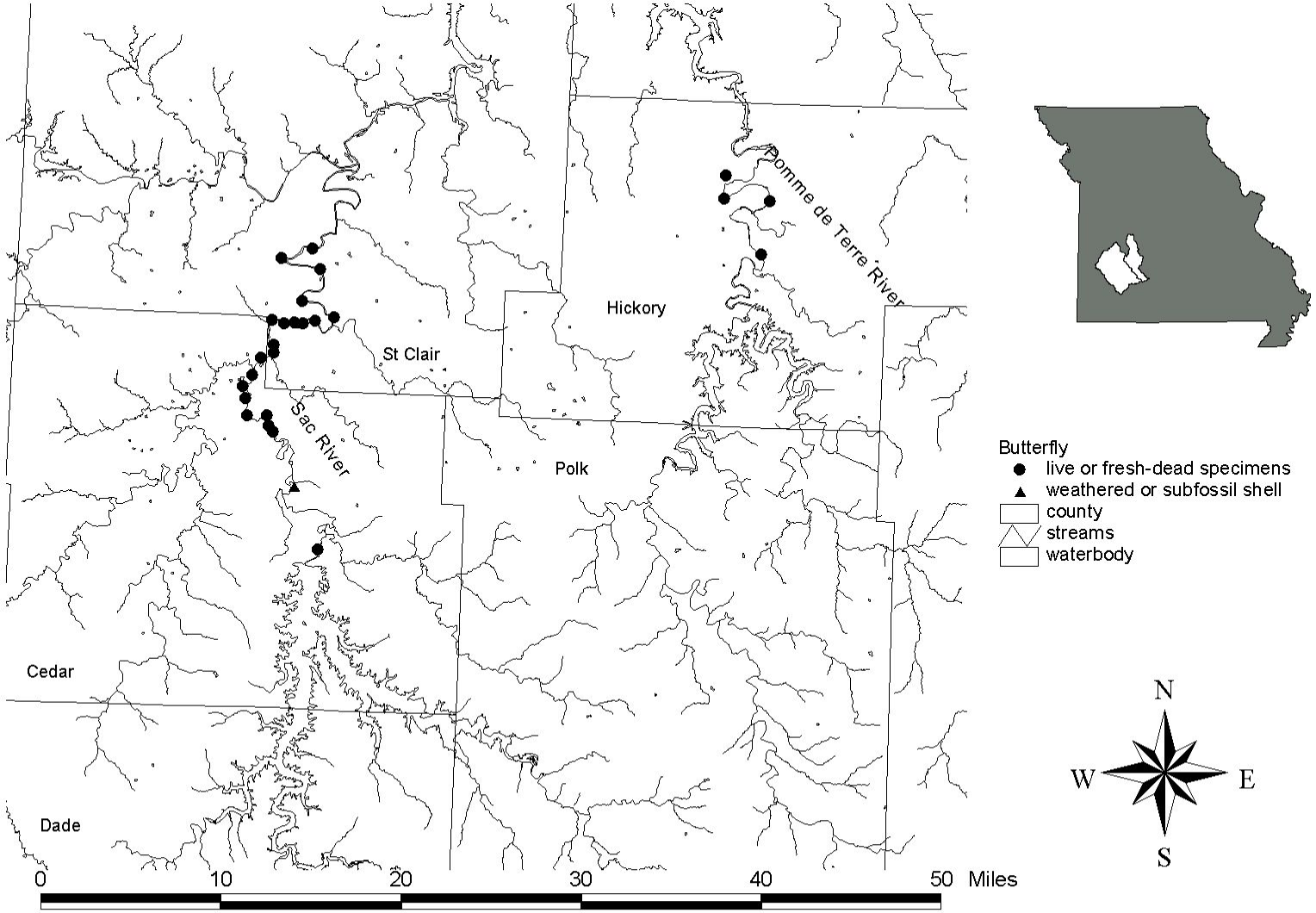

Figure 19. Distribution of the butterfly at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

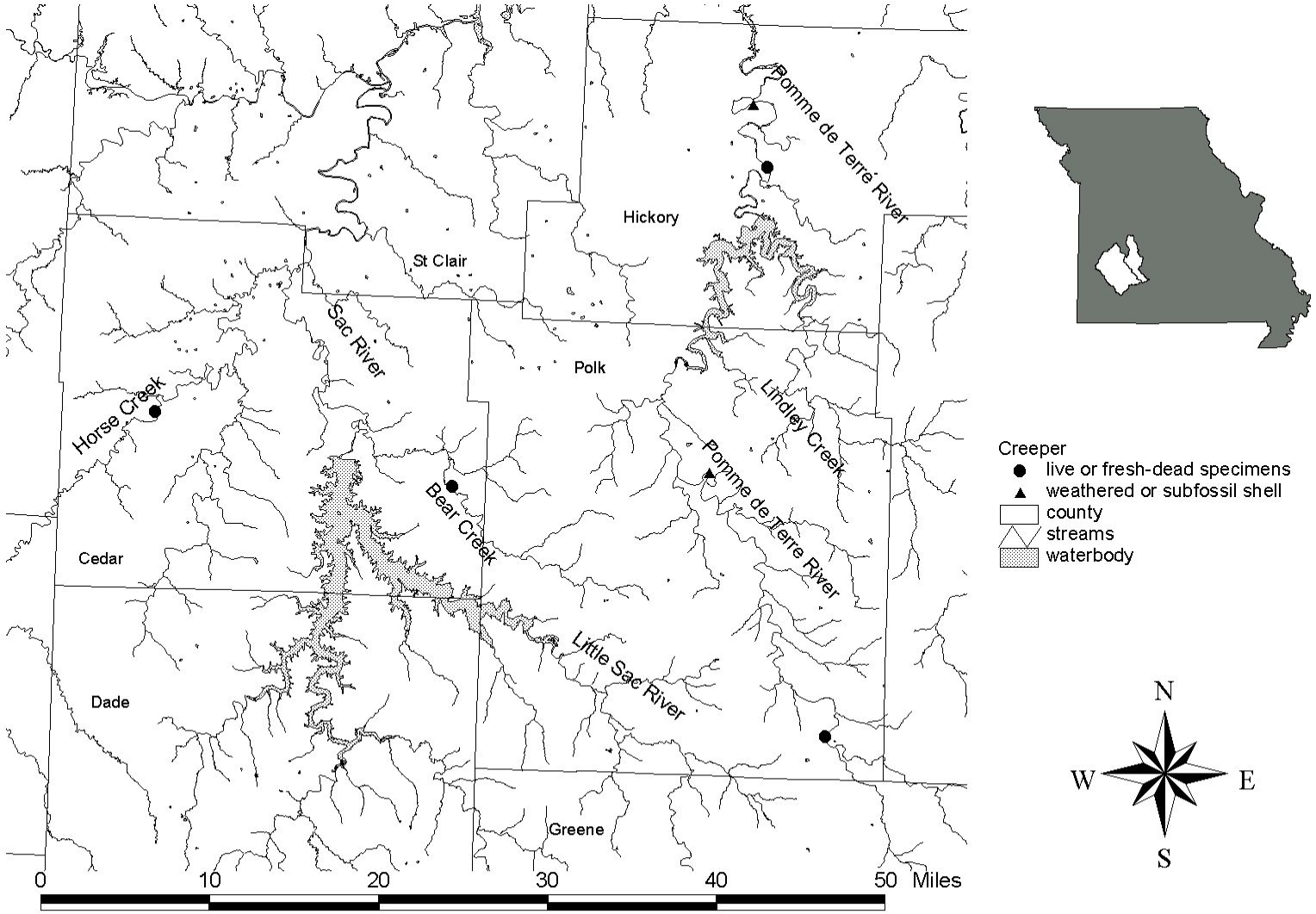

Figure 20. Distribution of the creeper at 50 survey sites in the Sac and Pomme de Terre River Basin Missouri, 2001-2002.

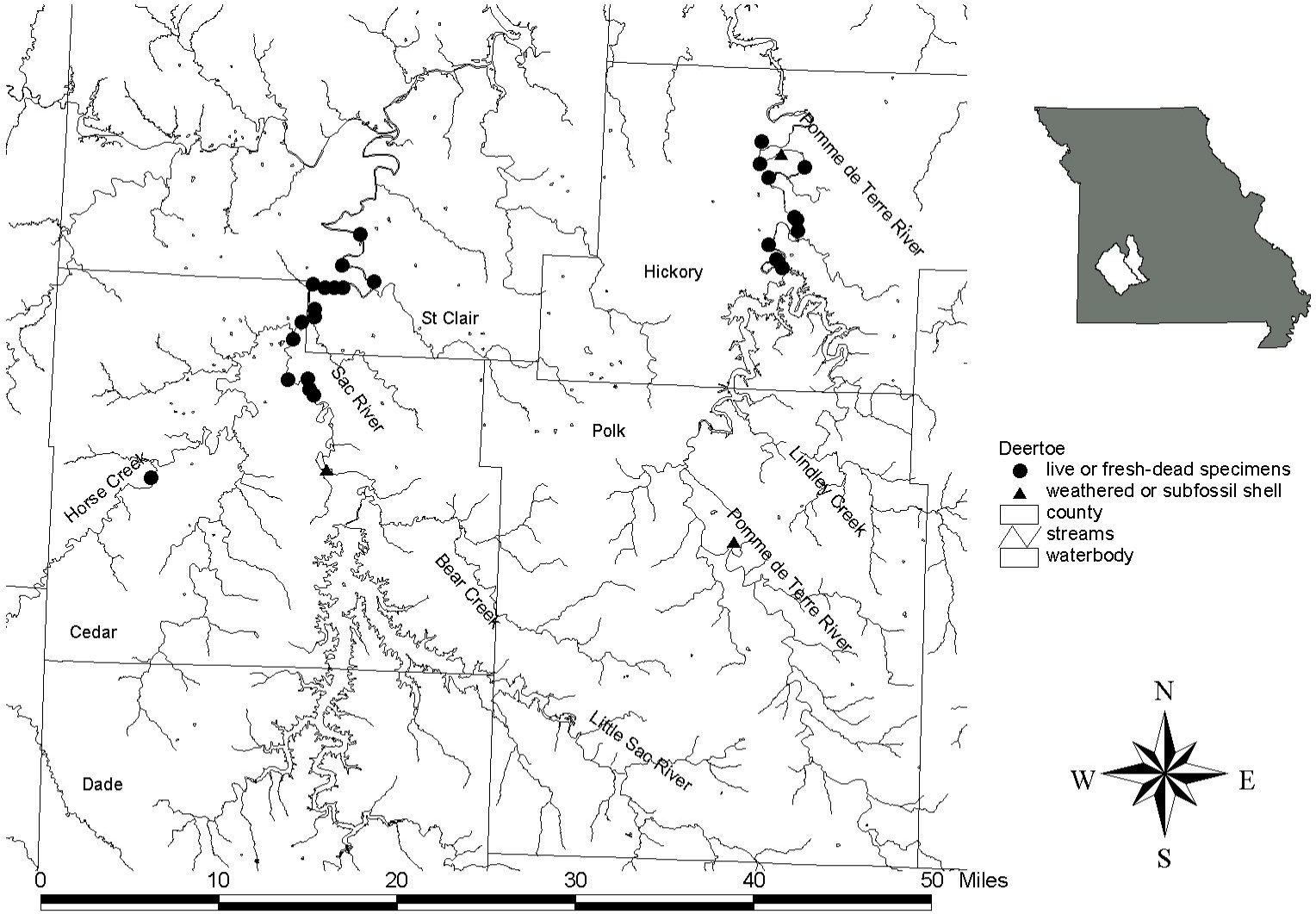

Figure 21. Distribution of the deertoe at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

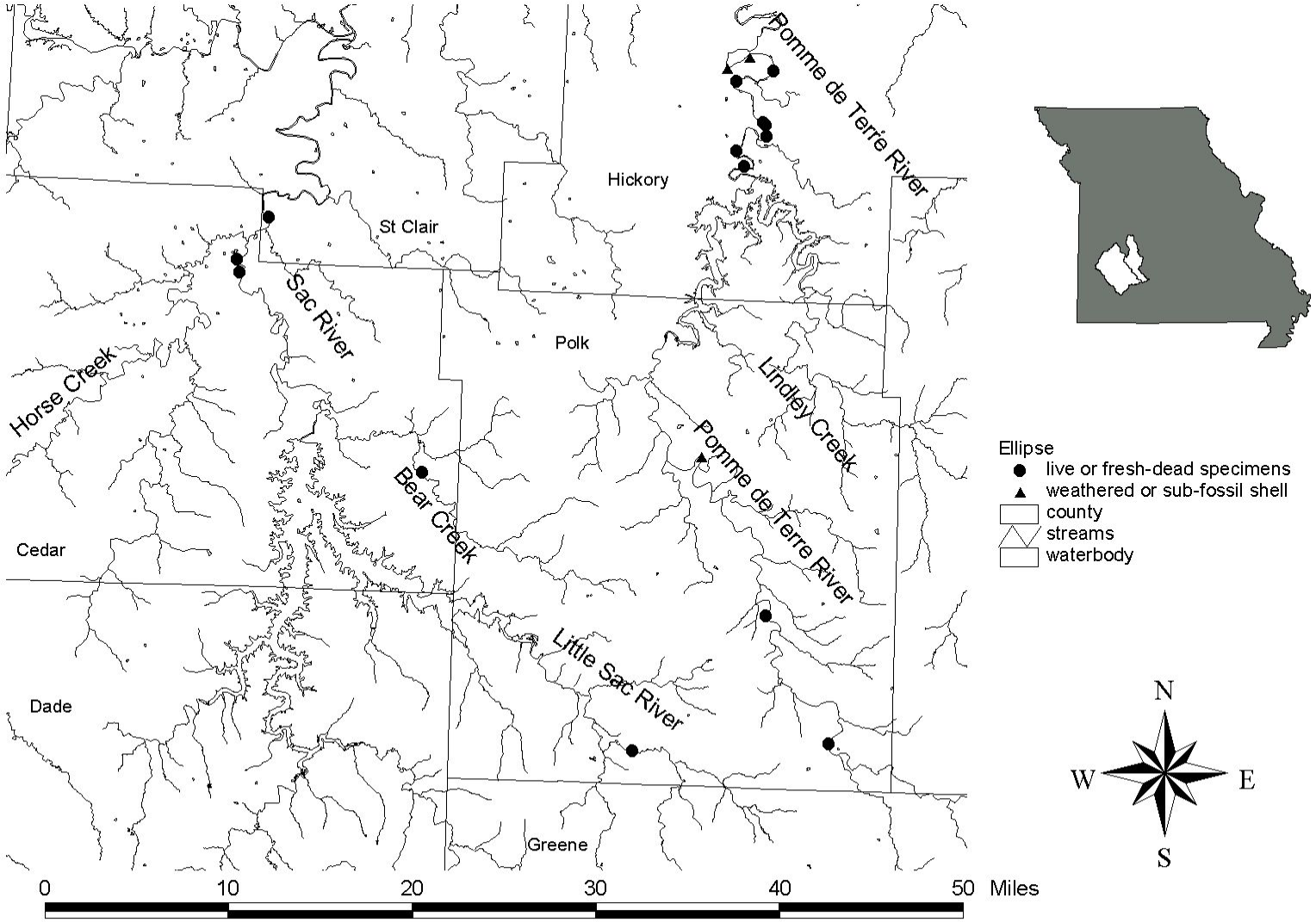

Figure 22. Distribution of the ellipse at 50 survey sites in the Sac and Pomme de Terre River Basins Missouri, 2001-2002.

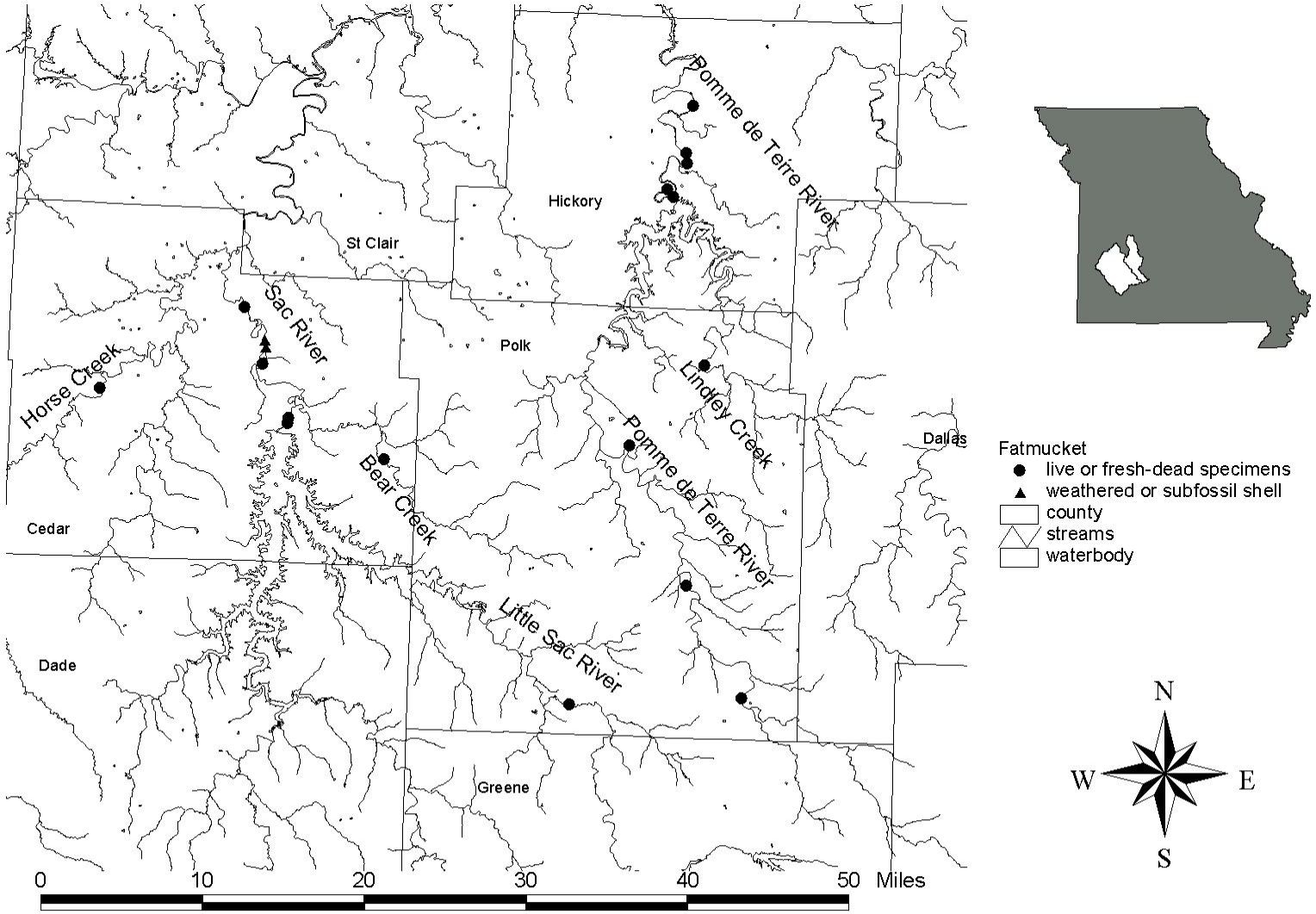

Figure 23. Distribution of the fatmucket at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

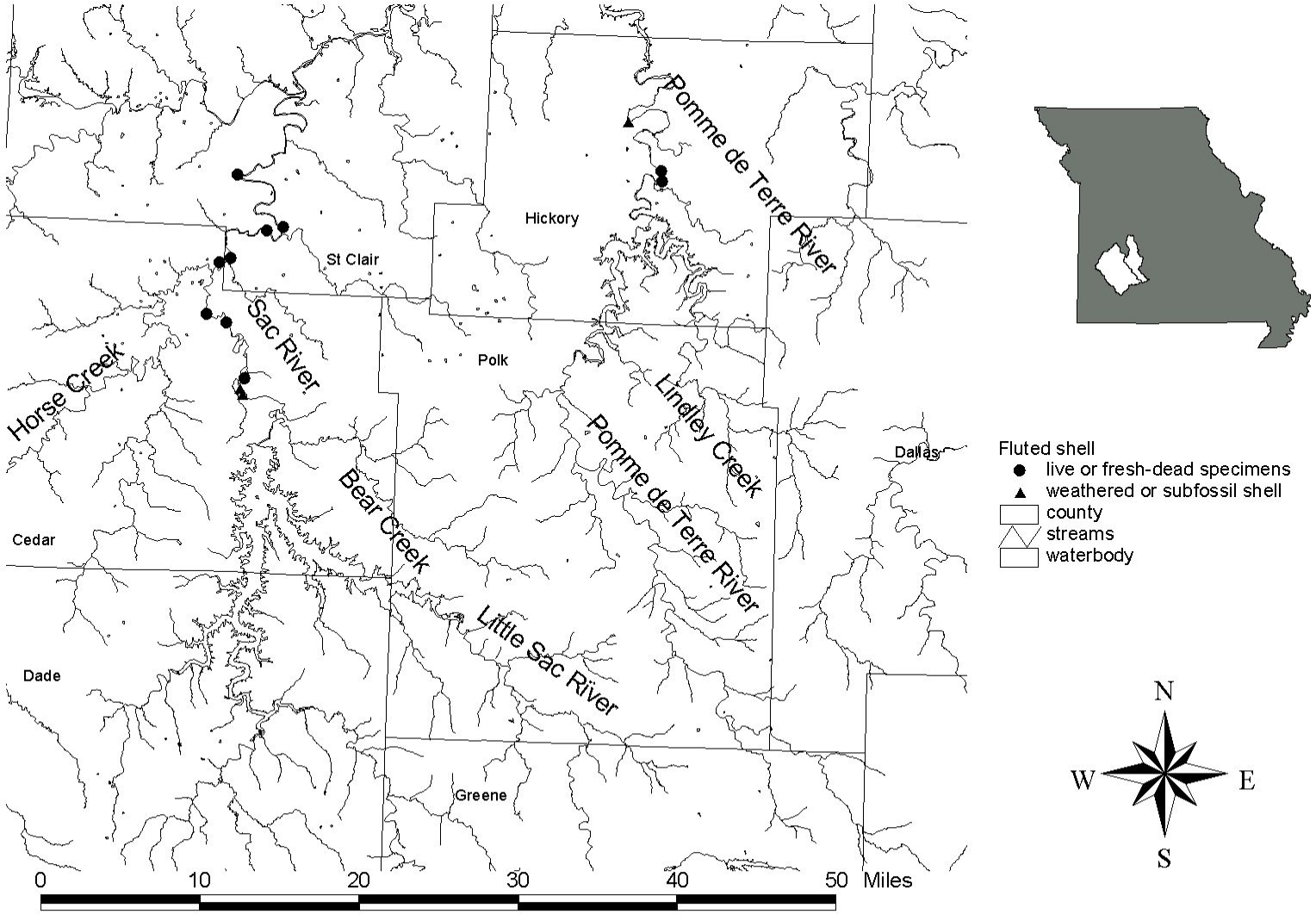

Figure 24. Distribution of the fluted shell at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

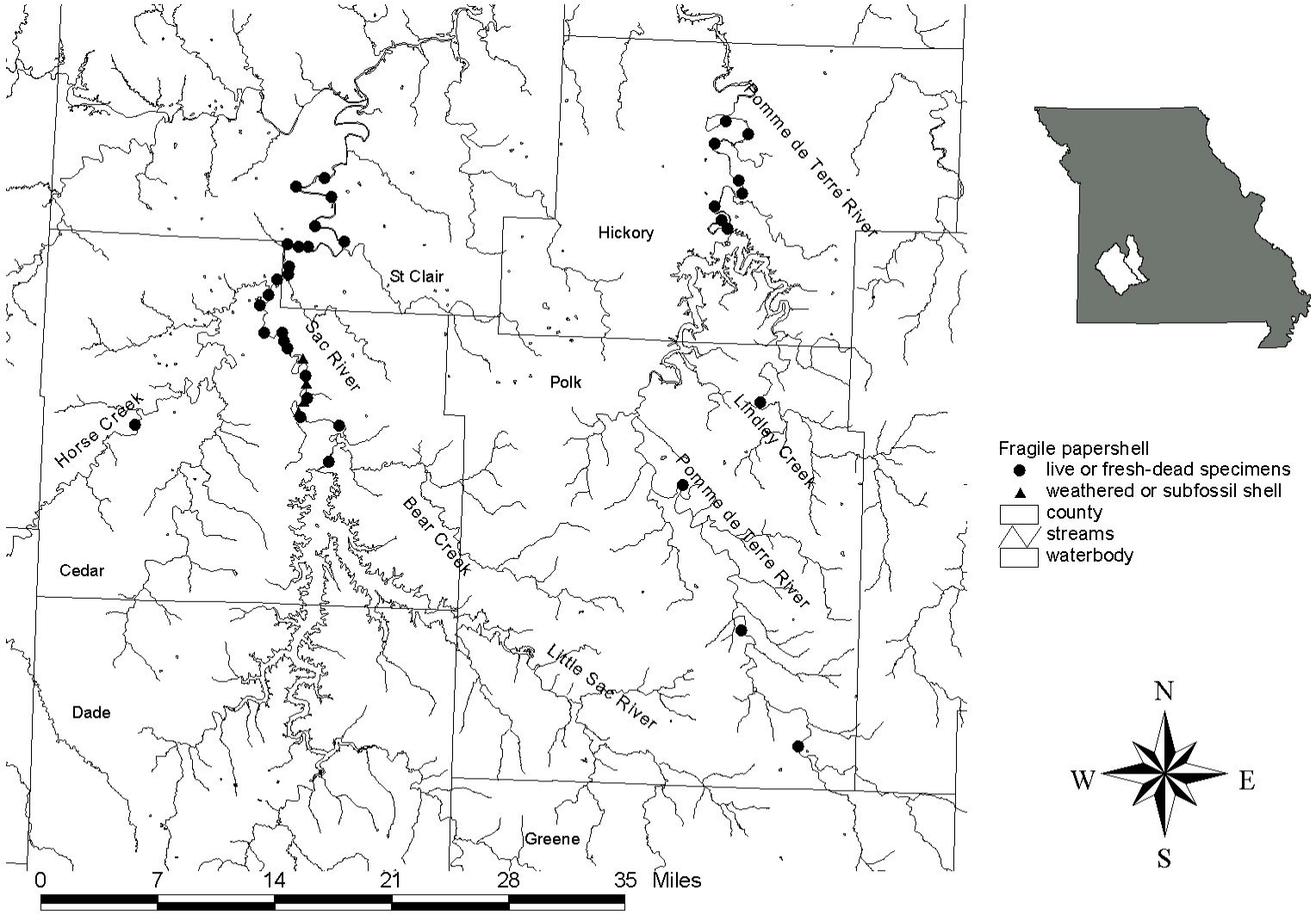

Figure 25. Distribution of the fragile papershell at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

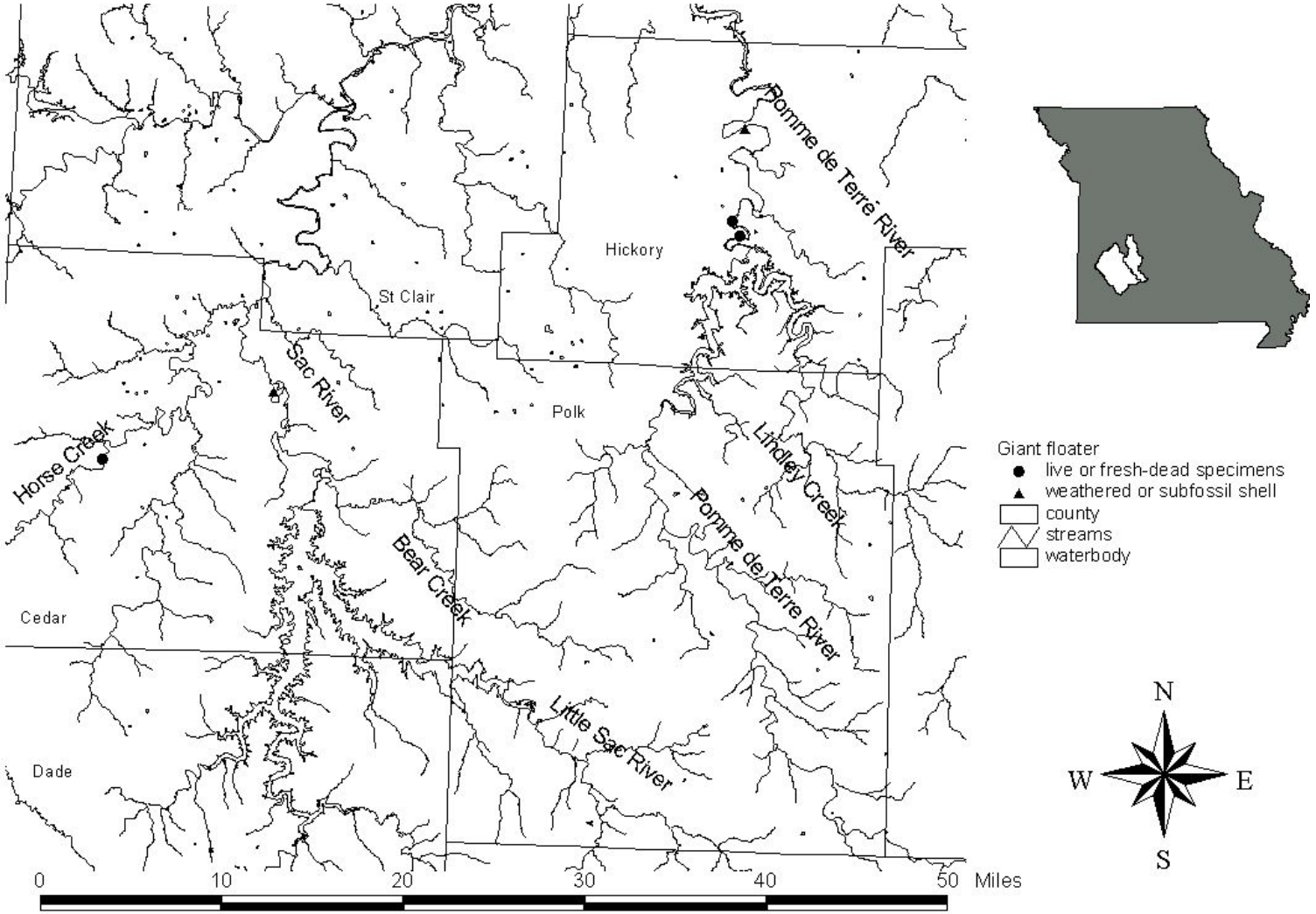

Figure 24. Distribution of the giant floater at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

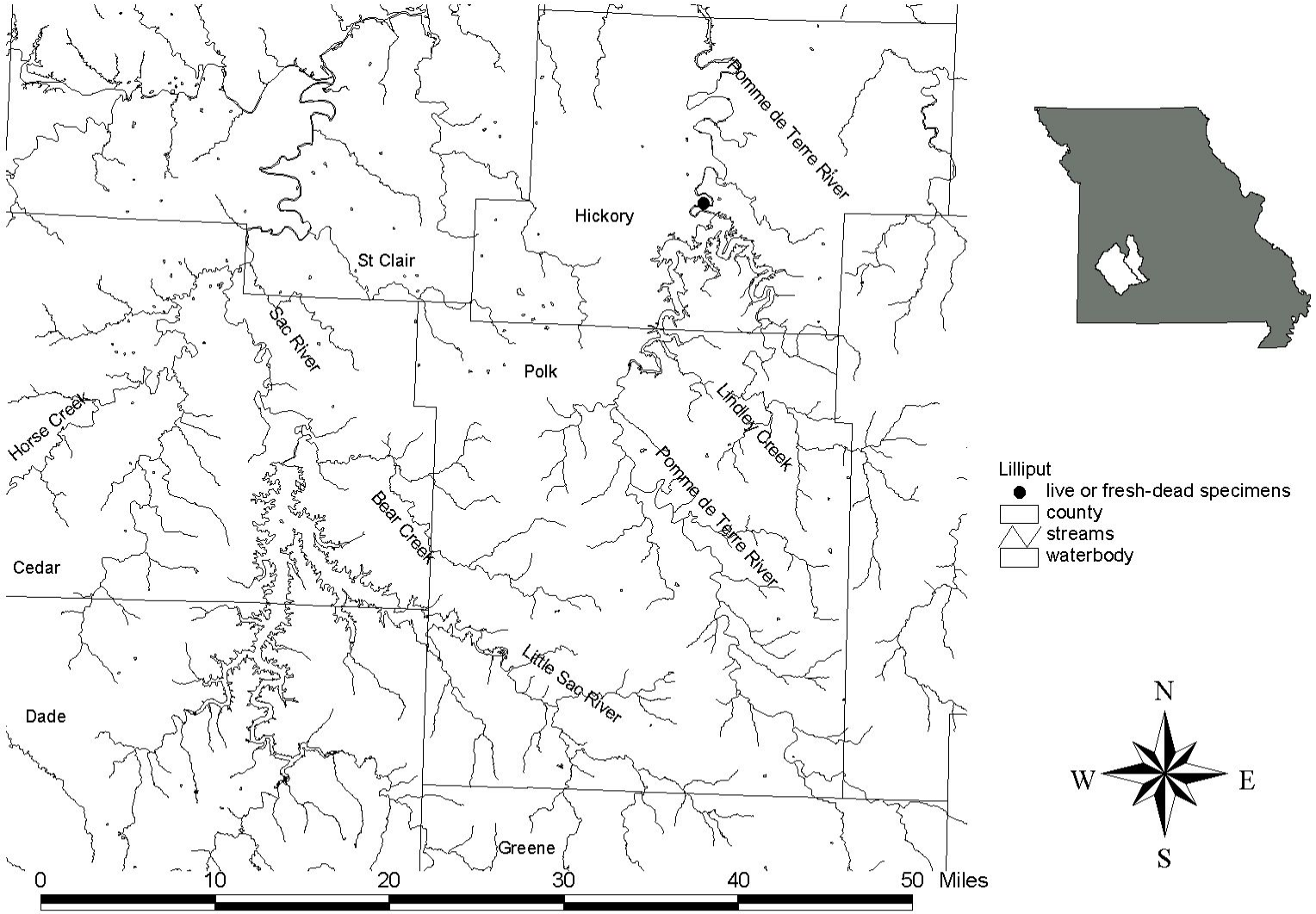

Figure 27. Distribution of the mucket at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

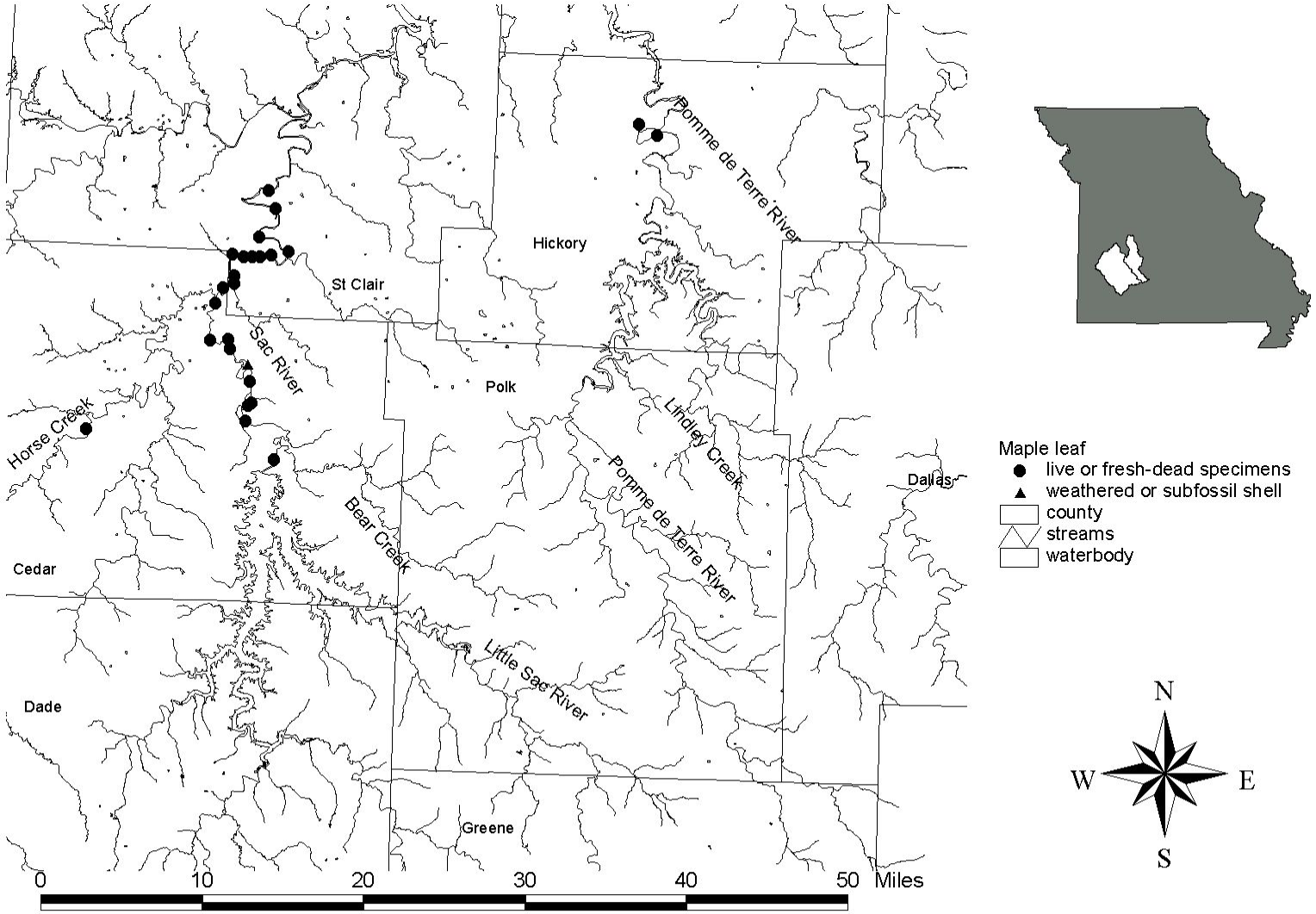

Figure 28. Distribution of the maple leaf at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

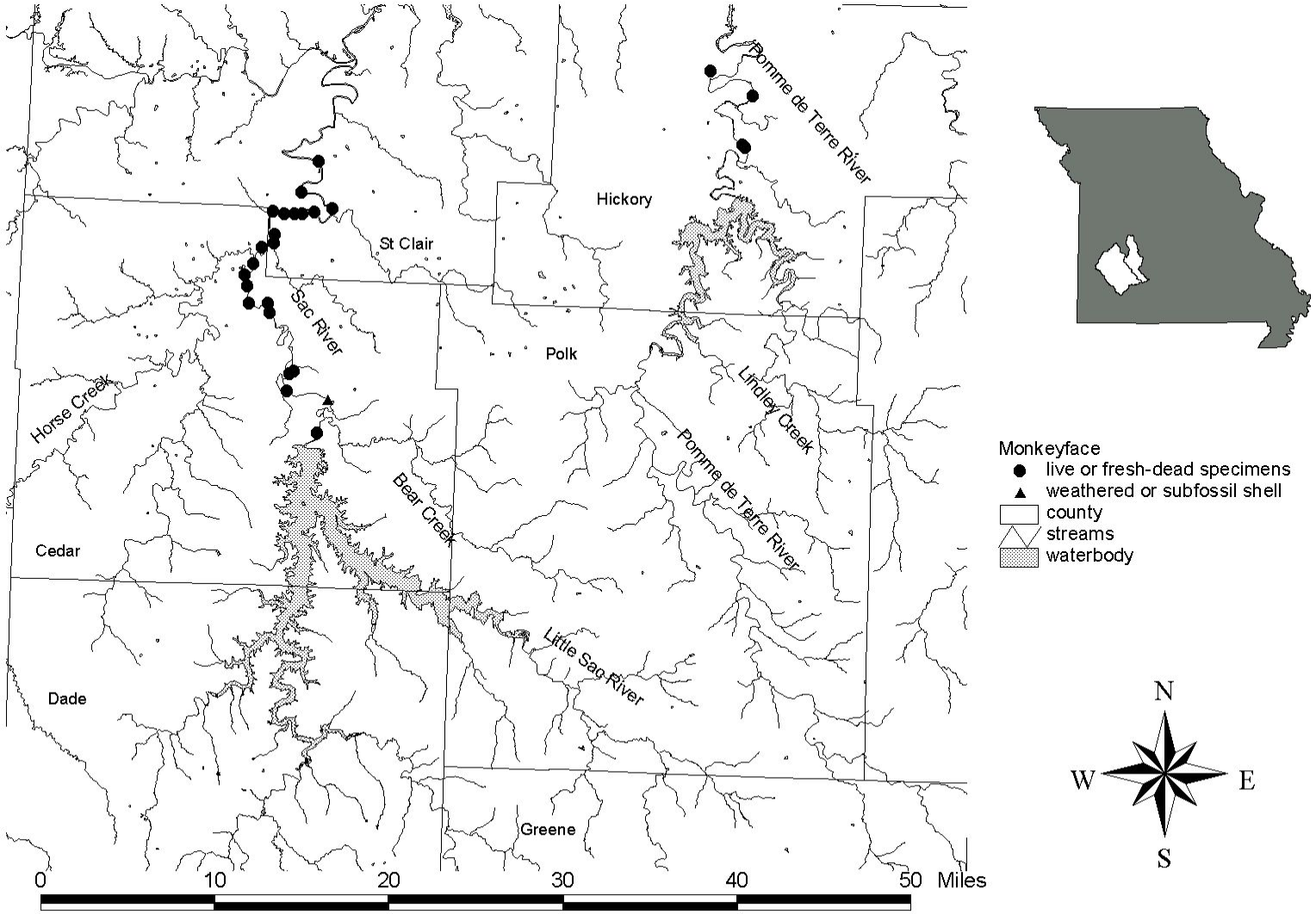

Figure 29. Distribution of the monkeyface at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

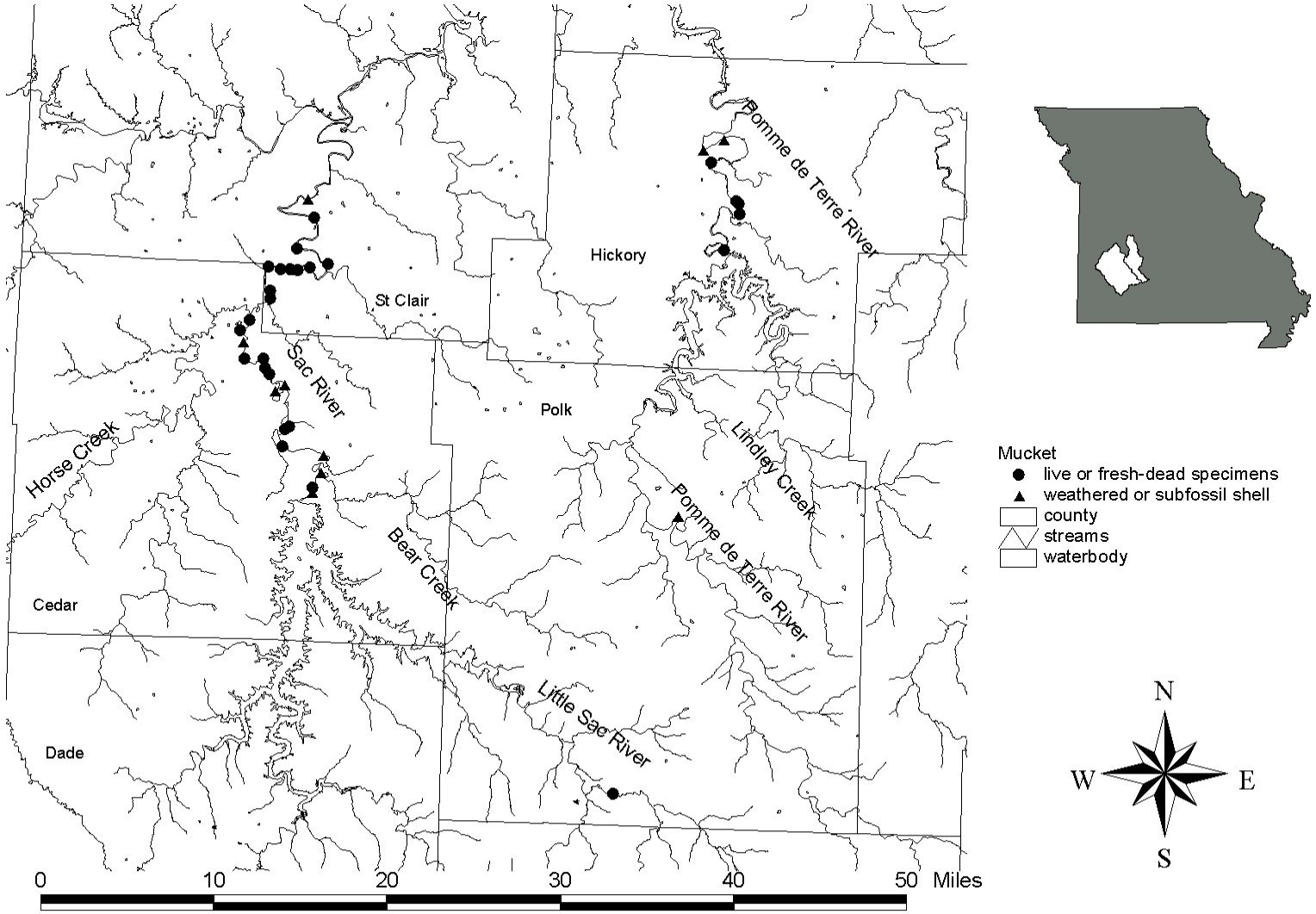

Figure 30. Distribution of the mucket at 50 survey sites in the Sac and Pomme de Terre River Basins Missouri, 2001-2002.

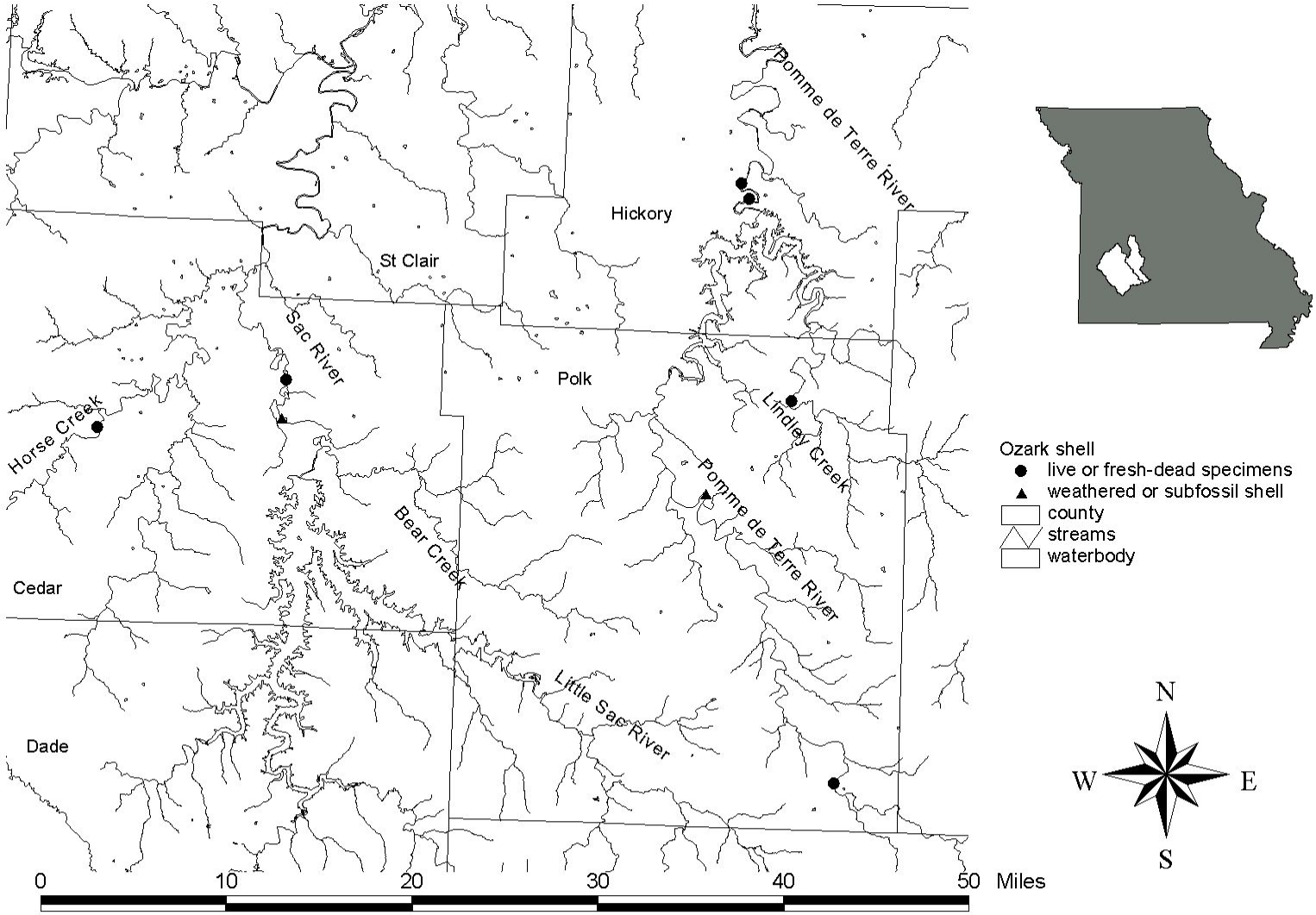

Figure 31. Distribution of the Ozark shell at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

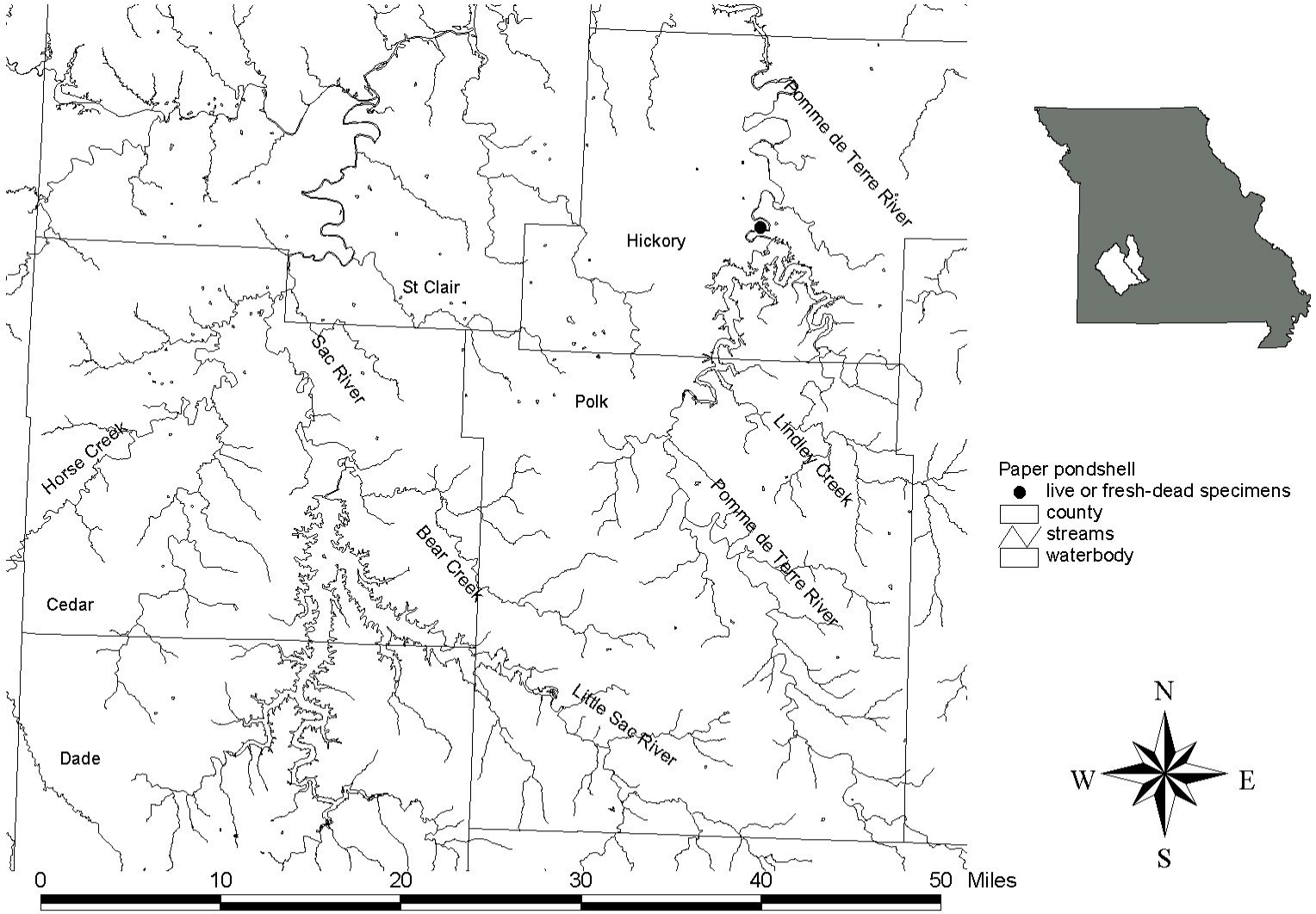

Figure 32. Distribution of the paper pondshell at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

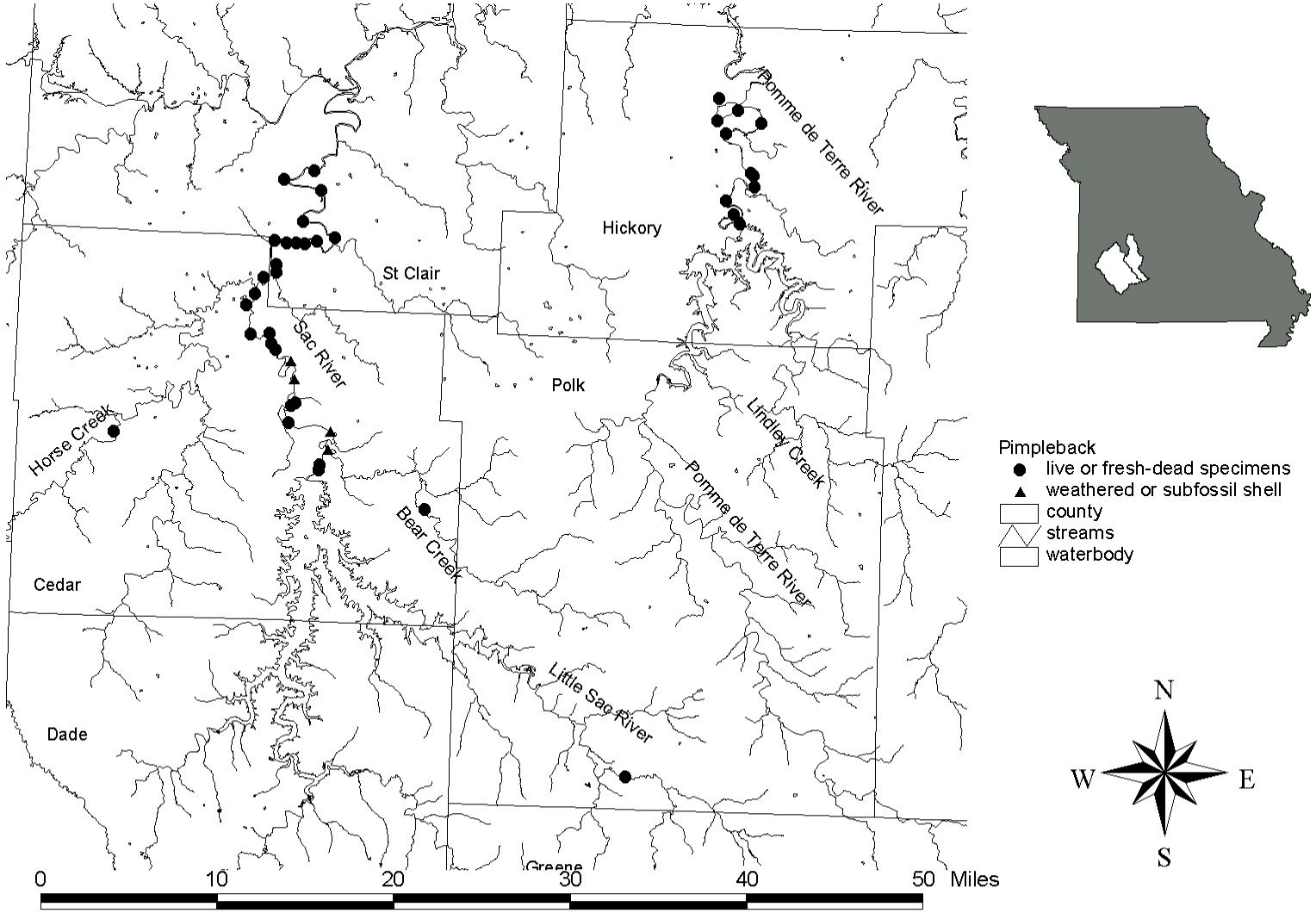

Figure 33. Distribution of the pimpleback at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

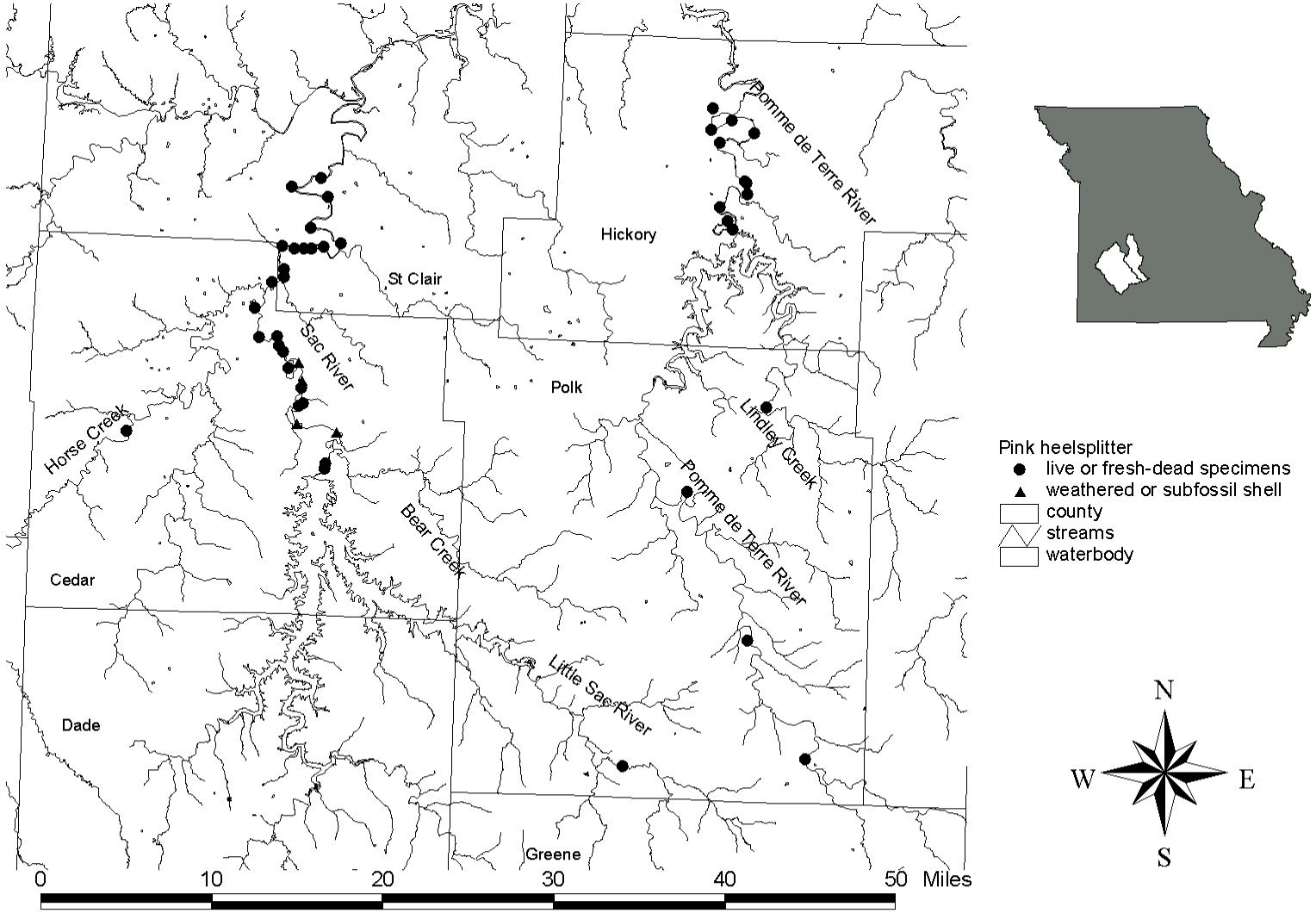

Figure 34. Distribution of the pink heelsplitter at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

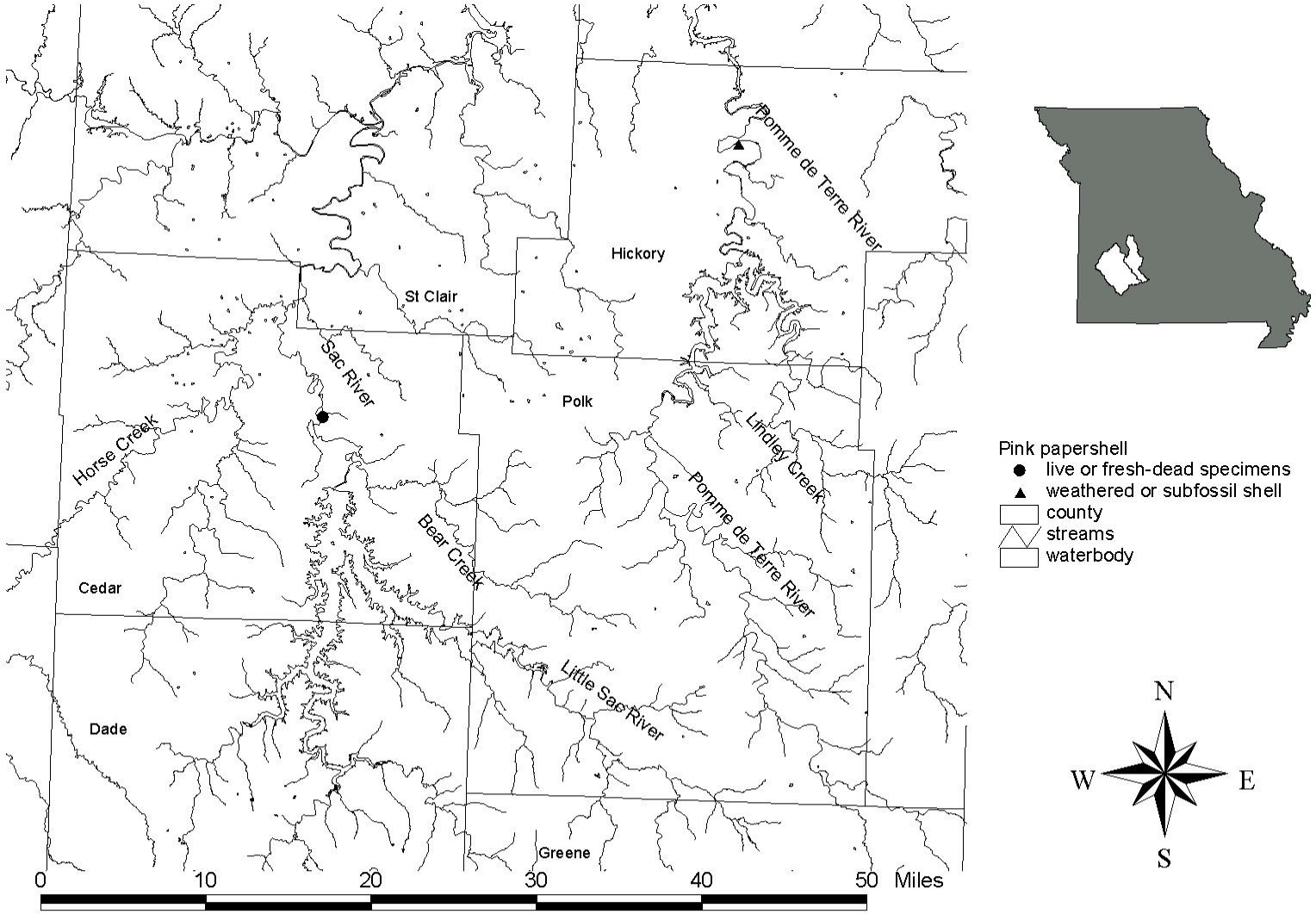

Figure 35. Distribution of the pink papershell at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

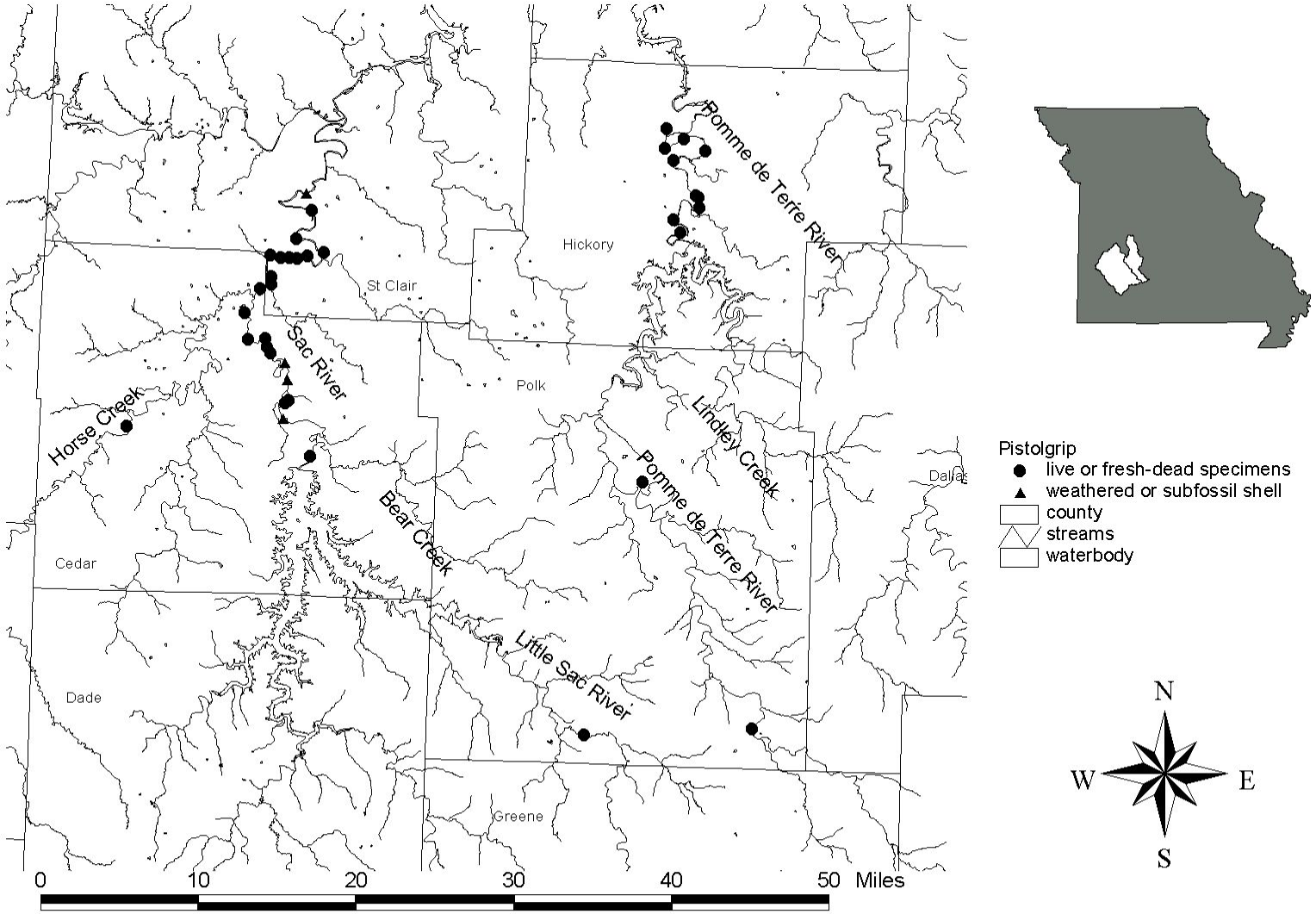

Figure 36. Distribution of the pistolgrip at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

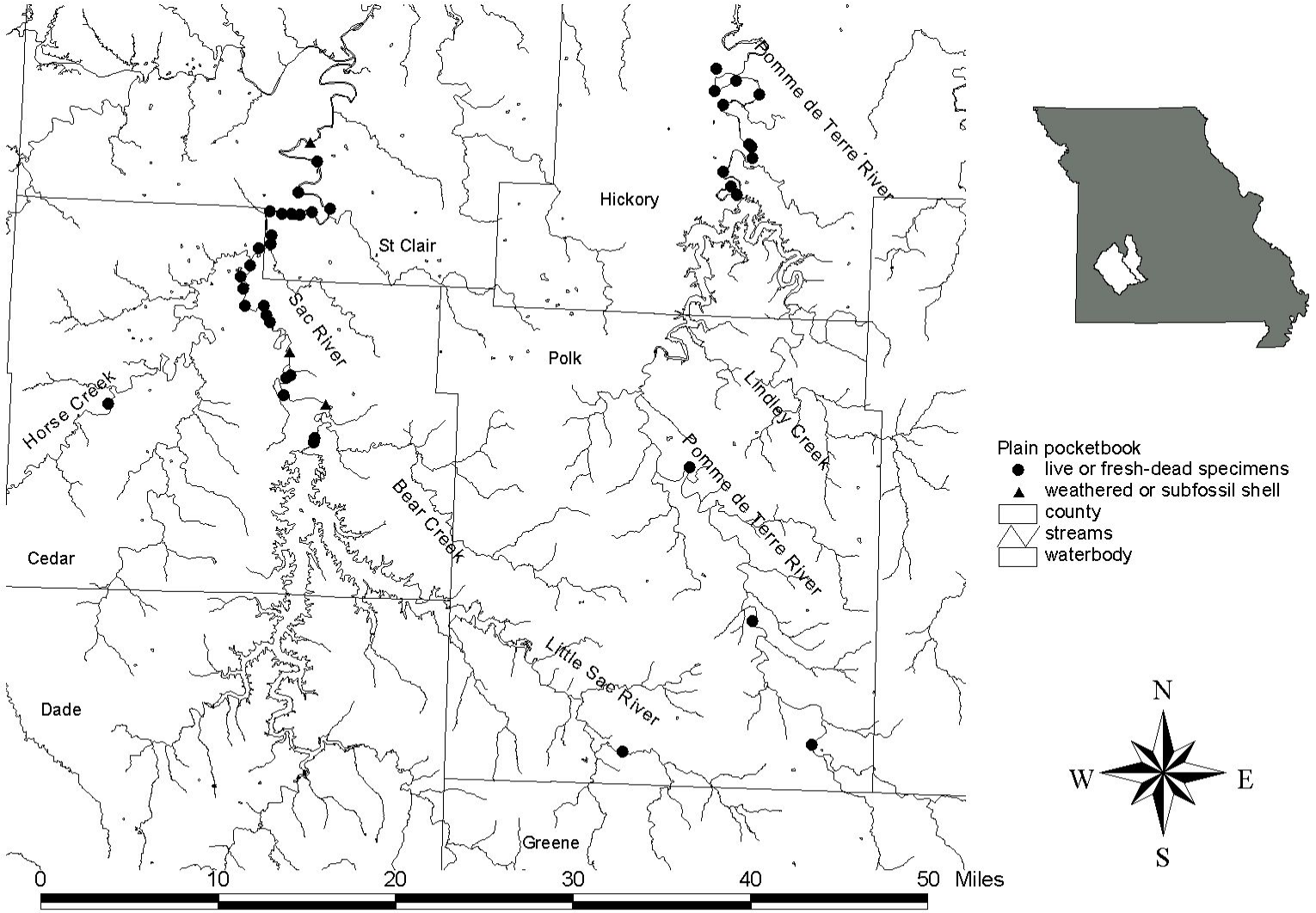

Figure 37. Distribution of the plain pocketbook at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

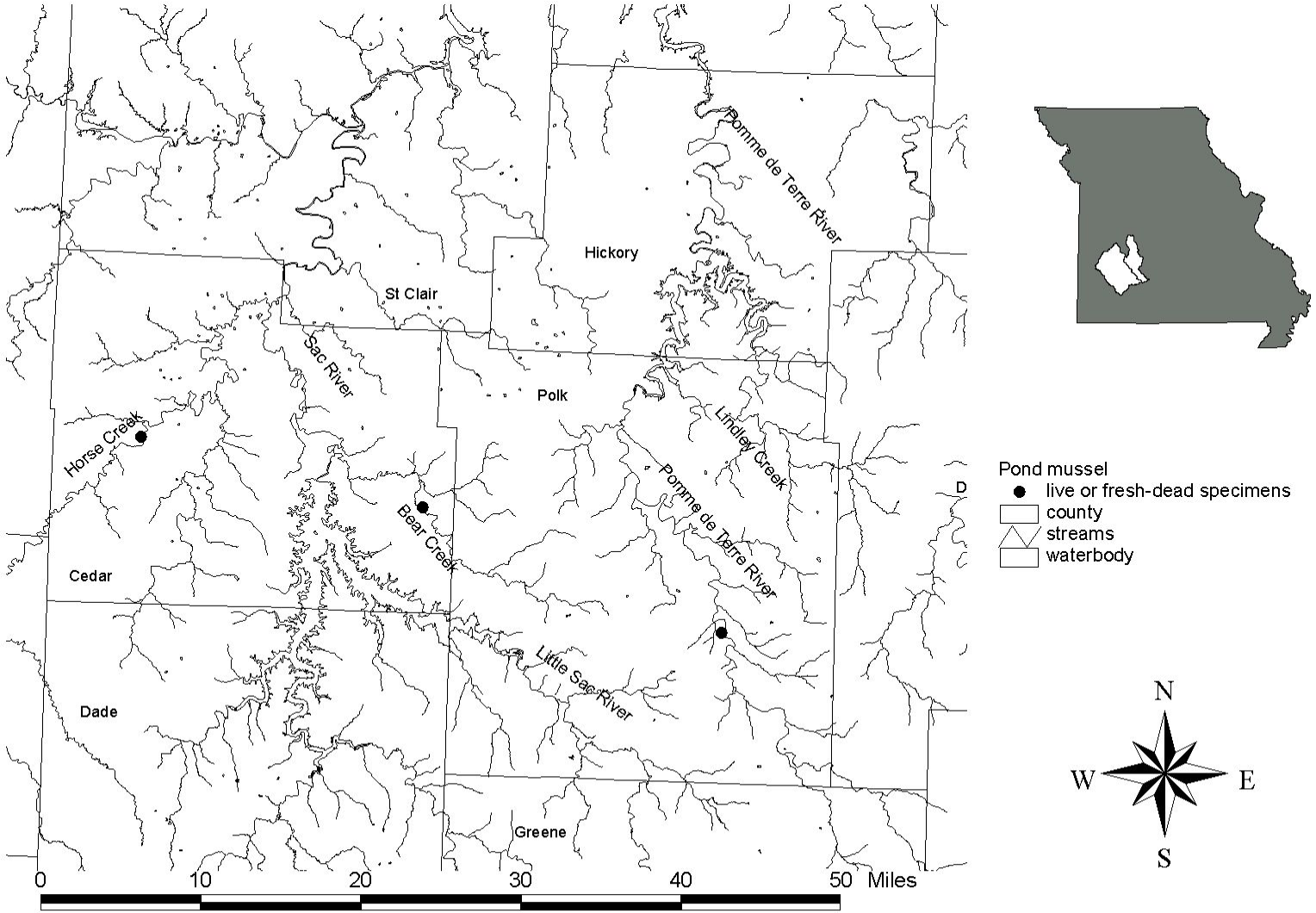

Figure 38. Distribution of the pond mussel at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

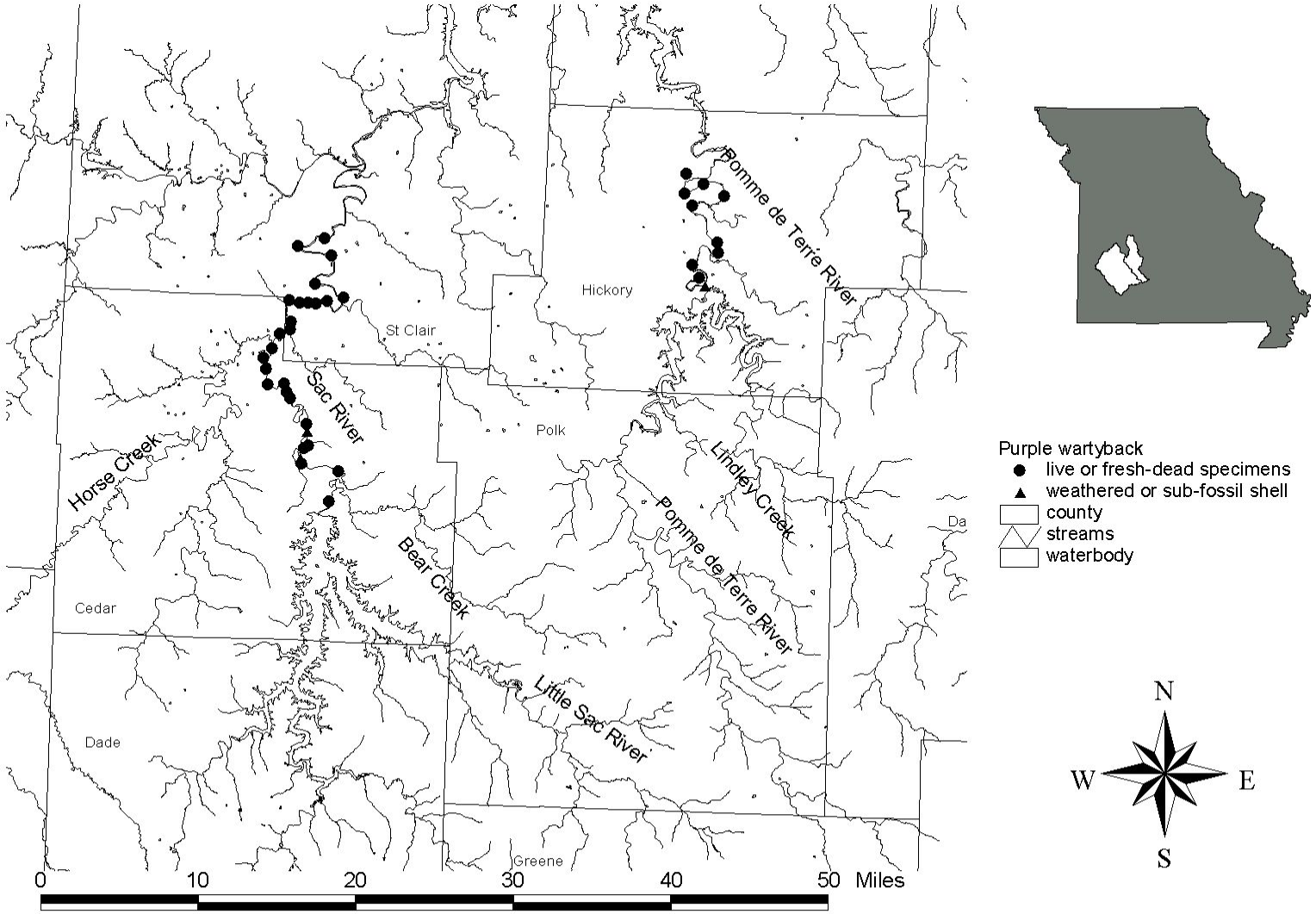

Figure 39. Distribution of the purple wartyback at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

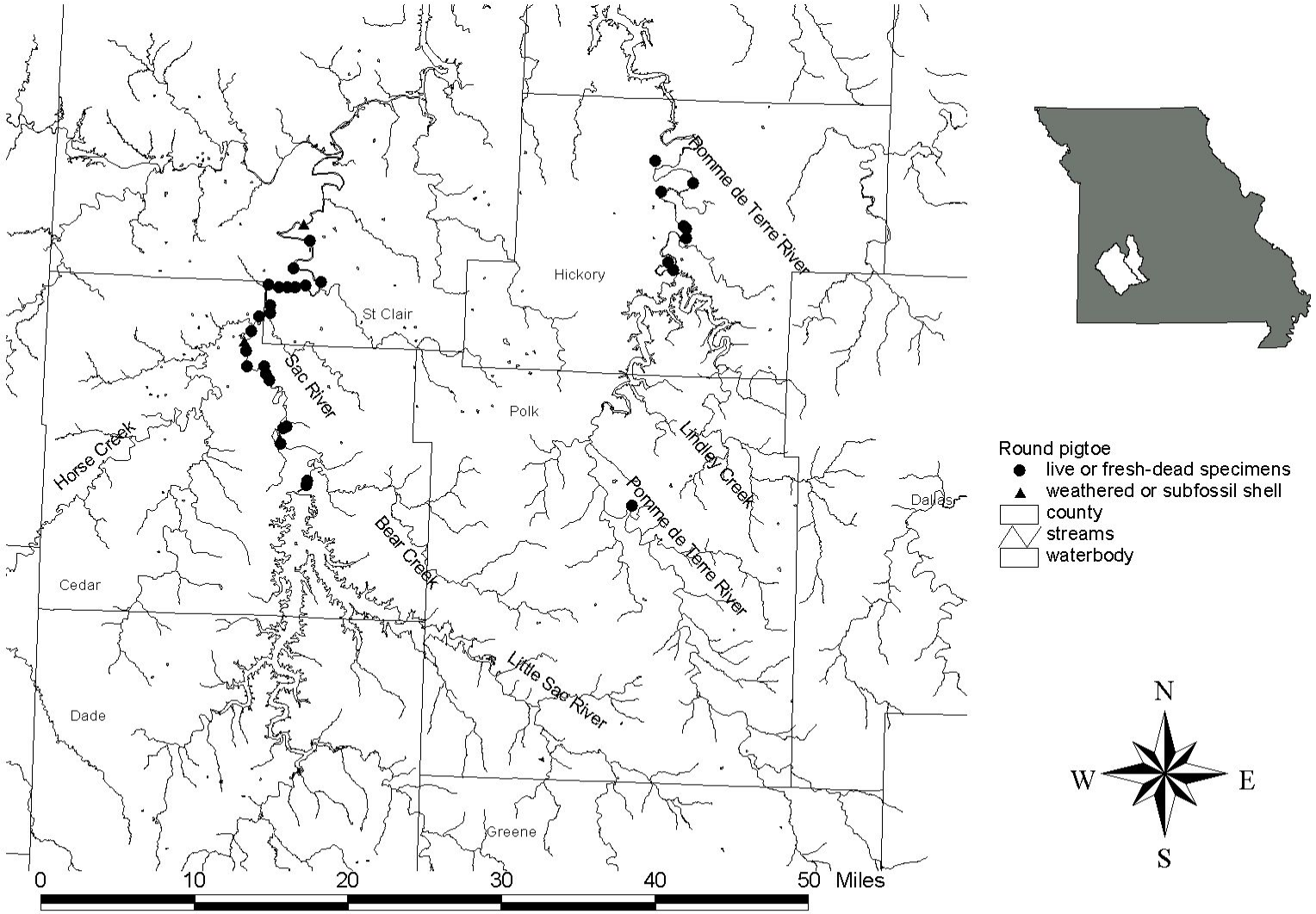

Figure 40. Distribution of the round pigtoe at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

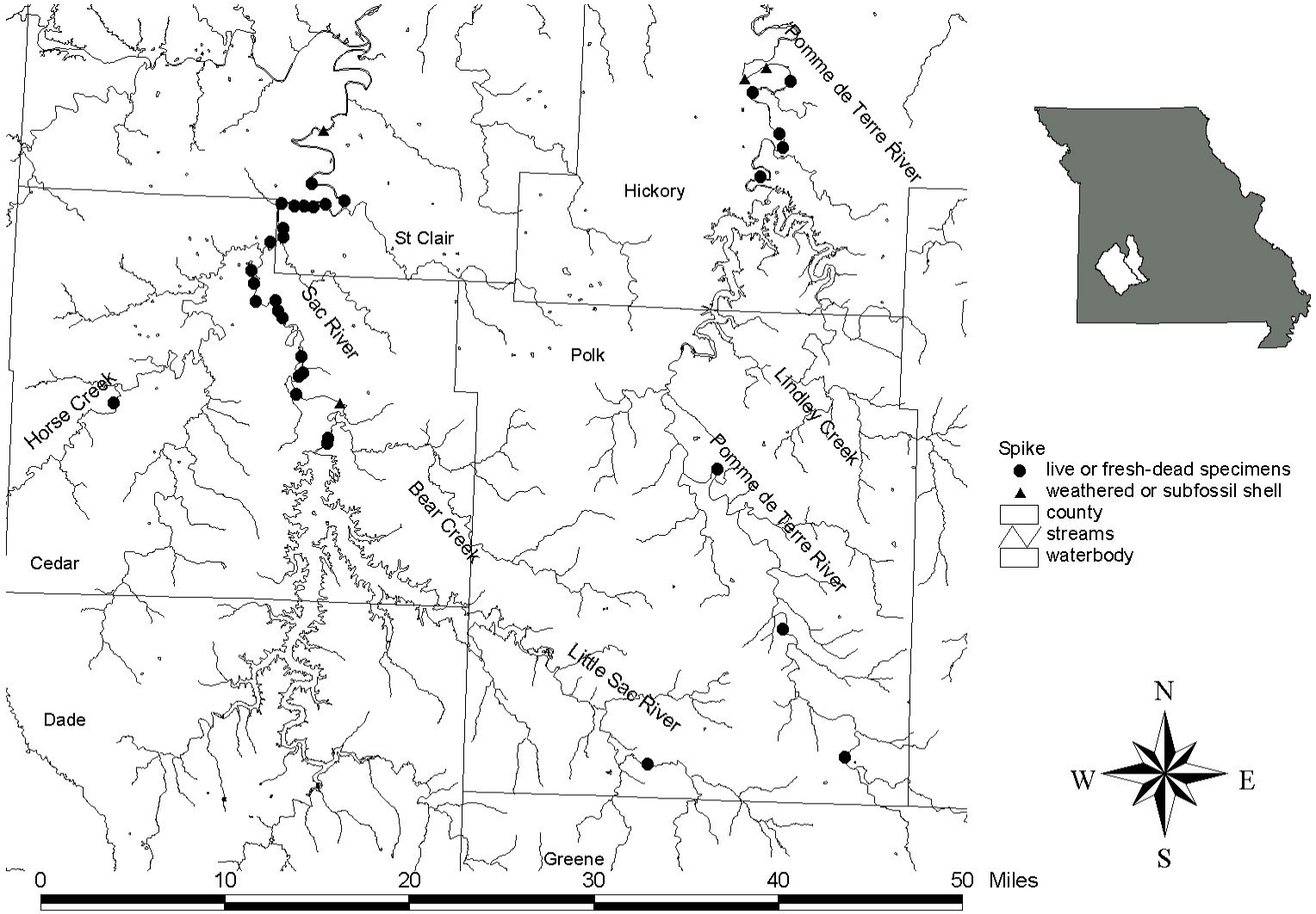

Figure 41. Distribution of the spike at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

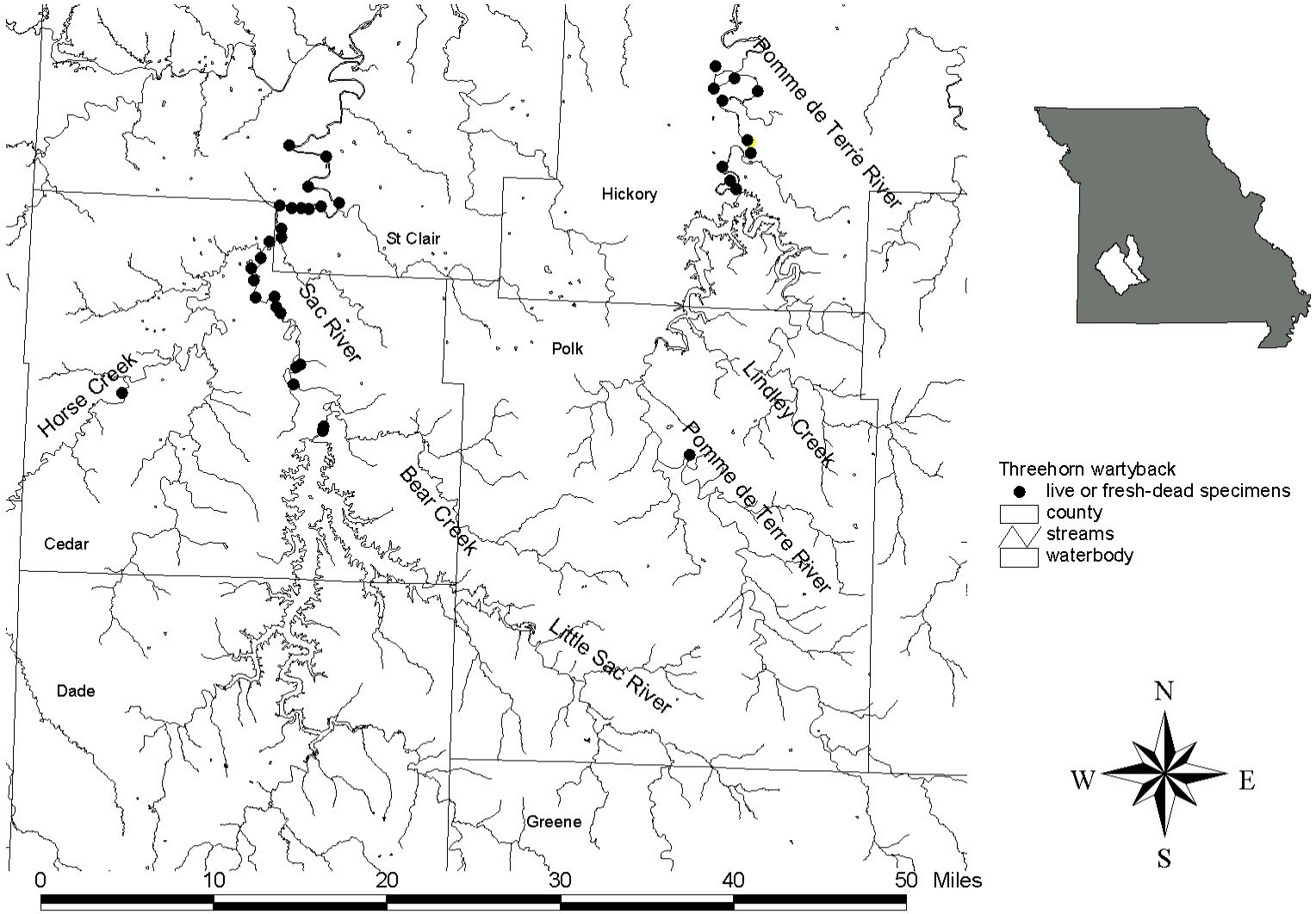

Figure 42. Distribution of the threehorn wartyback at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

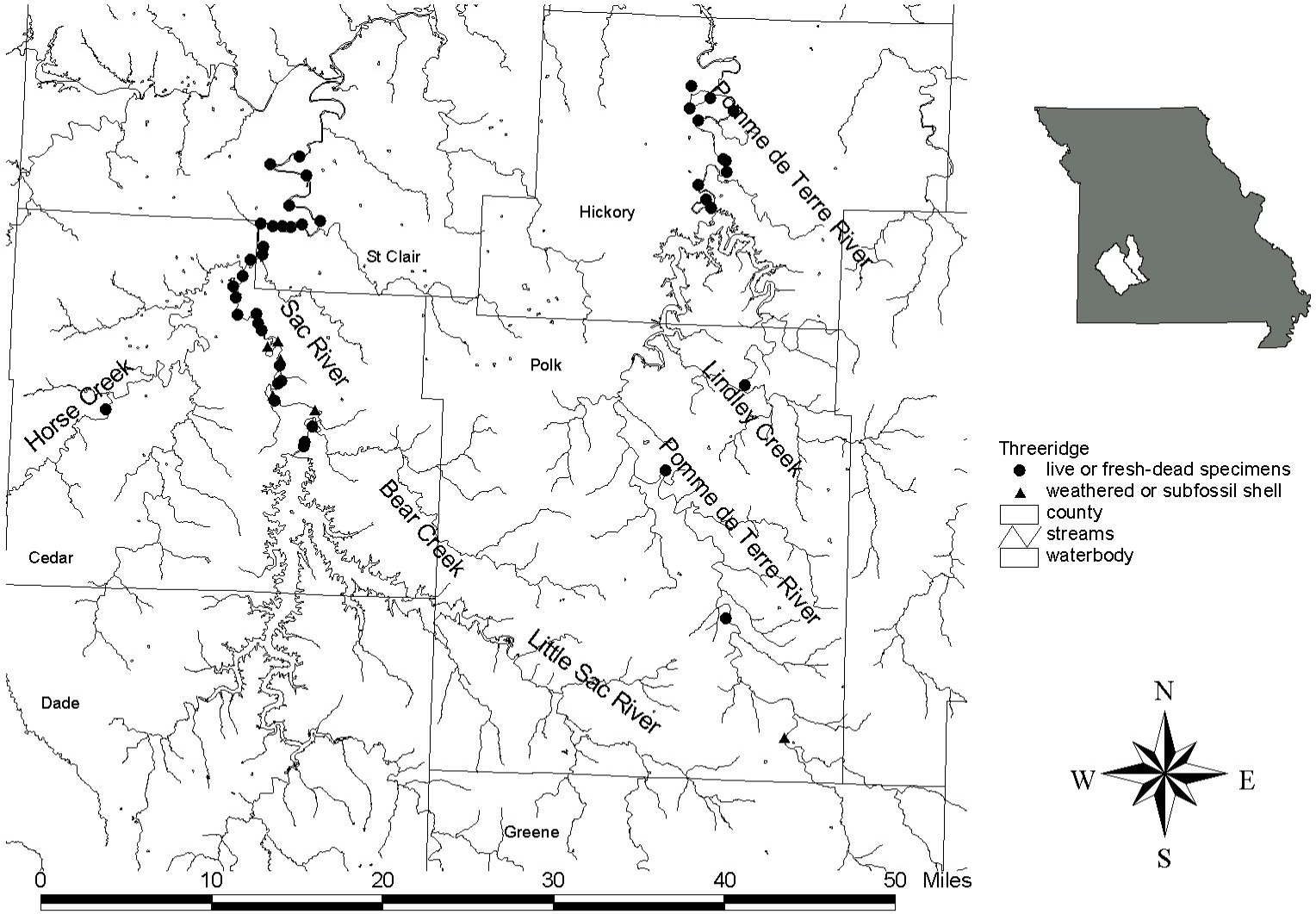

Figure 43. Distribution of the threeridge at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

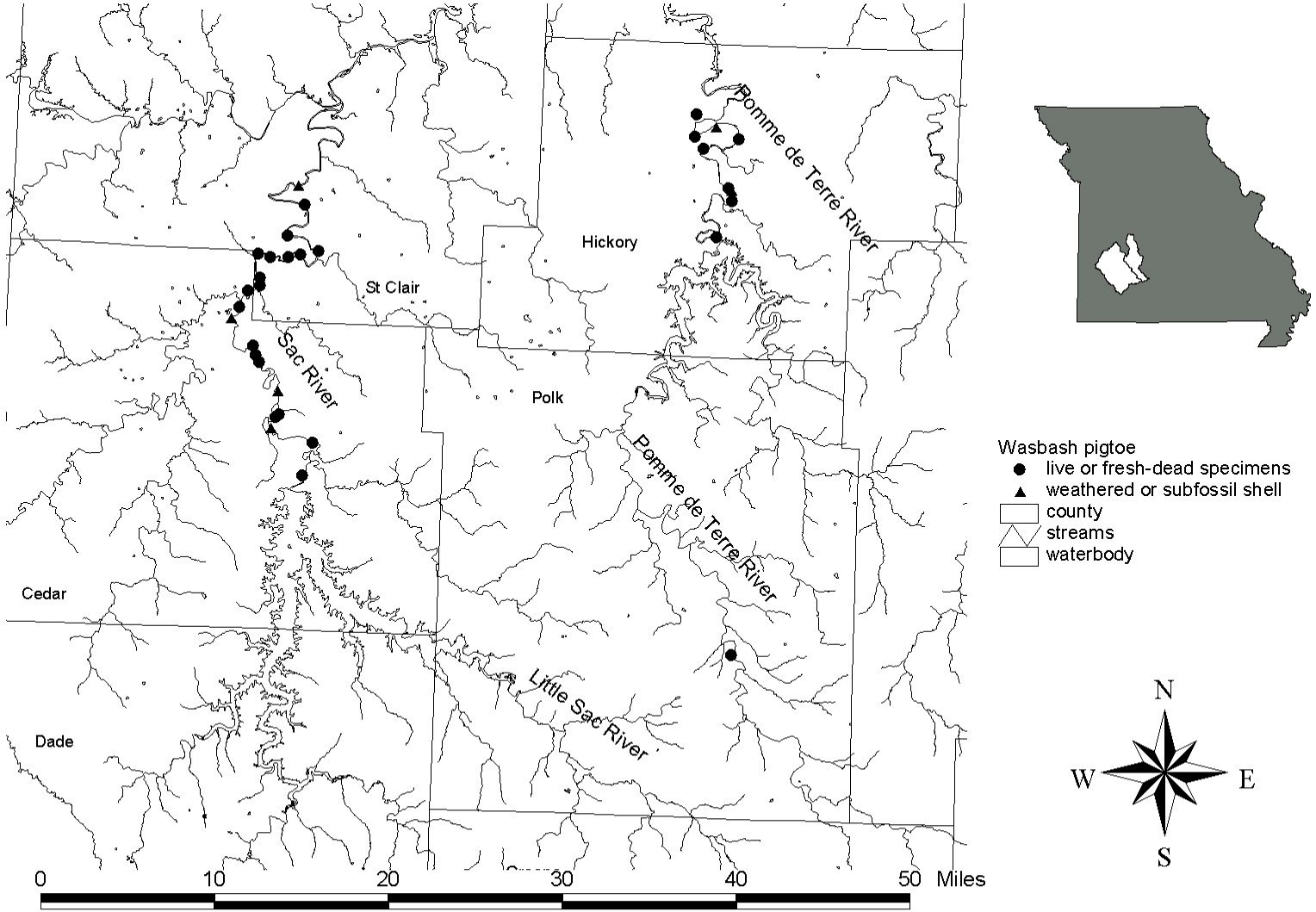

Figure 44. Distribution of the Wabash pigtoe at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

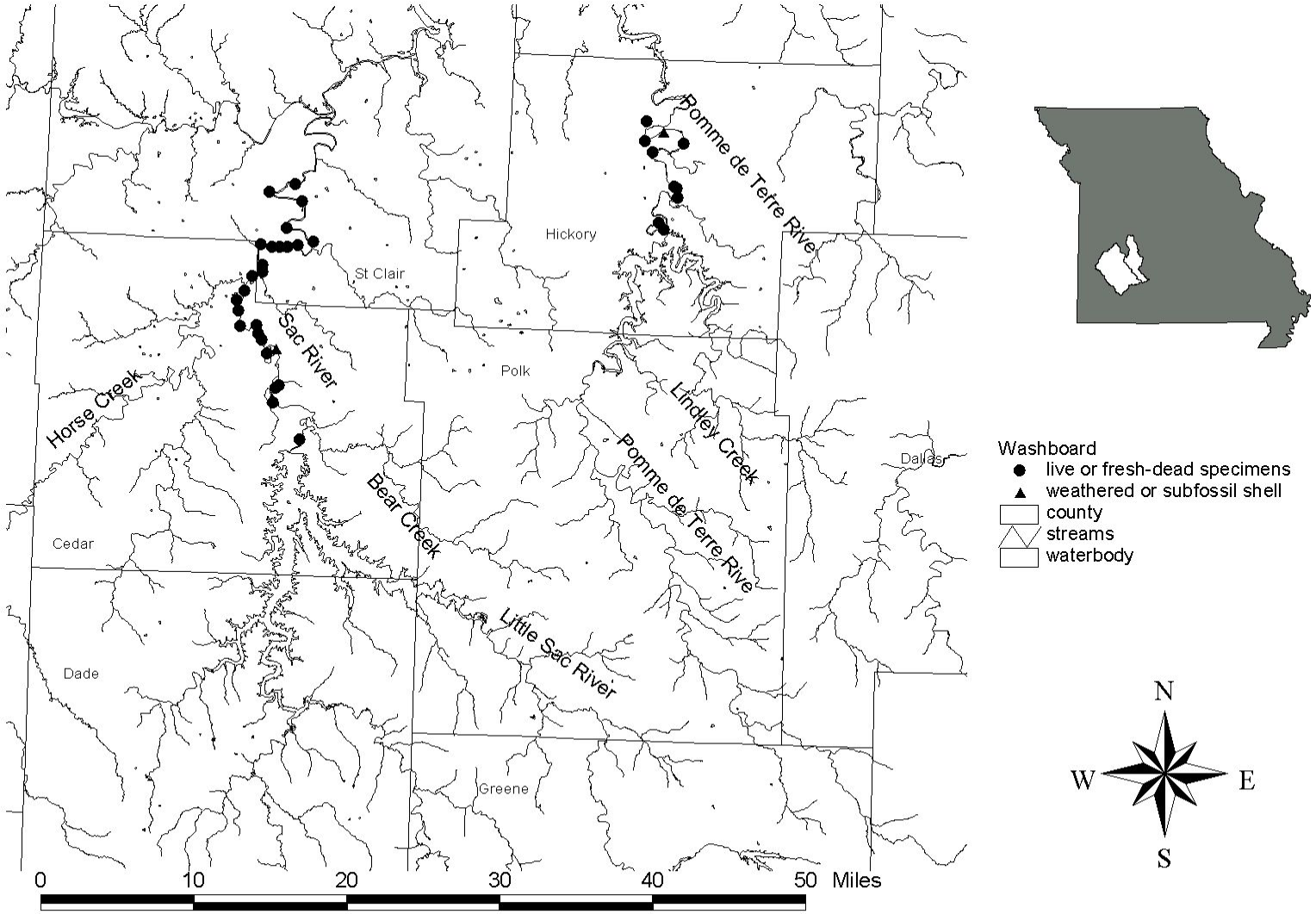

Figure 45. Distribution of the washboard at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

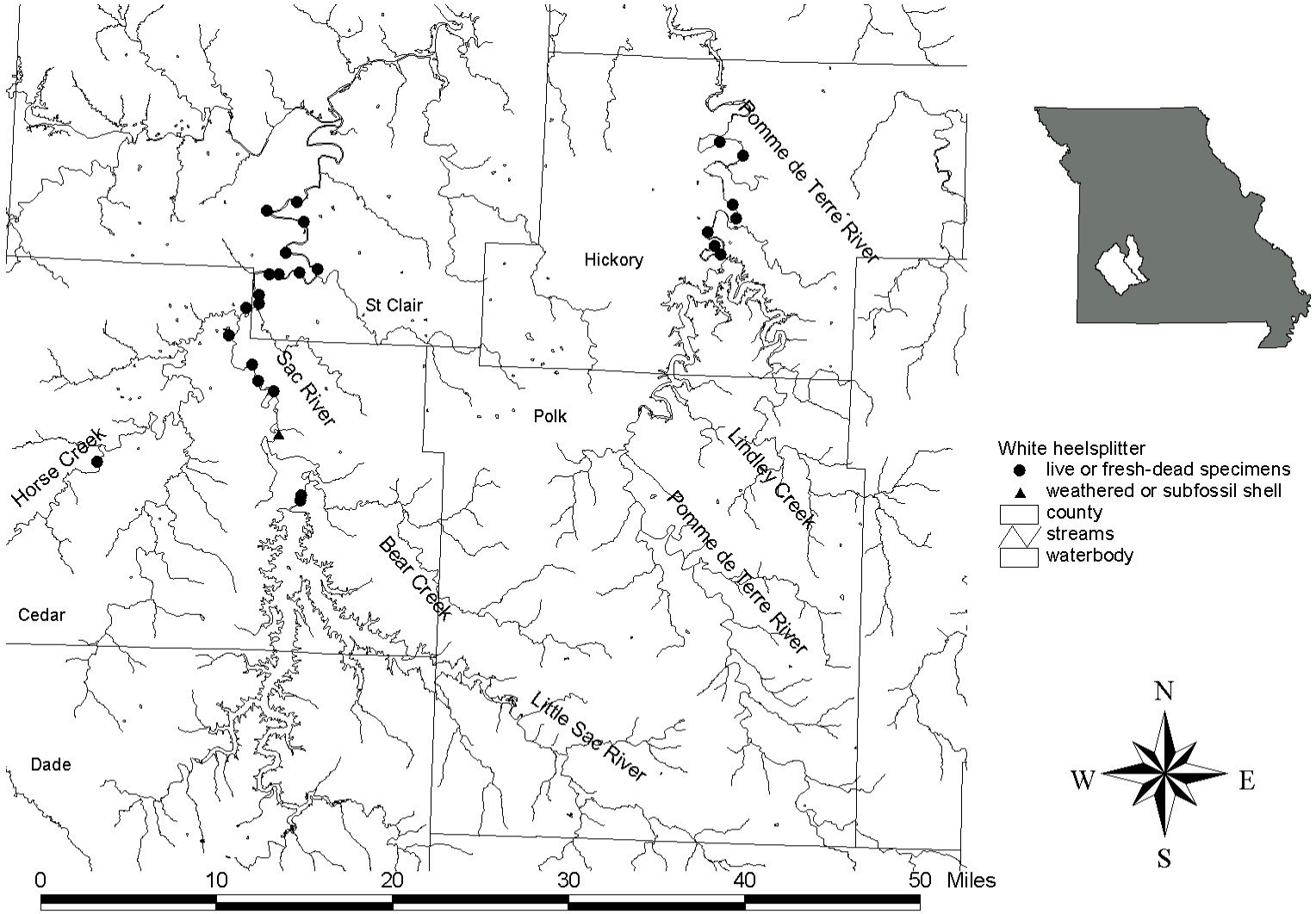

Figure 46. Distribution of the white heelsplitter at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

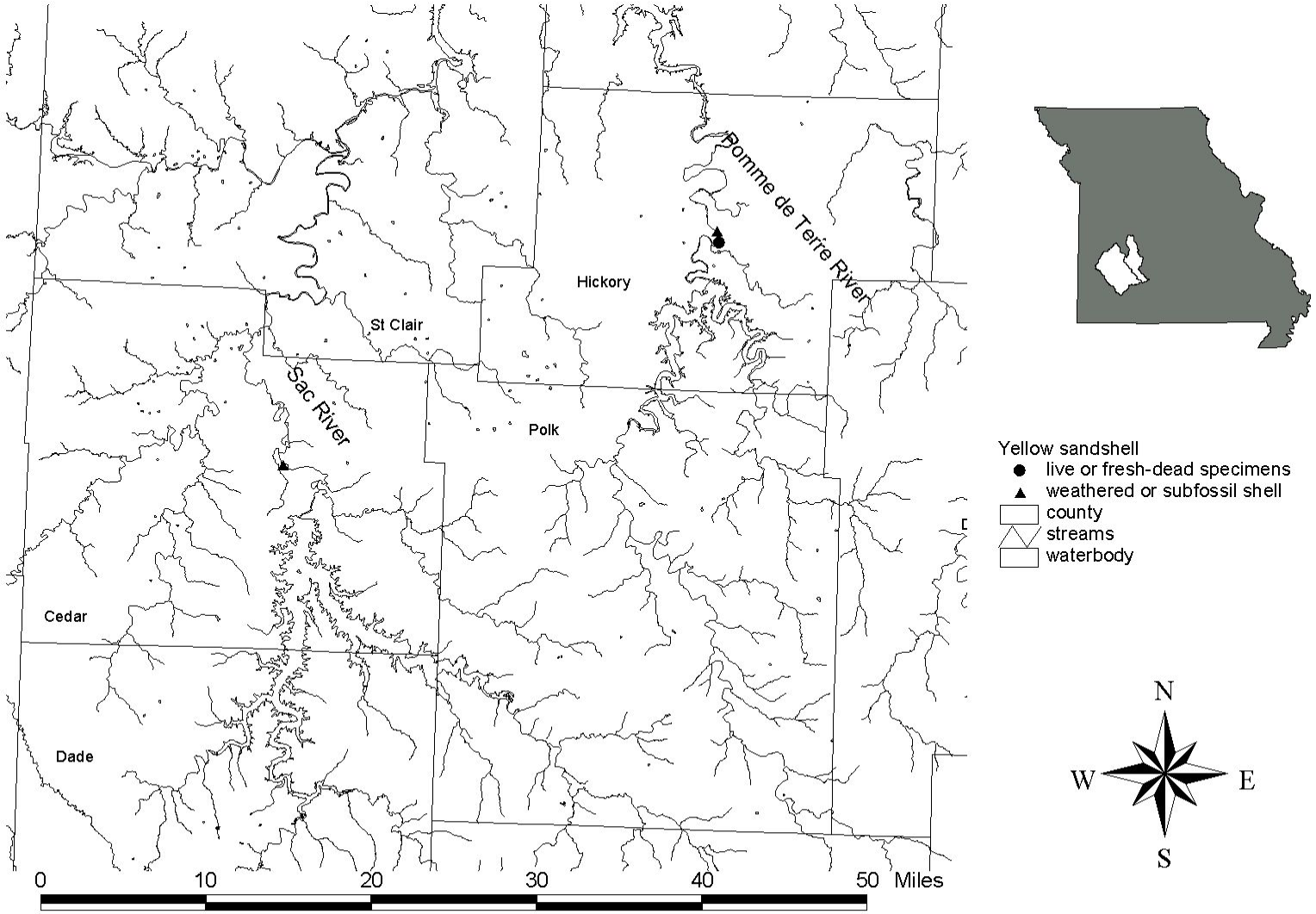

Figure 47. Distribution of the yellow sandshell at 50 survey sites in the Sac and Pomme de Terre River Basins, Missouri, 2001-2002.

St. Francis River -2002

Summary- St. Francis

Native freshwater mussels (Unionidae) were surveyed in the St Francis River system of southeast Missouri. The St. Francis is a direct tributary to the Mississippi river and drains 4461 square miles. The basin contains one of the most diverse and abundant freshwater mussel faunas in the Midwestern U.S. (Oesch 1984, MDC 2004).

We surveyed 55 sites (32 in the mainstem and 23 in tributaries) between May and October 2002. Sampling was carried out using timed searches by snorkeling and diving. Sampling effort averaged 2.3 hours per site and totaled 125.9 person-hours. We collected 7,732 individual mussels, representing 42 living species. The peak number of species per site was 23. Catch per unit effort ranged from 1 to 337 individuals per person-hour with an average of 61.4 individuals per person-hour.

The most abundant species in our samples were the Ouachita kidneyshell (27.6% of live specimens), mucket (16.7%), threeridge (12.4%), pimpleback (12.2%), and mapleleaf (4.8%). The most generally distributed species in our sample were plain pocketbook (56% of sites), bluefer (47%), threeridge (43%), fragile papershell (38%), yellow sandshell (32%) and Wabash pigtoe (31%). Species of conservation concern that were recovered (S = Missouri conservation rank) were *Alasmidonta marginata* (S2), *Anodonta suborbiculata* (S2), *Arcidens confragosus* (S3), *Cyprogenia aberti* (S1S2), *Epioblasma triquetra* (S1), *Ligumia recta* (S1S2), *Plectomerus dombeyanus* (S3), *Ptychobranchus occidentalis* (S2S3), *Quadrula cylindrica* (S1), *Quadrula nodulata* (S3), *Toxolasma lividis* (S2) and *Toxolasma texasensis* (S3).

The sites included 28 localities at which mussels had previously been surveyed. The most abundant species in past collections were mucket (36.9%), plain pocketbook (14.2%), fatmucket (10.9%), Ouachita kidneyshell (7.5%) and spike (6.0%). A major difference between past surveys and our data is the change in abundance of mucket and Ouachita kidneyshell. Muckets were the dominant species in previous surveys, but our collections indicate that Ouachita kidneyshell is now dominant. Also, rabbitsfoot were more frequent in the past (68/4,296=1.6%) than in the present study (11/4,259=0.3%).

Although the St. Francis system is regulated and does not possess an ideal flow regime, it presently holds a substantial diversity and abundance of unionids and deserves further attention and management effort to preserve this fauna.

Background – St. Francis River system

This project segment focused on the St Francis River system, a direct tributary to the Mississippi River. The St Francis River drains portions of both the Ozark Plateau and Mississippi Alluvial Plain zoogeographical regions as described by Funk (1968). The river originates in Iron County, flows northeast approximately 25 miles, then south 200 miles in Missouri and south 207 miles in Arkansas to the Mississippi River (Boone 2001). The St Francis basin comprises approximately 4461 square miles in total, and 1,839 mi^2 in Missouri in portions of Iron, St. Francois, Madison, Wayne, Washington, Ste. Genevieve, Bollinger, Stoddard, Butler and Dunklin Counties.

Approximately 71 percent of the drainage area (1,315 mi^2) is in the upper subbasin (upstream of Wappapello Dam) and 29 percent (524 mi^2) is in the lower subbasin (downstream of Wappapello Dam). The upper subbasin is mostly wooded and sparsely populated. A local mining industry (iron, lead, zinc and quarried red granite), small urban centers, and small farms provide important components of the basin's economy. The lower subbasin is 90 percent cropland and pasture (predominately row crop) and only 10 percent forest (MDNR 1984). Agriculture is the most important industry in the subbasin as indicated by the high percentage of cropland.

The total length of stream channels in the St. Francis watershed is 4,102 miles, 485 of which are perenial (MDNR 1981). The streams in the upper subbasin are clear with predominantly gravel, cobble, sand and granite boulders. Conversely, streams in the lower subbasin are generally turbid, with clay and sand as the dominant substrates. (Boone 2001). Major tributaries include Big Creek, Dudley Main Ditch, Little St. Francis River, Marble Creek, Mingo Ditch, Stouts Creek, Twelve-Mile Creek, Varney River Ditch and Wolf Creek.

Impoundments and levees have reduced and fragmented of habitat in the St Francis basin over the past 60 years. Wappapello Dam (completed in 1941) impounds 28 miles of the St. Francis River mainstem. The authorized purpose of Wappapello Lake is to provide flood control for the St. Francis River and its tributaries and it utilizes a rather small 175 kw turbine, that only provides power to the dam facilities. Another mainstem dam above Lake Wappapello, DiSalvo Lake (St. Francois County, Ozark Ore Company Lake, completed in 1944), impounds an additional 1.8 miles of St. Francis River (Boone 2001, MDC 2004).

The lower portion of the St. Francis River is controlled by a system of levees and drainage ditches that restrict the entry of tributaries into the partially channelized mainstem (Boone 2001). Nearly the entire west bank is a major levee that forces runoff westward into the Black River basin. As a result, the west bank has few tributaries. The east bank contains only a few controlled inlets (drainage ditches) (Boone 2001). Other ditches (the Floodway Ditches) drain a portion of the St. Francis River Basin. They contribute to the St. Francis River in the state of Arkansas and were not surveyed for this project.

The St. Francis River basin contains diverse and abundant freshwater mussel and fish faunas. Historically, 46 unionid species have been reported from the St Francis River system (Table 5, Boone 2001, MDC Database 2004). Surveys in the St. Francis River from 1962-1985 reported the federally endangered pink mucket, the state endangered snuffbox, and other SCC including the black sandshell, hickorynut, rock pocketbook, elktoe, purple lilliput, rabbitsfoot, bankclimber, western fanshell and flat floater. However, mussels in many areas of the St Francis River basin have not been systematically surveyed for over 20 years. Overall, 130 species of fish have been identified from the St. Francis River basin (Boone 2001). Six species (cypress minnow, taillight shiner, mountain madtom, crystal darter, harlequin darter, and longnose darter) are listed as state endangered (state rank S1) and one species is listed as extirpated, the pallid shiner. Twenty-three fish species found in the St. Francis River system are SCC to population declines or apparent vulnerability from a statewide perspective (MDC 2004a).

Results and Discussion- St. Francis

The survey was conducted between May and October 2002. We surveyed 55 sites in the St. Francis River system, including 32 sites in the mainstem and 23 sites in tributary streams. The mainstem sites were distributed over 250 river miles between SFRM 4.0-257.7. (Figures 48-49, Appendix D). Total search effort was 125.5 person-hours. We collected 7,731 living mussels and 42 living species (Table 6). Overall CPUE was 61.4 mussels/person-hour. Sampling effort, species, and numbers collected at each site appear in Appendix E.

Species diversity and abundance – St. Francis River

The most abundant species in our total sample were the Ouachita kidneyshell (27.6% of live specimens), mucket (16.7%), threeridge (12.4%), pimpleback (12.2%) and mapleleaf (4.8%) (Table 6, Figure 50). The six most generally distributed species in our sample were plain pocketbook (56% of sites), bluefer (47%), threeridge (43%), fragile papershell (38%), yellow sandshell (32%) and Wabash pigtoe (31%). Species of conservation concern (SCC) that were recovered (S = Missouri conservation rank) were elktoe (S2),flat floater (S2), rock pocketbooks (S3), Western fanshell (S1S2), snuffbox (S1), black sandshell (S1S2), bankclimber (S3), Ouachita kidneyshell (S2S3), rabbitsfoot (S1), wartyback (S3), purple lilliput (S2) and Texas lilliput (S3). The most rarely encountered unionid species in the St. Francis River system were the wartyback, lilliput, and black sandshell. All of these species were represented by only single live specimens. Other relatively rare species included purple wartyback, pondhorn, little spectaclecase, flat floater, and purple lilliput (all with n=5). (Table 6, Appendix E-Tables 1,2).

According to a hyperbolic regression model, the number of specimens collected at each site explained 69% of the variation in species number among sites in the St. Francis (Figure 51, Appendix E-Tables 1, 2). The regression predicts a typical maximum of 15 species per site, and a sample size of 200 specimens to recover 90% of this value.

Most (37/42) species we collected in the St. Francis River system were found in the St. Francis River mainstem. Five species, the pondhorn (*Uniomerus tetralasmus),* flat floater (*Anodonta suborbiculata*), paper pondshell (*Utterbackia imbecillis*), Texas lilliput (*Toxolasma texasensis*), and wartyback (*Quadrula nodulata*) were only collected in tributaries of the St. Francis River. Two species were new records for the St. Francis River, the wartyback (*Quadrula nodulata*) and the Texas lilliput (*Toxolasma texasensis*). The wartyback is reported to occur in portions of the St. Francis River in Arkansas, but has not previously been reported in Missouri (Jenkinson and Ahlstedt 1995)

The abundance and species diversity of unionids in the St. Francis River basin is high, with average CPUE=61 and 42 living species. For comparison, a recent survey of Meramec River unionids found average CPUE=22 and 40 living species (Roberts and Bruenderman 2000), a survey of the Gasconade River found CPUE=46 and 35 living species (Bruenderman et al. 2001), and a survey of the Sac River found average CPUE=100 and 33 living species (present study). Single specimens represented several species, and it is likely that other living species are present. Species that were previously reported in the St Francis River system, but were not found during this survey, were the federally endangered pink mucket (*Lampsilis abrupta*) (Oesch 1984), southern hickorynut (*Obovaria jacksoniana*), monkeyface *(Quadrula metanevra),* slippershell mussel *(Alasmidonta viridis),* and washboard *(Megalonaias nervosa)* (Bates and Dennis 1983, Oesch 1984, Boone 2001, MDC 2004). These species were rare in previous surveys and it is possible that they still occur in the St. Francis system (Table 1). Thus the fauna may be expected to total at least 47 species.

Comparisons with previous surveys - St Francis River

MDC personnel and Ron Oesch conducted surveys in the St. Francis River at various times from 1965-1985 (MDC 2004a). We were able to visit 28 localities that were previously surveyed. The most abundant species in past collections were the mucket (36.9%), plain pocketbook (14.2%), fatmucket (10.9%), Ouachita kidneyshell (7.5%) and spike (6.0%) (Table 7). This list can be compared to our relative abundance results (Figure 55). One striking difference is in relative abundance of Ouachita kidneyshell. Muckets were the dominant species in previous surveys, but Ouachita kidneyshell was most abundant in our collections. Rabbitsfoot were more numerous in past collections (68/4,296=1.6%) than in the present study (11/4,259=0.3%). While these differences may indicate overall changes in relative abundances, it should be noted that sampling techniques were not constant between past and present surveys. Much of the previous sampling was conducted using view buckets and snorkeling. Although we did snorkel in shallow areas, we also regularly used a surface air supply to investigate deeper areas of the river for long periods of time. Also, we vigorously disturbed the substrate to collect specimens that were totally buried and not visible through visual inspections.

Longitudinal distribution- St Francis River

The St. Francis basin is almost equally divided (north and south) between the high-relief Ozark Plateau and the low-relief Mississippi Alluvial Plain. Wappapello Dam and Lake

are located on the divide (Boone 2001). The mussel fauna in the headwaters of the St. Francis yielded a relatively low CPUE and species diversity (Figures 52-53). Upstream of SFRM 218 (Millstream Gardens) the river substrate contains large amounts of igneous rock from the Ozark uplift (St. Francois Mountains), and is sometimes lacking the finer substrate categories such as gravel. Channel substrates contain a significant proportion of stable cobble, stone and boulders. The areas in which mussels were collected were often small and patchy.

The middle section (SFRM 218-172.1) of the St. Francis had the highest CPUE and species diversity. This section, although still possessing large amounts of cobble and boulders, contains more gravel and fine grained substrate types. In these areas, with the heterogeneous substrates, high-density mussel beds were observed. This was also the section of river that yielded large numbers of SCC species including: *Alasmidonta marginata, Cyprogenia aberti, Epioplasma triquetra, Ligumia recta, Ptychobranchus occidentalis, Quadrula cylindrica* and *Toxolasma lividis.*

Flow in the lower St. Francis subbasin is regulated by Wappapello Dam, however extensive infiltration produces abundant groundwater supplies, high base flows, and a water table high enough to maintain standing water in large drainage ditches during prolonged dry periods. Immediately downstream of Wappapello Dam (SFRM 137.5) CPUE and species diversity were high, but then sharply declined (Figures 52-53). This result is not surprising, given that the river in this section is relatively slow with a homogeneous clay and sand substrate, conditions that are unfavorable for many mussel species. Excessive streambank erosion and headcutting are serious problems in the channelized section of the lower subbasin. Excessive sedimentation is occurring below these channelized sections.

Recruitment - St Francis River

Our data suggest good recruitment of mussels in the St. Francis River system (Figure 54, Appendix F). We found numerous young individuals (0-5 yr) of Ouachita kidneyshell (n=88), western fanshell (n=50), fragile papershell (n=50), yellow sandshell (n=48), pimpleback (n=43) and broken ray (n=43). Overall, we collected young specimens of 35 species in all areas of the river and also in many of the tributaries including the drainage ditches in the lower subbasin. It should be noted that qualitative sampling is biased towards collecting older, larger mussels (Negus 1966). Individuals less than 50 mm in length are difficult to find without excavation and sieving of the substrate, which we did not perform (Miller et al. 1993, Strayer et al. 1997). Therefore, the length-class distributions from our samples (Figure 54, Appendix F) almost certainly underestimate numbers of smaller individuals. However, our search techniques were adequate for finding at least some percentage of younger (2-5 yr) specimens for the more common species (see Appendix F). Although populations of abundant species appear to be comprised by a high percentage of old individuals, recruitment is evident.

Species of Concern - St. Francis River

Distribution maps for species of conservation concern and most other species encountered during our study appear in Figures 12-47. Specific river miles, age estimates, and lengths of all specimens collected are reported in Appendix F.

Bankclimber, *Plectomerus dombeyanus*

The bankclimber has a state rank of S3 and a global rank of G4 (MDC 2004b). The historical distribution of this species is the Mississippi River valley from southeast Missouri to Louisiana. It inhabits stream beds with sluggish current and is often collected in shallow water near stream banks (Oesch 1984). In Missouri, it has been reported from the Black and St. Francis River systems as well as some of the other large drainage ditches in the Bootheel region.

We collected a total of 33 live bankclimbers from the St. Francis River and the Mingo River (Table 6, Figure 56). Relative abundance was 0.43%. We did encounter the bankclimber above Lake Wappapello. The majority of our specimens were collected approximately 0.5 mi downstream of the dam at SFRM 138. The channel substrate was silt/sand/gravel and the flow was moderate. This site contained a high abundance and diversity of mussels. Making our way downstream, we collected bankclimbers only sporadically for the next 40 river miles. The river mainstem in the lower subbasin tends to contain only fine-grained sediments and very little gravel. We also collected bankclimbers in ditches which tended to consist of clay with pockets of sand and silt. These were small bodies of water with the majority of mussels congregating around riprap riffles from road crossings. Overall, the bankclimber was scarce in the lower subbasin, but no more so than other species in the lower subbasin. It still exists regularly, although not abundantly, in the lower St. Francis River subbasin.

Black sandshell, *Ligumia recta*

The black sandshell has a state rank of S1-S2 and a global rank of G5 (MDC 2004b). It has a large range and occurs throughout the Mississippi River system from New York to Minnesota, south to Oklahoma and east to the Alabama River basin, the Red River of the North, and the St. Lawrence River basin (Parmalee and Bogan 1998). In Missouri, it is known from the Black, Osage, White, Gasconade, Mississippi, Salt, Des Moines, Platte, Neosho, Meramec, Blackwater and St. Francis River basins (Utterback 1915, 1917; Oesch 1984; Barnhart 1999).

In our survey, a total of 1 living black sandshell was collected at 1 site in the St. Francis River (Table 6, Figure 57) at SFRM 172.1, and was found weathered dead at one site in the Little St. Francis River (LSFRM 5.2). The site where the live specimen was collected is adjacent to Camp Lewallen (Boy Scouts of America). This site yielded the highest CPUE and the highest species count of any survey site on the St. Francis River. The site is riffle/run and is only about 50 meters long. The extreme rarity of live black sandshell

suggests that this species has been drastically reduced and may soon be extirpated from the St. Francis River system.

Elktoe, *Alasmidonta marginata*

The elktoe has a global rank of G4 and a state rank of S2 (MDC 2004b). It is a widespread species, but records are sporadic throughout its range (Cummings and Mayer 1992). The historical distribution of *A. marginata* was the upper Mississippi, Ohio, Cumberland, Tennessee, Michigan, and upper St. Lawrence drainages (Burch 1975). Utterback (1915, 1917) reported this species from the Mississippi, Gasconade, and Jack's Fork rivers and from the Osage, Meramec, Neosho, Black and St. Francis river basins. More recently, this species was collected from the Whitewater, Black, St. Francis, Cuivre, Salt, Gasconade, Sac, Pomme de Terre, Current, James, Elk, Spring, and North Fork of the White rivers (Oesch 1984).

In our survey, the elktoe was a rare species. We collected 9 live elktoe at 4 sites and 1 weathered dead specimen at 1 site. (Table 6, Figure 58). The majority of the live specimens were collected at SFRM 172.1 (Camp Lewallen). Other sites with live elktoe were SFRM 207.8 (Near Highway E), SFRM 215 (at Highway O), and SFRM 218 (just upstream of Millspring Gardens). All of the elktoe were collected in riffle habitat and were only slightly buried in the substrate. The 9 specimens collected yielded a relative abundance of 0.12%. Overall, the extreme rarity of this species suggests that it may become extirpated from the St. Francis River system.

Flat Floater, *Anodonta suborbiculata*

The flat floater has a global rank of G5 and a state rank of S2 (MDC 2004b). It has a large historic range with reported occurrences throughout the Mississippi River floodplain. Presently, the range of this species can be described as locally abundant in the floodplain lakes, sloughs, and oxbows of the Mississippi and Ohio rivers and their tributaries (Cummings and Mayer 1992). In Missouri, it has been reported from the Missouri, St. Francis, and Osage River basins.

In our survey, the flat floater was a very rare species. We collected 5 live specimens at 1 site in the Indian Hill Slough and 2 fresh dead specimens at 2 sites in Mingo National Wildlife Refuge (Table 6 - Figure 59). The live specimens collected yielded a relative abundance of 0.06%. The site (Indian Hill Slough) where the live flat floaters were collected is unimpressive, the substrate is pure silt and the mussels were deeply buried. There is negligible flow in this area and the habitat resembles a lake. The water level is not deep (~1 m) and the banks are stable as there is no flow to cause erosion. Other species collected at this site in high numbers were giant floater (n=34) and the Texas lilliput (n=24). Some of the specimens were quite large, but others were very young. The silt was so soft that groping mussels was quite easy and productive. Although we did not encounter many flat floaters, it appears logical that other populations might occur in similar habitats elsewhere in the St. Francis system.

Ouachita kidneyshell, *Ptychobranchus occidentalis*

The Ouachita kidneyshell has a global rank of G3/G4 and a state rank of S2/S3 (MDC 2004b). The species is endemic to the Ozark and Ouachita highlands in Missouri, Kansas, Arkansas and Oklahoma. Specifically, it is known from the upper Arkansas, Red, Ouachita, Black, White and St. Francis River systems (Roberts et al. 1997). In Missouri, it occurs in streams along the southern slope of the Ozark highlands. These streams include the St. Francis, Niangua, Black, Little Black, Current, Eleven Point, James, North Fork of the White, and Spring Rivers, and in Flat, Bryant, Swan and Beaver Creeks (Oesch 1984, Buchanan 1996).

In our St. Francis River survey, the Ouachita kidneyshell was the most abundant species collected and comprised 27.6% of our total catch (Table 6, Figure 60). We collected this species from SFRM 219 to 172, primarily in shallow riffles with gravel/cobble in moderate to swift flow. At certain sites (SFRM 172.1, 190.5, 194 and 207.8), hundreds of Ouachita kidneyshell were observed including scores of juveniles. This species comprised a higher proportion of the total catch than in past surveys (Appendix G). However, even though this species was dominant in our collection, it only occurred live at 23.6% of our survey sites. Many other species that were much less numerous, occurred at a much higher percentage (45-55%) of survey sites. As long as this highly productive section of the St. Francis remains healthy, the Ouachita kidneyshell should remain secure.

Purple lilliput, *Toxolasma lividis*

The purple lilliput has a global rank of G2 and a state rank of S2 (MDC 2004b). The purple lilliput's historical distribution is in the Ohio, Tennessee, Cumberland and Arkansas river basins from Ohio and Virginia through Tennessee, west into Missouri and Oklahoma, and south through Arkansas (Parmalee and Bogan 1998). In Missouri, it has been recorded from the St. Francis, Black, James, Current, North Fork of the White, Spring, White, Little Black, Jack's Fork and Elk Rivers, and in Finely, Frederick and Shoal Creeks (MDC 2004b).

In our survey, the purple lilliput was an extremely rare species. We collected a total of 5 live specimens from 3 sites (SFRM 182, 183.5, and 218) in the St. Francis River with a relative abundance of 0.06% (Table 6, Figure 61). At all three sites it was found in shallow riffles with gravel substrate and moderate flow. This species has always been rare in Missouri, and was infrequently observed in past surveys of the St. Francis Riversystem (Appendix G). Overall, the rarity of this species suggests that it is at risk of being extirpated from the St. Francis River system.

Rabbitsfoot, *Quadrula cylindrica*

The rabbitsfoot has a global rank of G3 and a state rank of S1 (MDC 2004b). The historical distribution of this species is mainly the Ohio River system, including the Tennessee and Cumberland rivers and the Mississippi River system from Northern Louisiana north to Missouri and western Oklahoma. In Missouri it has been reported from the Spring (Upper Arkansas system), Black and St. Francis Rivers (Oesch 1984).

In our survey, the rabbitsfoot was a rare species. We found a total of 16 live specimens at 3 sites (SFRM 172.1, 183 and 190.5) in the St. Francis River with a relative abundance of 0.21% (Table 6 - Figure 62). At all three sites, this species was found at the margins of shallow riffles with gravel substrate in reduced flow. Almost without exception, live specimens were observed significantly sticking out of the substrate making them quite easy to detect. In past surveys of the St. Francis River system rabbitsfoot was also rarely collected. All past records were reported from the same portion of river as the present collection (Appendix G). Thus, this species remains rare and it appears to be at risk of being extirpated from the St. Francis River system in Missouri

Rock Pocketbook, *Arcidens confragosus*

The rock pocketbook has a global rank of G4 and a state rank of S3 (MDC 2004b). Its range includes the Mississippi River and major tributaries from Minnesota to Louisiana, as well as several other Gulf river systems from Texas to Alabama (Clarke 1981, Parmalee and Bogan 1998). In Missouri, it has been reported from the Missouri River (south of St. Louis), lower Meramec River, St. Francis River, Little Black River, and Osage River (Buchanan 1980, Oesch 1984, Buchanan 1996). Rock pocketbooks appear to be more common in the man-made agricultural ditches in southeast Missouri (Ahlstedt and Jenkinson 1987, Roberts et al. 1997, Barnhart 1998).

In our survey, the rock pocketbook was a very rare species. We collected a total of 6 live rock pocketbooks (Table 6, Figure 63). In the St. Francis River, we collected one individual at SFRM 20.0 approximately one mile downstream of Ben Cash Conservation Access. We also found live rock pocketbooks in Indian Hill Slough near Highway V and at two sites in the Mingo River. The substrate in this area of Missouri is comprised of primarily sand and silt. All of the live specimens were collected by groping, as the water clarity was too low for snorkeling. Water depths ranged from 1-2 meters and flow was slow to negligible. Although this species is rare, it occurs in habitats that are common in ditchesthroughout the lower St. Francis subbasin (Bootheel of Missouri). Therefore, it may be more abundant than our data reflects.

Snuffbox, *Epioblasma triquetra*

The snuffbox has a global rank of G3 and is listed as Missouri State Endangered (S1) (MDC 2004b). It is widespread but rare throughout the Midwest, and inhabits medium to large rivers in riffles with moderate to swift current (Cummings and Mayer 1992). In

Missouri, it has been reported previously from the Meramec, Bourbeuse and St. Francis Rivers (Buchanan 1980, Oesch 1984).

In our survey, the snuffbox was a rare species (Table 6, Figure 64). We collected a total of 12 live specimens at adjacent sites in the St. Francis River (SFRM 172-182). This yielded a relative abundance of 0.16%. All were collected in small riffles in shallow water and in gravel/pebble substrate. Snuffbox was rare in the St. Francis River, and is apparently restricted to this approximate 10 mi section. This stretch of river is the only area where this species has been collected in past surveys (MDC 2004a). Overall, there appears to be danger of this species becoming extirpated from the St. Francis River basin in the future.

Texas lilliput, *Toxolasma texasensis*

The Texas lilliput has a global rank of G4 and a state rank of S3 (MDC 2004b). Its range includes the southern portion of the Mississippi River system. Inside its range, this species can be widely distributed, but usually inhabits small to medium streams or sloughs in fine-grained substrate in slow-flowing water. In Missouri, the Texas lilliput has been reported from Williams Creek, Brushy Creek and the Floodways of Dunklin County (MDC 2004a).

In our survey, the Texas lilliput was extremely rare (Table 6, Figure 65). We collected a total of 24 live individuals from a single site in the Indian Hill Slough in Dunklin County. This site was a backwater area with muddy substrate, low flow and water depth of 0.5-1.5 m. The specimens were collected by groping along the margins or by following "track mark" left by mussels. We found no other evidence of this species in the St. Francis River system. This is the first record of this species' occurrence in the St. Francis River system in Missouri, although it was collected in 1996 in the nearby drainage ditches in Dunklin County. The St. Francis River system is at the northern most extent of the Texas lilliput's range and its rarity is not unreasonable. Additionally, this species may very well be locally abundant in other ditches or sloughs in the lower St. Francis River subbasin.

Wartyback, *Quadrula nodulata*

The wartyback has a global rank of G4 and a state rank of S3 (MDC 2004b). Its historic range included much of the Midwest in the Mississippi and Ohio River systems. Presently it is considered uncommon, but can be locally abundant in large rivers or in the lower reaches of medium-sized rivers in fine-grained substrates. In Missouri it has been reported from the South Grand, Salt, North Fabius and Mississippi Rivers, and from the ditches of Dunklin County (MDC 2004a).

In our survey, the wartyback was extremely rare (Table 6, Figure 66). We collected a total of one live specimen from one site in Indian Hill Slough. This site was a run with fine-grained substrate, low flow, and a water depth of 1-4 m. Most mussels in these areas were located by groping, as water clarity was low. This is the first record of this species occurrence in the St. Francis River system in Missouri, although it was collected in 1996

in the nearby drainage ditches in Dunklin County (MDC 2004a). The wartyback may very well be present in other ditches or sloughs in the lower St. Francis River subbasin, however due to its extreme rarity it is at risk of extirpation from the St. Francis River system.

Western fanshell, *Cyprogenia aberti*

The western fanshell has a global rank of G2 and a state rank of S1S2 (MDC 2004a). As currently recognized, its distribution is limited to streams west of the Mississippi. However, recent genetic and physiological studies indicate that the populations currently classified as western fanshell are actually a species complex (Eckert 2003). In Missouri, western fanshell has been recorded from the Black, Little Black, Cane Creek, Current and Spring Rivers (Black/White river system), the St. Francis River, Castor River, and from the North Fork Spring River and Spring River (upper Arkansas system) (MDC 2004a).

In our survey, the western fanshell was common and often locally abundant at certain sites in the St. Francis River (Table 6, Figure 67). The majority (240/245) of live specimens collected came from SFRM 172.1-218, and the remainder were collected immediately downstream of Wappapello Dam (SFRM 138). This species was almost always collected in riffles and runs with moderate to high flow. Water depths ranged from 0.5-2 m and substrate was generally composed of gravel with some cobble. In addition to being locally abundant at many of our sites, this species is actively reproducing. Approximately 1/5 of the western fanshell in our collection were age 5 or younger. By and large, this species is a regular component of the mussel fauna in the upper subbasin and the population appears to be recruiting regularly.

Threats in the St. Francis River System

- There are certain areas that are listed under Section 303(d) of the Clean Water Act in the St. Francis River system. The Farmington West wastewater treatment plant (WWFT) affects approximately 1.5 miles of the upper St. Francis River. In this section, both biological oxygen demand (BOD) and ammonia standards are not met. Big Otter Creek, a tributary to Big Creek, has been affected by releases of heavy metals from the Doe Run Lead Smelter. Village Creek receives excessive sediment from Mine La Motte. Sawdust pile leachate and an unknown source decrease the pH at two locations on Trace Creek near Saco (MDNR 1998).

- Eight National Pollution Discharge Elimination System (NPDES) permitted wastewater discharges are located in the upper subbasin. Upgraded facilities and improved operation and maintenance of the municipal sewage systems have reduced the frequency of untreated effluent releases, which most often resulted in only minor aesthetic impacts on six miles of permanent streams (MDNR 1984). Filamentous algal blooms often occur during the summer in the mainstem below Farmington, which indicates nutrient enrichment and the potential for periods of low dissolved oxygen (Boone 2001).

- There is nutrient and pesticide loading from agricultural runoff (90% of the lower watershed is in cropland and pasture) in lower subbasin tributary ditches. The resulting enrichment can cause extreme turbidity, excessive growth of aquatic plants, and low dissolved oxygen concentrations, which can cause localized fish kills during summer low flow periods (MDNR 1984). Pesticide residues are present in surface and shallow groundwater supplies throughout the subbasin. Two percent of 124 wells in the alluvial aquifer exceeded drinking water standards for pesticides (atrazine, alachlor or metolachlor) and Nitrate-N levels were exceeded in 17 percent of the wells (MDNR 1984).

- Headcutting and rill/gully erosion are substantial problems upstream from the channelized sections in the lower mainstem. An extensive depositional area of sand and silt is located on a reach of the mainstem channel immediately downstream from the Wilhelmina Cutoff at SFRM 259.2. In this area, the river changes from a channelized reach (26 miles were cut off) to a natural meandering channel. The gradient decreases at this point, which causes the deposition. Another depositional area is downstream of the Highway 84/90 Bridge, west of Kennett, Missouri (Boone 2001). Generally, the mussel habitat in the lower St. Francis mainstem is poor. The majority of the riverbed is sand and we only encountered mussels near pockets of cobble/gravel or silt, which was rare. The ditches often provided better habitat than the mainstem.

- From about 1720 until 1947, lead, copper, nickel and cobalt ores were mined from several locations near Fredericktown (MDNR 1984). This mining activity has periodically affected water quality by contaminating localized surface water, groundwater, channel substrates, and vegetation with heavy metals and other harmful mine, mill, or smelter byproducts (MDNR 1986). The primary pollutants, which often exceed State Water Quality Standards, are lead, zinc, iron, nickel, copper, cobalt, cadmium, chromium, airborne sulfur dioxide and acidic water. Village Creek, Mill Creek and Toler Branch suffered from sedimentation from mine tailings. Goose and Saline creeks contained elevated levels of cobalt and nickel from artesian flow from the Madison Mine (Boone 2001).

- The Annapolis Lead Mine on Big Creek, the Pilot Knob Pellet Company on Brewers Creek, the Iron Mountain Mine on Indian Creek, and the Catherine Lead Mine on Logtown Branch all have tailing ponds or chat piles. Although safely contained at the present time, they have the potential to release toxic trace elements into receiving streams (Boone 2001).

- Another threat of heavy metal trace-element contamination is the ASARCO lead smelter near Glover, Missouri. Smelter runoff entering nearby Big Creek once violated zinc and cadmium standards (MDNR 1984), and smelter smoke stack emissions, containing high concentrations of sulfur dioxide, can have negative impacts on downwind plant and animal communities. In the late 1980s, a water treatment facility was constructed that was successful in meeting state standards for

zinc and cadmium (MDNR 1984). However, a health advisory was issued in 1999 by the Missouri Department of Health for Big Creek near Glover. Centrarchids, the only fish analyzed, were contaminated with lead. Subsequently, additional samples of centrarchids and catostomids were tested for contaminants. Although they did not exceed the action level of 300 ppb for lead, the advisory was continued in 2000 because of the previous results (Boone 2001).

- In June 1992, a breached tailings barrier at International Specialty Products spilled 1,500 cubic yards of non-toxic powdered rhyolite rock into Big Creek near Annapolis, Missouri. The spill deposited fine sediments, 2 f deep, for a distance of 1 mi and temporarily caused extreme turbidities for 15 mi. No fish were killed, but macroinvertebrate communities did not fully recover until most of the sediment had been flushed out of the system by early 1994 (Boone 2001). We did not collect any mussels in Big Creek and only collected a handful in sections of the St. Francis downstream of the confluence. However, this area is very close to the upper end of Lake Wappapello and may become impounded during high water years.

- Intensive poultry operations have increased in recent years. At present, 18 intensive poultry farms, all operating in Stoddard County, have the potential to cause water quality problems without proper waste control (Boone 2001).

- Wappapello Lake is slightly eutrophic; low dissolved oxygen concentrations normally develop in the hypolimnion during summer stratification. During the summer, high water temperatures can occur in the lower river throughout a 20-mile reach between the mouth of Mingo Ditch and the Wilhelmina Cutoff. This occurs because the channelized reach is wide and shallow with poor riparian vegetation that limits shading (Boone 2001). Although we found numerous mussels immediately downstream of the dam, the lower St. Francis mainstem did not provide suitable mussel habitat and mussels were only sporadically collected.

- Two permitted water supply surface withdrawals exist in the upper subbasin. Fredericktown removes water (425,000 gpd) from Fredericktown City Lake and Ironton and Arcadia remove 290,000 gallons per day from Shepherd Mountain Lake (Boone 2001).

- Irrigation is a major use of groundwater in the Bootheel. More than 500,000,000 gallons were used for irrigation in 1984 in each of Stoddard and Dunklin counties (MDNR 1986). Most of this water probably comes from shallow wells. MDNR (1986) indicated that no irrigation occurs in the upper subbasin (Boone 2001).

Management Recommendations- St. Francis

Aquatic habitats, riparian areas, and the watershed are typically in good condition in the upper subbasin. The channelized sections of the lower subbasin have been drastically altered and need rehabilitation. Headcutting, erosion and sediment deposition are serious problems. The U.S. Army Corps of Engineers (USCOE) has regulatory control over these channels. Improvements in the subbasin are possible through improved coordination with, and assistance to, the USCOE. Land management can be improved on public and private land. Through coordination and cooperation with other agencies, best management practices can be employed. Overall, water quality is generally good throughout the basin. However, mines, tailing ponds, chat piles, and inadequate wastewater treatment facilities can cause poor water quality. Lead smelting will continue to be a concern for Big Creek. High water temperatures in the channelized sections of the lower subbasin can pose problems for aquatic organisms.

Taking into consideration the number of mussel SCC in the St. Francis River system, a number of proactive measures should be initiated. Accomplishing this will necessitate the cooperation of several entities including: state and federal agencies, non-governmental institutions, private landowners and the general public. This system supports a diversity of other aquatic organisms, some of which are in decline such as six state endangered fishes (cypress minnow, taillight shiner, mountain madtom, crystal darter, harlequin darter and longnose darter). Recovery actions for these animal groups are comparable to those required for mussels. Suggested conservation measures would include the following:

1. Maintain or improve aquatic habitat conditions to meet the needs of native aquatic biota while accommodating society's demands for agricultural production and economic development. There will always be a need to maintain, expand, and restore riparian corridors, enhance watershed management, improve in-stream habitat, and reduce streambank erosion throughout the basin. Work with the Natural Resource Conservation Service (NRCS), Farm Service Agency (FSA), and Soil and Water Conservation Districts (SWCD) to provide and promote incentive programs that will improve conditions in the lower subbasin basin (e.g., fencing, corridor tree planting, livestock watering systems, pond construction). Also, encourage Missouri Department of Natural Resources (MDNR) to implement best reclamation techniques for mine tailing dams, ponds, and chat piles in the upper subbasin. Partnerships should be formed with other government and non-government natural resource agencies, private landowners, and businesses to promote proper land use practices. Strategies for accomplishing this goal are outlined in the National Strategy for the Conservation of Native Freshwater Mussels. (NNMCC 1999).

2. Identify new mussel beds and monitor select mussel beds that possess significant populations, are highly diverse, and demonstrate evidence of recruitment. Much of the diversity and abundance of unionids is found in mussel beds, which are isolated and patchily distributed. Long-term sampling of these areas is necessary to assess

population status and recruitment and to document the success of water restoration projects. Then, perhaps, threats to habitat can be identified before the river is negatively impacted.

3. Augment populations of the snuffbox by artificial propagation and release of juveniles at suitable sites. Repeat the process for other state SCC, as propagation techniques for these species are refined. Threatened species can greatly benefit from artificial propagation, which can potentially stabilize existing populations and restore lost populations. However, the success of this process depends on the identification of suitable habitat that is not in danger of degradation.

4. Work with the Missouri Department of Natural Resources to monitor water quality, improve water quality, and ensure compliance with discharge permits.

5. Inform the public of the significant natural resources that exist in the St. Francis River Basin, their status, and the threats that face them. Increasing public awareness can help encourage landowners and others to participate in conservation efforts.

Table 5. Mussel species reported from the St. Francis River system in Missouri. Species considered synonomies by Oesch (1984) are not listed. Sources: 1=Oesch 1984, 2=Bates and Dennis 1983, 3=MDC Naiad Database, 4=present study. Conservation ranks are from MDC 2004b.

	Species	Common Name	Global Rank	State Rank	Sources
1.	*Actinonaias ligamentina*	Mucket			1, 2, 3, 4
2.	*Alasmidonta marginata*	Elktoe	G4	S2	1, 3, 4
3.	**Alasmidonta viridis*	Slippershell			1*
4.	*Amblema plicata*	Threeridge			1, 2, 3, 4
5.	*Anodonta suborbiculata*	Flat floater	G5	S2	4
6.	*Arcidens confragosus*	Rock pocketbook	G4	S3	1, 2, 3, 4
7.	*Cyclonaias tuberculata*	Purple wartyback			1, 4
8.	*Cyprogenia aberti*	Western fanshell	G2	S2S2	1, 2, 3, 4
9.	*Elliptio dilatata*	Spike			1, 2, 3, 4
10.	*Epioblasma triquetra*	Snuffbox	G3	S1	1, 3, 4
11.	*Fusconaia flava*	Wabash pigtoe			1, 2, 3, 4
12.	*Lampsilis abrupta*	Pink mucket	G2	S2	1
13.	*Lampsilis cardium*	Plain pocketbook			1, 2, 3, 4
14.	*Lampsilis reeveiana*	Brokenray			1, 3, 4
15.	*Lampsilis siliquoidea*	Fatmucket			1, 2, 3, 4
16.	*Lampsilis teres*	Yellow sandshell			1, 2, 3, 4
17.	*Lasmigona complanata*	White heelsplitter			1, 2, 3, 4
18.	*Lasmigona costata*	Fluted shell			1, 2, 3, 4
19.	*Leptodea fragilis*	Fragile papershell			1, 2, 3, 4
20.	*Ligumia recta*	Black sandshell	G5	S1S2	1, 3, 4
21.	*Ligumia subrostrata*	Pondmussel			1, 3, 4
22.	*Megalonaias nervosa*	Washboard			1, 2, 3
23.	*Obliquaria reflexa*	Threehorn wartyback			1, 2 ,3, 4
24.	*Obovaria jacksoniana*	Southern hickorynut	G1G2	S1	3
25.	*Plectomerus dombeyanus*	Bankclimber	G4	S3	1, 2, 3, 4
26.	*Pleurobema sintoxia*	Round pigtoe			1, 2, 3, 4
27.	*Potamilus ohiensis*	Pink papershell			1, 3, 4
28.	*Potamilus purpuratus*	Bluefer			1, 2, 3, 4
29.	*Ptychobranchus occidentalis*	Ouachita kidneyshell	G3G4	S2S3	1, 3, 4
30.	*Pyganodon grandis*	Giant floater			1, 2, 3, 4
31.	*Quadrula cylindrica*	Rabbitsfoot	G3	S1	1, 3, 4
32.	*Quadrula nodulata*	Wartyback	G4	S3	4
33.	*Quadrula metanevra*	Monkeyface			1, 2, 3
34.	*Quadrula pustulosa*	Pimpleback			1, 2, 3, 4
35.	*Quadrula quadrula*	Mapleleaf			1, 2, 3, 4
36.	*Strophitus undulatus*	Creeper			1, 2, 3, 4
37.	*Toxolasma lividis*	Little purple	G2	S2	1, 3, 4
38.	*Toxolasma parvus*	Lilliput			1, 3, 4
39.	*Toxolasma texasensis*	Texas lilliput	G4	S3	4
40.	*Tritogonia verrucosa*	Pistolgrip			1, 2, 3, 4
41.	*Truncilla donaciformis*	Fawnsfoot			1, 2, 4
42.	*Truncilla truncata*	Deertoe			1, 2, 3, 4
43.	*Uniomerus tetralasmus*	Pondhorn			4
44.	*Utterbackia imbecillis*	Paper pondshell			2, 3, 4
45.	*Venustaconcha ellipsiformis*	Ellipse			4
46.	*Villosa iris*	Rainbow			1, 3, 4
47.	*Villosa lienosa*	Little spectaclecase			1, 2 ,3, 4

* apparently erroneous reference to Utterback (1915)

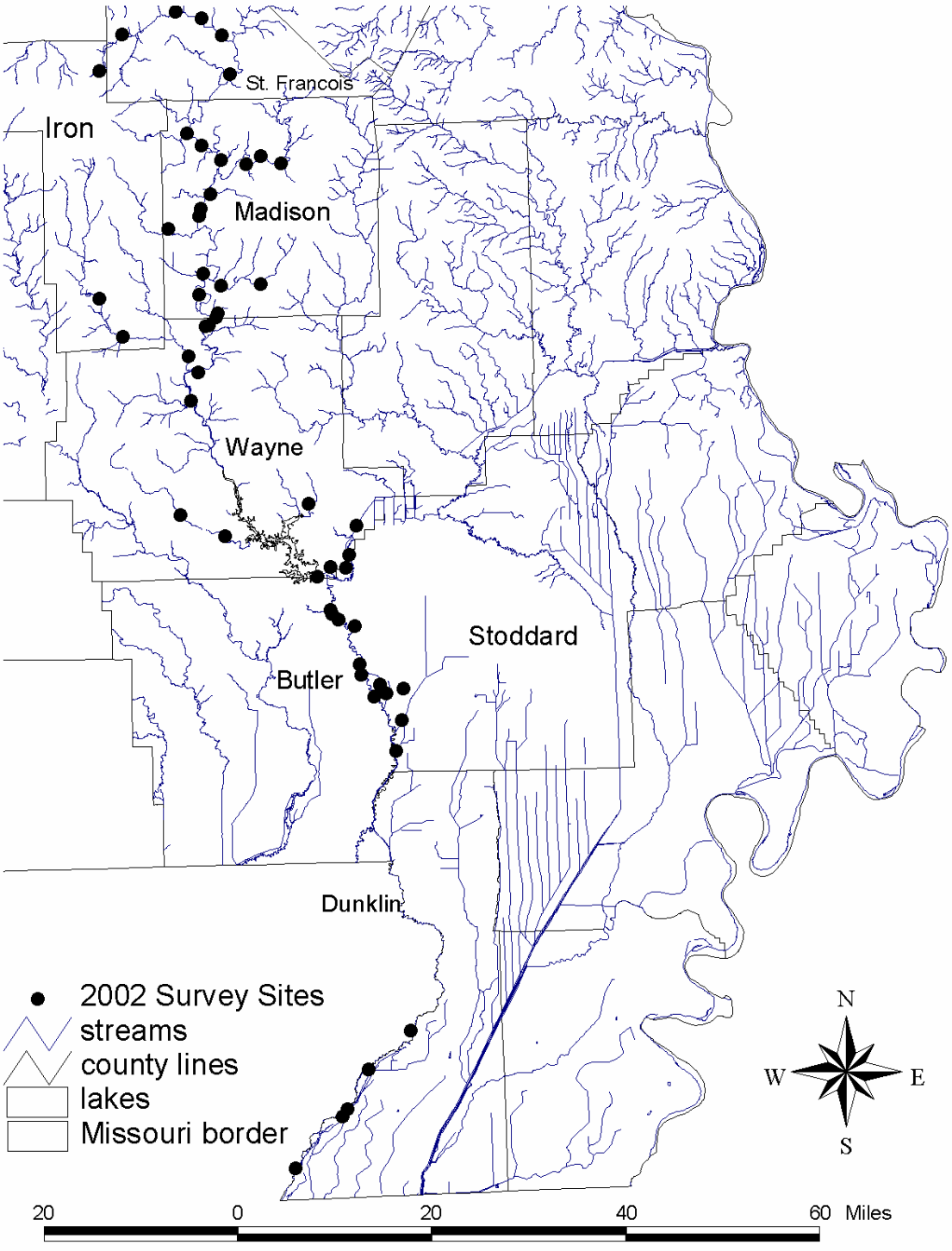

Figure 48. Distribution of 55 survey sites in the St. Francis River system..

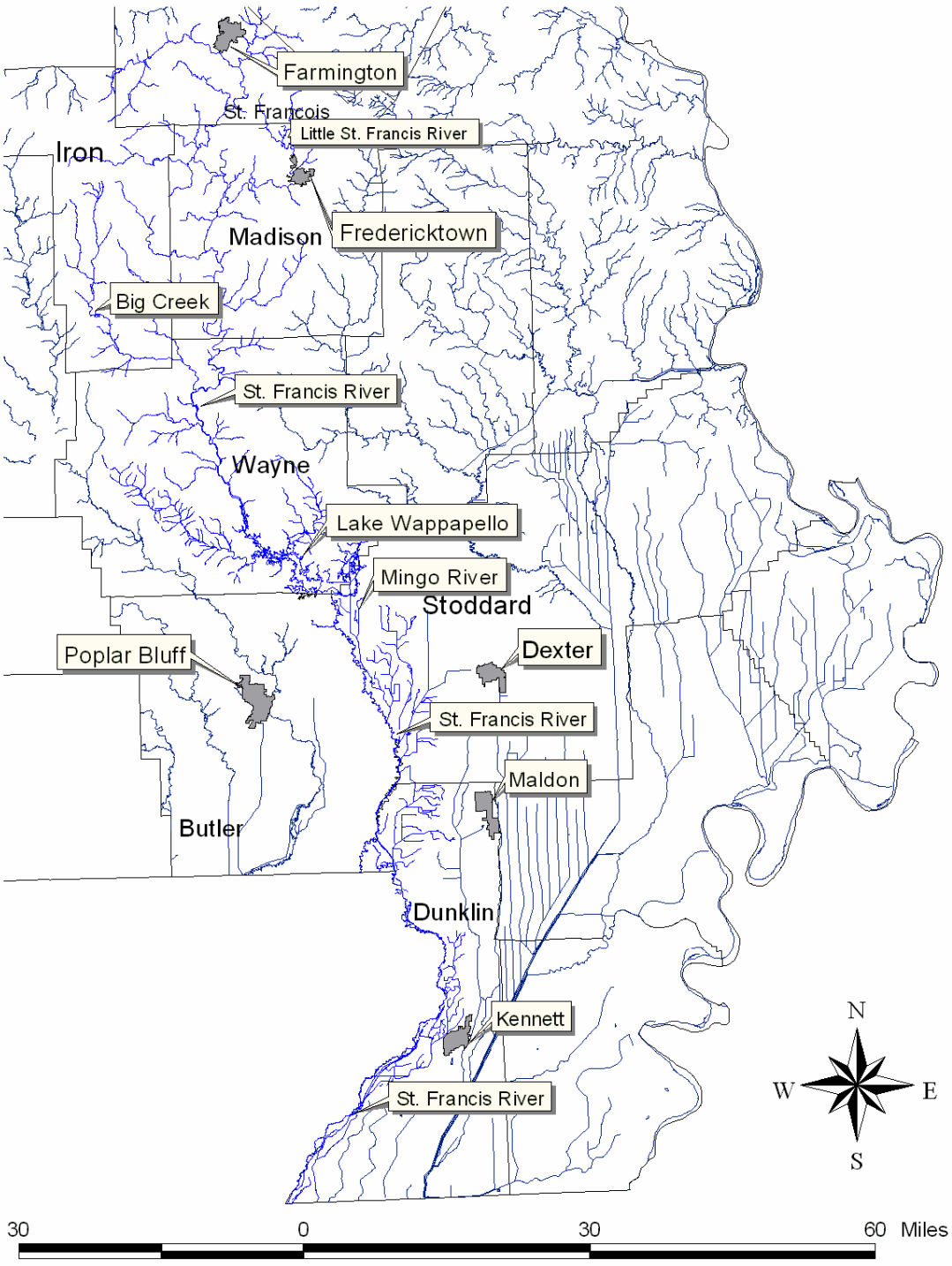

Figure 49. Landmarks in the St. Francis River basin, Missouri.

Table 6. Summary of sampling data for 42 unionid species collected in the St. Francis River system. Total sampling effort was 126 person-hours at 55 sites. Total live catch was 7,732 individuals.

	Species	Number of Live Individuals	Relative abundance (percent of total live catch)	Number of sites with live or fresh-dead individuals	Percent of sites with live or fresh-dead individuals
1.	*Ptychobranchus occidentalis*	2137	27.64	13	23.64
2.	*Actinonaias ligamentina*	1289	16.67	14	25.45
3.	*Amblema plicata*	955	12.35	24	43.64
4.	*Quadrula pustulosa*	945	12.22	16	29.09
5.	*Quadrula quadrula*	364	4.71	13	23.64
6.	*Lampsilis cardium*	285	3.69	31	56.36
7.	*Cyprogenia aberti*	245	3.17	12	21.82
8.	*Potamilus purpuratus*	231	2.99	26	47.27
9.	*Elliptio dilatata*	202	2.61	11	20.00
10.	*Lampsilis siliquoidea*	131	1.69	13	23.64
11.	*Lampsilis teres*	126	1.63	18	32.73
12.	*Fusconaia flava*	113	1.46	17	30.91
13.	*Leptodea fragilis*	104	1.35	21	38.18
14.	*Pleurobema sintoxia*	96	1.24	12	21.82
15.	*Lampsilis reeveiana*	81	1.05	14	25.45
16.	*Obliquaria reflexa*	79	1.02	11	20.00
17.	*Pyganodon grandis*	57	0.74	13	23.64
18.	*Lasmigona costata*	35	0.45	12	21.82
19.	*Plectomerus dombeyanus*	33	0.43	8	14.55
20.	*Potamilus ohiensis*	27	0.35	11	20.00
21.	*Toxolasma texasensis*	24	0.31	1	1.82
22.	*Venustaconcha ellipsiformis*	21	0.27	10	18.18
23.	*Quadrula cylindrica*	16	0.21	3	5.45
24.	*Strophitus undulatus*	15	0.19	11	20.00
25.	*Villosa iris*	14	0.18	6	10.91
26.	*Epioblasma triquetra*	12	0.16	3	5.45
27.	*Tritogonia verrucosa*	12	0.16	5	9.09
28.	*Lasmigona complanata*	10	0.13	6	10.91
29.	*Alasmidonta marginata*	9	0.12	5	9.09
30.	*Utterbackia imbecillis*	9	0.12	7	12.73
31.	*Ligumia subrostrata*	7	0.09	5	9.09
32.	*Truncilla donaciformis*	7	0.09	2	3.64
33.	*Truncilla truncata*	7	0.09	4	7.27
34.	*Arcidens confragosus*	6	0.08	4	7.27
35.	*Cyclonaias tuberculata*	5	0.06	1	1.82
36.	*Anodonta suborbiculata*	5	0.06	3	5.45
37.	*Toxolasma lividis*	5	0.06	3	5.45
38.	*Uniomerus tetralasmus*	5	0.06	1	1.82
39.	*Villosa lienosa*	5	0.06	5	9.09
40.	*Toxolasma parvus*	1	0.01	1	1.82
41.	*Ligumia recta*	1	0.01	1	1.82
42.	*Quadrula nodulata*	1	0.01	1	1.82

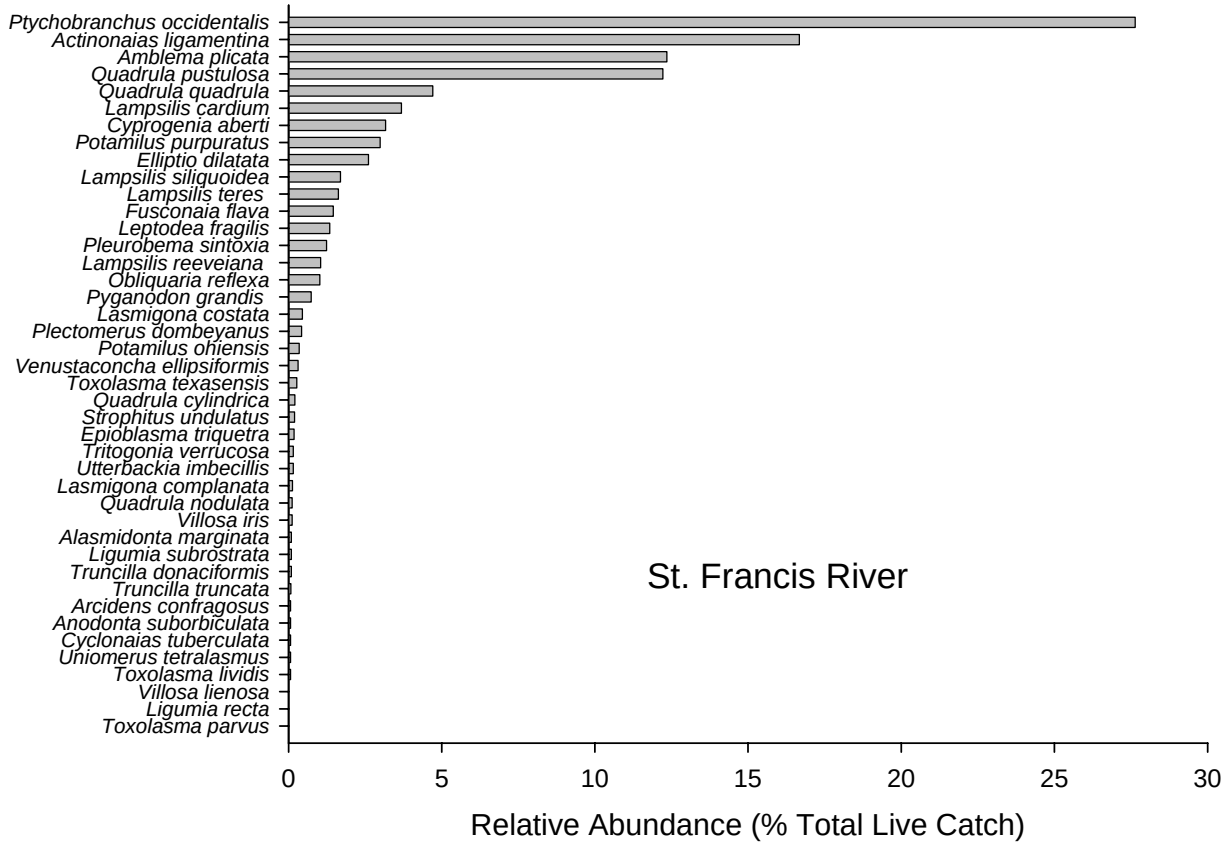

Figure 50. Relative abundance of species collected in the St. Francis River (see Table 6).

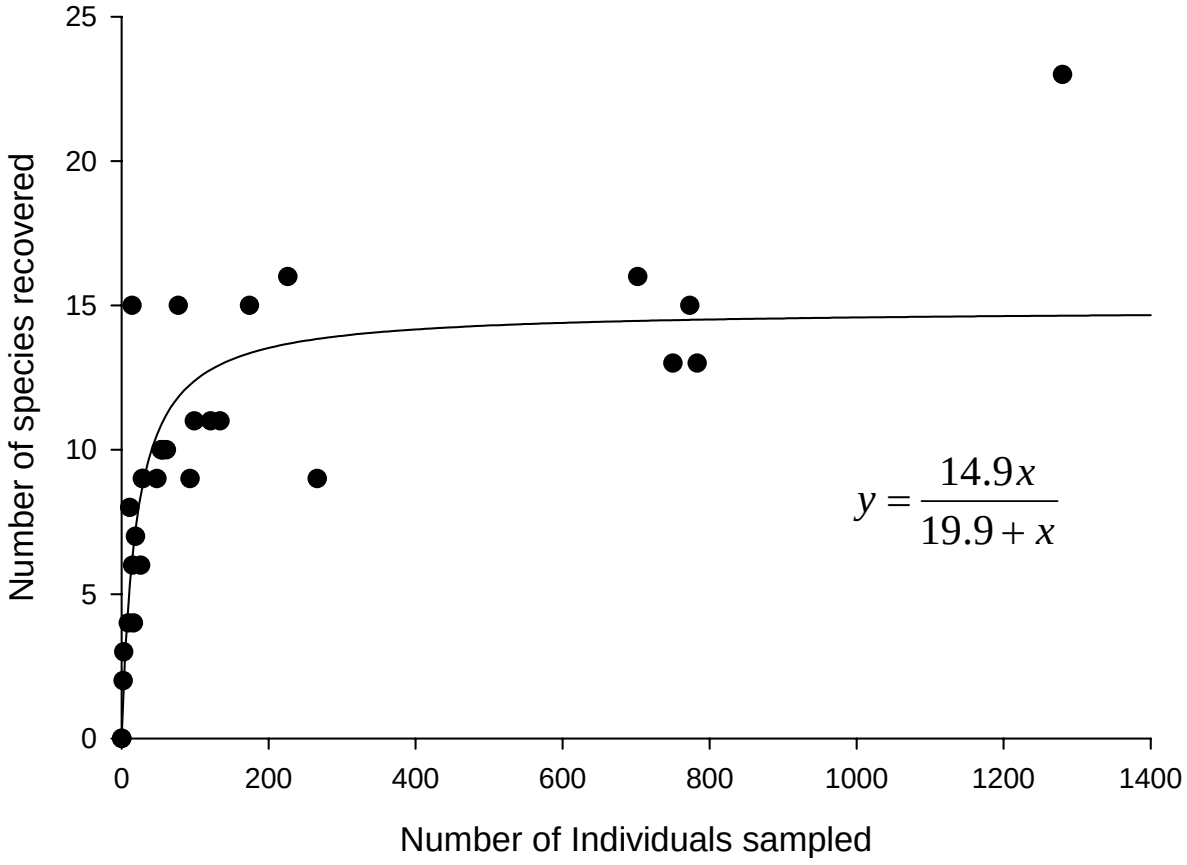

Figure 51. Number of species recovered versus sample size at sites in the St. Francis River. Hyperbolic regression: $p < 0.0001$, $R^2 = 0.69$.

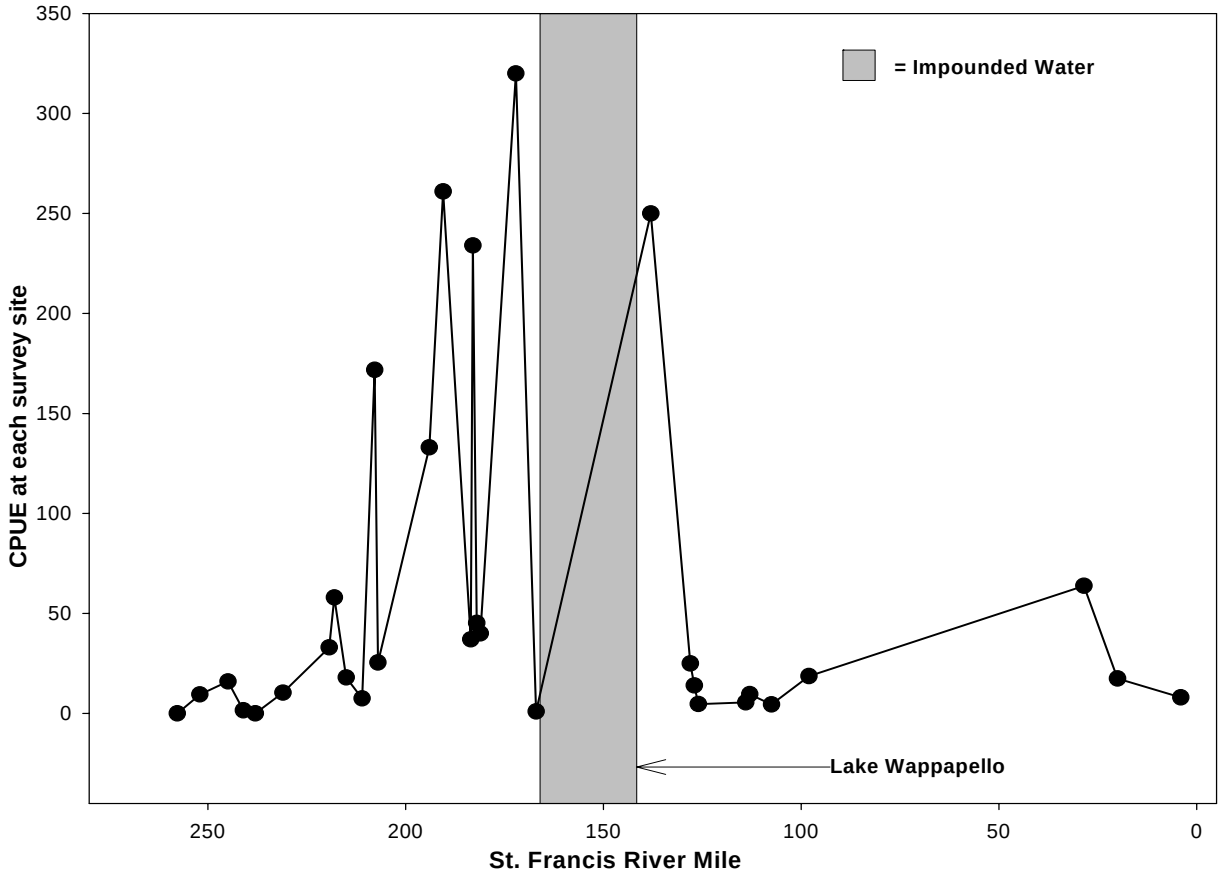

Figure 52. Longitudinal distribution of catch per unit effort (CPUE) at survey sites from the St. Francis River.

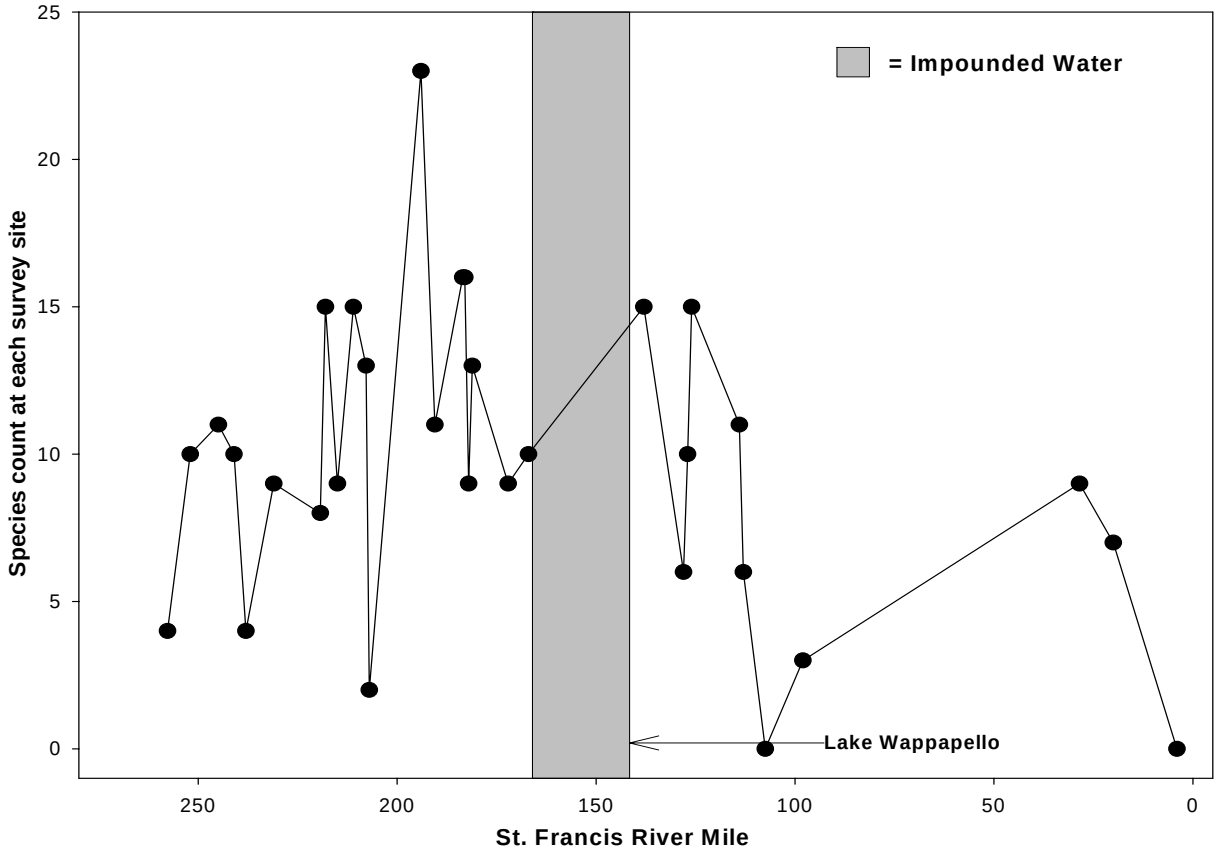

Figure 53. Longitudinal distribution of species counts at survey sites in the St. Francis River.

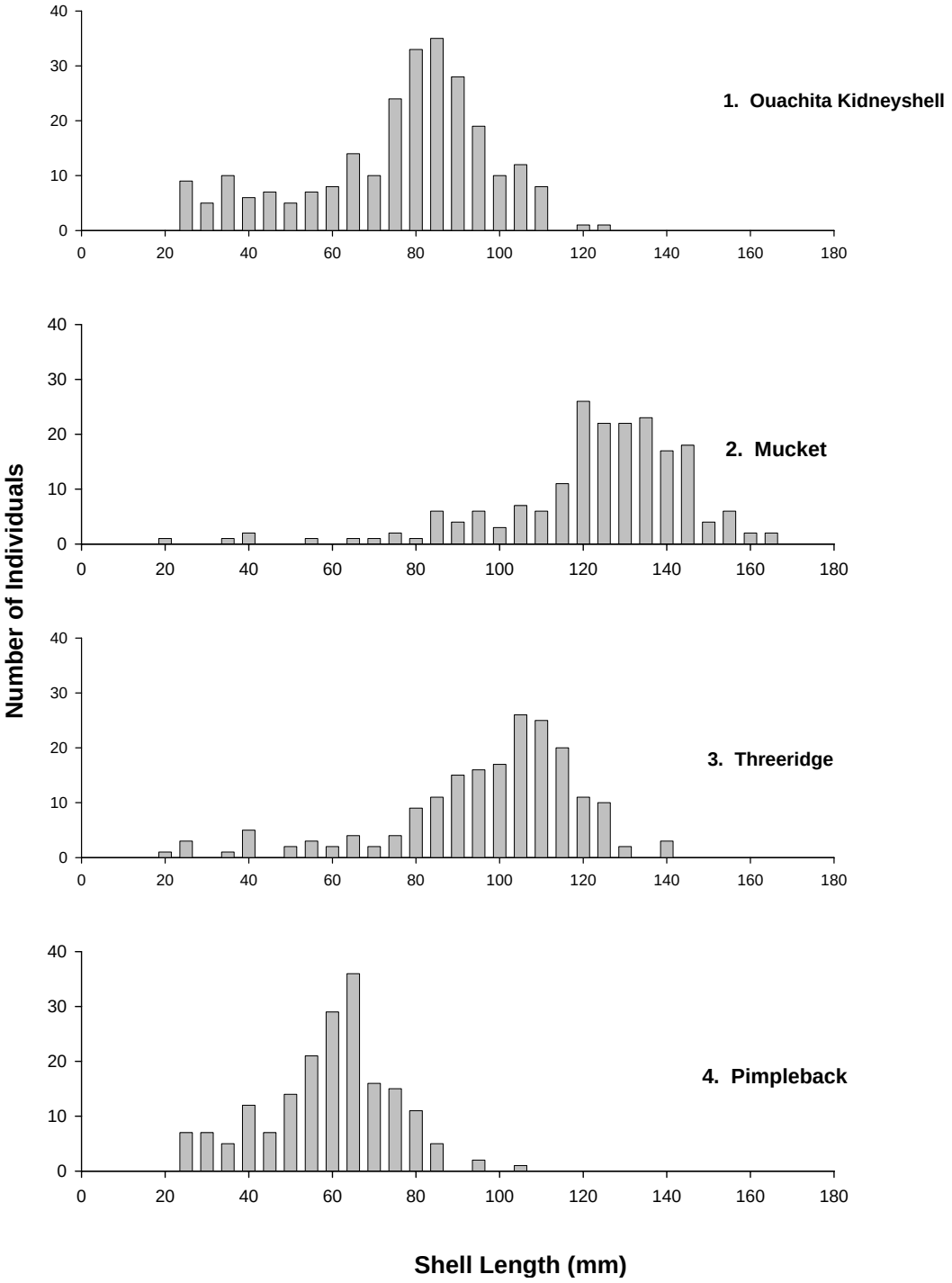

Figure 54. Shell length frequencies of the eight most abundant species in the St. Francis River basin.

.

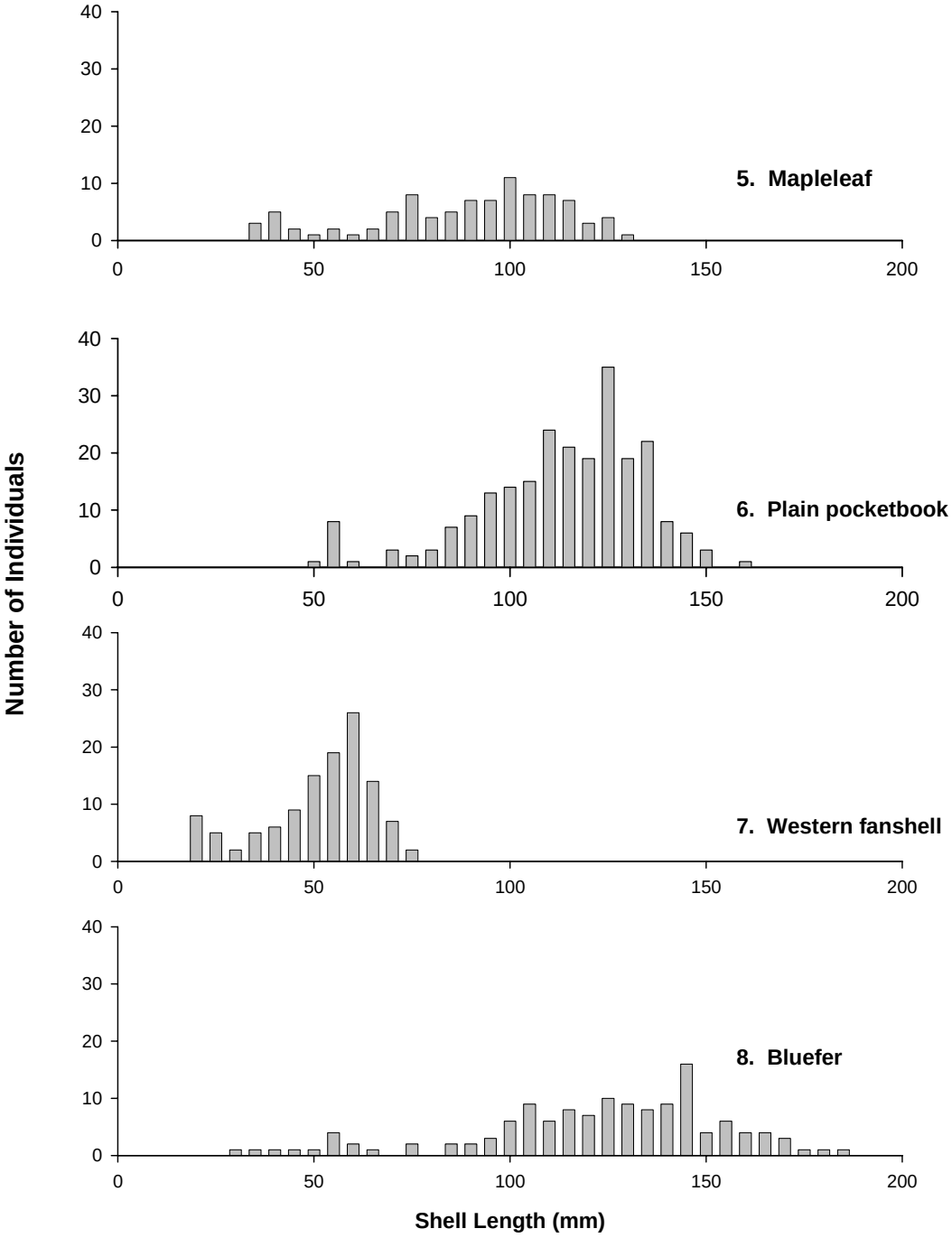

Figure 54, continued.

Table 7. Summary of re-survey data for 28 localities in the St. Francis River system (see Appendix G).

Species	Sites surveyed from 1969-1985		Sites surveyed from 2001-2002		Changes	
	No. of living individuals	Relative Abundance	No. of living individuals	Relative Abundance	Change in Relative Abundance	% Change between Surveys
Actinonaias ligamentina	1584	36.9	705	16.6	-20.3	-44%
Alasmidonta marginata	15	0.3	9	0.2	-0.1	-60%
Anodonta suborbiculata	10	0.2	0	0.0	-0.2	-0%
Amblema plicata	172	4.0	266	6.2	2.2	155%
Arcidens confragosus	4	0.1	1	0.0	-0.1	-25%
Cyclonaias tuberculata	0	0.0	5	0.1	0.1	0%
Cyprogenia aberti	173	4.0	212	5.0	1.0	122%
Elliptio dilatata	258	6.0	171	4.0	-2.0	-66%
Epioblasma triquetra	5	0.1	11	0.3	0.1	220%
Fusconaia flava	138	3.2	55	1.3	-1.9	-40%
Lampsilis abrupta	4	0.1	0	0.0	-0.1	-0%
Lampsilis cardium	611	14.2	234	5.5	-8.7	-38%
Lampsilis reeveiana	62	1.4	70	1.6	0.2	113%
Lampsilis siliquoidea	469	10.9	136	3.2	-7.7	-29%
Lampsilis teres	3	0.1	21	0.5	0.4	700%
Lasmigona complanata	0	0.0	0	0.0	0.0	0%
Lasmigona costata	57	1.3	36	0.8	-0.5	-63%
Leptodea fragilis	0	0.0	18	0.4	0.4	0%
Ligumia recta	14	0.3	1	0.0	-0.3	-7%
Ligumia subrostrata	37	0.9	6	0.1	-0.7	-16%
Obliquaria reflexa	6	0.1	38	0.9	0.8	633%
Megalonaias nervosa	2	0.0	0	0.0	0.0	0%
Obovaria jacksoniana	0	0.0	0	0.0	0.0	0%
Plectomerus dombeyanus	0	0.0	24	0.6	0.6	0%
Pleurobema sintoxia	30	0.7	53	1.2	0.5	177%
Potamilus purpuratus	68	1.6	34	0.8	-0.8	-50%
Potamilus ohiensis	0	0.0	5	0.1	0.1	0%
Ptychobranchus occidentalis	323	7.5	1523	35.8	28.2	471%
Pyganodon grandis	46	1.1	4	0.1	-1.0	-9%
Quadrula cylindrica	68	1.6	11	0.3	-1.3	-16%
Quadrula metanevra	6	0.1	0	0.0	-0.1	-0%
Quadrula nodulata	0	0.0	0	0.0	0.0	0%
Quadrula pustulosa	17	0.4	528	12.4	12.0	3106%
Quadrula quadrula	14	0.3	28	0.7	0.3	200%
Strophitus undulatus	46	1.1	7	0.2	-0.9	-15%
Toxolasma lividis	0	0.0	4	0.1	0.1	0%
Toxolasma parvus	10	0.2	0	0.0	-0.2	0%
Toxolasma texasensis	0	0.0	0	0.0	0.0	0%
Tritogonia verrucosa	5	0.1	3	0.1	0.0	60%
Truncilla donaciformis	5	0.1	4	0.1	0.0	80%
Truncilla truncata	6	0.1	2	0.0	-0.1	-33%
Uniomerus tetralasmus	1	0.0	0	0.0	0.0	0%
Utterbackia imbecillis	2	0.0	1	0.0	0.0	50%
Venustaconcha ellipsiformis	1	0.0	20	0.5	0.4	2000%
Villosa iris	3	0.1	9	0.2	0.1	300%
Villosa lienosa	21	0.5	4	0.1	-0.4	-19%
Total	**4296**		**4259**			

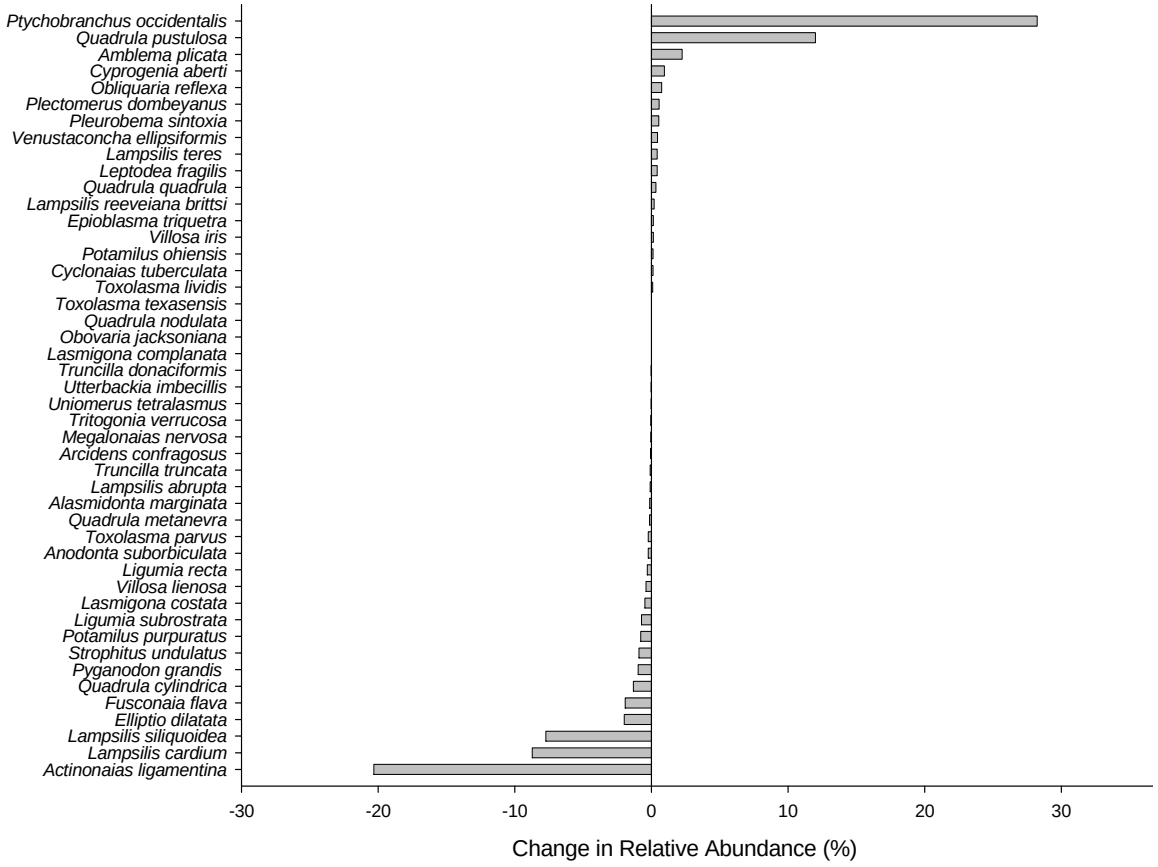

Figure 55. Change in relative abundance (% total live catch) at re-survey sites in the St. Francis River system, Missouri (see table 7).

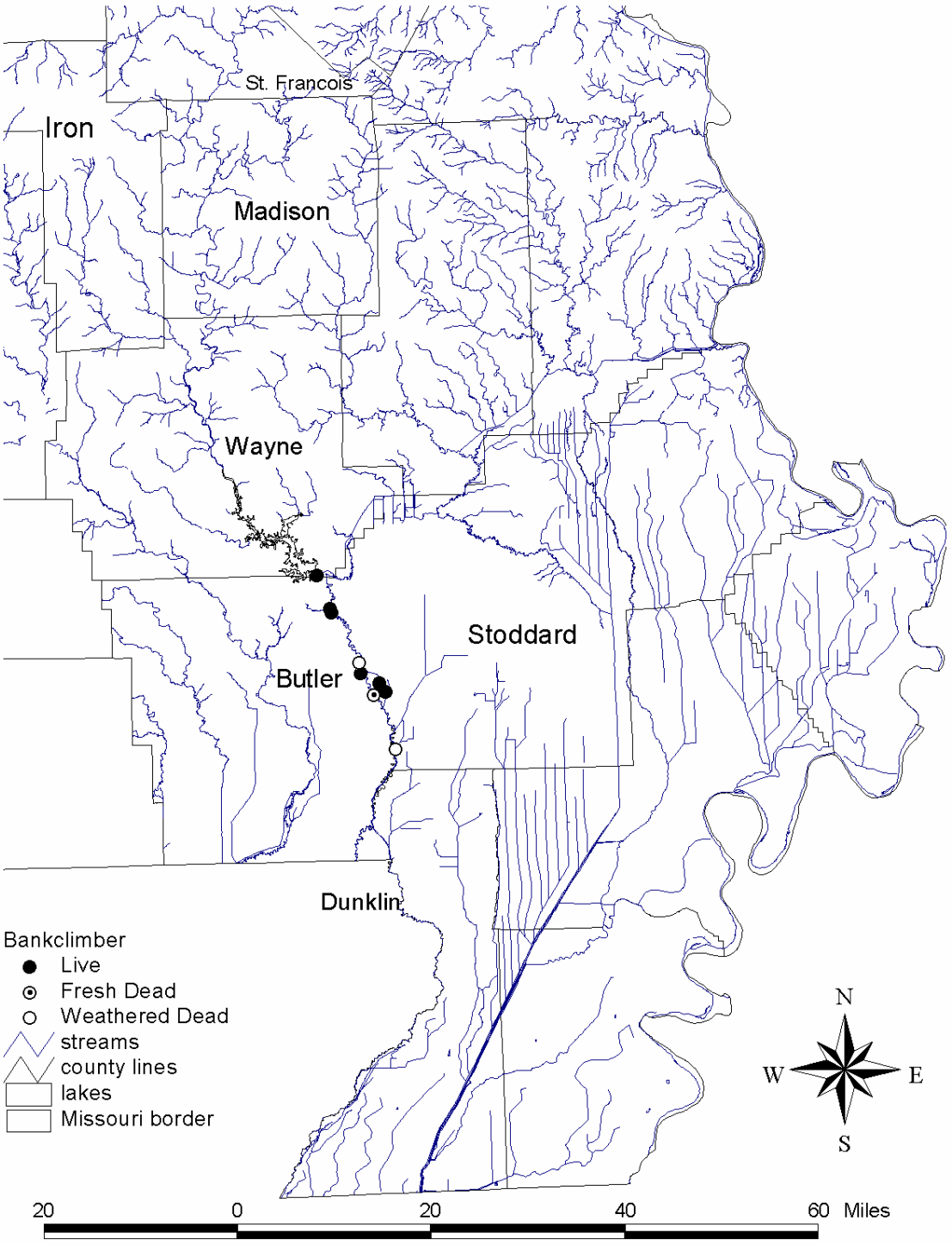

Figure 56. Distribution of the bankclimber in the St. Francis River system.

.

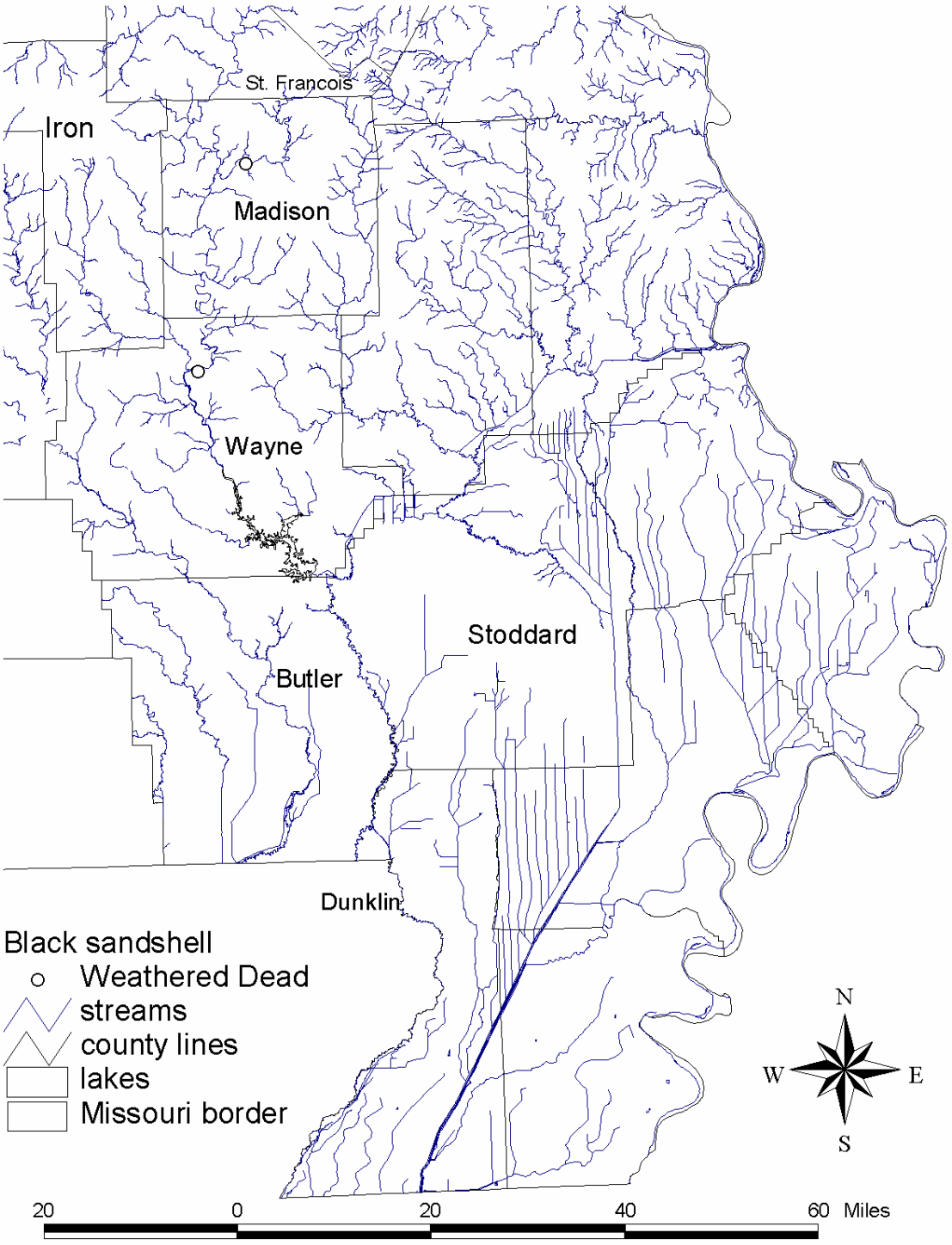

Figure 57. Distribution of the black sandshell in the St. Francis River system.

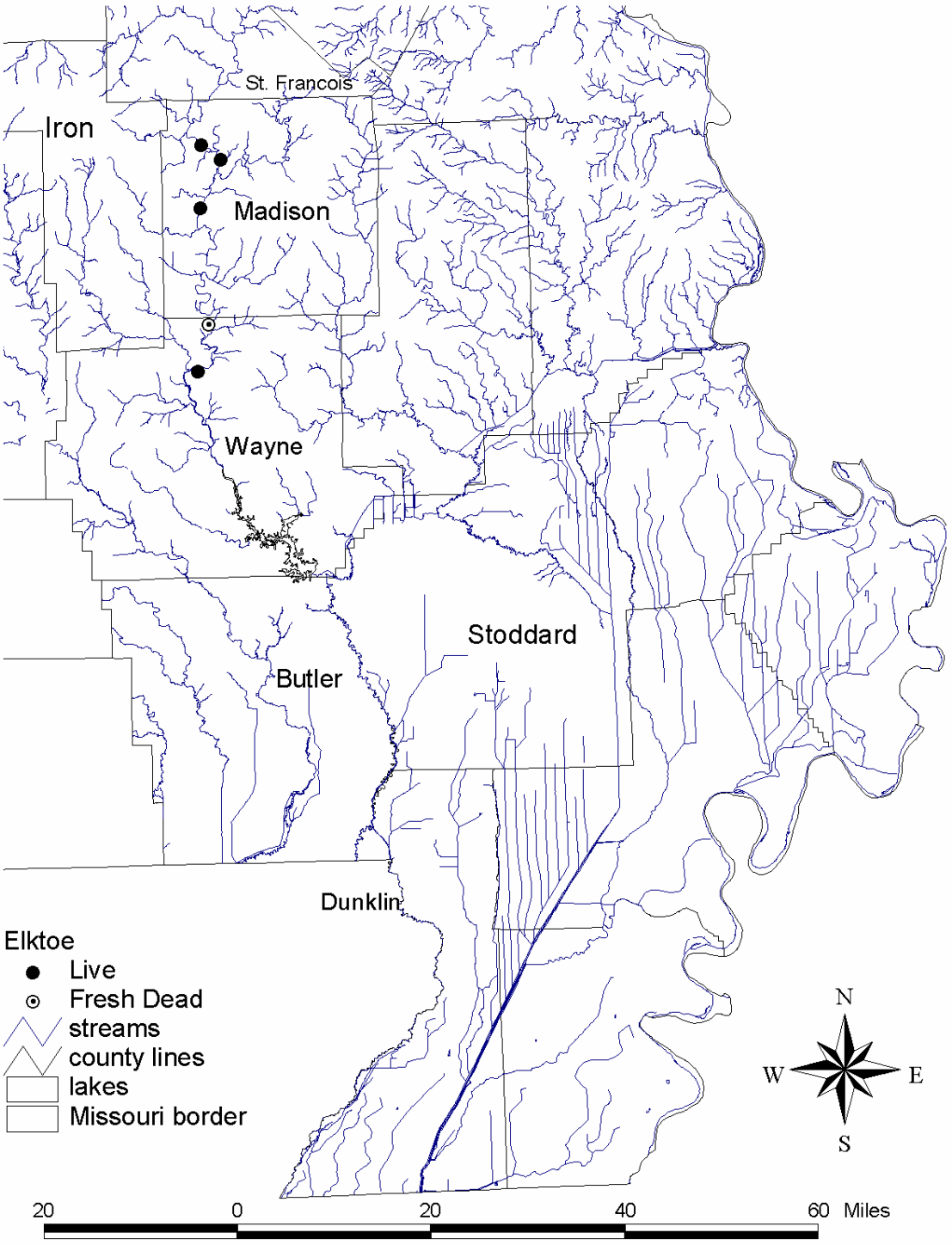

Figure 58. Distribution of the elktoe in the St. Francis River system.

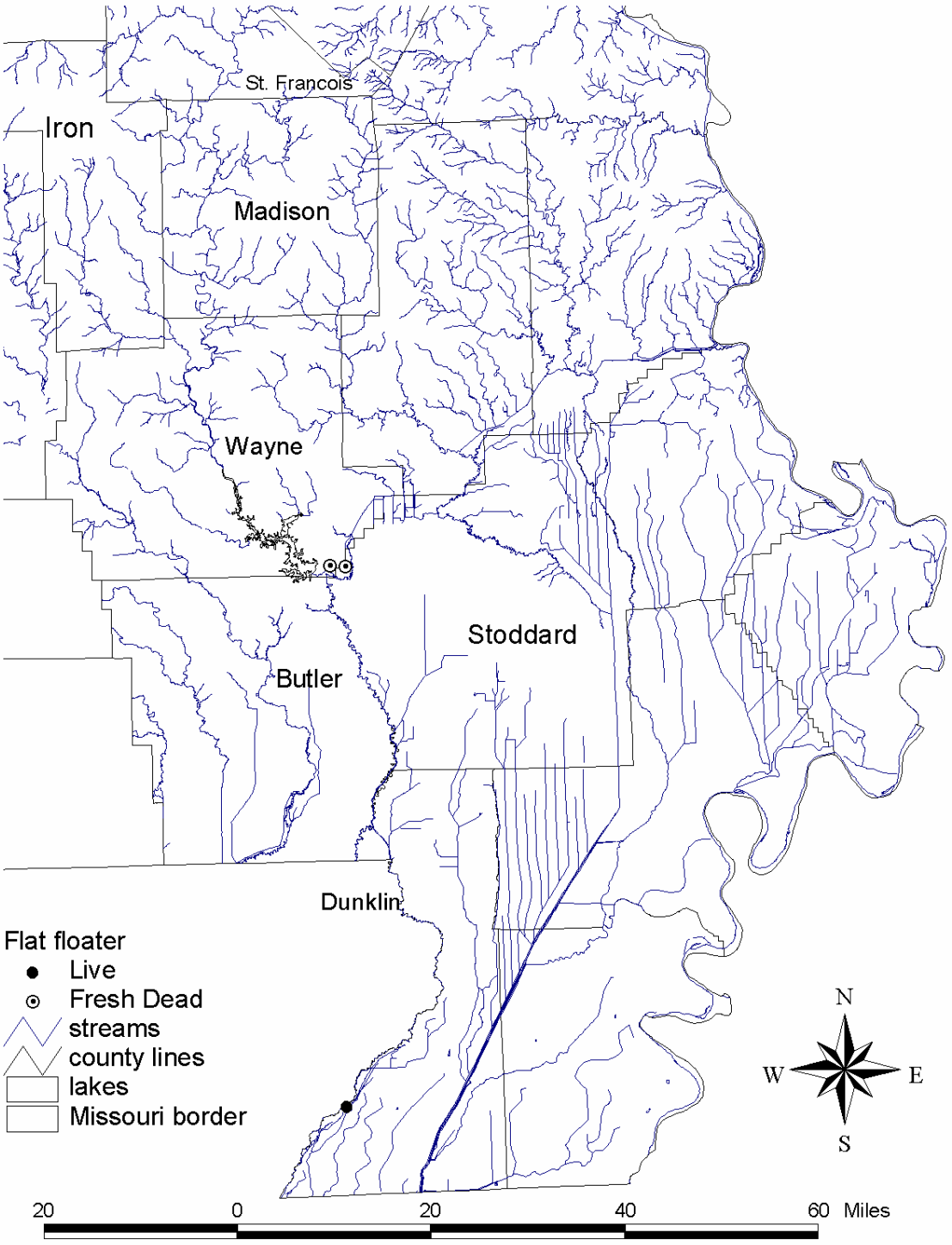

Figure 59. Distribution of the flat floater in the St. Francis River system.

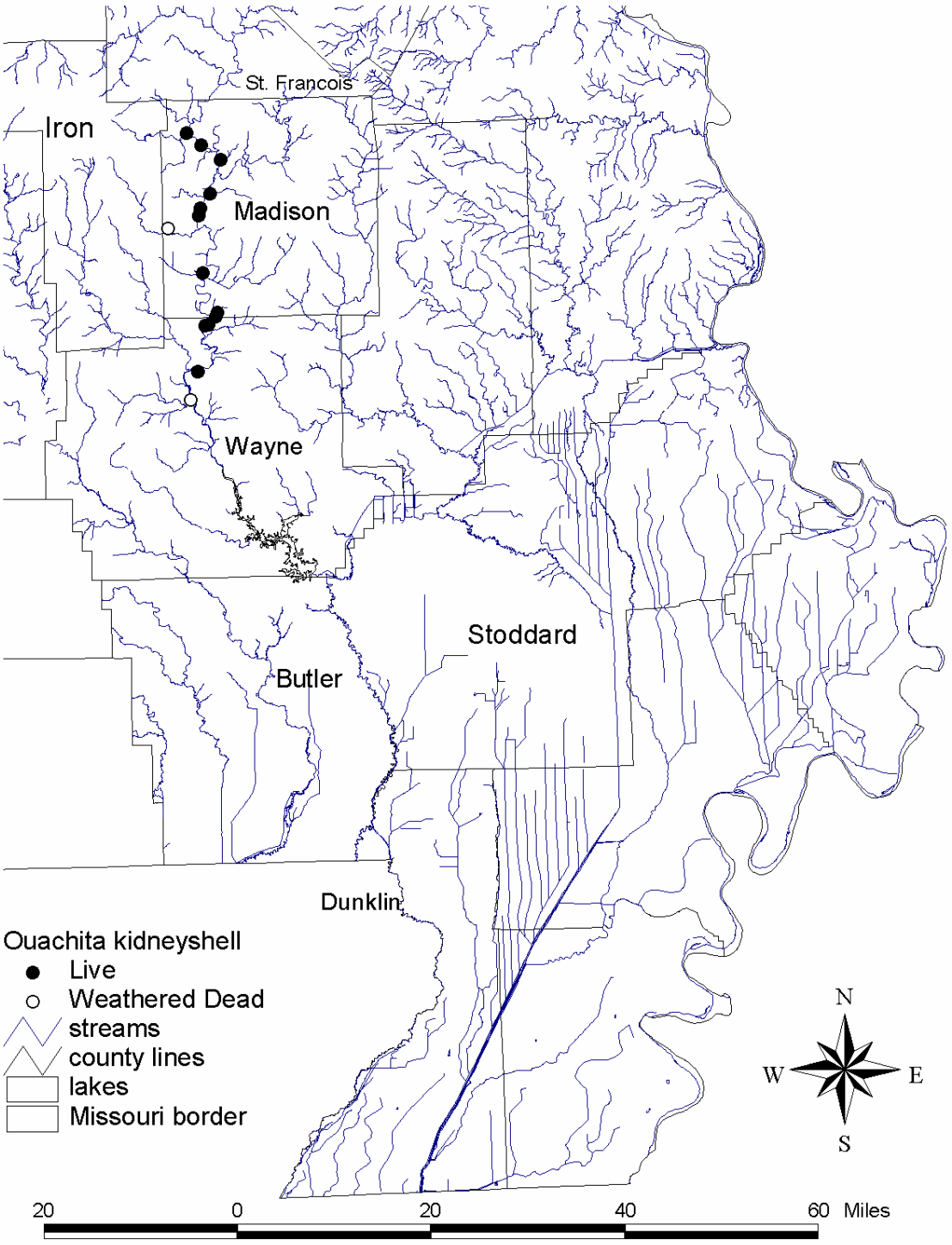

Figure 60. Distribution of the Ouachita kidneyshell in the St. Francis River system.

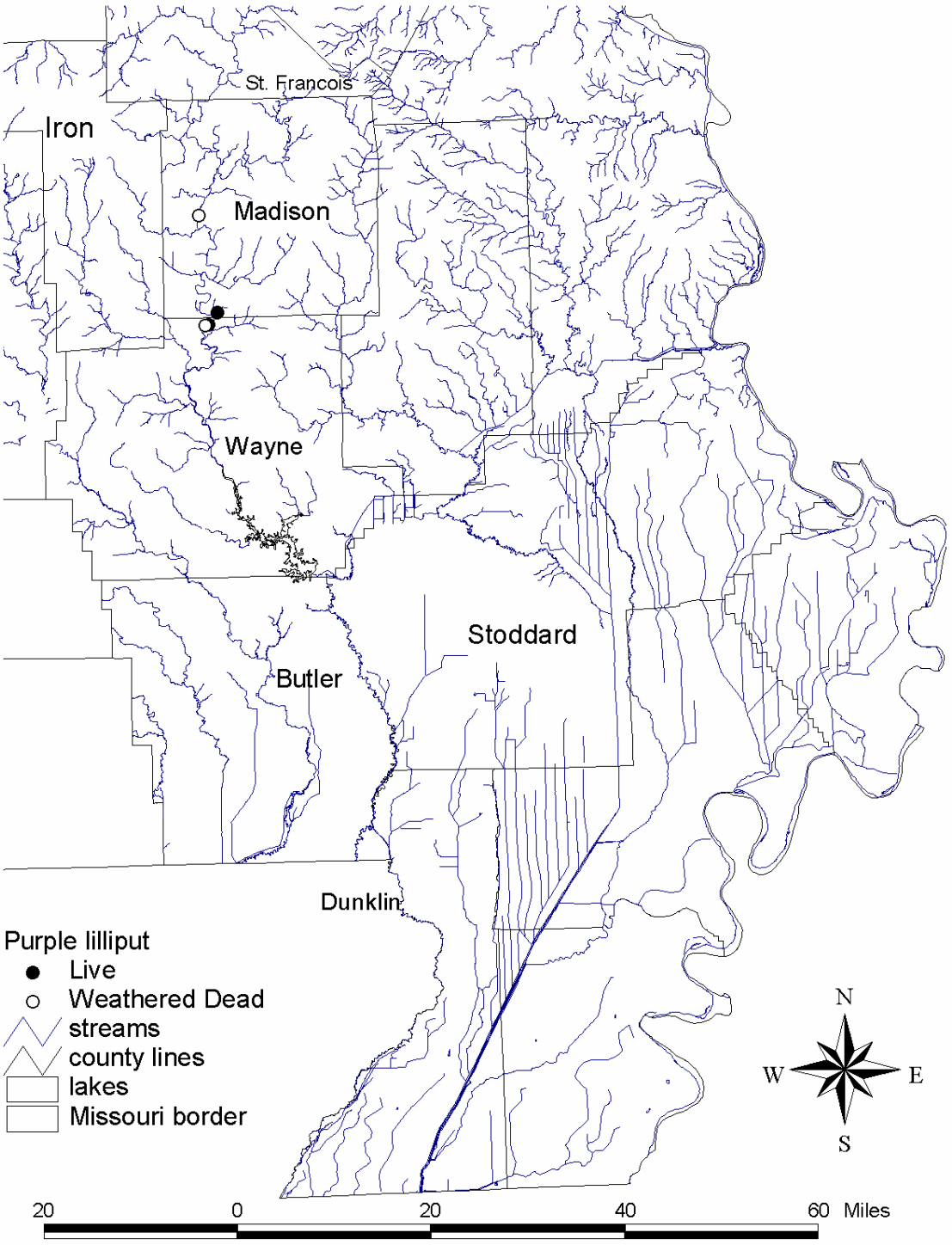

Figure 61. Distribution of the purple lilliput in the St. Francis River system.

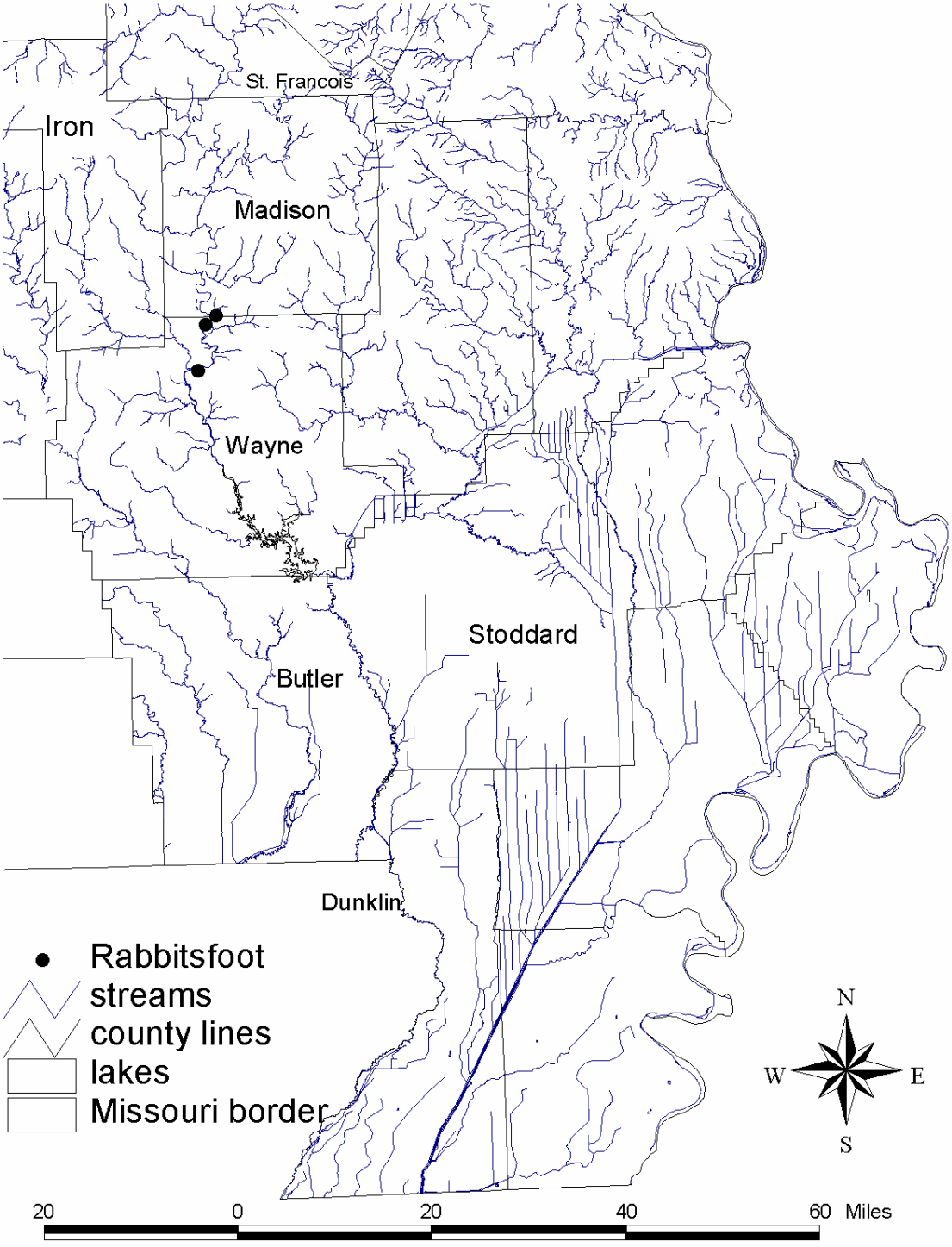

Figure 62. Distribution of the rabbitsfoot in the St. Francis River system.

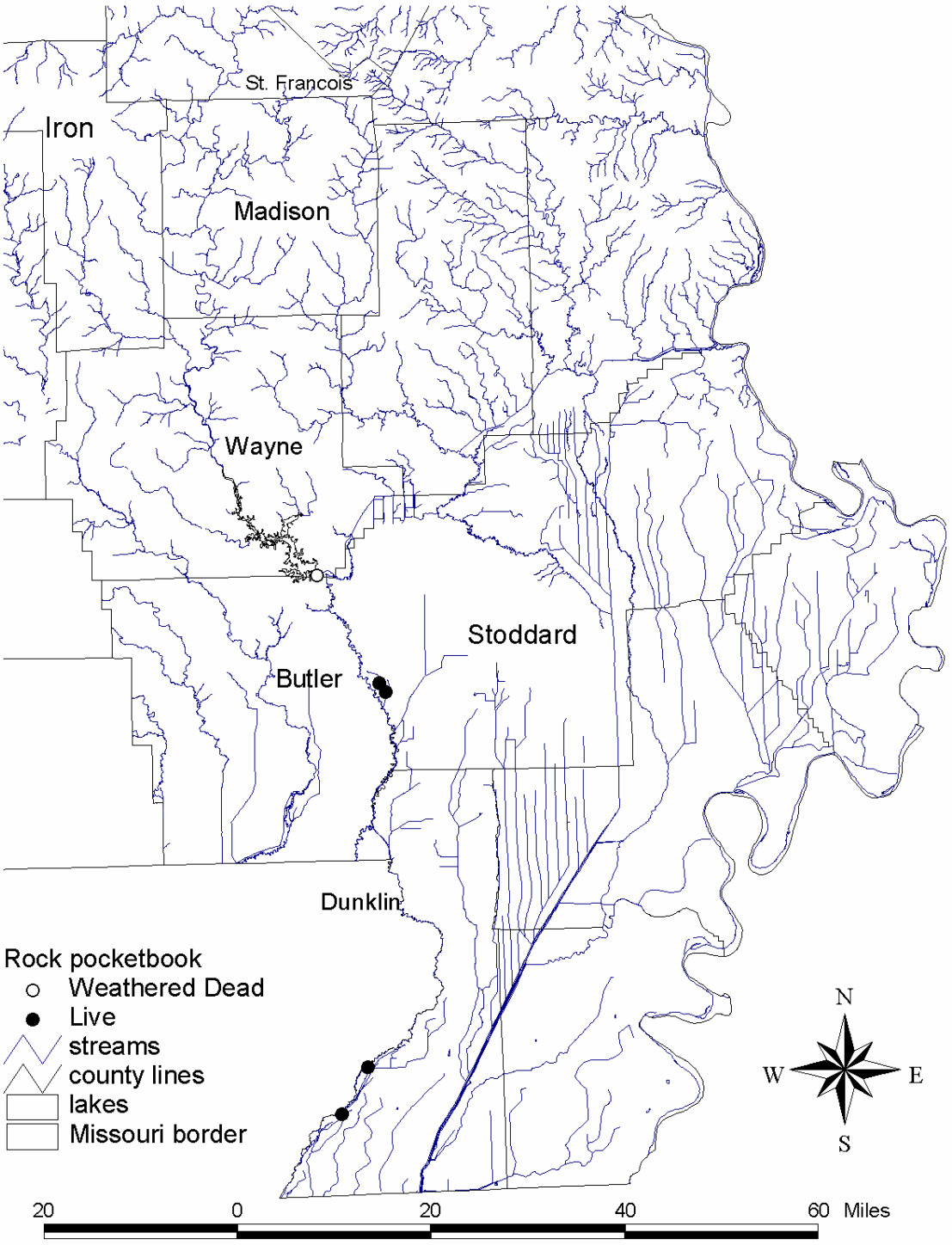

Figure 63. Distribution of the rock pocketbook in the St. Francis River system.

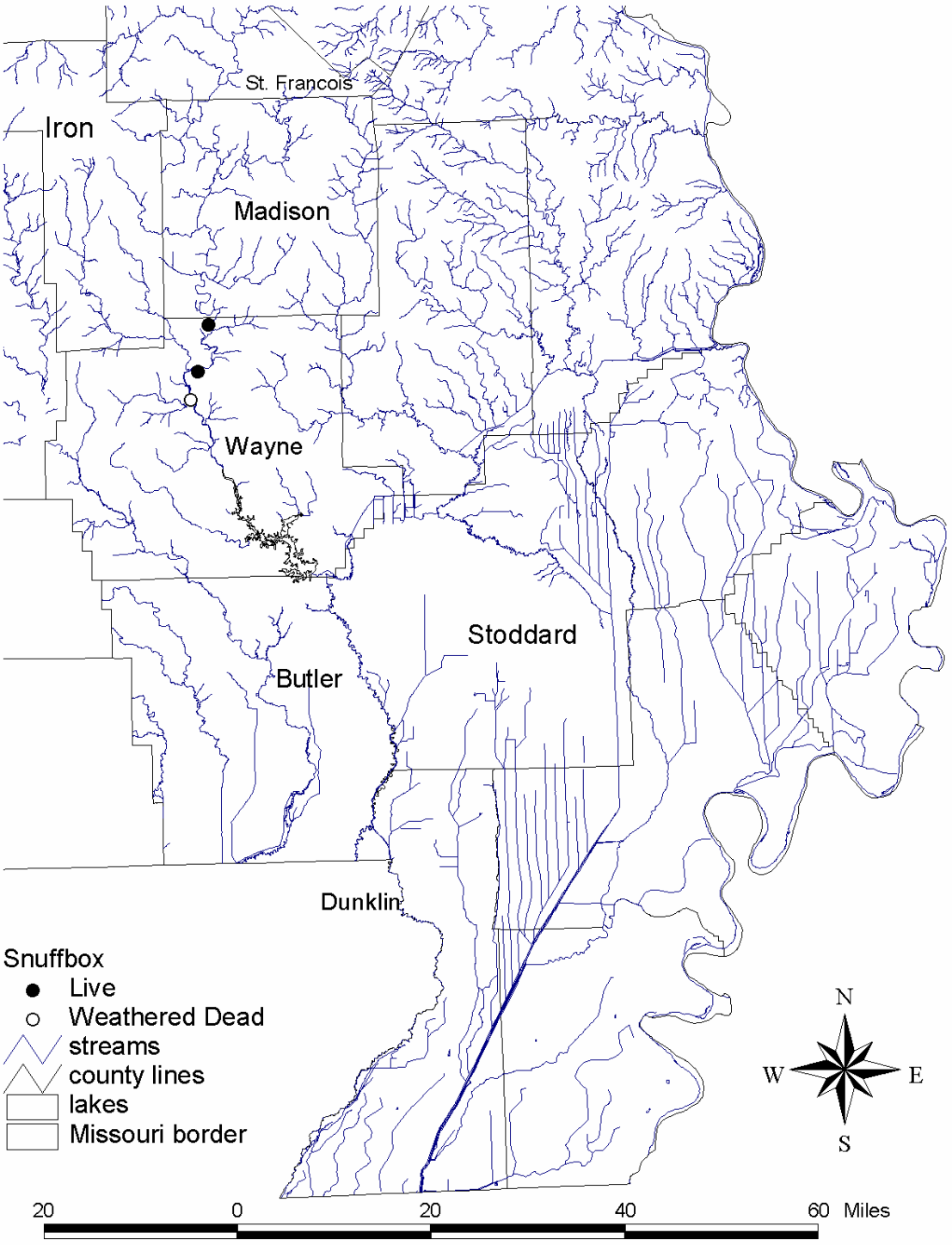

Figure 64. Distribution of the snuffbox in the St. Francis River system.

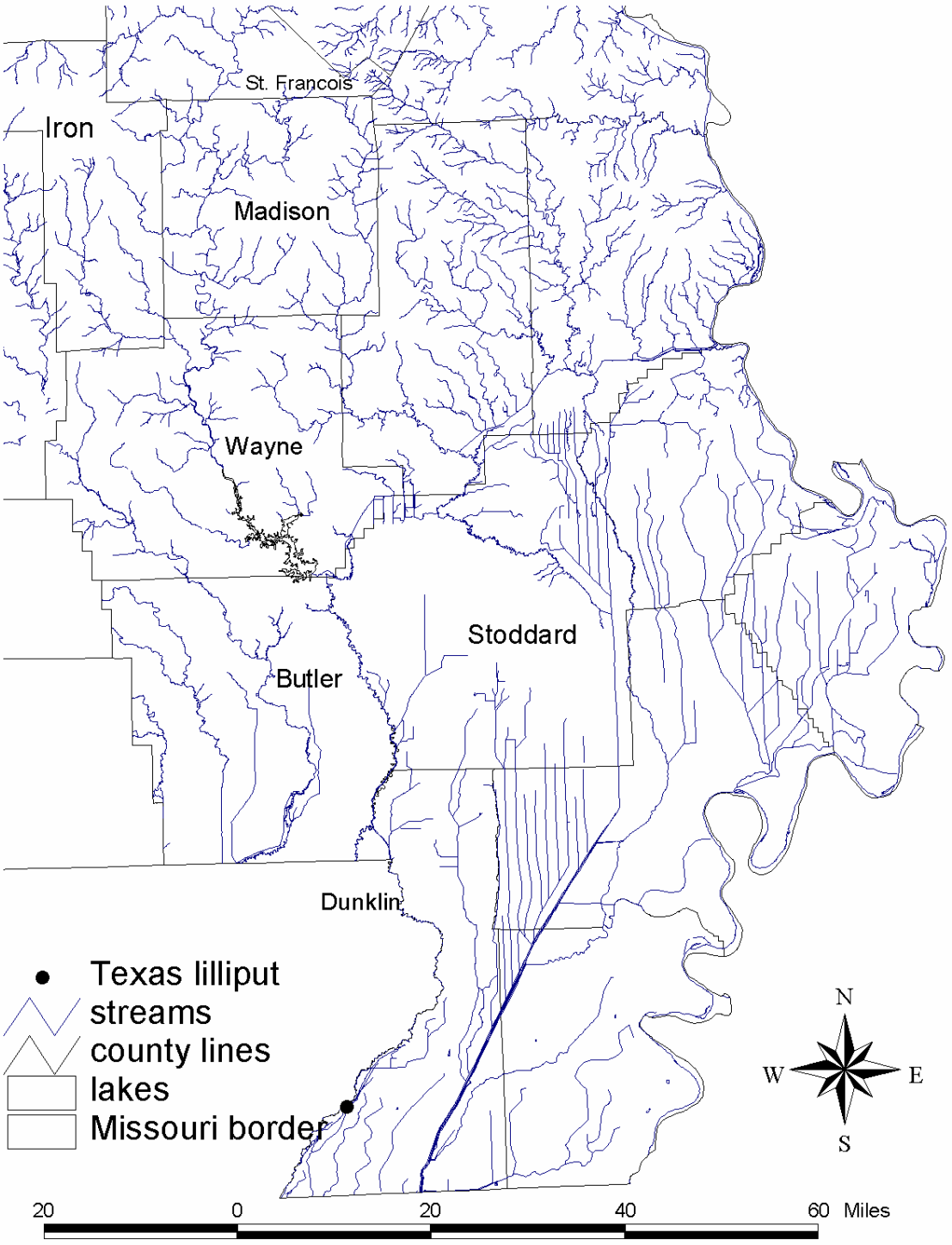

Figure 65. Distribution of the Texas lilliput in the St. Francis River system.

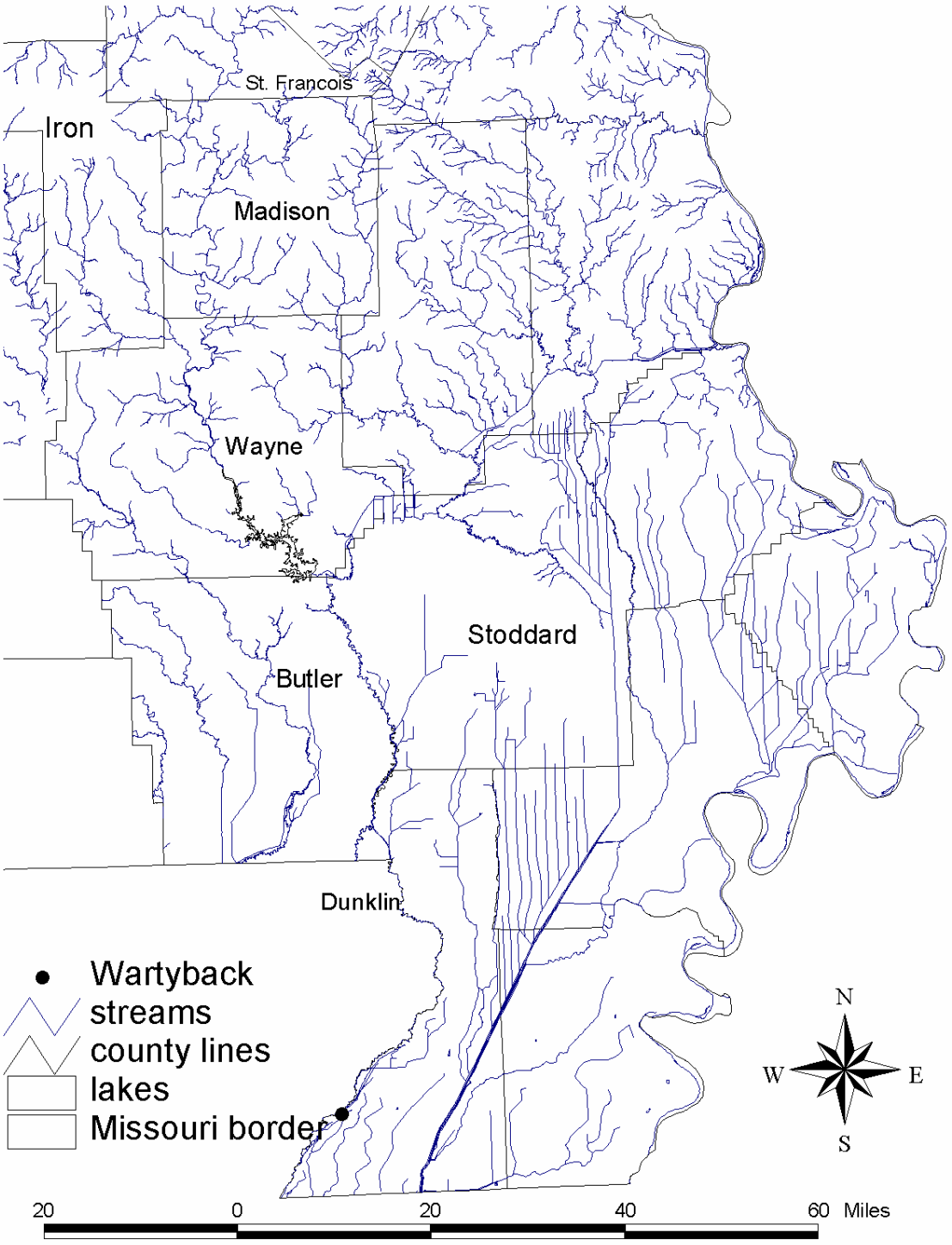

Figure 66. Distribution of the wartyback in the St. Francis River system.

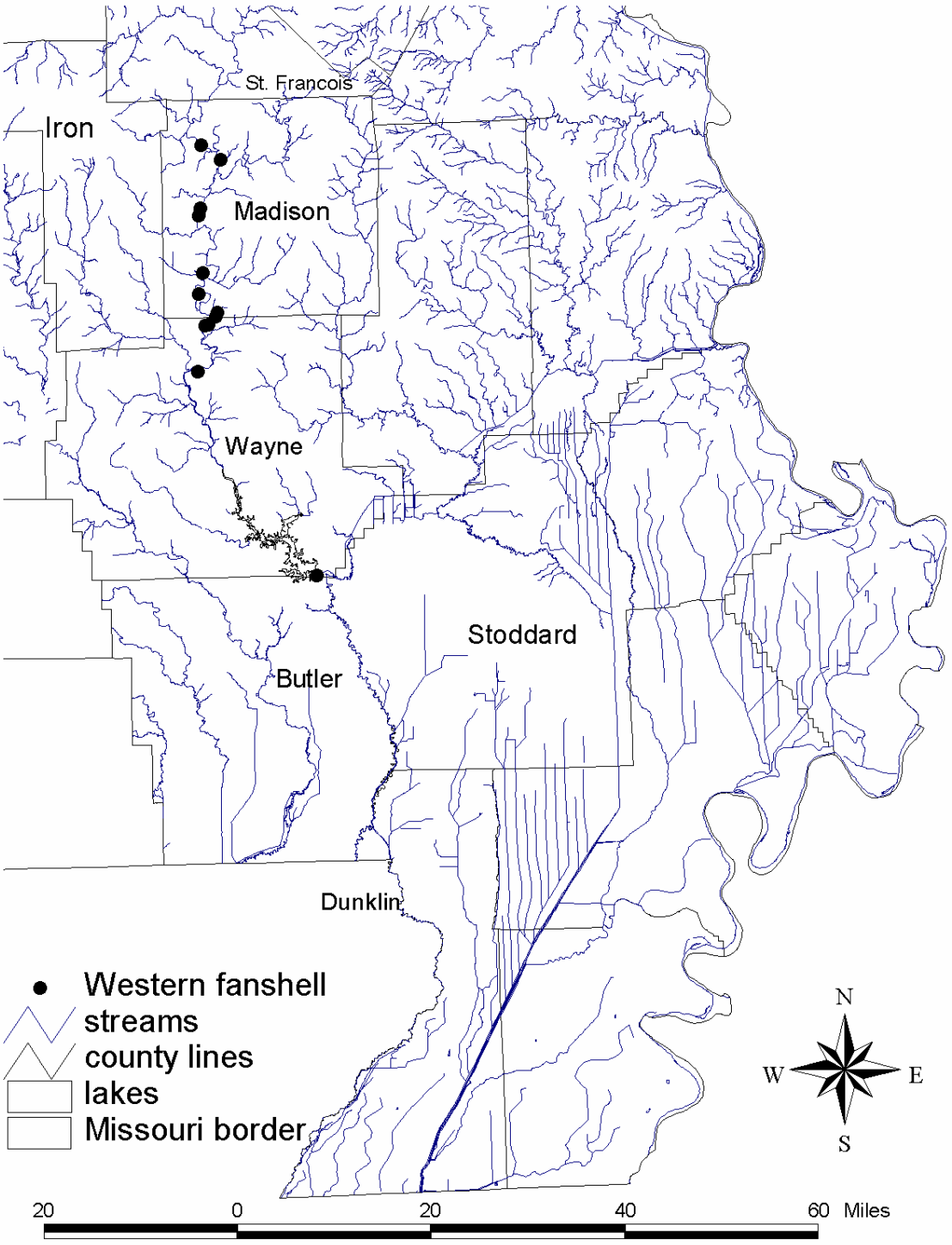

Figure 67. Distribution of the Western fanshell in the St. Francis River system.

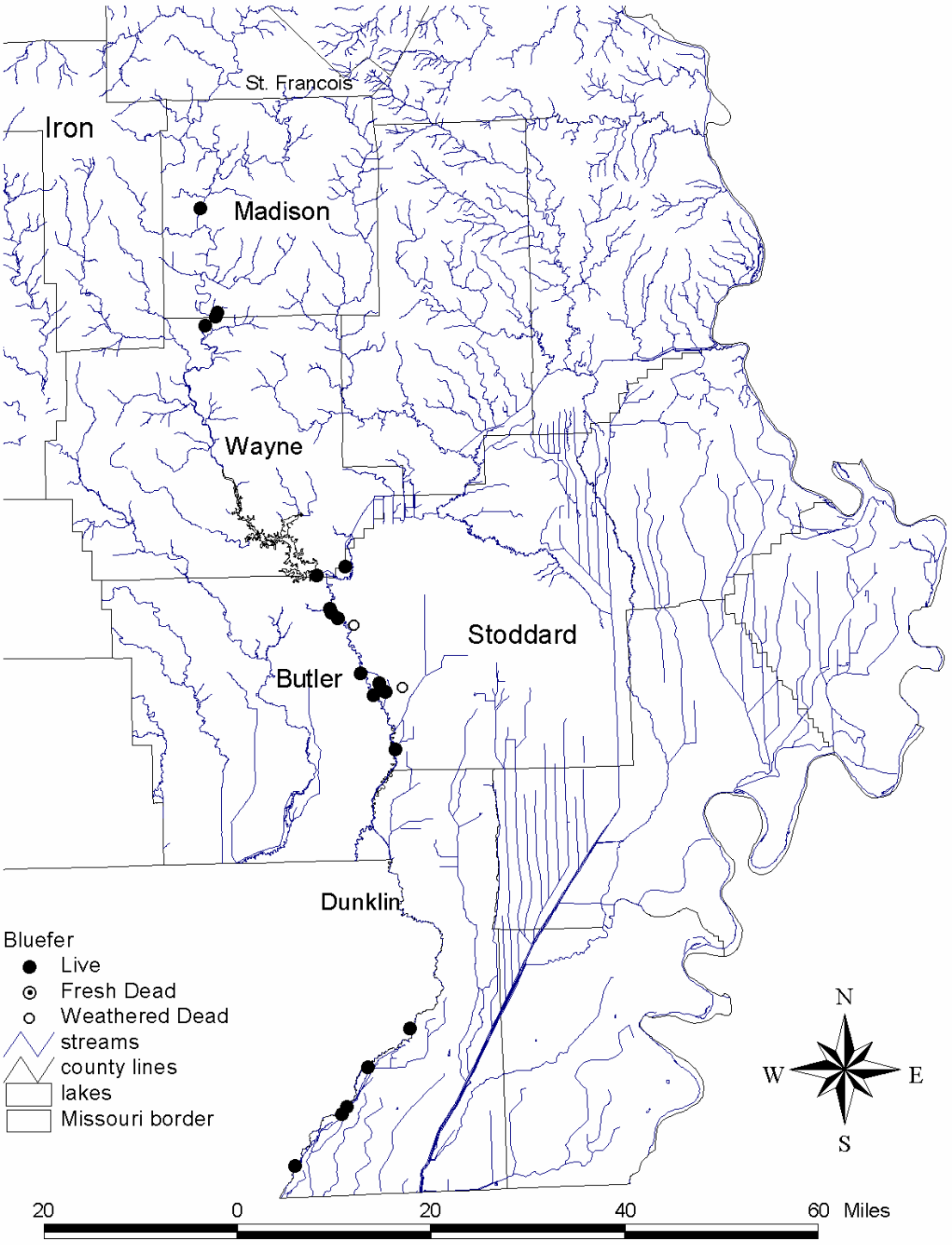

Figure 68. Distribution of the bluefer in the St. Francis River system.

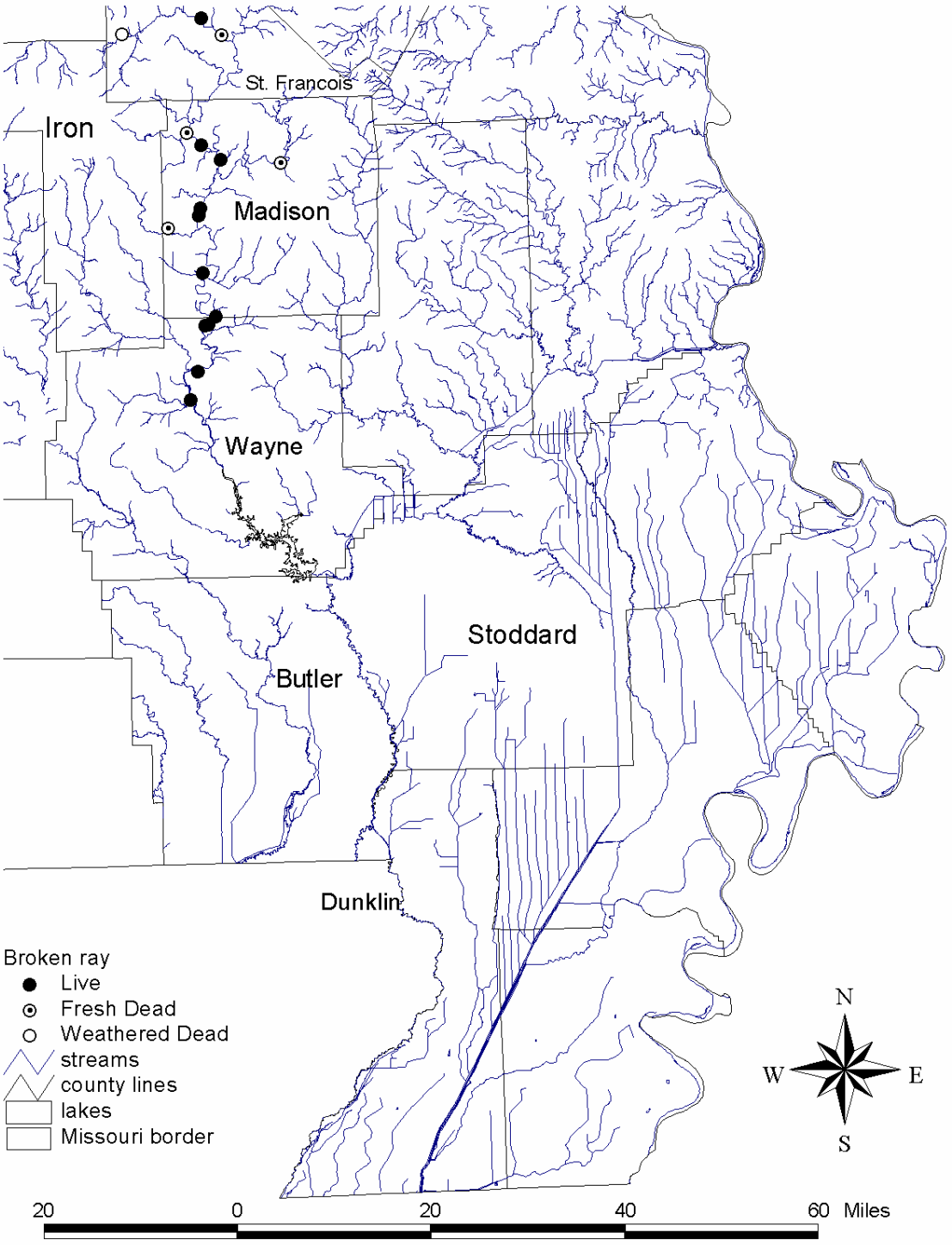

Figure 69. Distribution of the broken ray in the St. Francis River system.

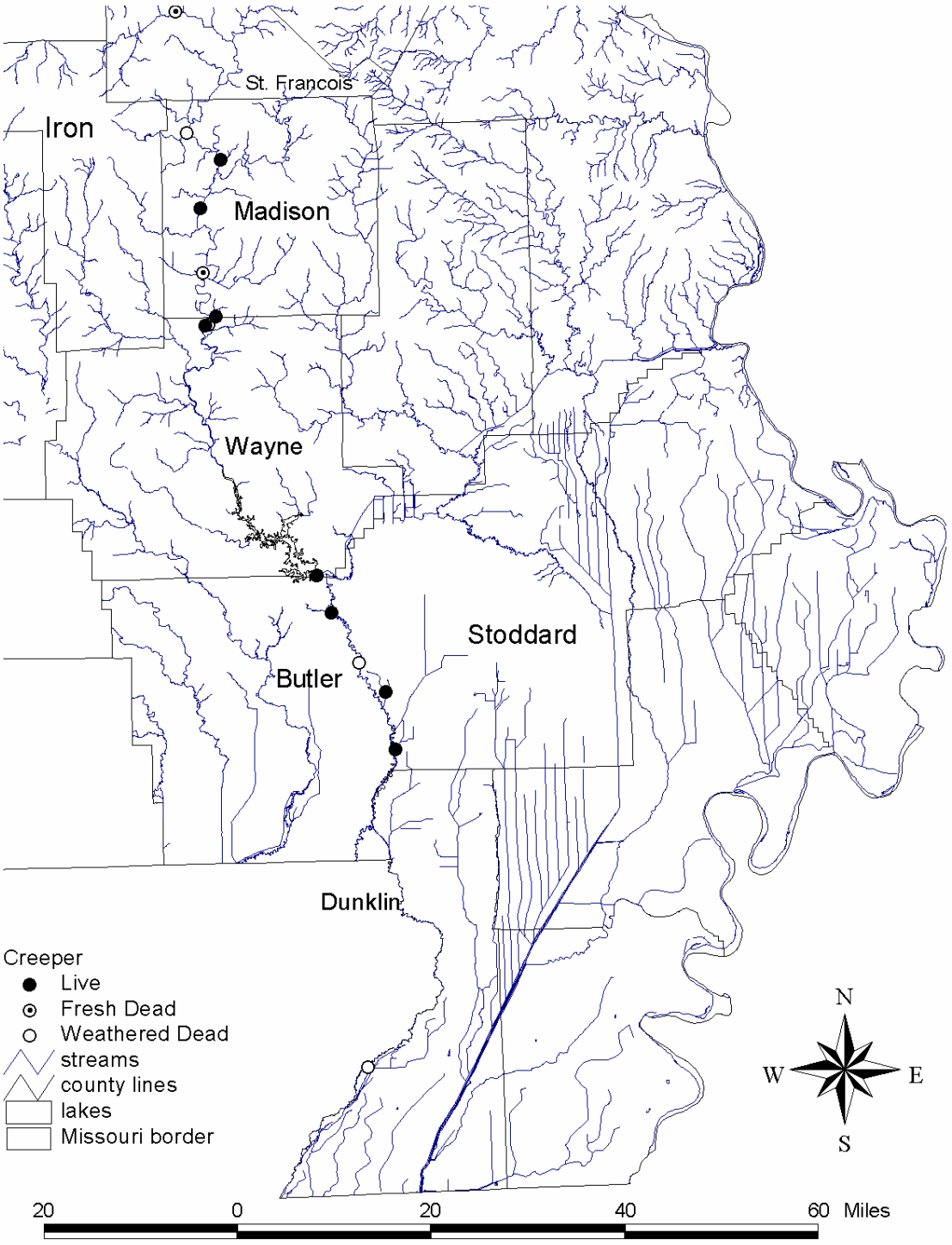

Figure 70. Distribution of the creeper in the St. Francis River system.

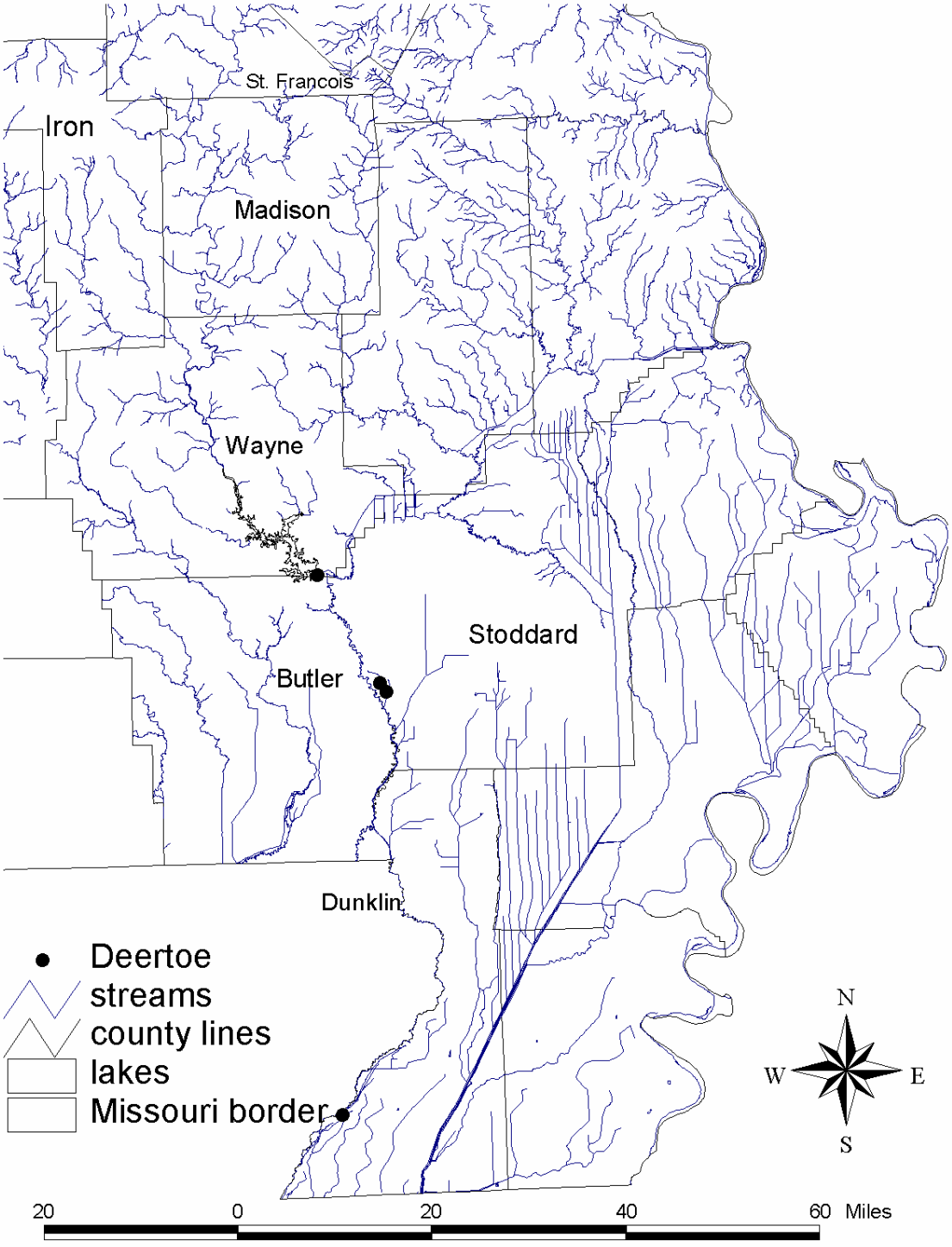

Figure 71. Distribution of the deertoe in the St. Francis River system.

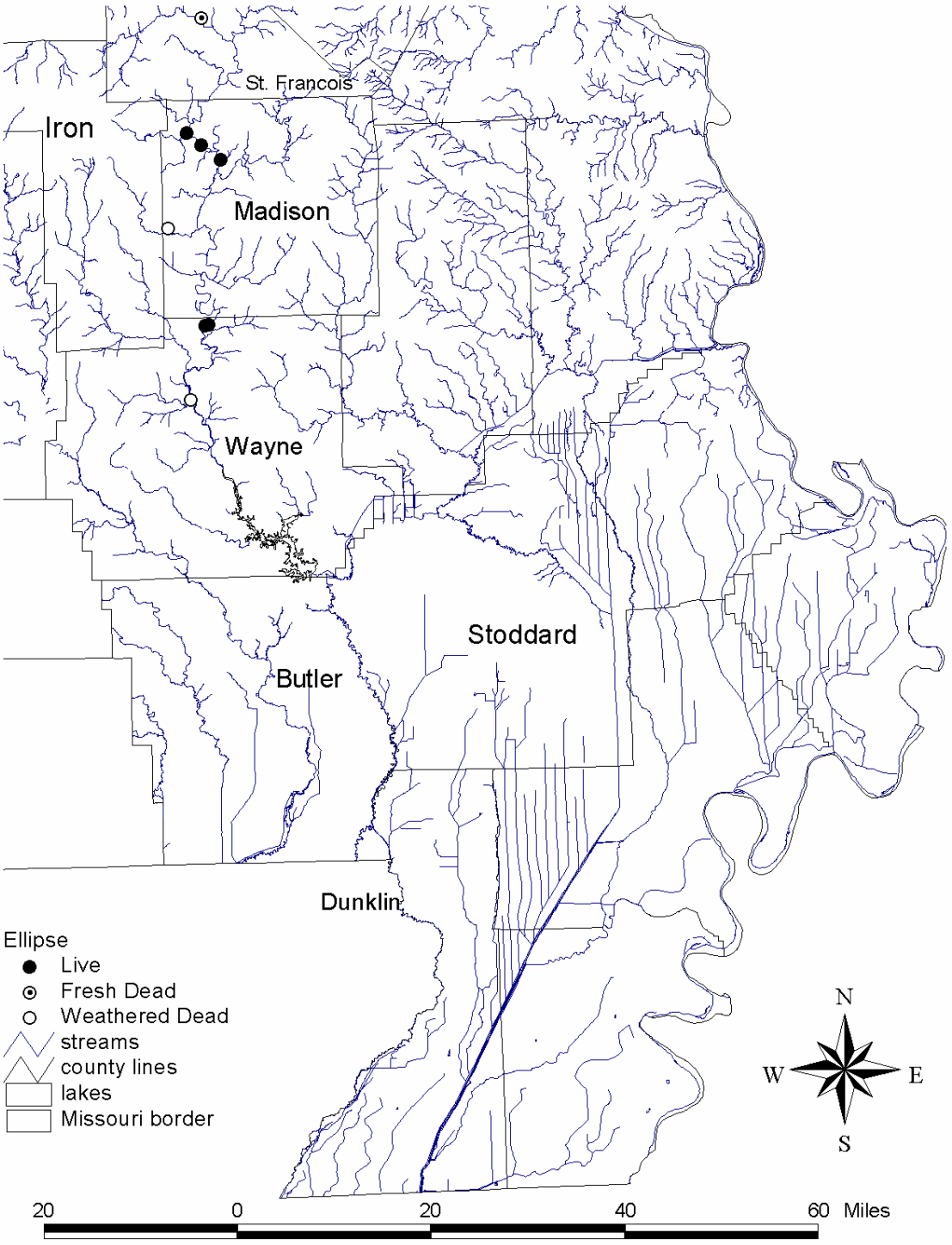

Figure 72. Distribution of the ellipse in the St. Francis River system.

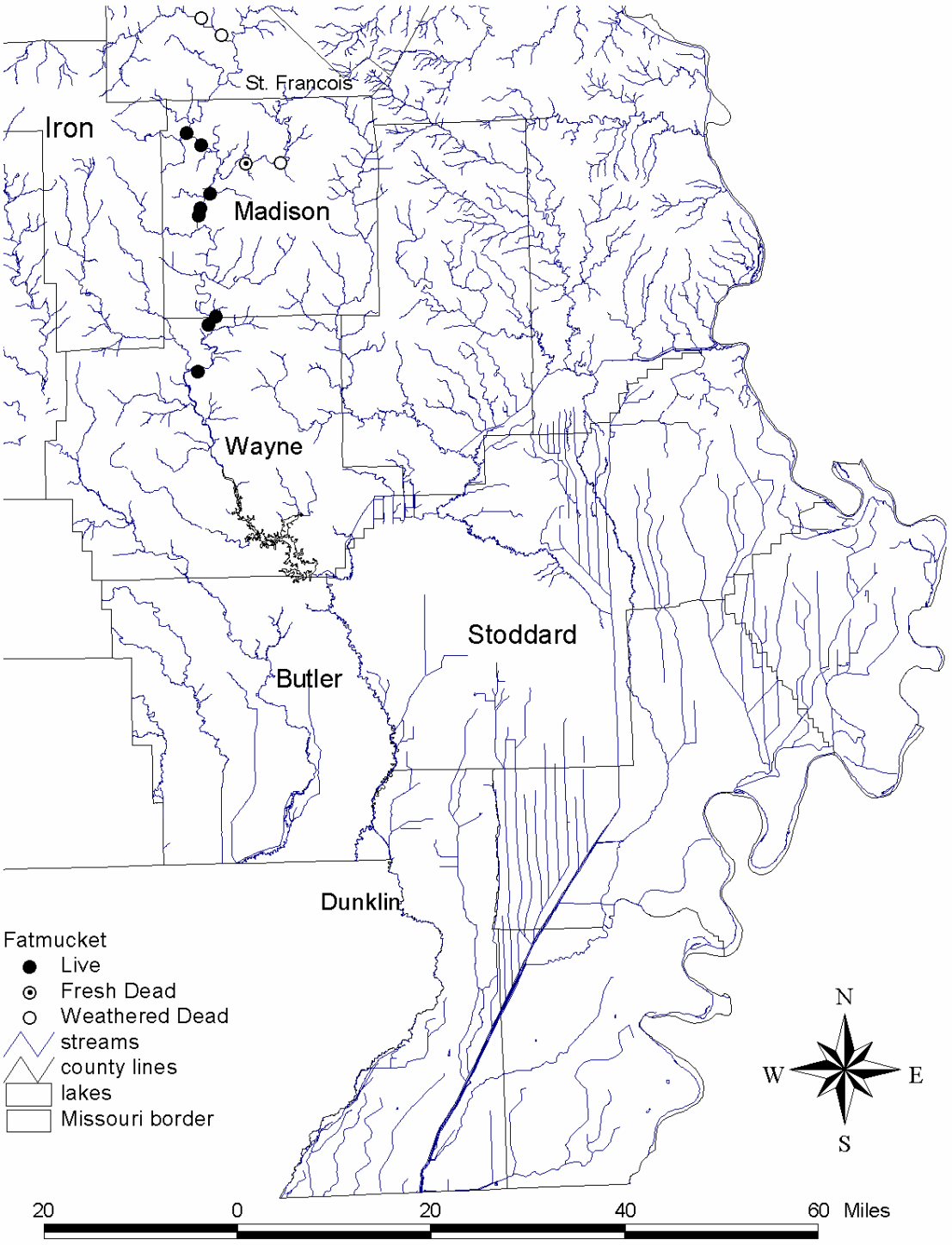

Figure 73. Distribution of the fatmucket in the St. Francis River system.

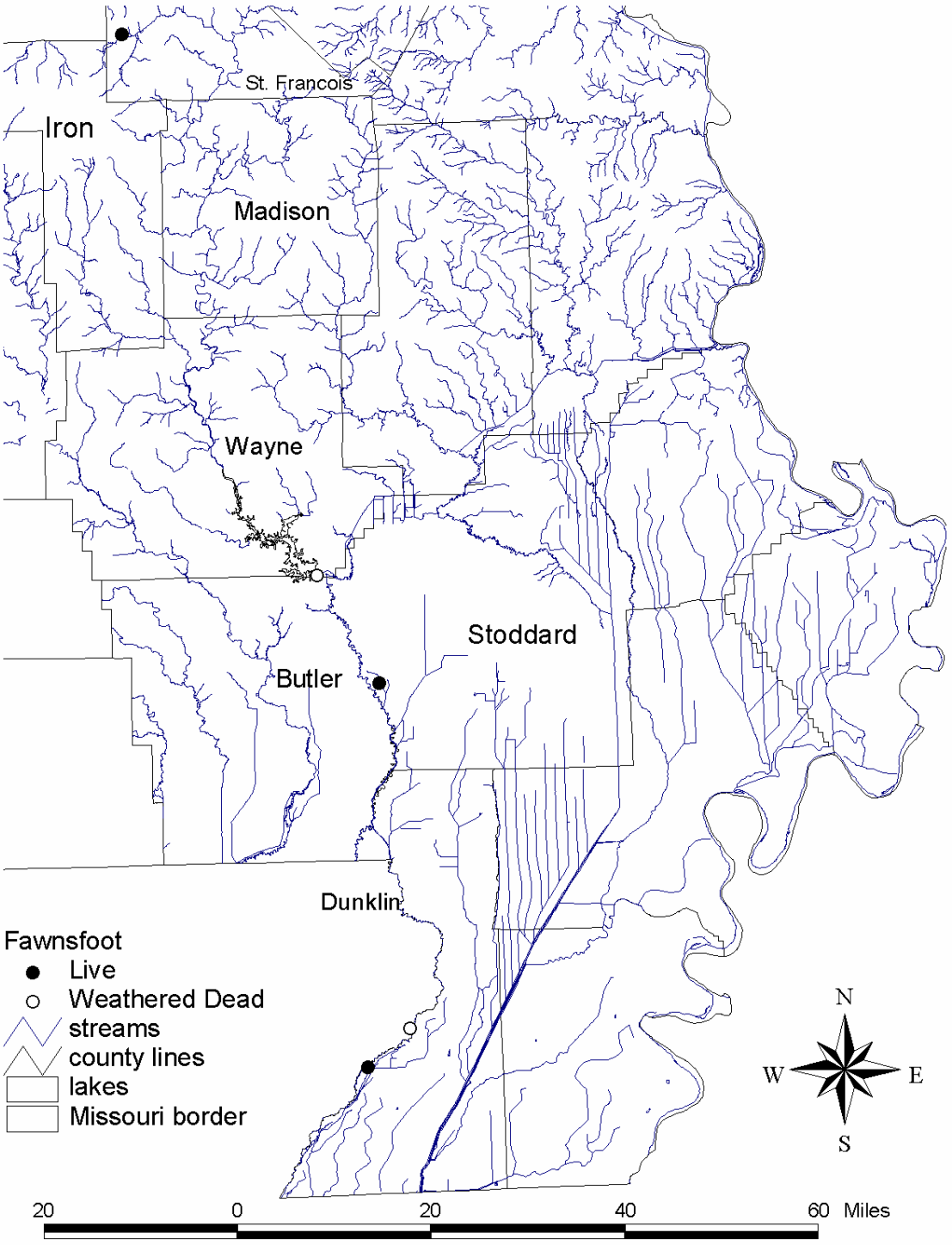

Figure 74. Distribution of the fawnsfoot in the St. Francis River system.

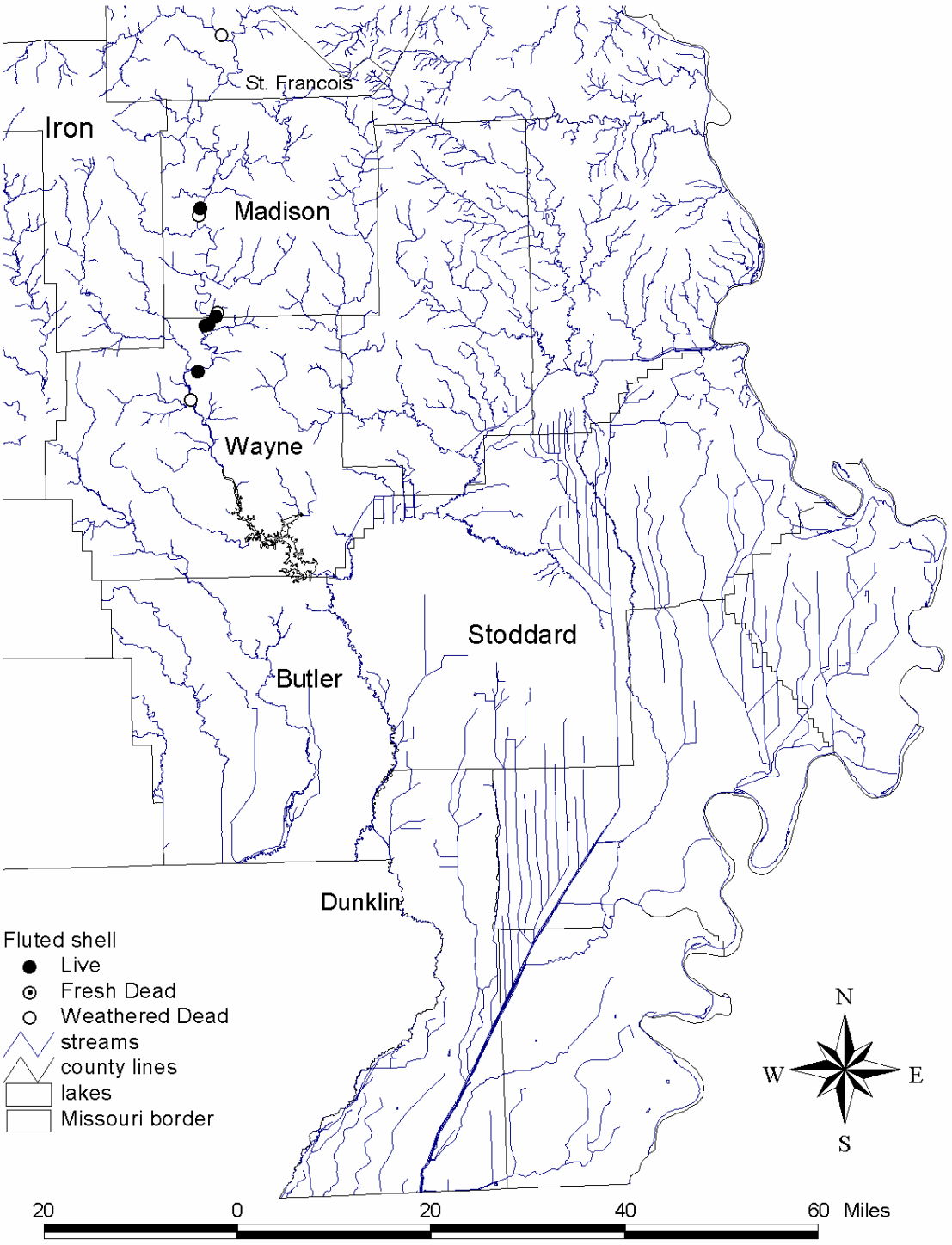

Figure 75. Distribution of the flutedshell in the St. Francis River system.

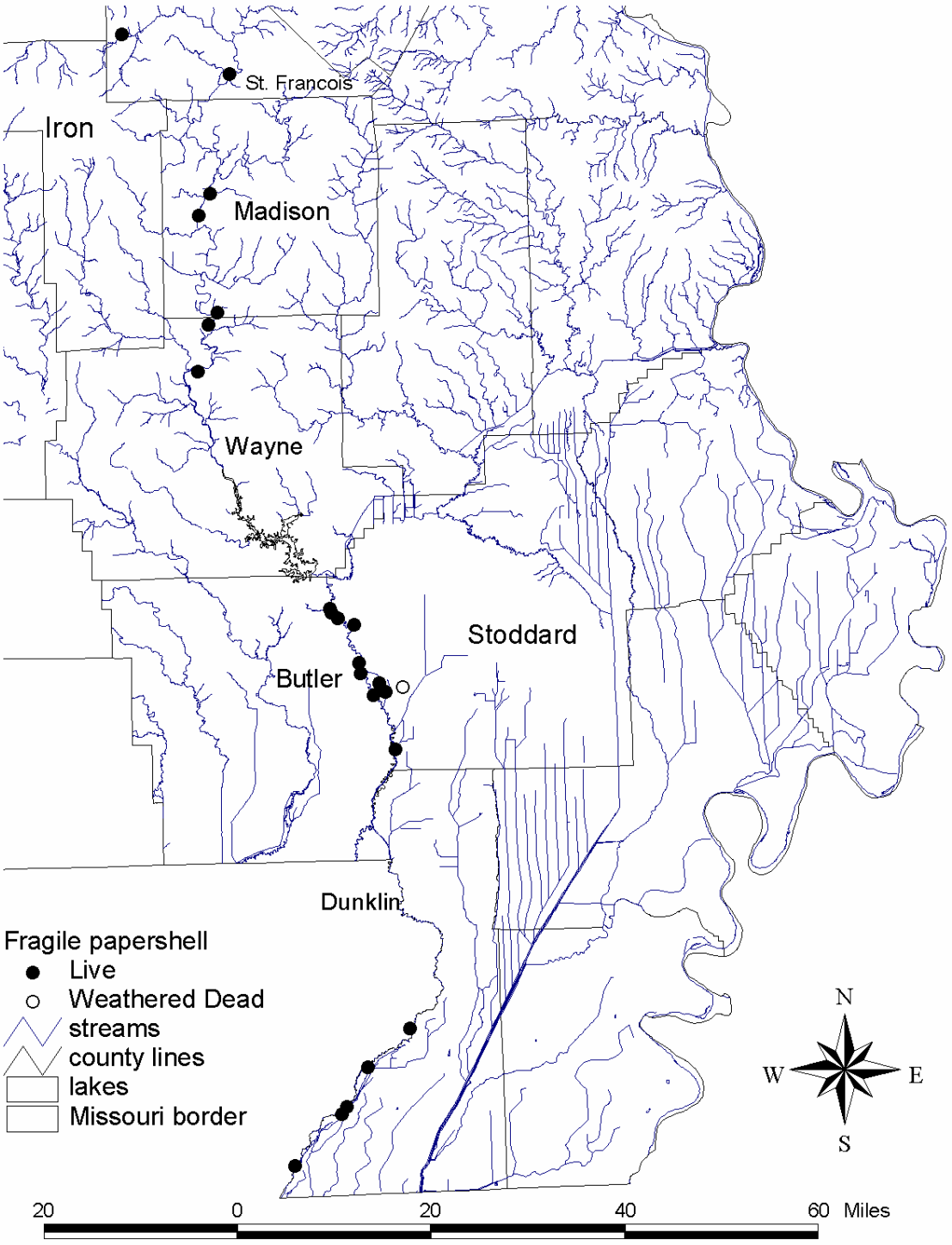

Figure 76. Distribution of the fragile papershell in the St. Francis River system.

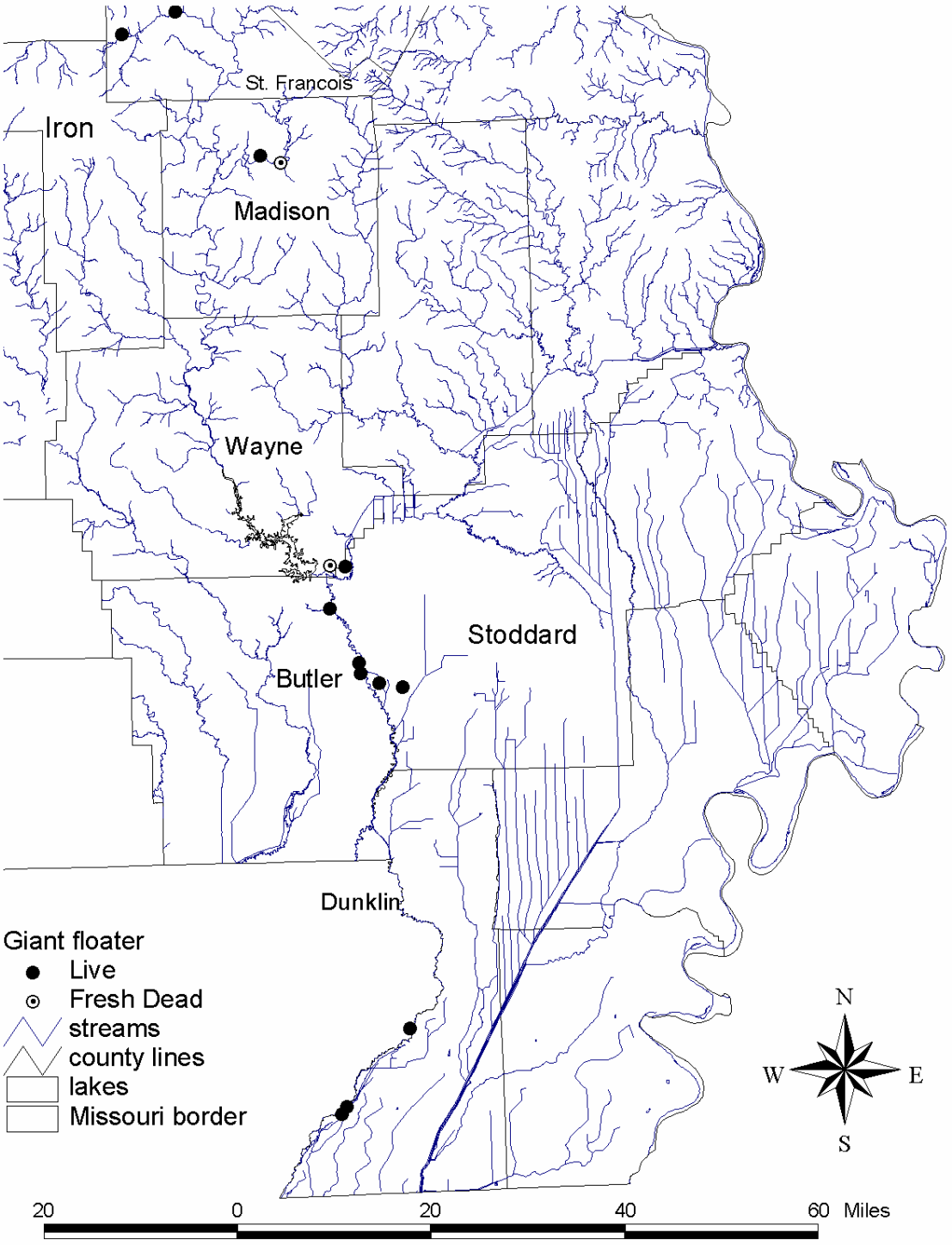

Figure 77. Distribution of the giant floater in the St. Francis River system.

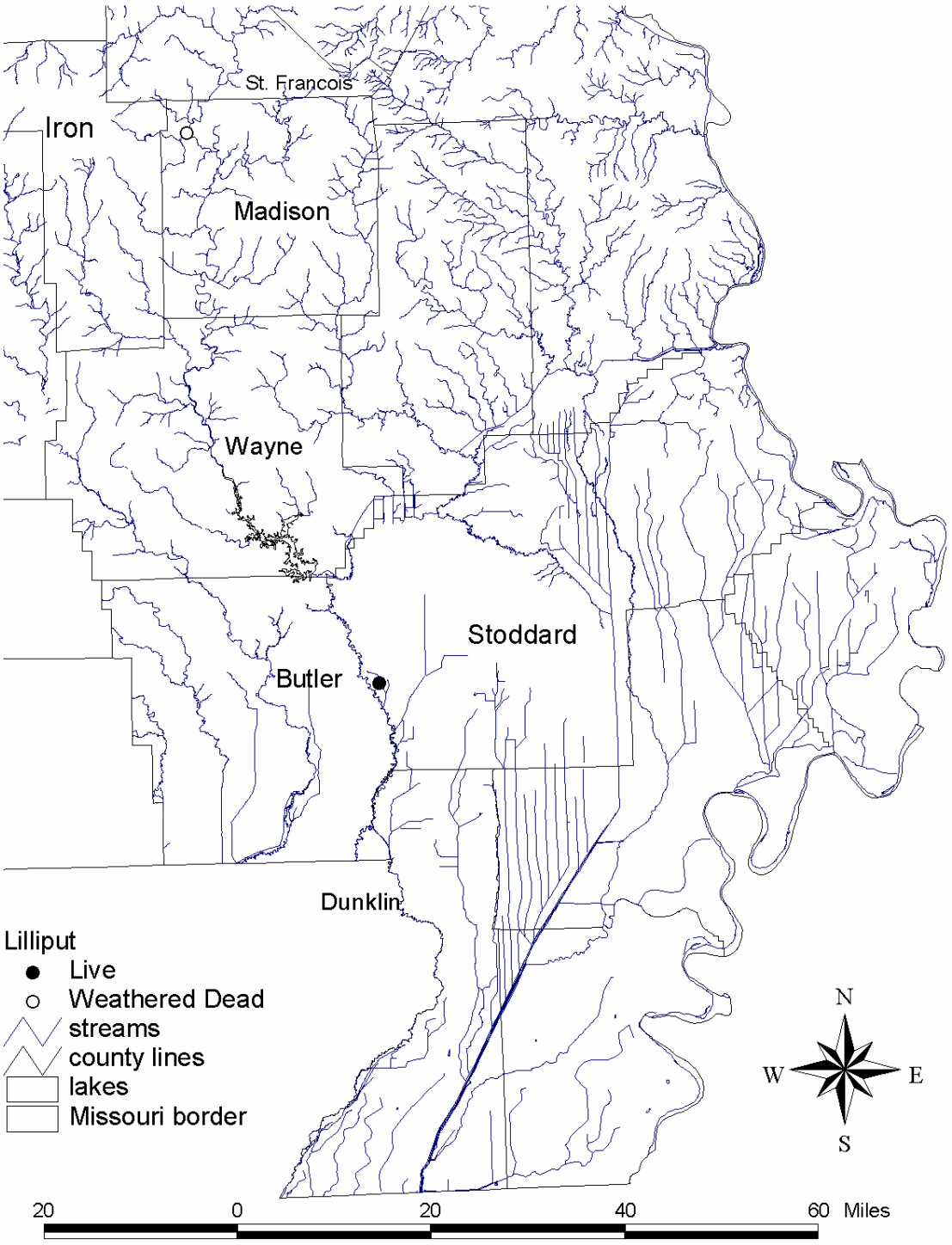

Figure 78. Distribution of the lilliput in the St. Francis River system.

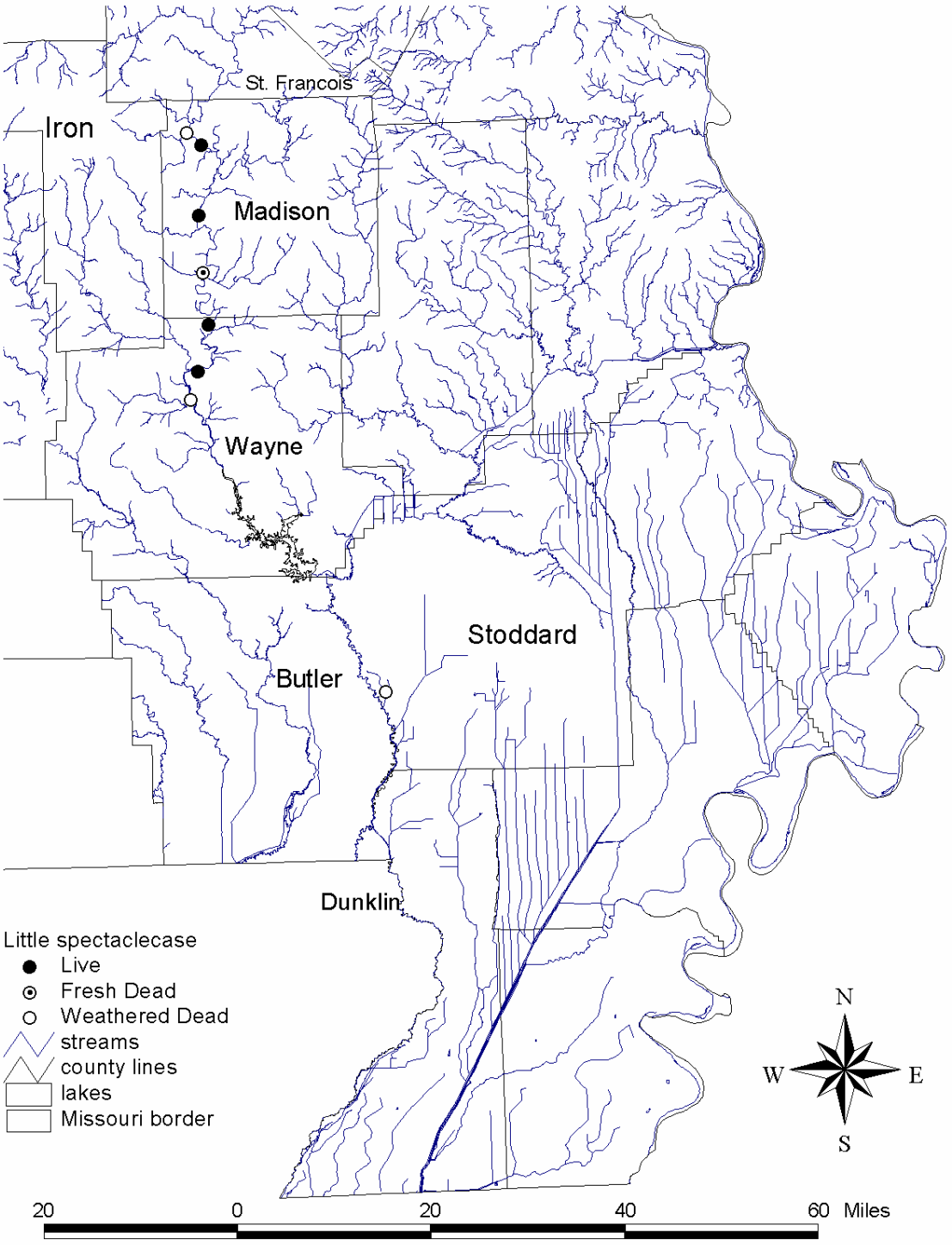

Figure 79. Distribution of the little spectaclecase in the St. Francis River system.

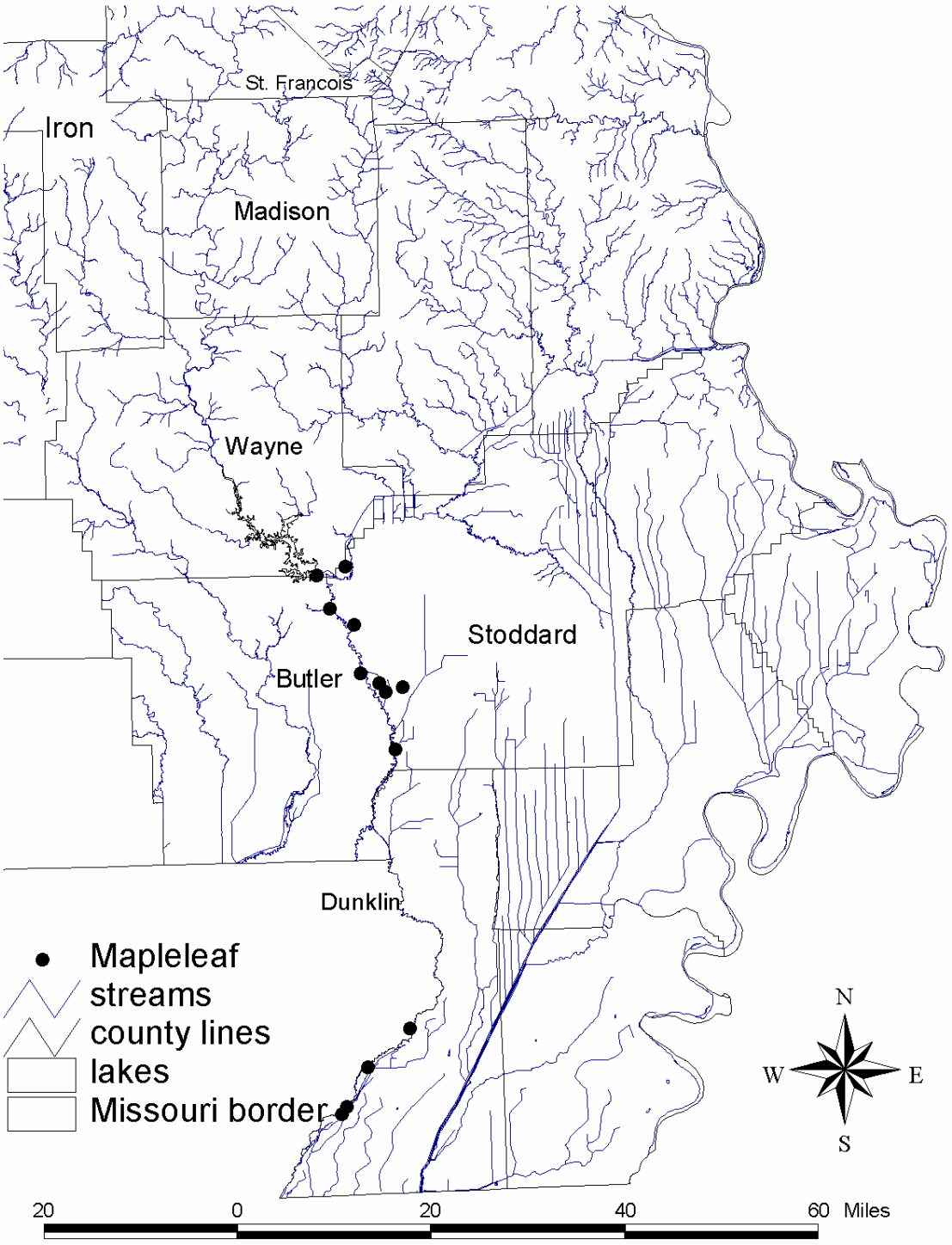

Figure 80. Distribution of the mapleleaf in the St. Francis River system.

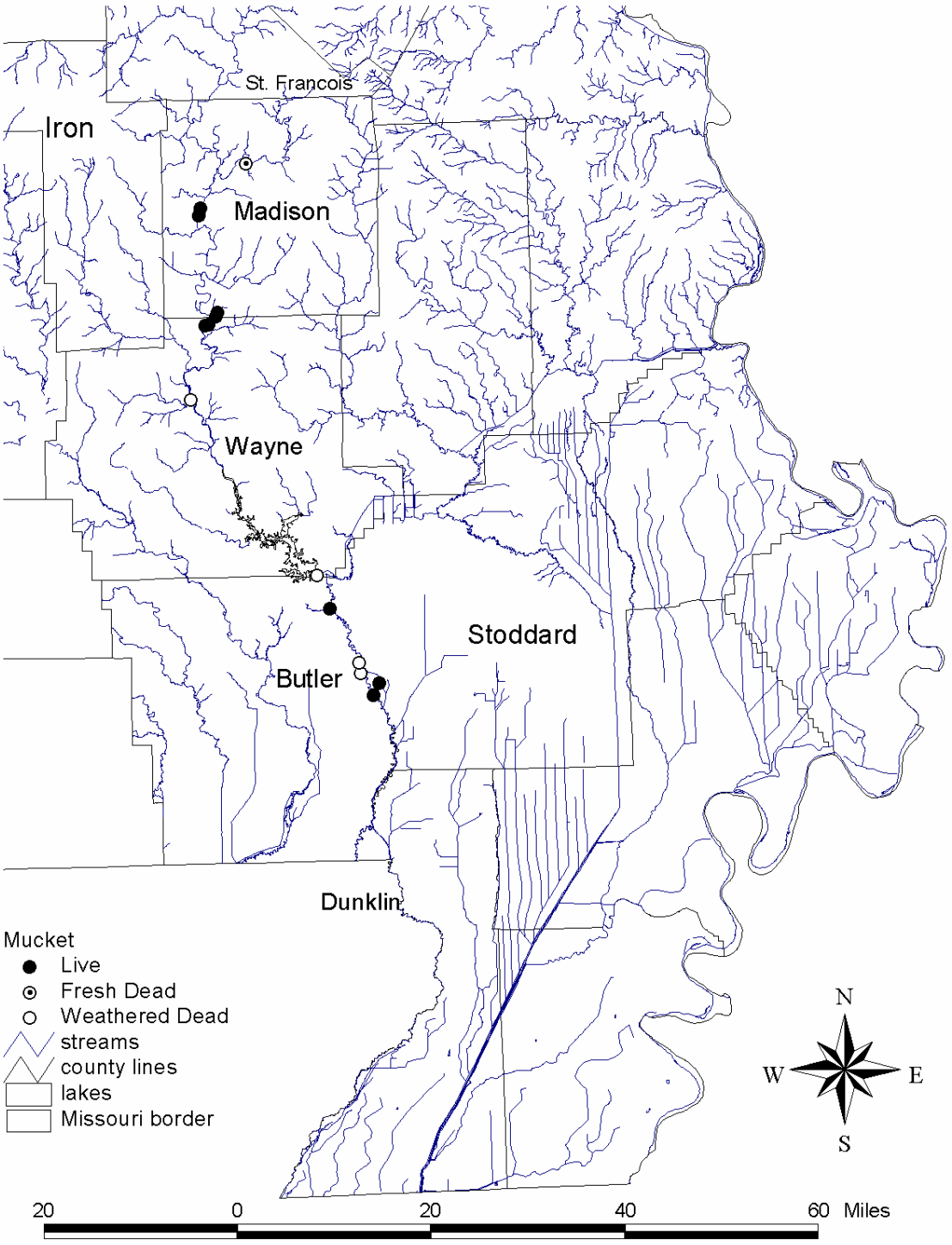

Figure 81. Distribution of the mucket in the St. Francis River system.

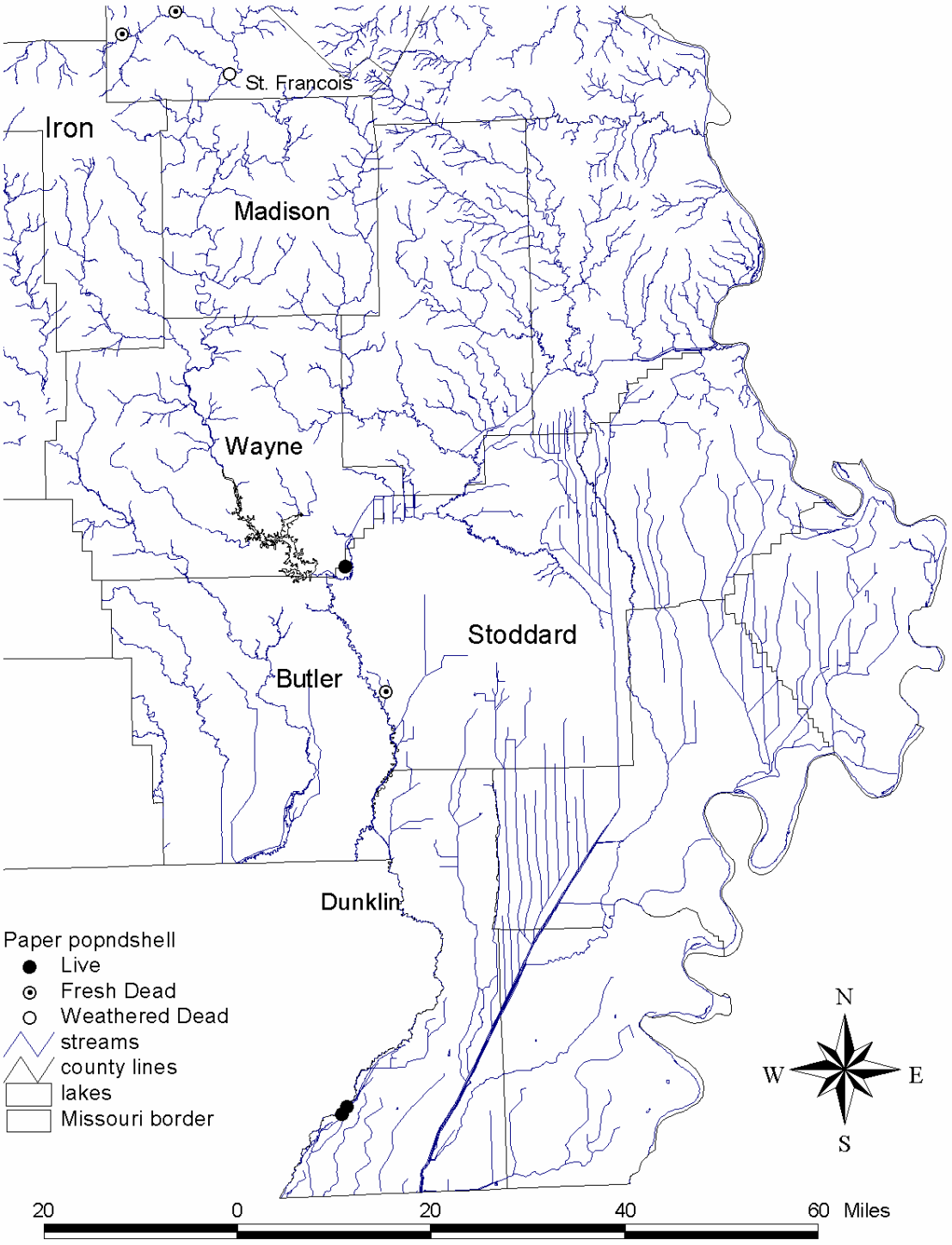

Figure 82. Distribution of the paper pondshell in the St. Francis River system.

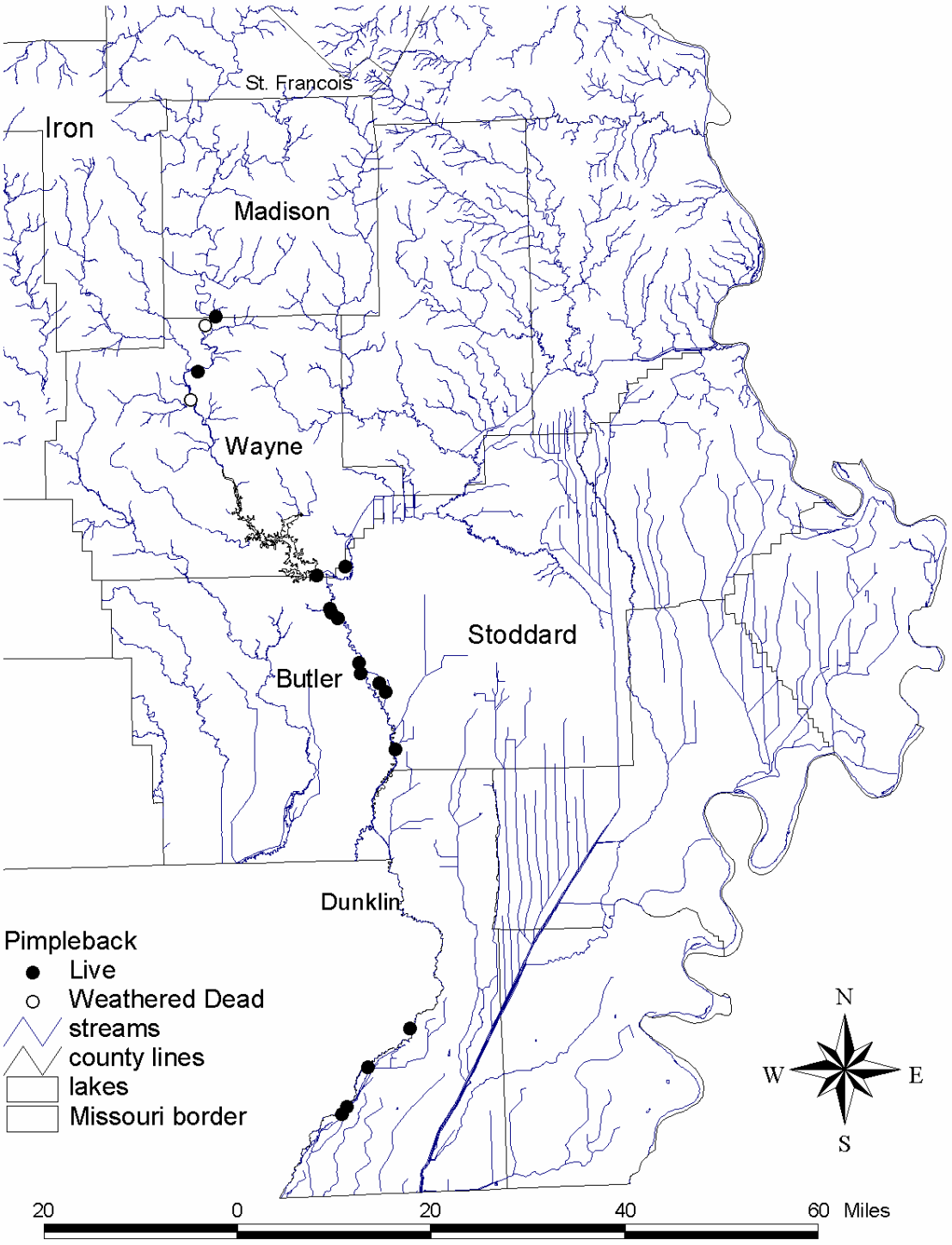

Figure 83. Distribution of the pimpleback in the St. Francis River system.

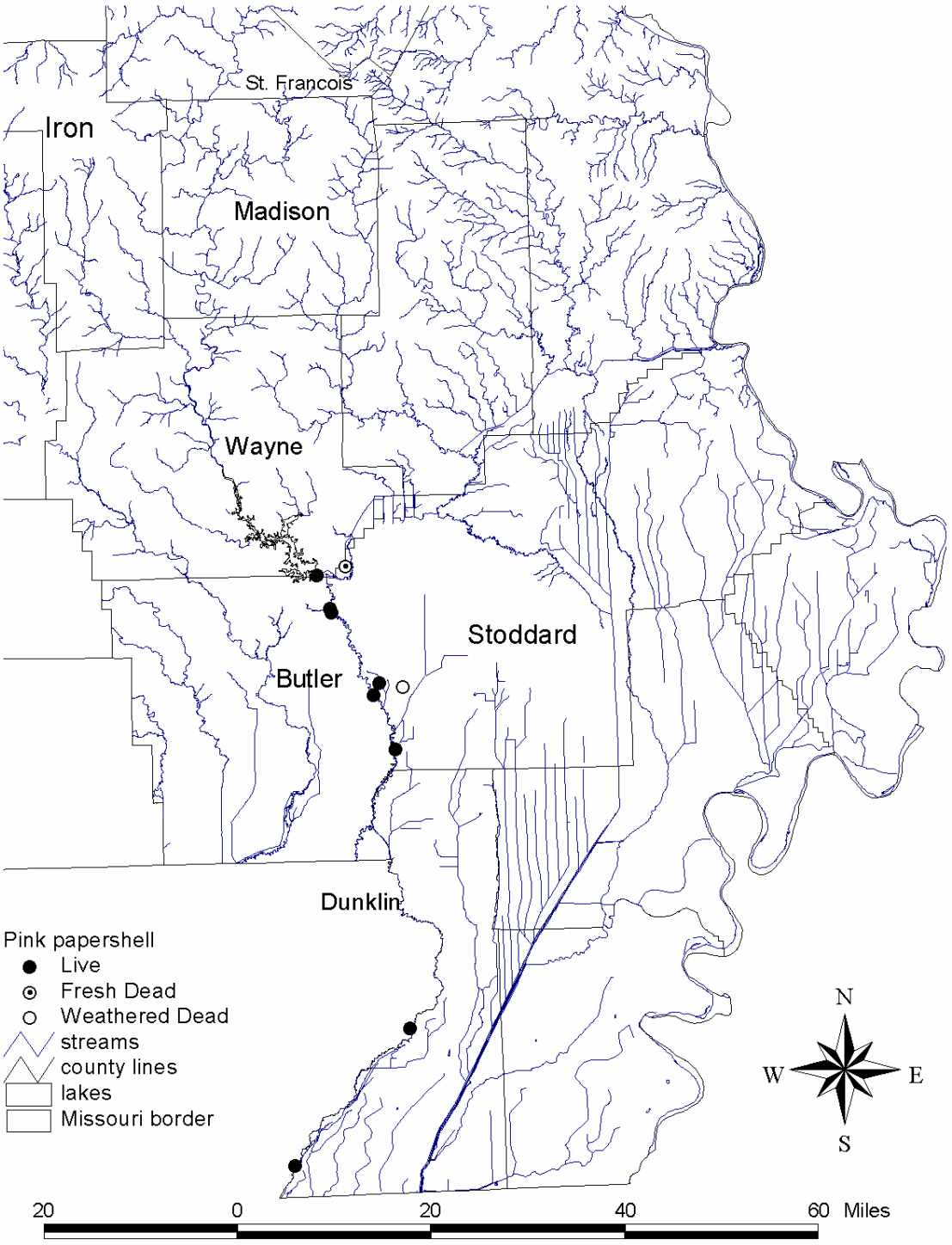

Figure 84. Distribution of the pink papershell in the St. Francis River system.

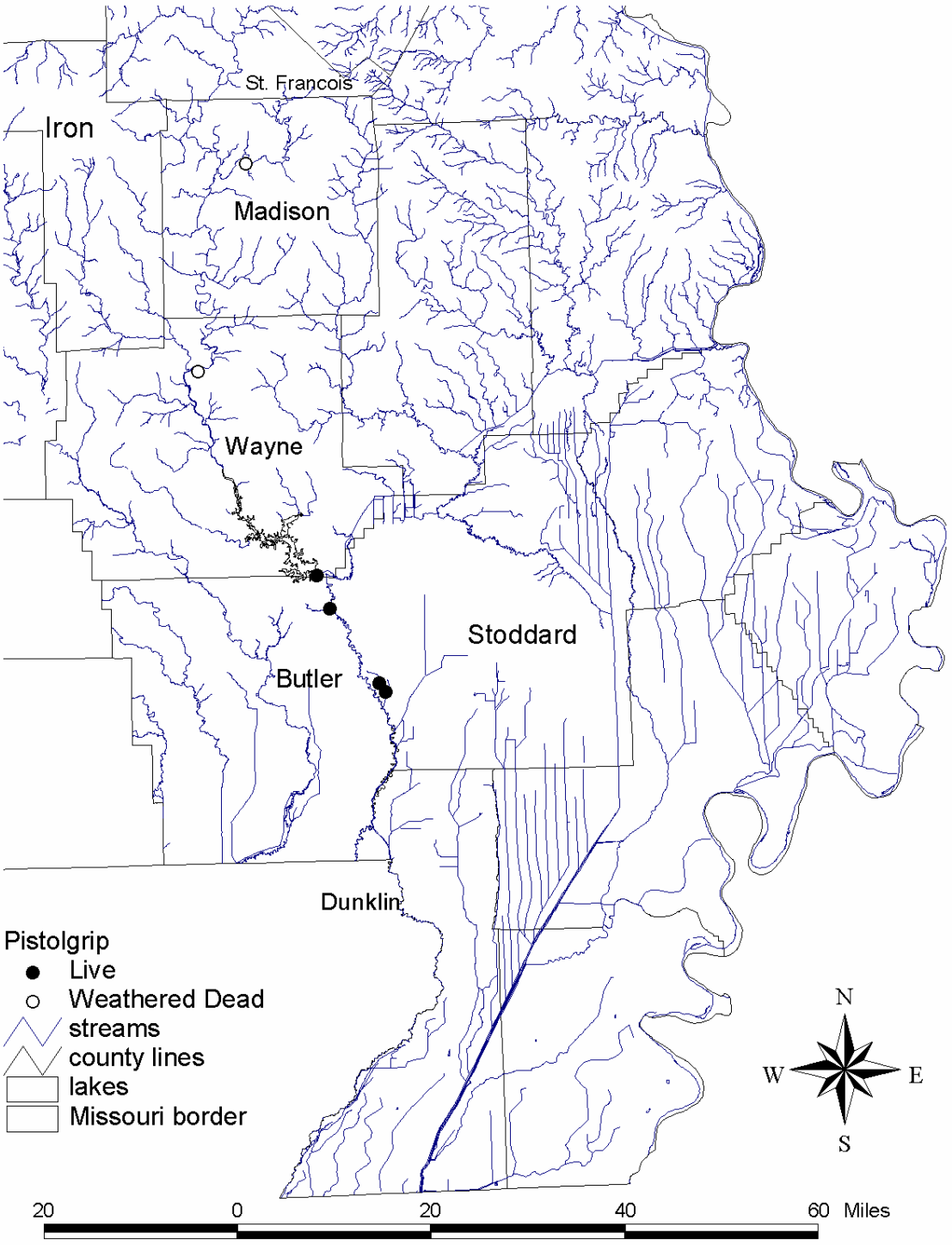

Figure 85. Distribution of the pistolgrip in the St. Francis River system.

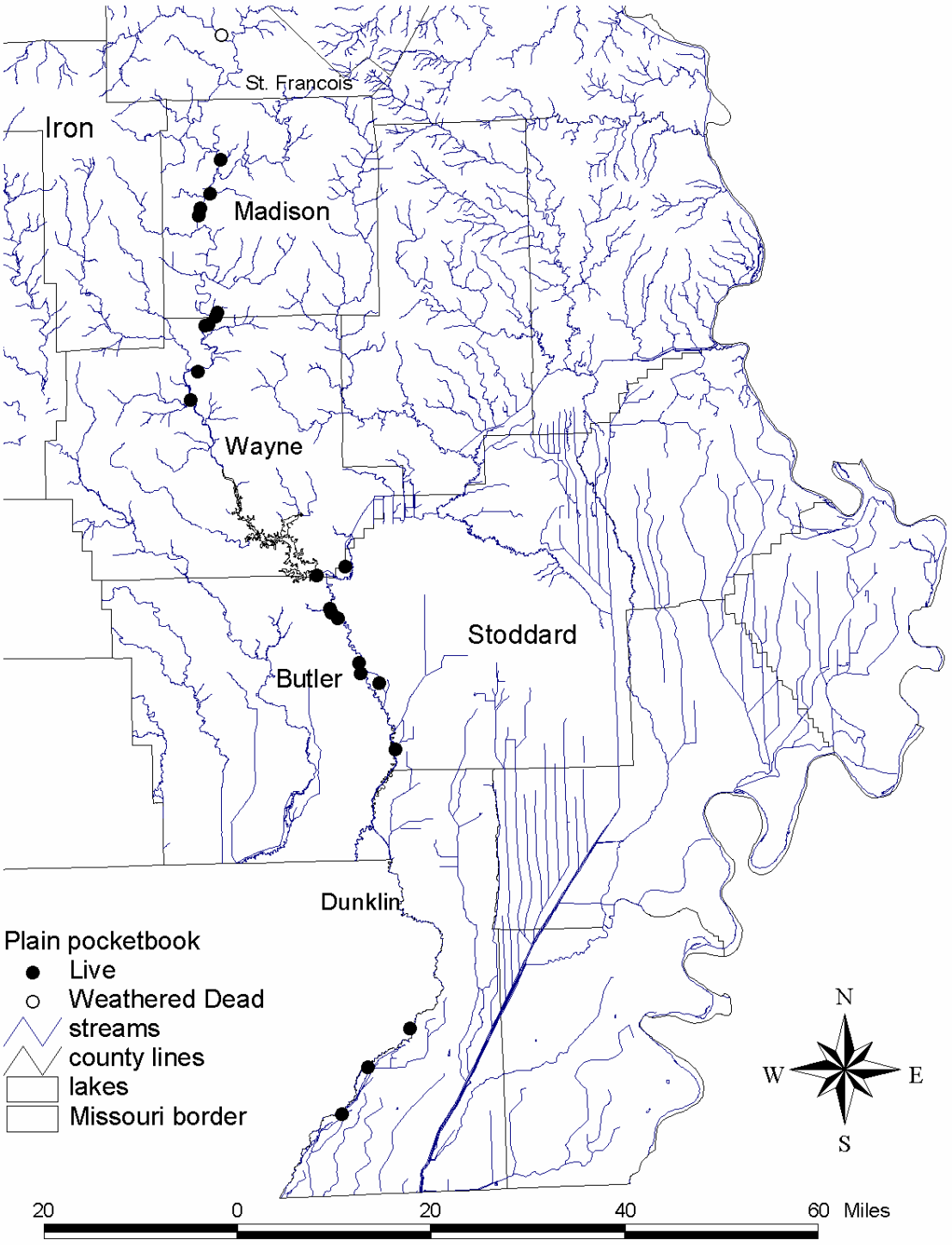

Figure 86. Distribution of the plain pocketbook in the St. Francis River system.

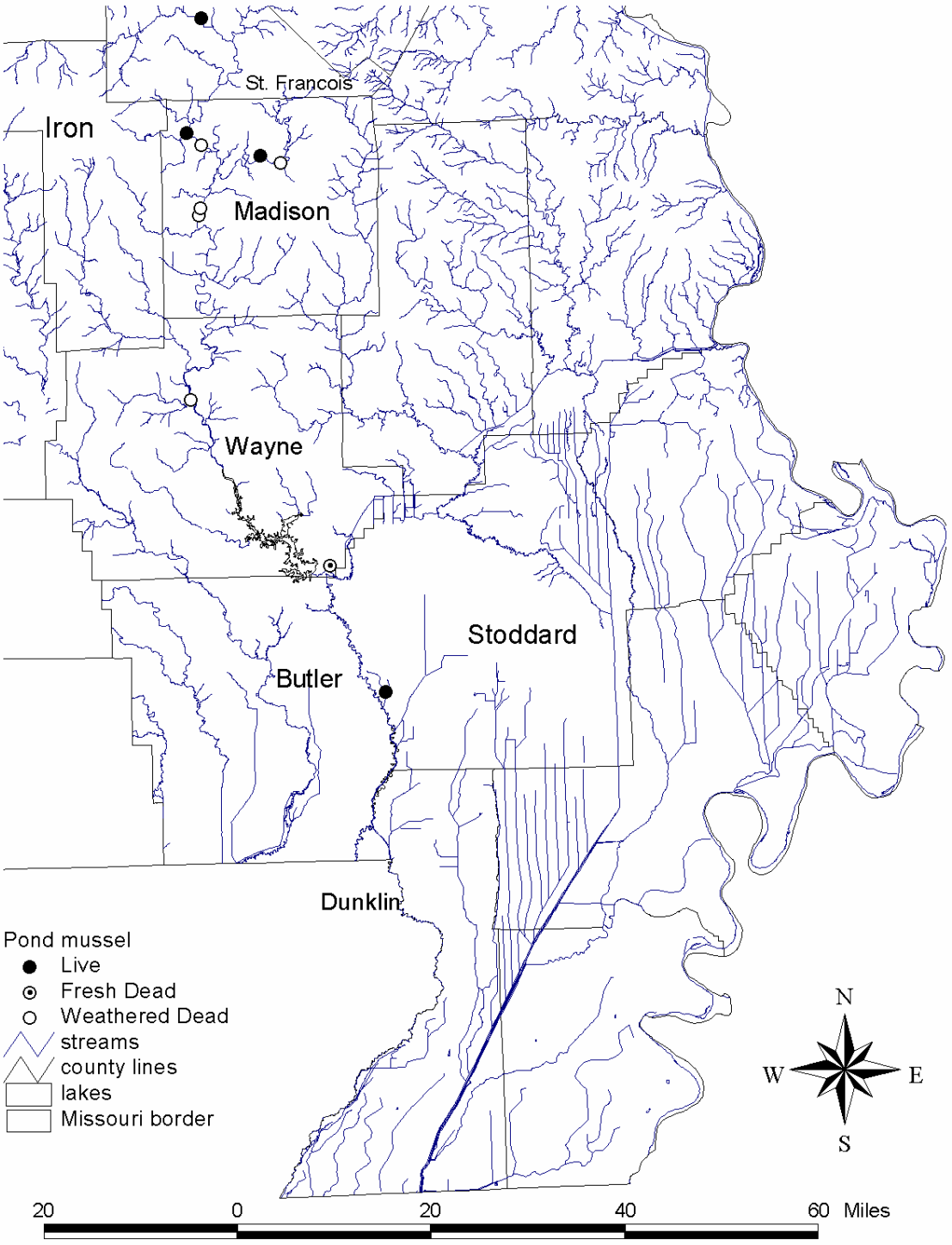

Figure 87. Distribution of the pondmussel in the St. Francis River system.

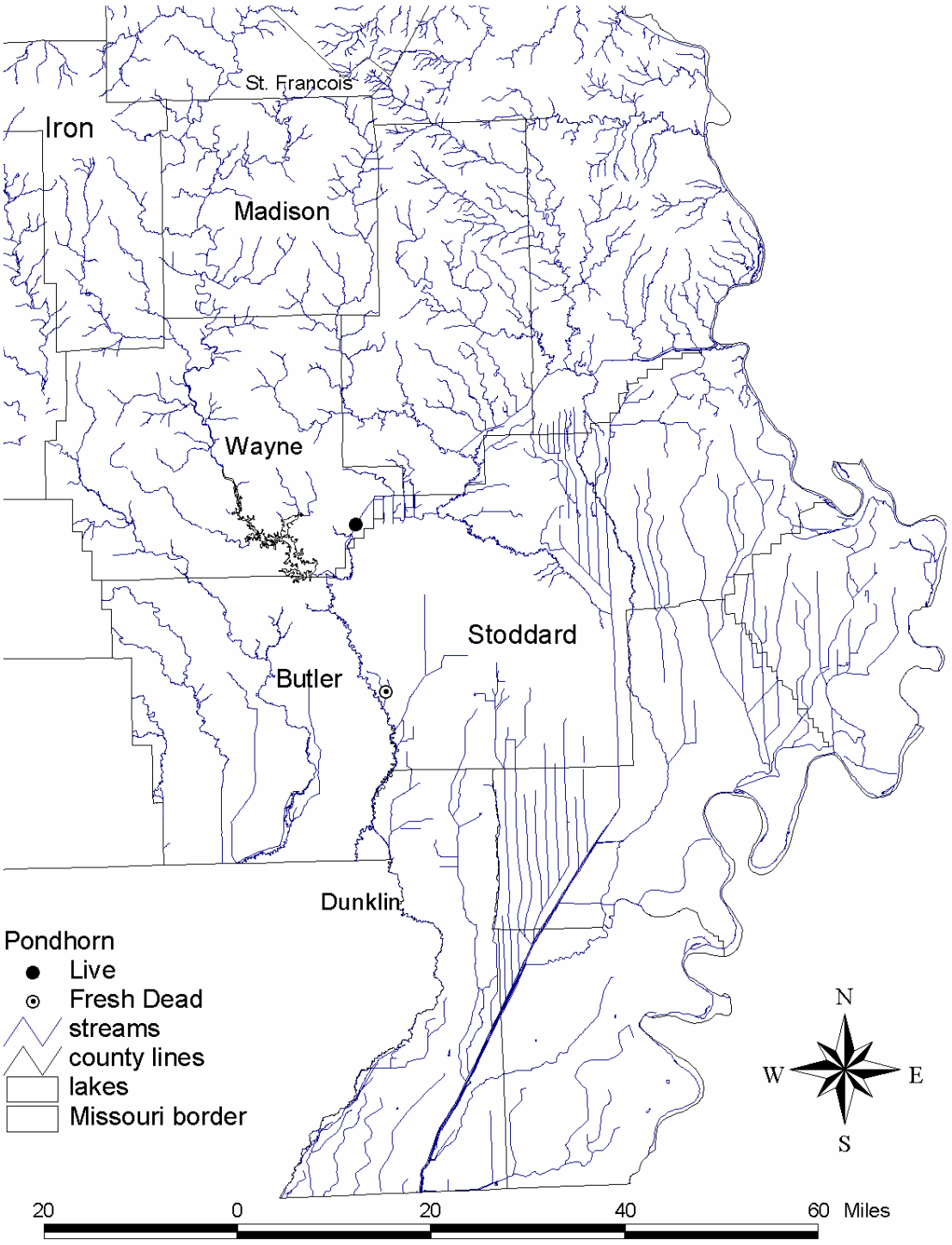

Figure 88. Distribution of the pondhorn in the St. Francis River system.

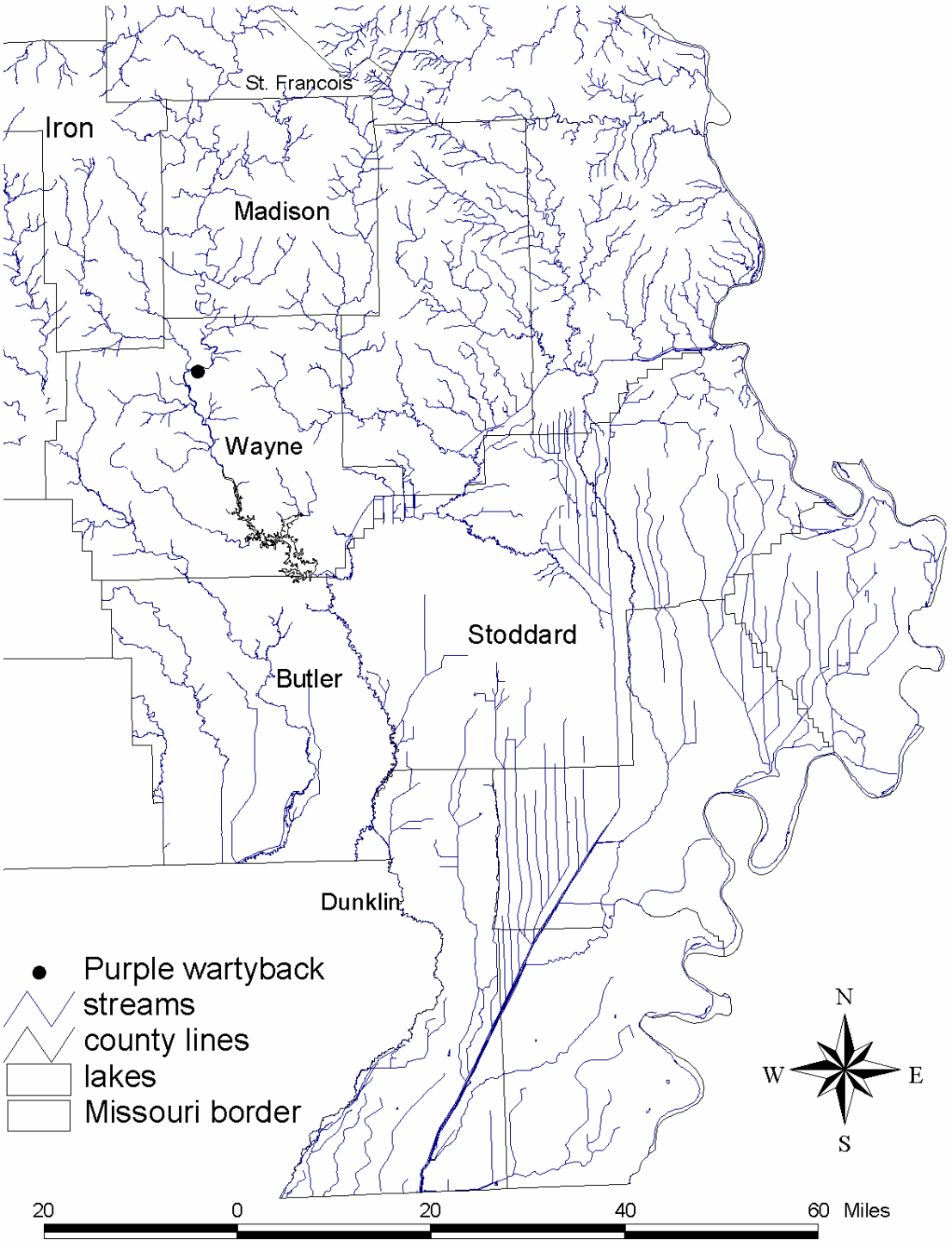

Figure 89. Distribution of the purple wartyback in the St. Francis River system.

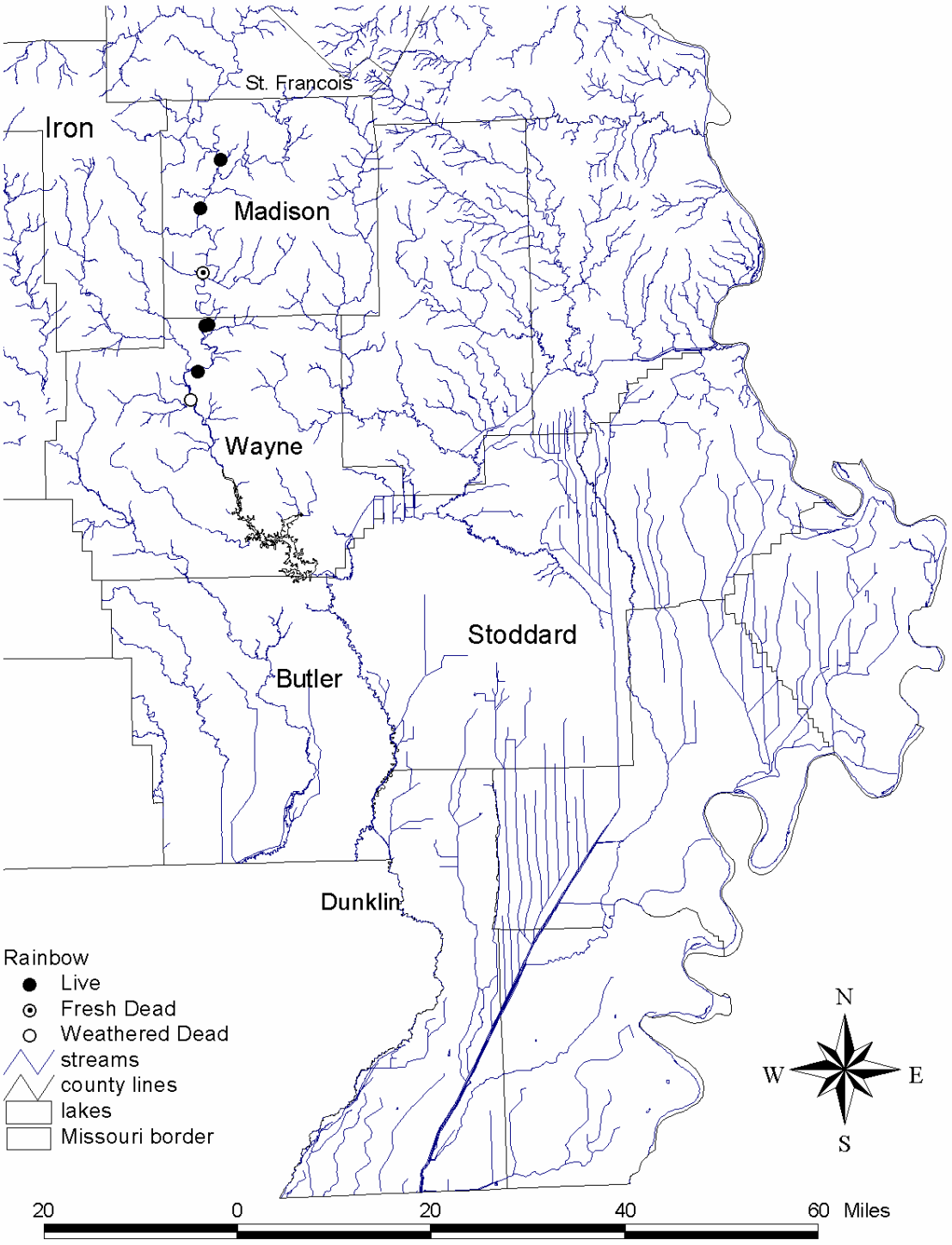

Figure 90. Distribution of the rainbow in the St. Francis River system.

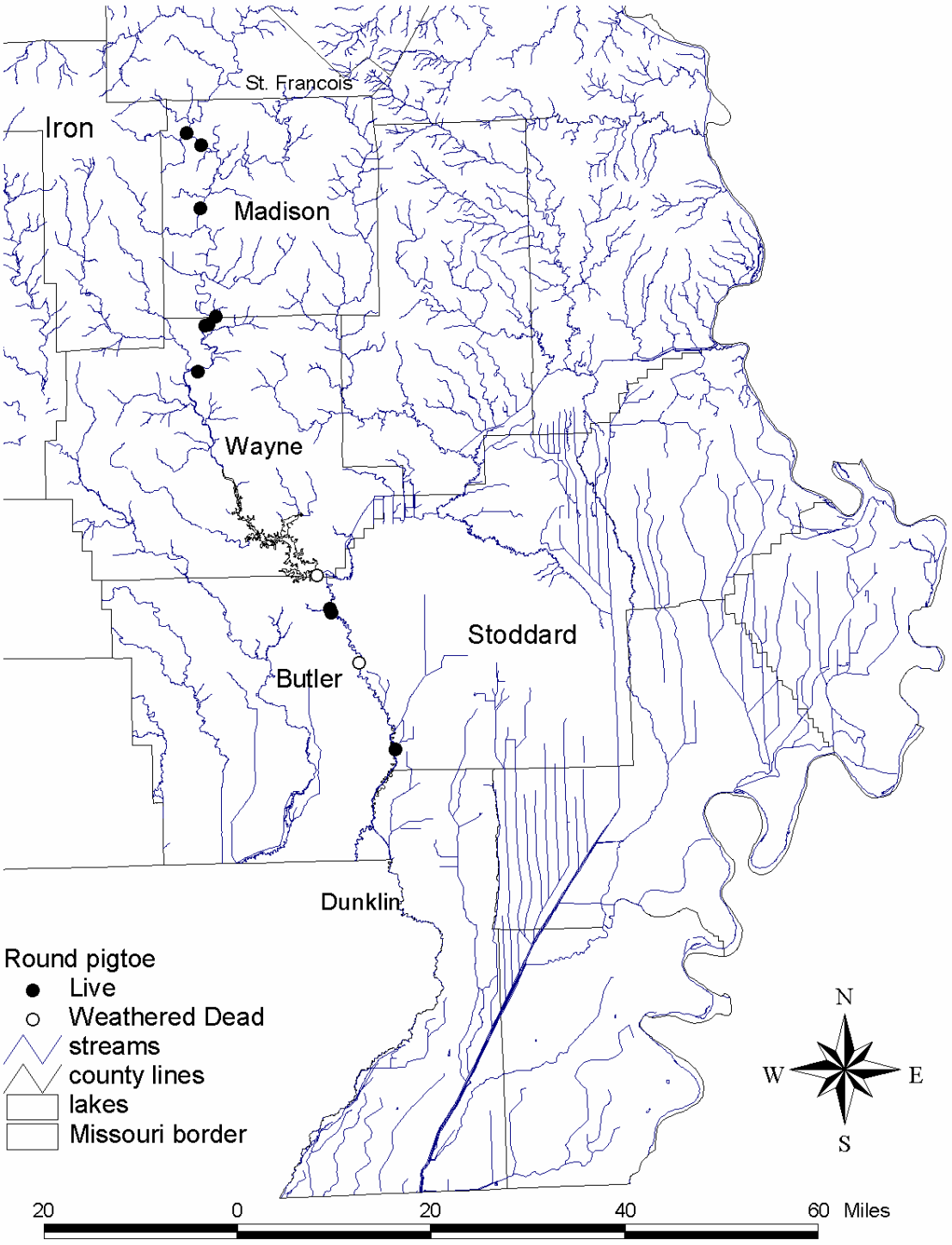

Figure 91. Distribution of the round pigtoe in the St. Francis River system.

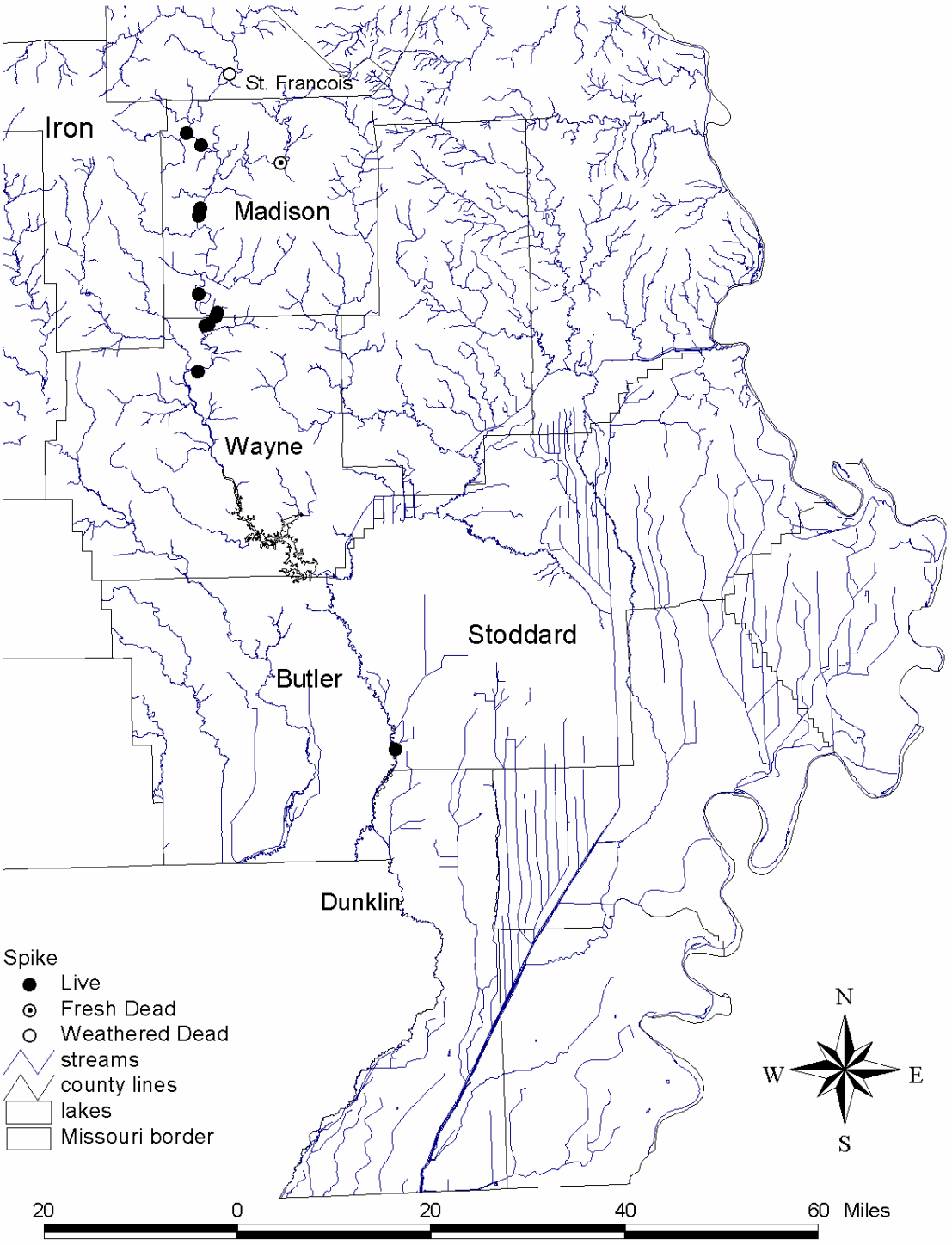

Figure 92. Distribution of the spike in the St. Francis River system.

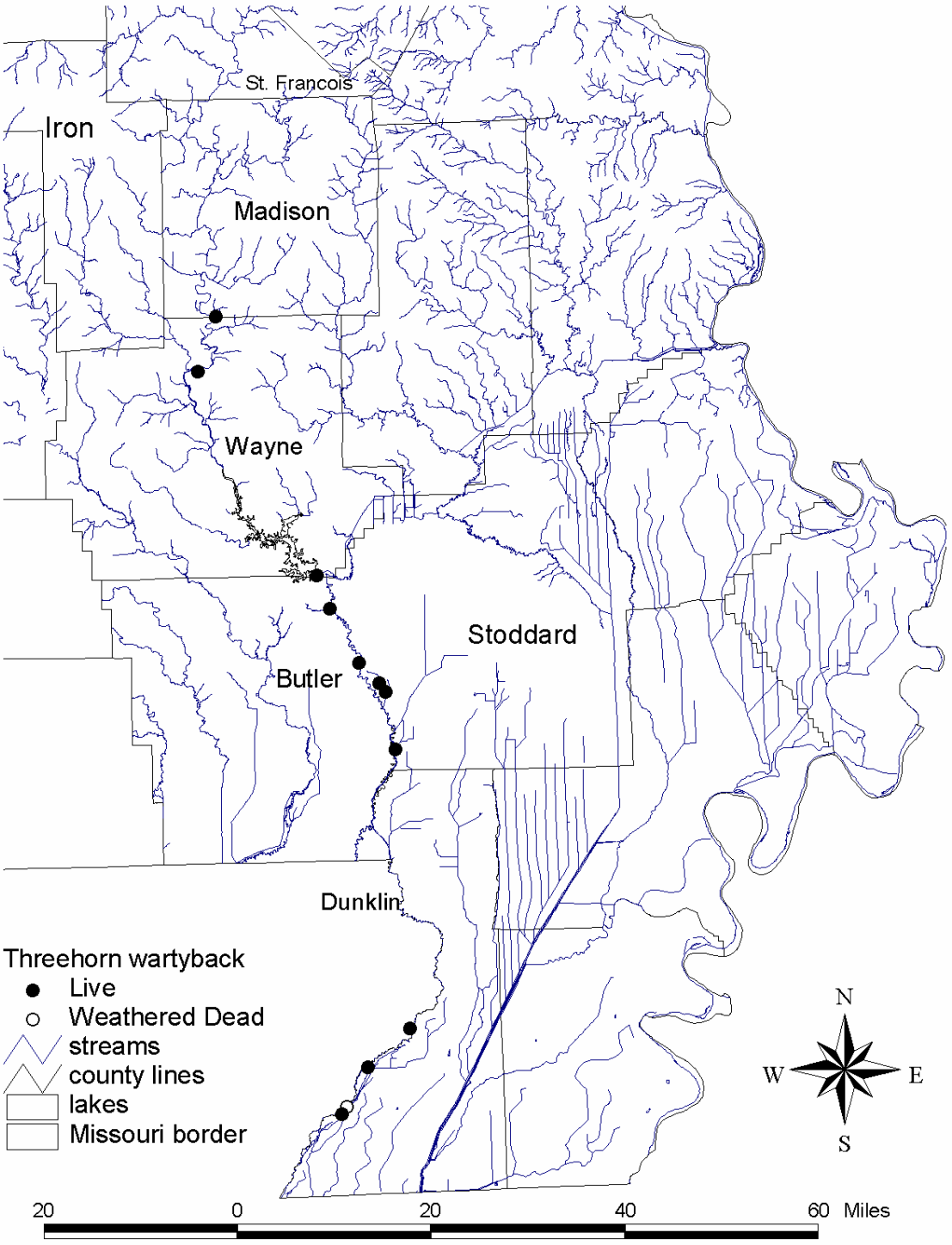

Figure 93. Distribution of the threehorn wartyback in the St. Francis River system.

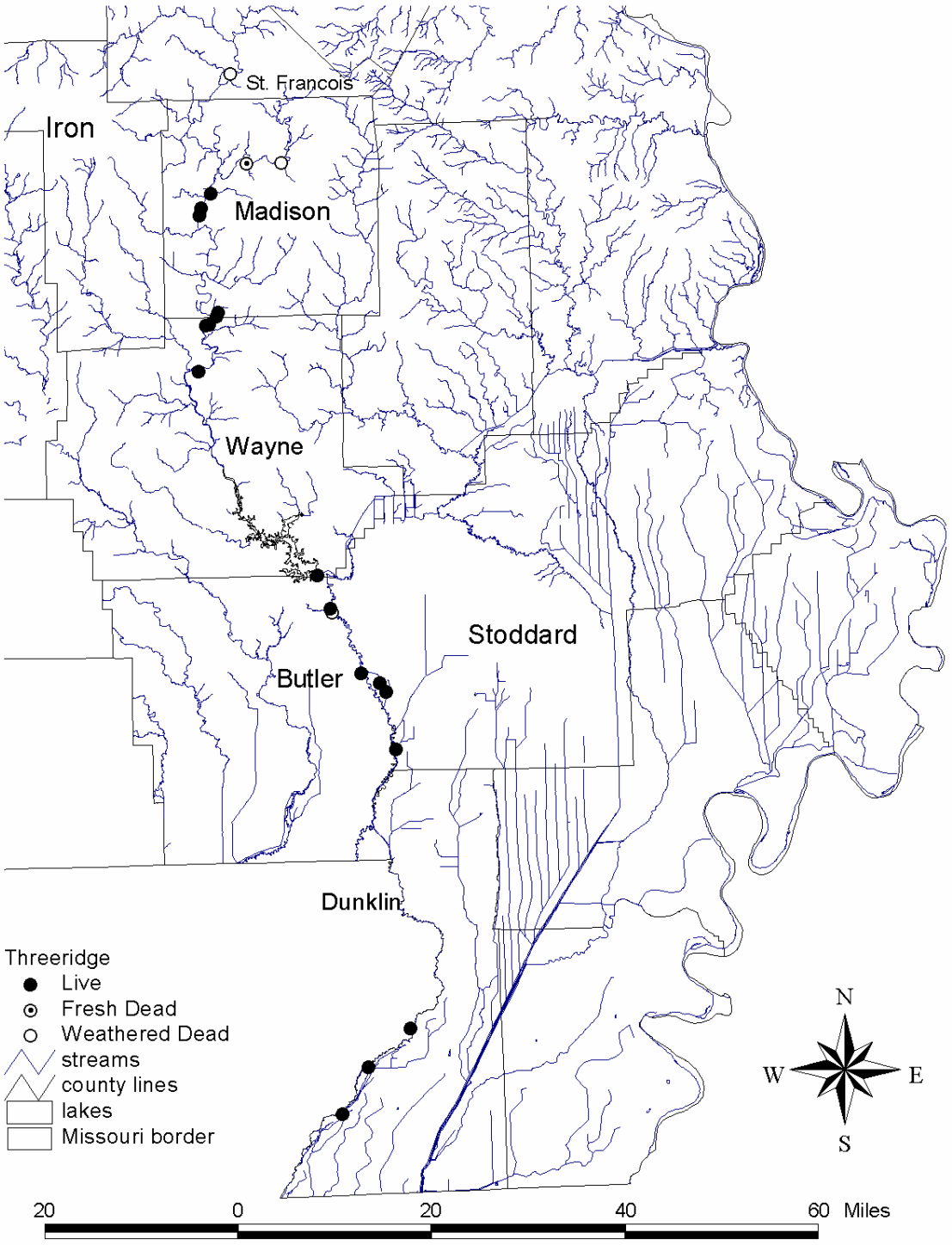

Figure 94. Distribution of the threeridge in the St. Francis River system.

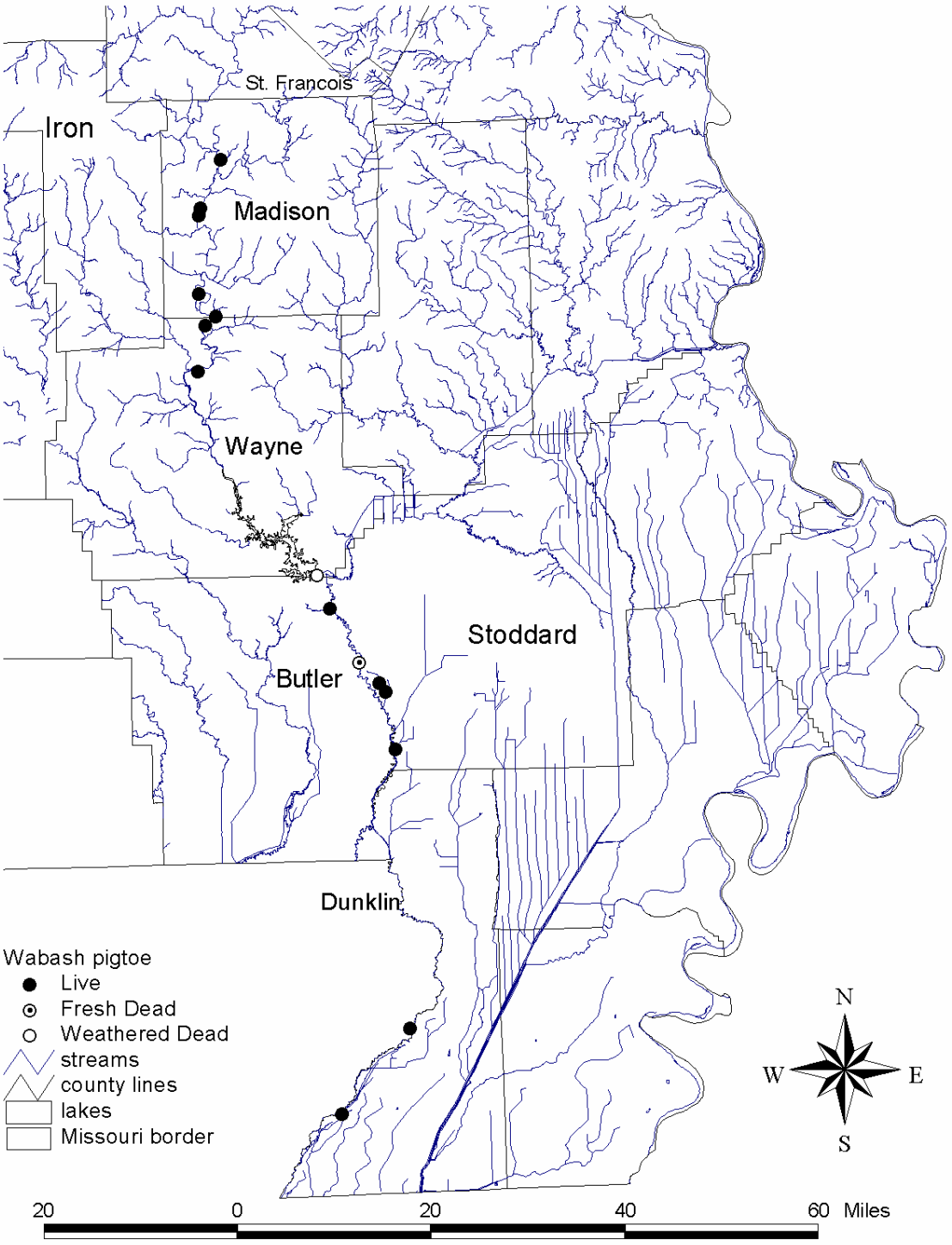

Figure 95. Distribution of the Wabash pigtoe in the St. Francis River system.

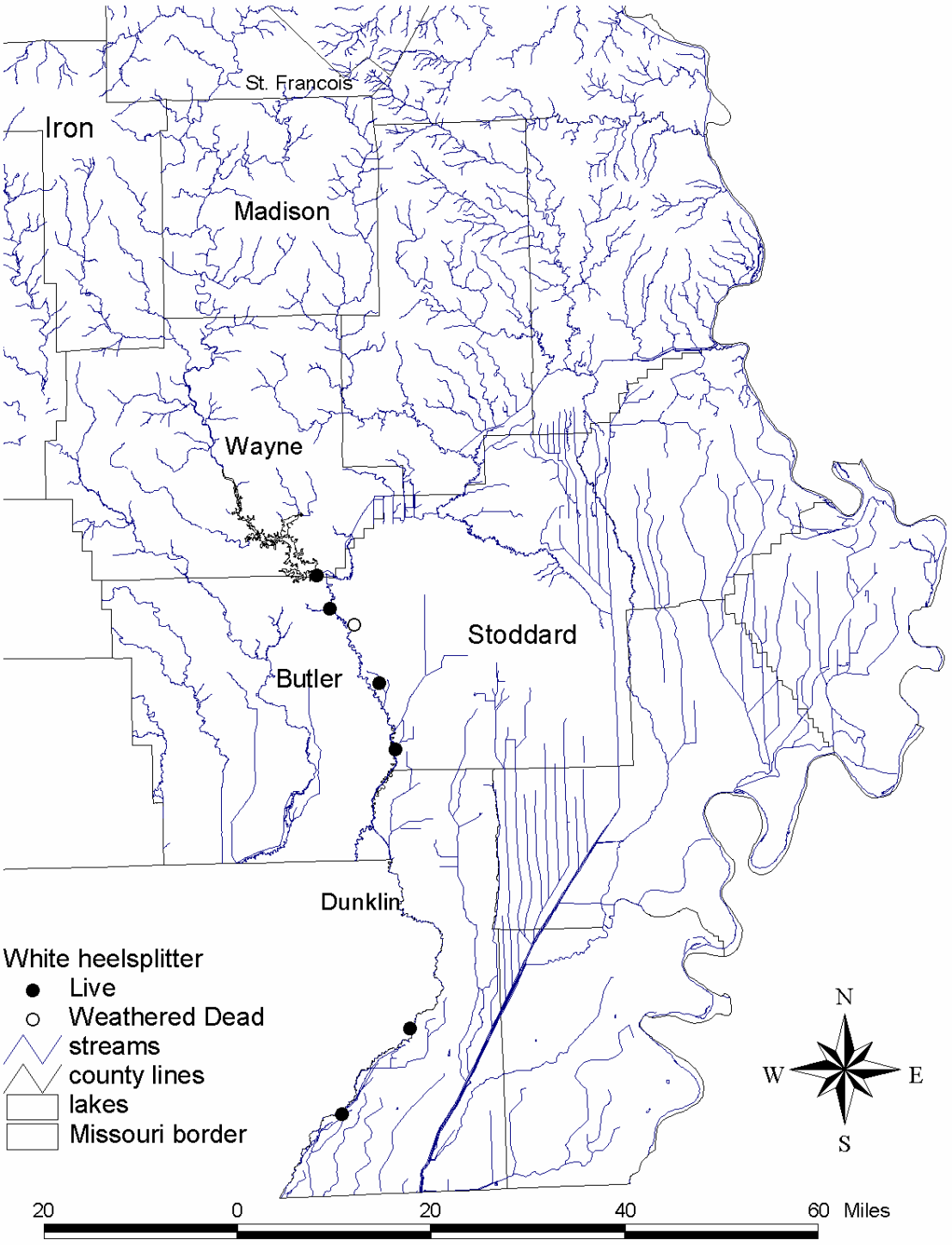

Figure 96. Distribution of the white heelsplitter in the St. Francis River system.

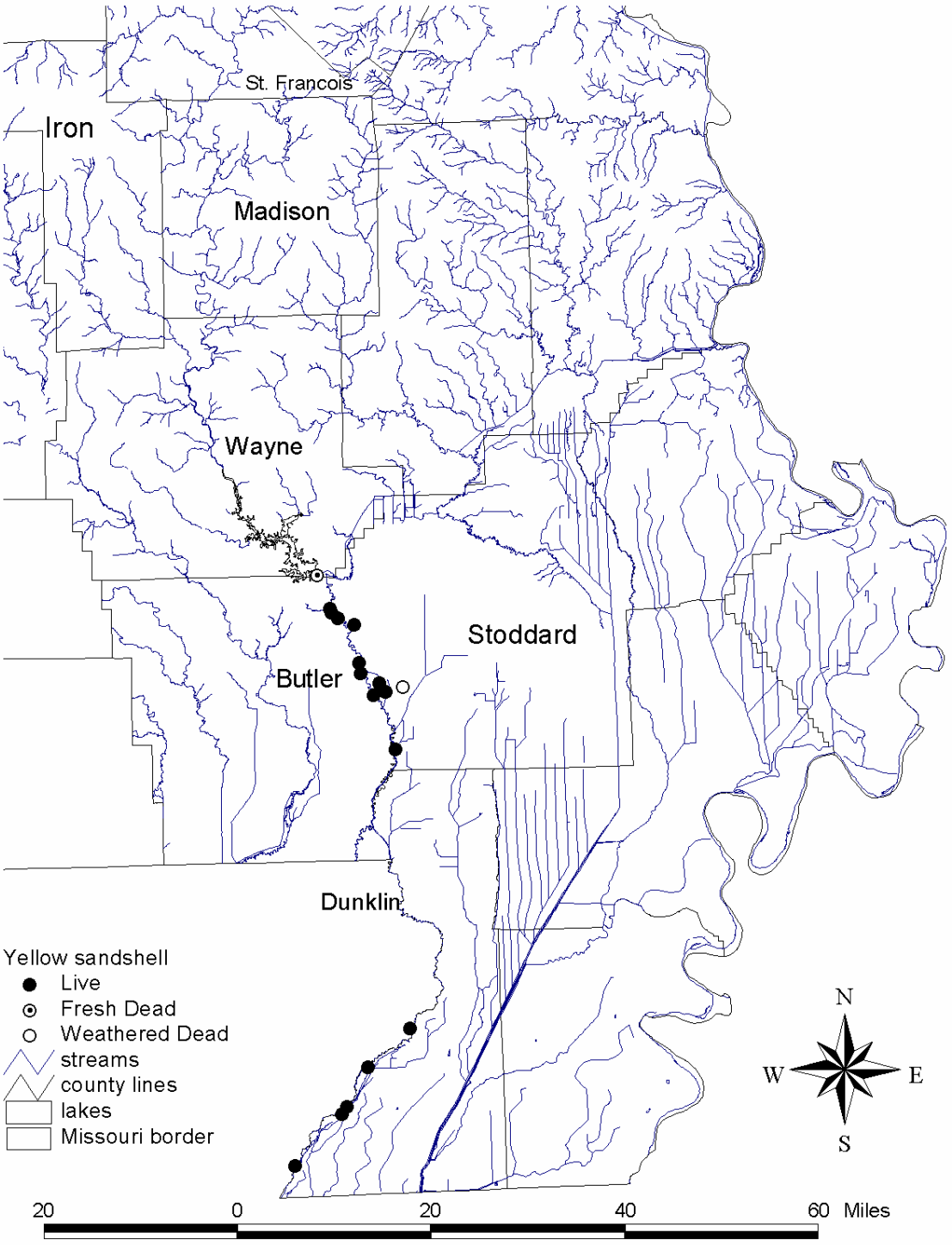

Figure 97. Distribution of the yellow sandshell in the St. Francis River system.

Black River - 2003

Summary

Native freshwater mussels (Unionidae) were surveyed in the Black River system of southeast Missouri. The Black River is a tributary of the White River and drains 1,756 square miles in Missouri. The system contains one of the most diverse and abundant freshwater mussel faunas in the Midwestern U.S. (Oesch 1984, MDC 2004a)

We surveyed 51 sites (31 in the mainstem and 20 in tributaries) between May and September 2003. Sampling was carried out using timed searches by snorkeling and diving. Sampling effort averaged 2.15 hours per site and totaled 109.5 person-hours. We collected 9,189 individual mussels, representing 42 living species. The peak number of species per site was 23. Catch per unit effort ranged from 1 to 462 individuals per person-hour with an average of 83.9 individuals per person-hour.

The most abundant species in our sample were the round pigtoe (27.11% of live specimens), mucket (17.93%), Wabash pigtoe (16.53%), western fanshell (8.64%) and pimpleback (5.67%). The most generally distributed species in our sample were Wabash pigtoe (51% of sites), mucket (49%), pimpleback and bluefer (each at 47%), and fragile papershell, plain pocketbook and monkeyface (each at 43%). Species of conservation concern (SCC) that were recovered (S = Missouri conservation rank) were the federally endangered pink mucket (S1) and the ebonyshell (S1), elktoe (S2), flat floater (S2), rock pocketbook (S3), western fanshell (S1S2), snuffbox (S1), black sandshell (S1S2), bankclimber (S3), Ouachita kidneyshell (S2S3) and wartyback (S3) . These results indicate that the Black River system is a significant refuge for T&E mussel species.

We visited 16 localities that had previously been surveyed. The five most abundant species in the previous collections were mucket (44%), round pigtoe (15.25%), plain pocketbook (10.78%), monkeyface (5.59%), fatmucket (2.7%), and Western fanshell (2.7%). Mucket and plain pocketbook were a markedly higher proportion of the catch in previous surveys than in our collections.

Background – Black River

This project segment focused on the Black River system, a tributary of the White River (Figures 98, 99). The Black River drains portions of both the Ozark Plateau and Mississippi Alluvial Plain zoogeographical regions as described by Funk (1968). The Black River basin comprises approximately 1,756 square miles in Missouri and includes portions of Iron, Madison, Wayne, Butler, and Carter Counties. The Black River originates in Iron and Reynolds counties, and flows south through Reynolds, Wayne, and Butler Counties to the state line and then southwesterly in Arkansas to empty into the White River near Newport, AR. Major tributaries include Brushy Creek, Cane Creek, Little St. Francis River, Ten Mile Creek, McKenzie Creek, Craven Ditch, Miller Creek, Logan Creek and the Main Ditch. The Black River's two largest tributaries are the Current and Eleven Point Rivers, which join the Black River in Arkansas. These rivers are not included in this study.

Impoundments and levees have reduced and fragmented portions of habitat of the Black basin over the past 60 years. Clearwater Dam (completed in 1948) islocated at BRM (Black River Mile) 82.5 and has impounded a total of 10 mi of the mainstem. The authorized purpose of Clearwater Lake is to provide flood control for the Black River and its tributaries and it utilizes a rather small turbine that only provides power to the dam facilities. Another mainstem dam, Lower Taum Sauk Dam impounds 2.6 miles of the East Fork of the Black River (Cieslewicz 2004, MDC 2004).

The Black River drains 1,756 square miles in Missouri. Approximately 52 % of the Black River drainage area (906mi^2) is in the upper subbasin (upstream of Clearwater Dam) and 48% (850 mi^2) is in the lower subbasin (downstream of Clearwater Dam), which is controlled by a system of levees and drainage ditches that restrict the entry of tributaries into the partially channelized mainstem (Cieslewicz 2004). The streams found in the upper subbasin are clear with predominantly gravel, cobble, sand, and boulders. In the lower subbasin the streams ranged from clear with gravel substrates to turbid with clay and sand substrates (Cieslewicz 2004).

The upper subbasin of the Black is mostly wooded and sparsely populated. This subbasin lies within the Viburnum Trend, also known as the "new lead belt" (Smith 1988). In 1955, substantial deposits of lead, zinc, copper and silver were discovered in this subbasin. By 1970, the new lead belt was the largest lead-producing region in the world (Wixson and Tranter 1972). The lower subbasin is 55% forest and 45% row crop or pasture (MDNR 1995).

Historically, 39 unionid species have been reported from the Black River basin (Table 8, Cieslewicz 2004, MDC Database 2004). Surveys of mussels performed from 1965-1985 recorded the federally endangered pink mucket and Curtis pearly mussel, the state endangered snuffbox and ebonyshell, and other Missouri SCC including the black sandshell, southern hickorynut, rock pocketbook, elktoe, purple lilliput, rabbitsfoot, bankclimber and western fanshell. However, the mussels in many areas of the Black River basin have not been systematically surveyed for over 20 years.

Overall, 132 species of fish have been identified from the Black River basin (Cieslewicz 2004) and nine species (cypress minnow, taillight shiner, sabine shiner, mountain madtom, crystal darter, harlequin darter, swamp darter, goldstripe darter, and longnose darter) are listed as state endangered (state rank S1) and 1 is listed as extirpated, the pallid shiner. Twenty-six fish species found in the Black River system are of conservation concern due to population declines or apparent vulnerability from a statewide perspective (MDC 2004a).

Results and Discussion- Black River

The survey was conducted between May and September 2003. We surveyed 51 sites in the Black River system, including 31 sites in the mainstem and 20 sites in tributary streams. The mainstem sites were distributed over 98 river miles between BRM 9.0-107 (Figure 98, Figure 99, Appendix H). Total search effort was 109.5 person-hours. We collected 9,189 living mussels and 42 total species (40 living) (Table 9). Overall CPUE was 83.9 mussels/person-hour. Sampling effort, species, and numbers collected at each site appear in Appendix I.

Species diversity and abundance

The most abundant species in our samples were the round pigtoe (27.11% of live specimens), mucket (17.93%), Wabash pigtoe (16.53%), western fanshell (8.64%), pimpleback (5.67%) and monkeyface (4.20%) (Table 9, Figure 100). The most generally distributed species in our sample were Wabash pigtoe (51% of sites), mucket (49%), pimpleback and bluefer (each at 47%), and fragile papershell, plain pocketbook and monkeyface (each at 43%). Species of conservation concern (SCC) that were recovered (S = Missouri conservation rank) were the federally endangered pink mucket (S1), elktoe, (S2), flat floater (S2), rock pocketbook (S3), western fanshell (S1S2), snuffbox (S1), ebonyshell (S1) (fresh-dead specimen only), black sandshell (S1S2), bankclimber (S3), Ouachita kidneyshell (S2S3) and wartyback (S3). The most rarely encountered unionid species in the Black River system were the wartyback, fawnsfoot, rainbow and snuffbox. All of these species were represented by only single live specimens. The pondhorn was only represented by weathered-dead specimens at two sites. Other relatively rare species included pink mucket (n=4) and the elktoe (n=5) (Table 9, Appendix I-Tables 1-2).

The regression of species number on number of specimens collected at each site explained 79% of the variation in species number among sites (Figure 101, Appendix I-Tables 1-2). The regression coefficients indicate that 20 species are expected per site, and 355 specimens must be collected to recover 90% of these.

Most (41/42) species we collected in the Black system were found in the Black River mainstem. One species, the pondhorn (*Uniomerus tetralasmus)* was only collected in tributaries of the Black River. Seven species were new records for the system, the flat floater, snuffbox, rock pocketbook, wartyback, pond horn, butterfly and pink papershell.

The abundance of unionids in the Black River system is apparently higher than other rivers of similar size in southern Missouri, and species diversity is very high. For example, a recent survey of Meramec River unionids found average CPUE=22 and 40 living species (Roberts and Bruenderman 2000) and a survey of the Gasconade River found CPUE=46 and 35 living species (Bruenderman et al. 2001). These values compare to CPUE=83.9 and 40 living species in the St. Francis (present study). Several species were represented by single specimens, and it is likely that other species are present.

Comparisons with previous surveys

Species that were previously reported to occur in the Black River system, but were not found during this survey, were the federally endangered Curtis pearly mussel, (*Epioblasma curtisi*), Ozark pigtoe (*Fusconaia ozarkensis*), Pleas' mussel (*Venustaconcha pleasii*), rabbitsfoot *(Quadrula cylindrica),* southern hickorynut (*Obovaria jacksoniana*), purple lilliput *(Toxolasma lividus),* slippershell mussel *(Alasmidonta viridis)* and washboard (*Megalonaias nervosa*) (Table 8, Oesch 1984, Cieslewicz 2004, MDC 2004). These species were rare in previous surveys and it is possible that they still occur in the Black system. Thus the fauna may be expected to total up to 50 species (Table 8).

MDC personnel conducted surveys in the Black River at various times from 1969-1982 (MDC 2004a). We were able to visit 16 localities that were previously surveyed. The most abundant species in past collections were mucket (44%), round pigtoe (15.25%), plain pocketbook (10.78%), monkeyface (5.59%), fatmucket (2.7%) and western fanshell (2.7%) (Table 10). This list can be compared to our relative abundance results (Table 10, Figure 105). One striking difference is in relative abundance of mucket, which were the dominant species in previous surveys, but comprised a much smaller fraction of our collections. The plain pocketbook was also more frequent in the past (289/2,682=10.8%) than in the present study (52/1,114=4.7%). While these differences may indicate overall changes in relative abundances, it should be noted that sampling techniques we not constant between past and present surveys. Much of the previous sampling was conducted using view buckets and snorkeling. Although we did snorkel in shallow areas, we also regularly used our surface air supply to investigate deeper areas of the river for long periods of time. Also, we vigorously disturbed the substrate to collect specimens that were totally buried and not visible through visual inspections.

Longitudinal distribution

The Black River basin is nearly equally divided (north and south) by Clearwater Dam and Lake (Cieslewicz 2004). This reservoir is operated by the Corps of Engineers for the primary purpose of flood control, with conservation of fish and wildlife and recreation as other purposes.

We observed no mussels at 2 sites in the Black River mainstem upstream of Clearwater Reservoir (Figures 102, 103). The only mussels we collected in the upper subbasin were located near Lower Taum Sauk Dam in the East Fork of the Black River. Throughout

this area there are excessive amounts of gravel bedload in the stream channel. Along with large amounts of gravel, the river substrate contains some pebbles and cobble, but is lacking the finer substrate categories.

The section of river immediately downstream of Clearwater Dam (BRM 82.5-60) had a low CPUE and moderately high species diversity. This section, although still possessing large amounts of gravel and cobble, contained more sand and silt. In these areas, usually along the margins, small mussel beds were observed. The margins most likely provide refuge for mussels during high releases from Clearwater Dam. This was also the section of river that formerly held a small population of Curtis pearly mussel *(Epioblasma florentina curtisi).* Unfortunately, we found no evidence of this species in our survey.

The next section of river (BRM 60-BRM 33.7) yielded an extremely high CPUE and species diversity (Figures 102, 103). The channel substrate was heterogeneous and quite stable. This habitat produced mussel beds that were very dense, diverse and large. We also note that these mussel beds are not located in the most picturesque portion of the Black River. Urban communities, including Poplar Bluff, adjoin the river and considerable trash and refuse were observed in the river. This section also yielded *Cyprogenia aberti, Plectomerus dombeyanus, Ligumia recta, Alasmidonta marginata, Lampsilis abrupta, Epioblasma triquetra* and *Fusconaia ebena.*

The lower portion of the Black River (BRM 33.7-0) had lower CPUE and species diversity. This result is not surprising, given that the river in this section is relatively slow with a homogeneous clay and sand substrate, conditions that are unfavorable for many mussel species. Streambank erosion and headcutting are serious problems in the channelized and leveed section of the lower subbasin. We did observe some unique areas near Coon Island Conservation Area. There were side pools with extensive silty habitat. In these areas, we collected mud-dwelling species including *Amblema plicata, Utterbackia imbecillis, Anodonta suborbiculata, Arcidens confragosus, Plectomerus dombeyanus* and *Pyganodon grandis.*

Recruitment

Our data suggest good recruitment of mussels in the Black system (Figure 104, Appendix J). We found numerous young individuals (0-5 yr) of pimpleback (n=46), Wabash pigtoe (n=43), monkeyface (n=36), lilliput (n=28), western fanshell (n=28), fragile papershell (n=24) and spike (n=23). Overall, we collected young specimens from 35 species. Young individuals were collected in the all areas of the river and also in many of the tributaries including the drainage ditches in the lower subbasin (see Appendix J). Although populations of abundant species appear to be composed mainly of old individuals, it is clear that recruitment is occurring.

Unionid Species of Concern: Distribution and Habitat

Distribution maps for SCC and other species encountered during our study appear in Figures 106-147. Specific river miles, age estimates, and lengths of all specimens collected are reported in Appendix J.

Bankclimber, *Plectomerus dombeyanus*

The bankclimber has a state rank of S3 and a global rank of G4 (MDC 2004b). The historical distribution of this species is the Mississippi River valley from southeast Missouri to Louisiana. It inhabits mud-rock /gravel stream beds with sluggish current and is often collected in shallow water near banks (Oesch 1984). In Missouri, it has been reported from the Black and St. Francis River systems as well as some of the other large drainage ditches in the Bootheel region.

We collected a total of 126 live bankclimbers from the Black River system (Table 9, Figure 106). The relative abundance of this species was 1.4%. The majority of our specimens were collected from two sites near the Missouri/Arkansas border (BRM 9.0 and 10.5). The overall habitat of these sites was swamp-like and the channel substrate was silt and sand. These sites contained a moderate abundance and diversity of mussels. The mussel beds in these areas were located along the margins or near islands where the silt became more prevalent. Water clarity was low and we collected all specimens by groping. Making our way upstream, we collected bankclimbers only sporadically for the remainder of the survey sites. Overall, the bankclimber was scarce in the lower subbasin, but it still exists regularly in swampy areas.

Black sandshell, *Ligumia recta*

The black sandshell has a state rank of S1-S2 and a global rank of G5 (MDC 2004b). It has a large range and occurs throughout the Mississippi River system from New York to Minnesota, south to Oklahoma and east to the Alabama River basin, the Red River of the North, and the St. Lawrence River basin (Parmalee and Bogan 1998). In Missouri, it is known from the Black, Osage, White, Gasconade, Mississippi, Salt, Des Moines, Platte, Neosho, Meramec, Blackwater and St. Francis River basins (Utterback 1915, 1917; Oesch 1984; Barnhart 1999).

In our survey, a total of 12 living black sandshell were collected at 8 sites in the Black River (BRM 33.7-80.0) (Table 9, Figure 107). Additionally, many weathered dead specimens were collected throughout this section of river at 8 more survey sites. The relative abundance of this species was 0.13%. Black sandshells were collected in riffle/run habitat at water depths of 0.5-1.5 m. The substrate was heterogeneous and the water clarity was generally excellent. We did collect one young (age 3) individual at BRM 33.7. Overall, the rarity of this species suggests that it may become extirpated from the Black River system. However, MDC does manage a walleye fishery in the Black River. Between 1996 and 2000, 1.3 million walleye fry were stocked into the lower Black River just downstream from Clearwater Dam. As walleye are the host for *L. recta,*

the recent fish stockings could become a factor in the restoration of this species in the Black River.

Ebonyshell, *Fusconaia ebena*

The ebonyshell has a global rank of G4G5 and is listed as endangered in Missouri with a state rank of S2 (MDC 2004b). The historical range includes the Mississippi River drainage to New York, west and north to Minnesota and eastern South Dakota, south to east Texas and northern Louisiana and the Alabama River system (Parmalee and Bogan 1998). In Missouri is has been recorded from the Mississippi, Osage, Platte, St. Francis, and White rivers (Utterback 1915). Recent records indicate this species inhabits the Meramec, Osage, Gasconade, Current and Little Black rivers (Buchanan 1979, Grace and Buchanan 1981, Buchanan 1994).

In our survey, the ebonyshell was an extremely rare species (Table 9, Figure 108). The only evidence of this species was a single fresh-dead shell collected in downtown Poplar Bluff (BRM 36). This urban site contains a very large mussel bed, which is highly diverse and very dense. It is the same site where a single young pink mucket was collected. The specimen was collected in a large riffle in shallow water and in gravel/pebble/cobble substrate. This is the first record of this species' occurrence in the Black River system in Missouri. Overall, the extreme rarity of this species suggests that it may extirpated from the Black River system in the future.

Elktoe, *Alasmidonta marginata*

The elktoe has a global rank of G4 and a state rank of S2 (MDC 2004b). It is a widespread species, but records are sporadic throughout its range (Cummings and Mayer 1992). The historical distribution of *A. marginata* was the upper Mississippi, Ohio, Cumberland, Tennessee, Michigan and upper St. Lawrence drainages (Burch 1975). Utterback (1915, 1917) reported this species from the Mississippi, Gasconade and Jack's Fork rivers and from the Osage, Meramec, Neosho, Black and St. Francis River basins. More recently, this species was collected from the Whitewater, Black, St. Francis, Cuivre, Salt, Gasconade, Sac, Pomme de Terre, Current, James, Elk, Spring (Neosho system) and North Fork of the White Rivers (Oesch 1984).

In our survey, the elktoe was a rare species. We collected 5 live elktoe at 3 sites and weathered dead specimens at additional sites (Table 9, Figure 109). All of the live specimens were collected north of Poplar Bluff at BRM 55, 62, and 69.4. These sites contain highly diverse and moderately dense mussel beds. All of the elktoe were collected in riffle/run habitat and were partially buried in the substrate. Channel substrates were a mixture of sand, gravel, and cobble. Water depths varied from 1-3 meters. The 5 specimens yielded a relative abundance of 0.05%. Overall, the extreme rarity of this species suggests that it may become extirpated from the Black River system in the future.

Flat Floater, *Anodonta suborbiculata*

The flat floater has a global rank of G5 and a state rank of S2 (MDC 2004b). It has a large historic range with reported occurrences throughout the Mississippi River floodplain. Presently, the range of this species can be described as locally abundant in the floodplain lakes, sloughs, and oxbows of the Mississippi and Ohio rivers and their tributaries (Cummings and Mayer 1992). In Missouri, it has been reported from the Missouri, St. Francis and Osage River basins.

In our survey, the flat floater was a rare species. We collected 17 live specimens at 4 sites in the Black River. (Table 9, Figure 110). The live specimens collected yielded a relative abundance of 0.19%. The sites were located at BRM 8, 13, 55, and 57 and contained at least some substrate that was pure silt. All specimens were buried deeply and were collected by groping. In these areas, flow was negligible and the habitat was almost stagnant. The water levels were not deep (~1 m) and the banks were usually stable as there was no flow to cause erosion. The silt was very soft and groping mussels was reasonably easy and productive. This is the first record of this species occurrence in the Black River system in Missouri. Although we did not encounter many flat floaters, it seems reasonable that other populations might occur in similar habitats elsewhere in the Black River system.

Ouachita kidneyshell, *Ptychobranchus occidentalis*

The Ouachita kidneyshell has a global rank of G3/G4 and a state rank of S2/S3 (MDC 2004b). The species is endemic to the Ozark and Ouachita highlands in Missouri, Kansas, Arkansas and Oklahoma. Specifically, it is known from the Red, Ouachita, Black, White, St. Francis, upper Arkansas and Meramec River drainages (Roberts et al. 1997). In Missouri, it occurs in streams along the southern slope of the Ozark highlands. These streams include the St. Francis, Niangua, Black, Little Black, Current, Eleven Point, James, North Fork of the White and Spring Rivers, and in Flat, Bryant, Swan and Beaver Creeks (Oesch 1984, Buchanan 1996).

In our Black River survey, the Ouachita kidneyshell was very rare. We collected 8 live specimens from 5 sites (BRM 35.5, 36, 62, 65.5, and 74.6) and it comprised 0.09% of our total catch (Table 9, Figure 111). It was found primarily in shallow riffles with gravel/cobble in moderate to swift flow. All of the sites that this species occurred at contained large and diverse mussel beds. It is curious that this species would be so rare in the Black system when it is exceptionally abundant in the adjacent St. Francis system. This species was apparently rare in past surveys as well (Appendix K). The only other evidence of this species was one weathered-dead specimen collected at one site. Overall, the extreme rarity of this species suggests that it may become extirpated from the Black River system in the future.

Pink Mucket, *Lampsilis abrupta*

The pink mucket, listed as federally endangered in 1976, has a global ranking of G2 and a state ranking of S2 (MDC 2004b). Its historical distribution includes the Tennessee, Ohio and Cumberland River basins with occasional records from the Mississippi River (USFWS 1985). In Missouri, it has been reported from the lower reaches of the Osage, Gasconade and Meramec Rivers (Buchanan 1980, Grace and Buchanan 1981), and from the St. Francis, Sac, Black and Little Black Rivers (Grace and Buchanan 1981, Oesch 1984).

In our survey, four live female pink muckets were collected in the Black River at BRM's 10.5, 36, 39, and 48.5. (Figure 112 and Appendix I-Table 1). Three of the sites (BRM 36, 39, 48.5) are located in a section of the Black River that contained large and diverse mussel beds in areas of very stable and diverse substrate. These areas contain some of the best mussel habitat that we encountered in the basin. Bank stability was generally good, although there were areas of localized erosion. The riparian zones were mostly forested except for one site (BRM 36) that is located in downtown Poplar Bluff beneath two automobile bridges and one railroad bridge. At this site that we collected a single young pink mucket (approximately 6 years old) in water approximately 1 m deep.

It should be noted that the reach in Poplar Bluff is vulnerable to damage by bridge construction/repair and is also under consideration for flow modifications. In July 2004, we met informally with representatives of Smith and Company, an engineering firm in Poplar Bluff, as well as other interested parties including USFWS to discuss possible impacts of such modifications on the mussel fauna. The proposed modifications would be designed to more or less isolate a meander loop just downstream of BRM 36 in order to prevent occasional flooding of a city park at that point.

The fourth pink mucket site, BRM 10.5, was rather different from the sites described above. The stream substrates in this area consist of only sand, silt, and clay and the riparian corridor is very dense. Our specimen was located in the margin at an approximate water depth of 1.5 m. The overall habitat of this area is swamp-like and we were quite surprised to collect this species there. The site does contain a variety of mussel species including other SCC species such as the wartyback, rock pocketbook, and bankclimber. Overall, *L. abrupta* was one of the rarest mussels encountered during this survey. Due to its extreme scarcity, this species may be in danger of becoming extirpated from the Black River system in the near future.

Rock Pocketbook, *Arcidens confragosus*

The rock pocketbook has a global rank of G4 and a state rank of S3 (MDC 2004b). Its range includes the Mississippi River and major tributaries from Minnesota to Louisiana, as well as several other Gulf river systems from Texas to Alabama (Clarke 1981, Parmalee and Bogan 1998). In Missouri, it has been reported from the Missouri River (south of St. Louis), lower Meramec River, St. Francis River, Little Black River and Osage River (Buchanan 1980, Oesch 1984, Buchanan 1996). Rock pocketbooks appear

to be more common in the man-made agricultural ditches in southeast Missouri (Ahlstedt and Jenkinson 1987, Roberts et al. 1997, Barnhart 1998).

In our survey, the rock pocketbook was a rare species. We collected a total of 12 live rock pocketbooks at sites in the Black River (Table 9, Figure 113). All of the sites were located near Coon Island CA at BRM's 10.5, 13 and 15.5. The relative abundance of this species was 0.13%. The substrate in this area is comprised of primarily sand and silt. All of the live specimens were collected by groping, as the water clarity was too low for snorkeling. Water depths ranged from 1-2 m and flow was slow to negligible. Although this species is rare, it occurs in habitats that are common throughout the lower Black River near the Missouri/Arkansas border. Therefore, it may be more abundant than our data reflects.

Snuffbox, *Epioblasma triquetra*

The snuffbox has a global rank of G3 and is listed as Missouri State Endangered (S1) (MDC 2004b). It is also a federal candidate (category 2). It is widespread but rare throughout the Midwest (Cummings and Mayer 1992). In Missouri, it has been reported from the Meramec, Bourbeuse and St. Francis Rivers (Buchanan 1980, Oesch 1984). This species inhabits medium to large rivers in riffles with moderate to swift current.

In our survey, the snuffbox was extremely rare (Table 9, Figure 114). The only evidence of this species was 1 live male collected the Highway-A bridge in Wayne County (BRM 65.5), which yielded a relative abundance of 0.01%. The specimen was collected in the margin of a small riffle in shallow water and in gravel/pebble substrate. The mussel bed in this area is moderately diverse and not very dense. This site is a popular recreational area for swimmers and fisherman, as well as a cattle access site. This is the first record of this species occurrence in the Black River system in Missouri. Overall, the extreme rarity of this species suggests that it may become extirpated from the Black River system in the future.

Wartyback, *Quadrula nodulata*

The wartyback has a global rank of G4 and a state rank of S3 (MDC 2004b). Its historic range included much of the Midwest in the Mississippi and Ohio River systems. Presently it is considered uncommon, but can be locally abundant in large rivers or in the lower reaches of medium-sized rivers in fine-grained substrates. In Missouri, it has been reported from the South Grand, Salt, North Fabius and Mississippi Rivers, and from the ditches of Dunklin County (MDC 2004a).

In our survey, the wartyback was extremely rare (Table 9, Figure 115). We collected a single live specimen from 1 site in the Black River near Coon Island CA (BRM 10.5). This site was a swampy area with fine-grained substrate, low flow and water depth of 1-2 m. All mussels in this area were located by groping, as water clarity was low. Other species collected at this site include the threeridge, mucket, rock pocketbook, and bankclimber. This is the first record of this species occurrence in the Black River system

in Missouri. The wartyback may very well be present in other swampy areas of the Black River or in ditches or sloughs, however due to its extreme rarity it is at risk of extirpation from the Black River system.

Western Fanshell, *Cyprogenia aberti*

The western fanshell has a global rank of G2 and a state rank of S1S2 (MDC 2004b). As currently recognized, its distribution is limited to streams west of the Mississippi. However, recent genetic and physiological studies indicate that the populations currently classified as western fanshell are actually a species complex (Eckert 2003). In Missouri, western fanshell has been recorded from the Black River, Little Black River, Cane Creek, Current River, and Spring River (Black/White river system) and the St. Francis River, Castor River, and from the North Fork Spring River and Spring River (Neosho system) (MDC 2004a).

In our survey, the western fanshell was very common and often locally abundant at many sites in the Black River (Table 9, Figure 100). We collected a total of 794 live specimens at 19 sites in the Black River (Table 9, Figure 116). The relative abundance of this species was 8.64%. It was almost always collected in riffles and runs with moderate to high flow. Water depths ranged from 0.5-2 m and substrate was generally composed of gravel with some cobble. In addition to being locally abundant at many of our sites, this species is reproducing (29 individuals under age 5). This species was also common in the Black River during past surveys (Appendix K). In addition to this species being abundant in our collection, it was also widespread, occurring at 37.2% of our survey sites. In general, this species is a regular component of the mussel fauna in the Black River and the population appears to be recruiting.

<u>Threats in the Black River System</u>

Threats to water quality in the Black River system (Cieslewicz 2004):

- In the basin, there are 16 public and 29 private wastewater treatment plants. The largest wastewater treatment plant is at Poplar Bluff with an estimated discharge of 2.9 million gallons per day.

- The presence of enormous amounts of tailings (finely ground rock) stored behind dams in several basin streams represents a substantial threat in the form of sediment pollution and lead contamination to aquatic life. Failure of these dams would allow large quantities of tailings to quickly enter basin streams.

- Streams in the southeast portion of this subbasin have been completely channelized and leveed. Aquatic habitat problems include unstable streambed substrates, loss of deep-water habitat and lack of riparian corridor. Generally, the mussel habitat in the lower Black mainstem is poor until the river reaches Coon

Island Conservation Area. Upstream of this area, the riverbed consists mainly of sand and we only encountered mussels sporadically.

- Gravel pushing and poor gravel removal methods are widespread and relatively common especially in the upper subbasin. The detrimental effects of these activities on the stream health are significant, but localized. It is difficult to quantify the cumulative effects of these activities on the streams.

- Instream gravel mining formed both the Hendrickson and the Keener Springs pools in the Black River (mining has since ceased). The expected bank failures upstream of these pools due to headcuts have not occurred. However, local residents indicate that the Keener Springs pool is rapidly filling in with gravel.

- North Fork of Webb Creek, Doe Run Creek, and Dickson Valley Creek have several miles of riparian corridor that are nonexistent or consist of a single row of trees.

- Many streams in the basin are experiencing moderate erosion even with an excellent riparian corridor. This erosion can be attributed to the excessive amounts of gravel bedload in the stream channel.

- In the lower subbasin, the Poplar Bluff wastewater treatment plant degrades approximately five miles of Main Ditch, where both biological oxygen demand and non-filterable residue standards are not met. In McKenzie Creek, low pH waters from the Gads Hill Quarry degrade approximately 0.5 mi of creek. In the upper subbasin, nutrients from the Doe Run West Fork Mine degrade 0.2 miles of the West Fork of the Black River. We did not collect any unionids (live or dead) in this region of the upper subbasin.

Management Recommendations- Black River system

Aquatic habitats, riparian areas, and the water quality are typically in good condition in the Black River system. Sections of the lower subbasin have been altered and need rehabilitation. Headcutting, erosion, and sediment deposition are moderate problems. Land management can be improved on public and private land. Through coordination and cooperation with other agencies, best management practices can be employed. Overall, water quality is generally good throughout the basin. However, mines, tailing ponds, chat piles and inadequate wastewater treatment facilities can cause poor water quality.

Taking into consideration the mussel SCC in the Black system, a number of proactive measures should be initiated. Accomplishing this will necessitate the cooperation of several entities including: state and federal agencies, non-governmental institutions, private landowners, and the general public. This system supports a diversity of other aquatic organisms, some of which are in decline such as nine state endangered fishes (cypress minnow, taillight shiner, sabine shiner, mountain madtom, crystal darter,

harlequin darter, swamp darter, goldstripe darter, and longnose darter). Recovery actions for these animal groups are comparable to those required for mussels. Suggested conservation measures would include the following:

1. Maintain or improve aquatic habitat conditions to meet the needs of native aquatic biota while accommodating society's demands for agricultural production and economic development. Maintain, expand, and restore riparian corridors, enhance watershed management, improve in-stream habitat, and reduce streambank erosion throughout the basin. Work with the Natural Resource Conservation Service (NRCS), Farm Service Agency (FSA), and Soil and Water Conservation Districts (SWCD) to provide and promote incentive programs that will improve conditions in the lower subbasin basin (*e.g.* fencing, corridor tree planting, livestock watering systems, pond construction). Promote and participate in SALT and EARTH projects so that appropriate practices are available to landowners to improve watershed, riparian corridor, and stream stewardship. Encourage drainage districts and landowners to leave vegetated strips, preferably trees, along ditches and streams which will reduce channel instability, sedimentation, and streambank sloughing and increase instream woody habitat.

2. Encourage Missouri Department of Natural Resources (MDNR) to implement best reclamation techniques for mine tailing dams and ponds, and chat piles in the upper subbasin. Partnerships should be formed with other government and non-government natural resource agencies, private landowners, and businesses to promote proper land use practices. Strategies for accomplishing this goal are outlined in the National Strategy for the Conservation of Native Freshwater Mussels. (NNMCC 1999).

3. Identify new mussel beds and monitor select mussel beds that possess significant populations, are highly diverse, and demonstrate evidence of recruitment. Much of the diversity and abundance of Unionids is found in mussel beds, which are isolated and patchily distributed. Long-term sampling of these areas is necessary to assess population status and recruitment and to document the success of water restoration projects. Then, perhaps, threats to habitat can be identified before the river is negatively impacted.

4. Augment populations of the pink muckets (and other SCC) by artificial propagation and release of juveniles at suitable sites. Repeat the process for other state SCC, as propagation techniques for these species are refined. Threatened species can greatly benefit from artificial propagation, which can potentially stabilize existing populations and restore lost populations. However, the success of this process depends on the identification of suitable habitat that is not in danger of degradation.

5. Work with the Missouri Department of Natural Resources to monitor water quality, improve water quality, and ensure compliance with discharge permits.

6. Inform the public of the significant natural resources that exist in the Black River Basin, their status, and the threats that face them. Increasing public awareness can help encourage landowners and others to participate in conservation efforts.

Table 8. Mussel species reported from the Black River basin in Missouri. Sources: 1=Oesch 1984, 2=MDC Naiad Database, 3=present study. Conservation ranks are from MDC 2004a.

	Species	Common Name	Global Rank	State Rank	Sources
1	*Actinonaias ligamentina*	Mucket			1, 2, 3
2	*Alasmidonta marginata*	Elktoe	G4	S2	1, 2, 3
3	**Alasmidonta viridis*	Slippershell			1*
4	*Amblema plicata*	Threeridge			1, 2, 3
5	*Anodonta suborbiculata*	Flat floater			3
6	*Arcidens confragosus*	Rock pocketbook			2 ,3
7	*Cyclonaias tuberculata*	Purple wartyback			1, 2, 3
8	*Cyprogenia aberti*	Western fanshell	G2	S2S2	1, 2, 3
9	*Ellipsaria lineolata*	Butterfly			3
10	*Elliptio dilatata*	Spike			1, 2, 3
11	*Epioblasma triquetra*	Snuffbox			3
12	*Epioblasma florentina curtisi*	Curtis pearlymussel	G1	S1	1 ,2
13	*Fusconaia ebena*	Ebonyshell	G4G5	S1	2, 3
14	*Fusconaia flava*	Wabash pigtoe			1, 2, 3
15	**Fusconaia ozarkensis*	Ozark pigtoe			1*
16	*Lampsilis abrupta*	Pink mucket	G2	S2	1, 2, 3
17	*Lampsilis cardium*	Plain pocketbook			1, 2, 3
18	*Lampsilis reeveiana*	Brokenray			1, 2, 3
19	*Lampsilis siliquoidea*	Fatmucket			1, 2, 3
20	*Lampsilis teres*	Yellow sandshell			1, 2, 3
21	*Lasmigona complanata*	White heelsplitter			1, 2, 3
22	*Lasmigona costata*	Fluted shell			1, 2, 3
23	*Leptodea fragilis*	Fragile papershell			1, 2, 3
24	*Ligumia recta*	Black sandshell	G5	S1S2	1, 2, 3
25	*Ligumia subrostrata*	Pondmussel			1, 2, 3
26	*Megalonaias nervosa*	Washboard			2
27	*Obliquaria reflexa*	Threehorn wartyback			1, 2, 3
28	*Obovaria jacksoniana*	Southern hickorynut	G1G2	S1	1
29	*Plectomerus dombeyanus*	Bankclimber	G4	S3	2, 3
30	*Pleurobema sintoxia*	Round pigtoe			1, 2, 3
31	*Potamilus ohiensis*	Pink papershell			3
32	*Potamilus purpuratus*	Bluefer			1, 2, 3
33	*Ptychobranchus occidentalis*	Ouachita kidney-shell	G3G4	S2S3	1, 2, 3
34	*Pyganodon grandis*	Giant floater			1, 2, 3
35	*Quadrula cylindrica*	Rabbitsfoot			1
36	*Quadrula metanevra*	Monkeyface			1, 2, 3
37	*Quadrula nodulata*	Wartyback	G4	S3	3
38	*Quadrula pustulosa*	Pimpleback			1, 2, 3
39	*Quadrula quadrula*	Mapleleaf			3
40	*Strophitus undulatus*	Creeper			1, 2, 3
41	*Toxolasma lividis*	Little purple	G2	S2	1
42	*Toxolasma parvus*	Lilliput			2, 3
43	*Tritogonia verrucosa*	Pistolgrip			1, 2, 3
44	*Truncilla donaciformis*	Fawnsfoot			1, 2, 3
45	*Truncilla truncata*	Deertoe			1, 2, 3
46	*Uniomerus tetralasmus*	Pondhorn			3
47	*Utterbackia imbecillis*	Paper pondshell			1, 2, 3
48	**Venustaconcha pleasii*	Pleas' mussel			1*
49	*Villosa iris*	Rainbow			1, 2, 3
50	*Villosa lienosa*	Little spectaclecase			1, 2, 3

*record attributed to Utterback (1915-1916) by Oesch (1984).

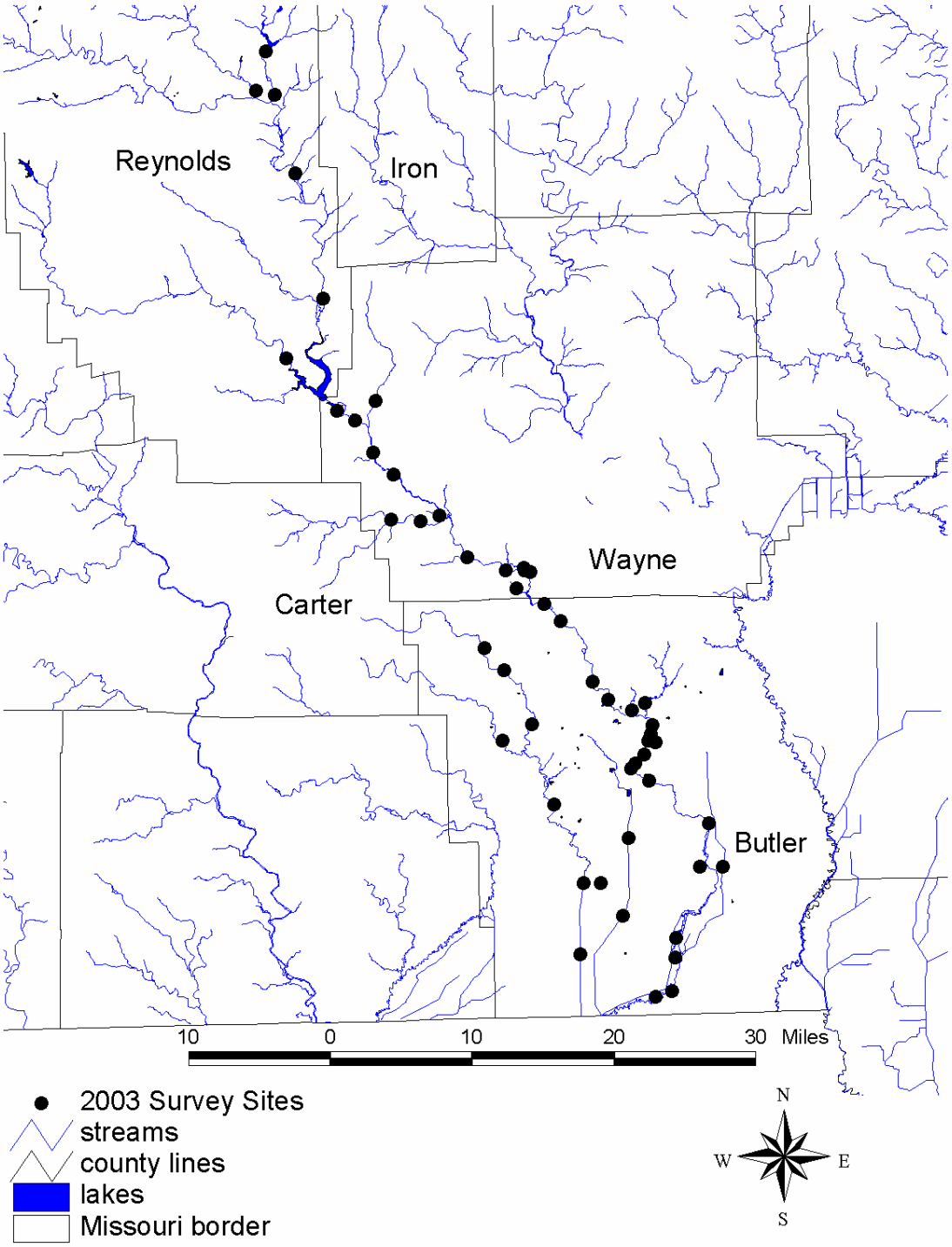

Figure 98. Distribution of 55 survey sites in the Black River basin.

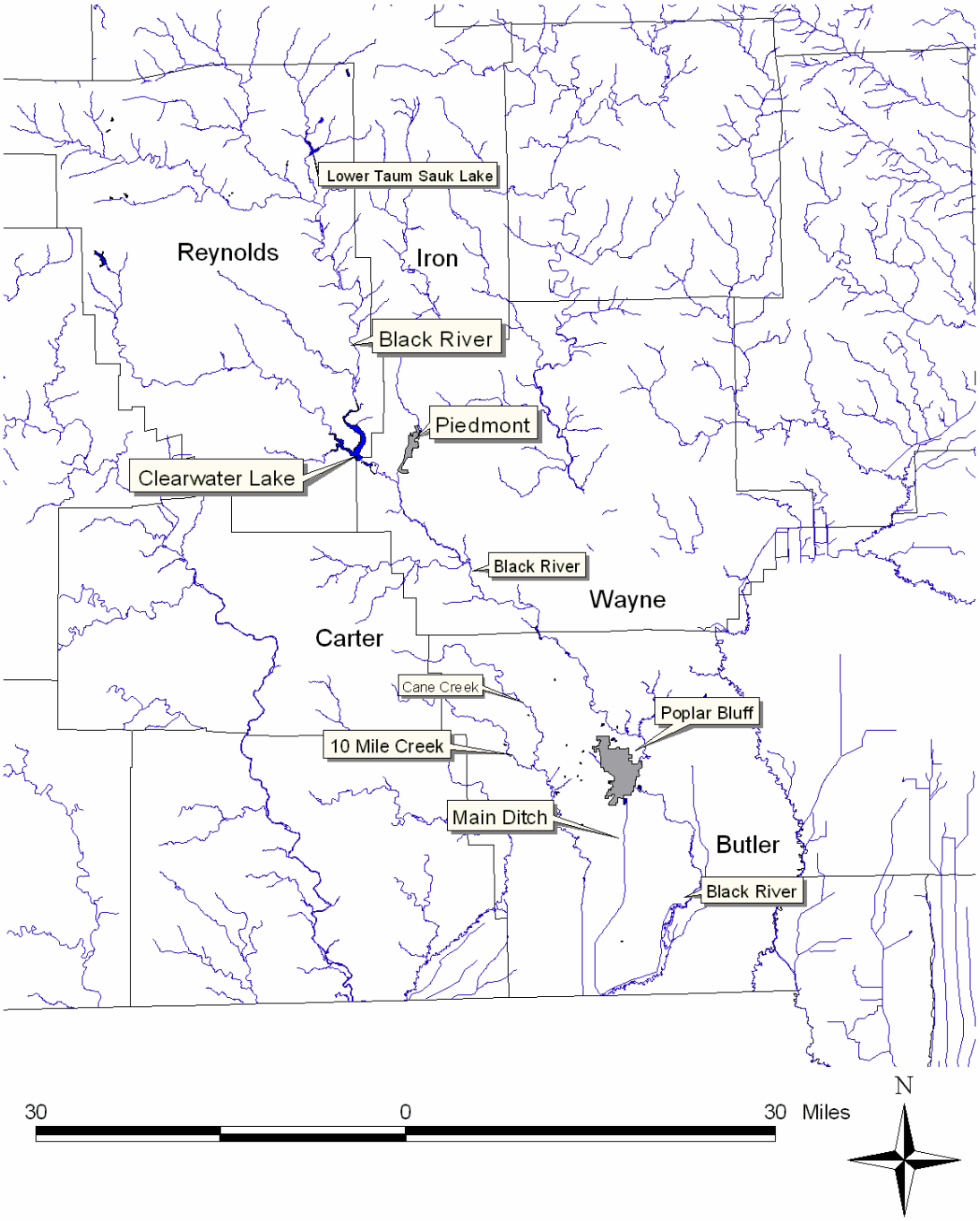

Figure 99. Landmarks in the Black River basin, Missouri.

Table 9. Summary of sampling data for 42 unionid species collected in the Black River system. Total sampling effort was 109.5 person-hours at 51 sites. Total live catch was 9,189 individuals.

	Species	Number of Live Individuals	Relative abundance (percent of total live catch)	Number of sites with live or fresh-dead individuals	Percent of sites with live or fresh-dead individuals
1	*Pleurobema sintoxia*	2491	27.11	21	41.18
2	*Actinonaias ligamentina*	1648	17.93	25	49.02
3	*Fusconaia flava*	1519	16.53	26	50.98
4	*Cyprogenia aberti*	794	8.64	19	37.25
5	*Quadrula pustulosa*	521	5.67	24	47.06
6	*Quadrula metanevra*	386	4.20	22	43.14
7	*Amblema plicata*	340	3.70	21	41.18
8	*Potamilus purpuratus*	189	2.06	24	47.06
9	*Tritogonia verrucosa*	173	1.88	18	35.29
10	*Cyclonaias tuberculata*	152	1.65	14	27.45
11	*Plectomerus dombeyanus*	126	1.37	11	21.57
12	*Lampsilis cardium*	118	1.28	22	43.14
13	*Elliptio dilatata*	94	1.02	17	33.33
14	*Lampsilis teres*	81	0.88	14	27.45
15	*Obliquaria reflexa*	58	0.63	17	33.33
16	*Truncilla truncata*	55	0.60	15	27.45
17	*Pyganodon grandis*	53	0.58	5	9.80
18	*Ligumia subrostrata*	45	0.49	6	11.76
19	*Leptodea fragilis*	44	0.48	22	43.14
20	*Strophitus undulatus*	34	0.37	14	27.45
21	*Lasmigona complanata*	34	0.37	6	11.76
22	*Lasmigona costata*	34	0.37	14	27.45
23	*Toxolasma parvus*	31	0.34	7	13.73
24	*Lampsilis reeveiana*	31	0.34	3	5.88
25	*Quadrula quadrula*	18	0.20	6	11.76
26	*Anodonta suborbiculata*	17	0.19	4	7.84
27	*Potamilus ohiensis*	15	0.16	3	5.88
28	*Utterbackia imbecillis*	13	0.14	4	7.84
29	*Ligumia recta*	12	0.13	8	13.73
30	*Arcidens confragosus*	12	0.13	4	5.88
31	*Lampsilis siliquoidea*	11	0.12	9	17.65
32	*Villosa lienosa*	10	0.11	5	9.80
33	*Ellipsaria lineolata*	9	0.10	4	7.84
34	*Ptychobranchus occidentalis*	8	0.09	5	9.80
35	*Alasmidonta marginata*	5	0.05	3	5.88
36	*Lampsilis abrupta*	4	0.04	4	7.84
37	*Villosa iris*	1	0.01	1	1.96
38	*Epioblasma triquetra*	1	0.01	1	1.96
39	*Quadrula nodulata*	1	0.01	1	1.96
40	*Truncilla donaciformis*	1	0.01	1	1.96
41	*Fusconaia ebena*	0	0.00	1	0.00
42	*Uniomerus tetralasmus*	0	0.00	0	0.00

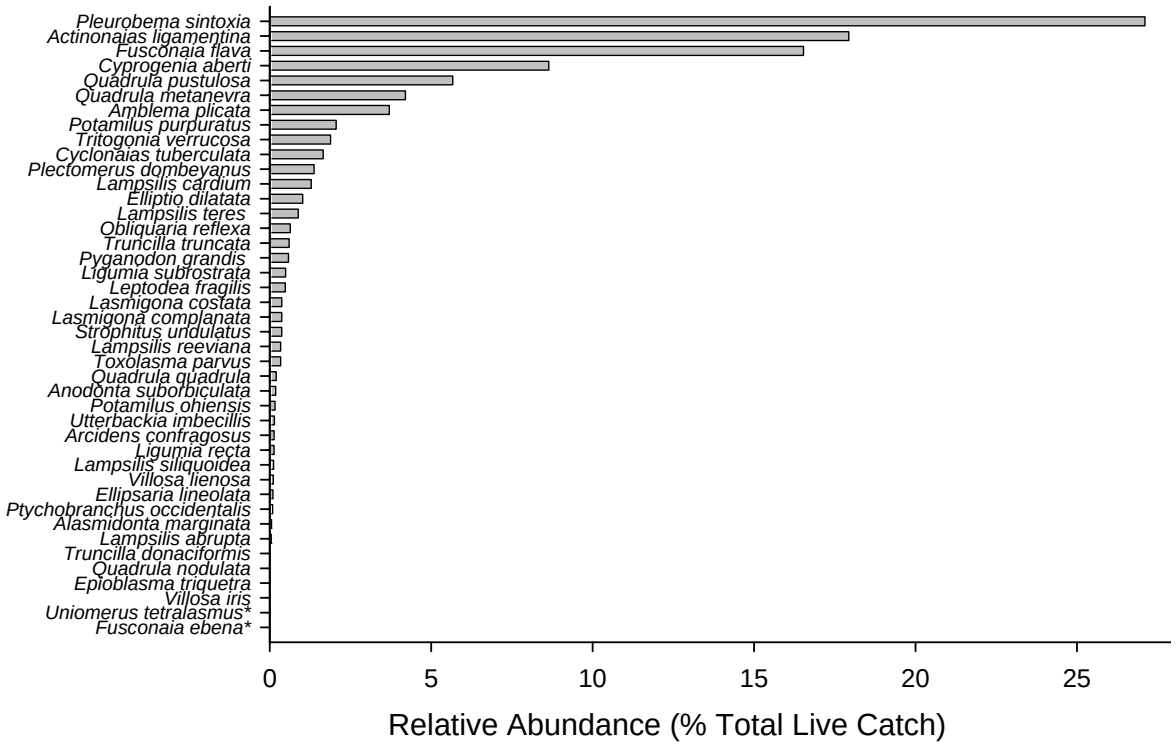

Figure 100. Relative abundance of 42 unionid species from 50 sites in the Black River system.

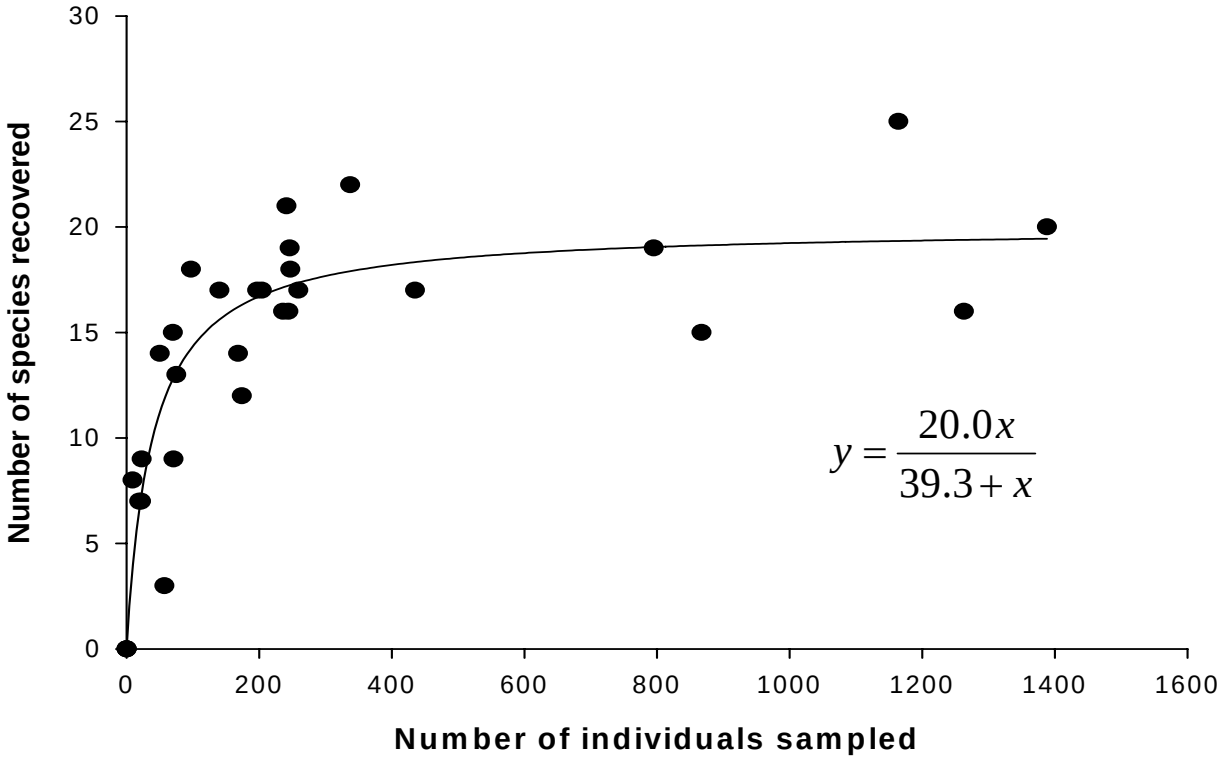

Figure 101. Number of species recovered versus sample size at sites in the Black River. Hyperbolic regression: $p < 0.0001$, $R^2 = 0.79$.

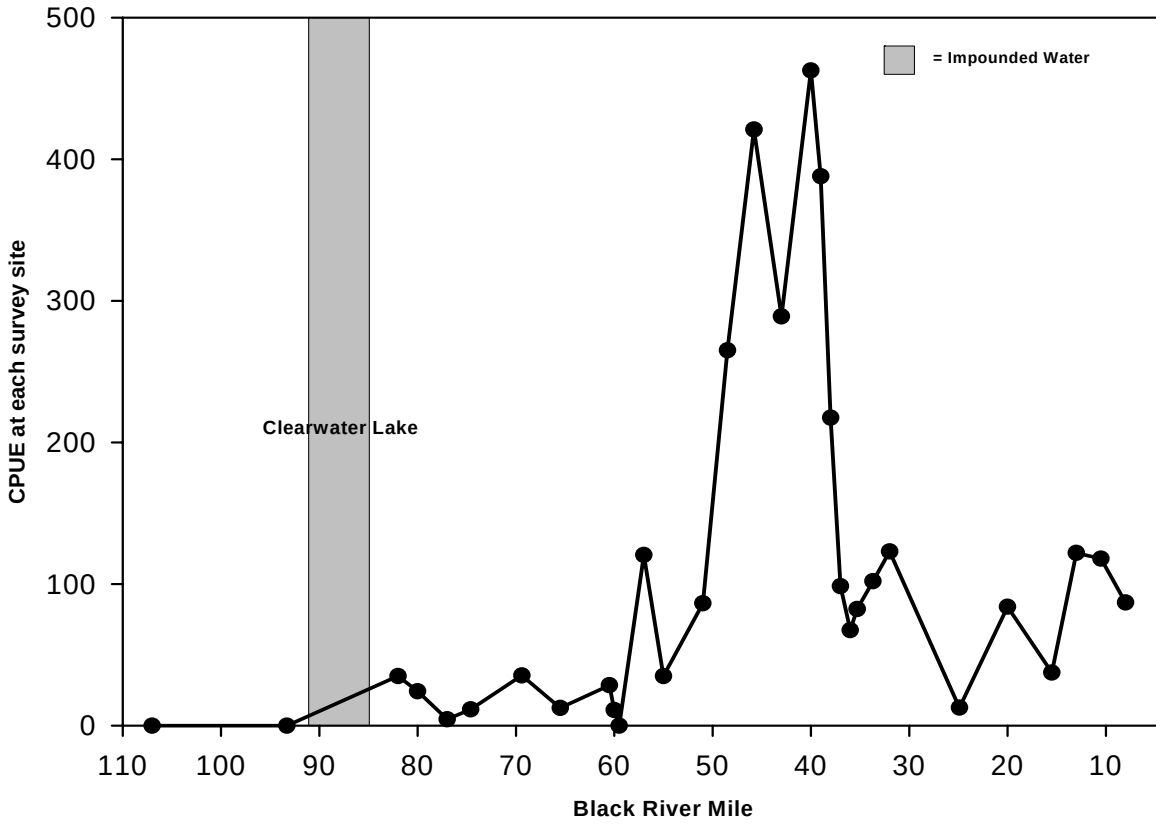

Figure 102. Longitudinal distribution of catch per unit effort (CPUE) at survey sites in the Black River.

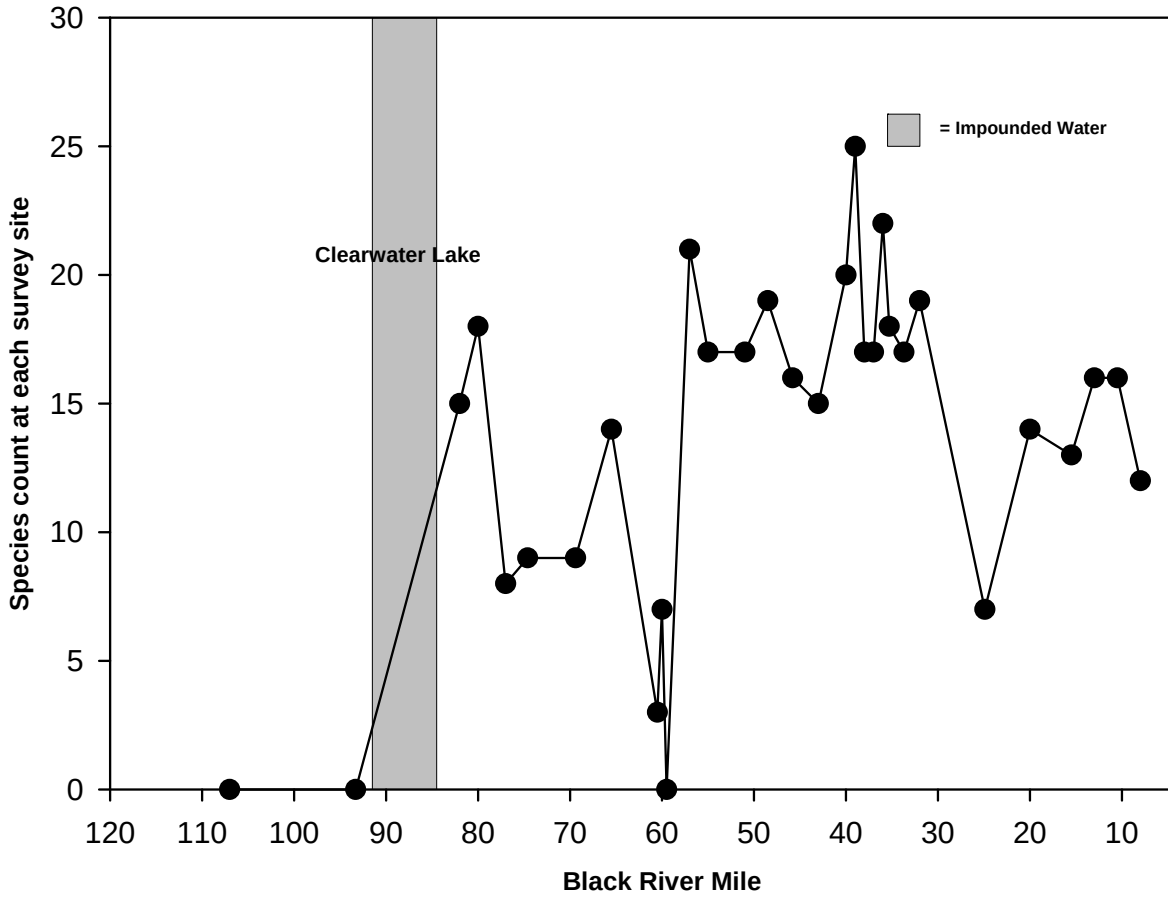

Figure 103. Longitudinal distribution of species counts at survey sites in the Black River.

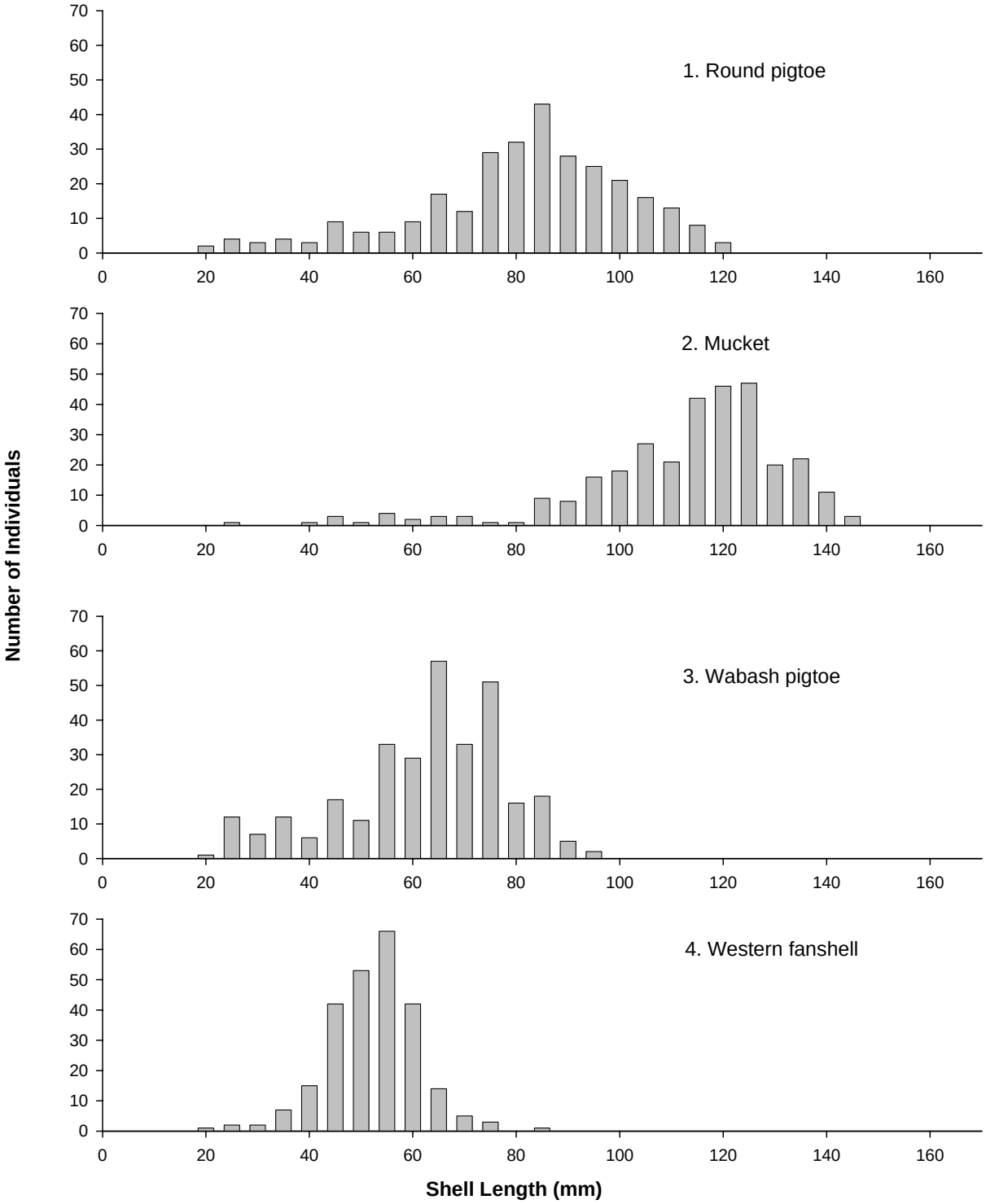

Figure 104. Shell length frequencies of the eight most abundant species in the Black River.

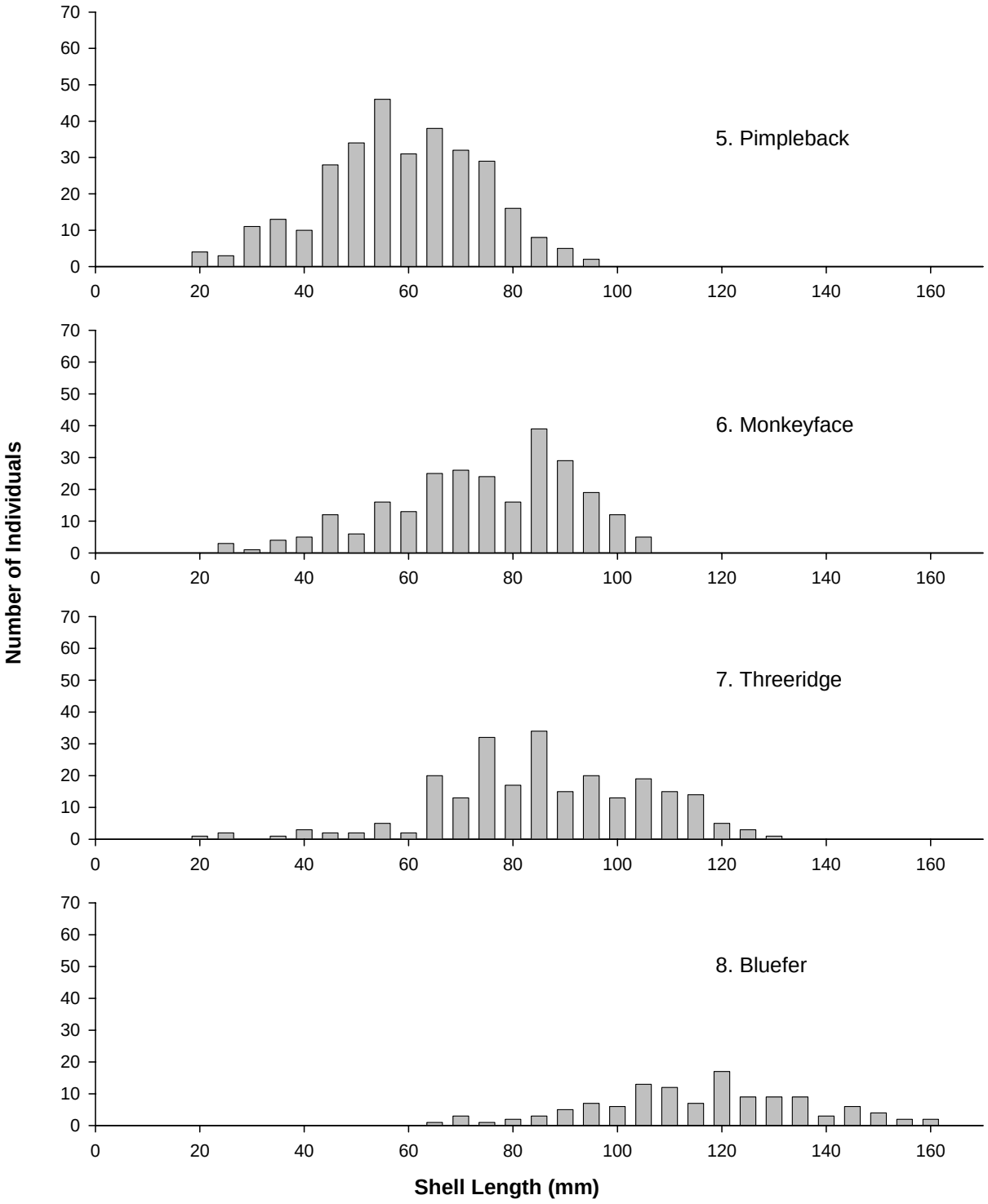

Figure 104, continued.

Table 10. Summary of re-survey data for 16 localities in the Black River system (see Appendix K).

Species	Sites surveyed from 1969-1982		Sites surveyed from 2000-2003		Changes	
	Number of living individuals	Relative Abundance	Number of living individuals	Relative Abundance	Change in Relative Abundance	% Change in Relative Abundance
Actinonaias ligamentina	1180	44.00	278	24.89	-19.1	-23.6%
Pleurobema sintoxia	409	15.25	159	14.23	-1.0	-38.9%
Cyprogenia aberti	74	2.76	106	9.49	6.7	143.2%
Quadrula metanevra	150	5.59	89	7.97	2.4	59.3%
Cyclonaias tuberculata	70	2.61	77	6.89	4.3	110.0%
Amblema plicata	54	2.01	57	5.10	3.1	105.6%
Fusconaia flava	77	2.87	57	5.10	2.2	74.0%
Lampsilis cardium	289	10.78	52	4.66	-6.1	-18.0%
Quadrula pustulosa	31	1.16	34	3.04	1.9	109.7%
Lampsilis r. reeveiana	14	0.52	31	2.78	2.3	221.4%
Elliptio dilatata	66	2.46	29	2.60	0.1	43.9%
Lasmigona costata	35	1.30	25	2.24	0.9	71.4%
Ligumia subrostrata	0	0.0	18	1.61	1.6	0.0%
Tritogonia verrucosa	20	0.75	16	1.43	0.7	80.0%
Truncilla truncata	5	0.19	15	1.34	1.2	300.0%
Potamilus purpuratus	14	0.52	11	0.98	0.5	78.6%
Leptodea fragilis	5	0.19	9	0.81	0.6	180.0%
Ligumia recta	14	0.52	7	0.63	0.1	50.0%
Ptychobranchus occidentalis	0	0.0	7	0.63	0.6	0.0%
Lampsilis siliquoidea	73	2.72	6	0.54	-2.2	-8.2%
Strophitus undulatus	5	0.19	6	0.54	0.4	120.0%
Alasmidonta marginata	5	0.19	5	0.45	0.3	100.0%
Lampsilis teres	4	0.15	3	0.27	0.1	75.0%
Plectomerus dombeyanus	0	0.0	3	0.27	0.3	0.0%
Pyganodon grandis	63	2.35	3	0.27	-2.1	-4.8%
Utterbackia imbecillis	0	0.0	3	0.27	0.3	0.0%
Anodonta suborbiculata	0	0.0	2	0.18	0.2	0.0%
Obliquaria reflexa	0	0.00	2	0.18	0.2	0.0%
Epioblasma curtisi	6	0.22	0	0.00	-0.2	-0.0%
Lampsilis abrupta	6	0.22	1	0.09	-0.1	-16.7%
Villosa iris	1	0.04	1	0.09	0.1	100.0%
Villosa lienosa	7	0.26	1	0.09	-0.2	-14.3%
Arcidens confragosus	4	0.15	0	0.00	-0.1	-0.0%
Toxolasma lividis	1	0.04	0	0.00	0.0	0.0%
Total	**2682**		**1113**			

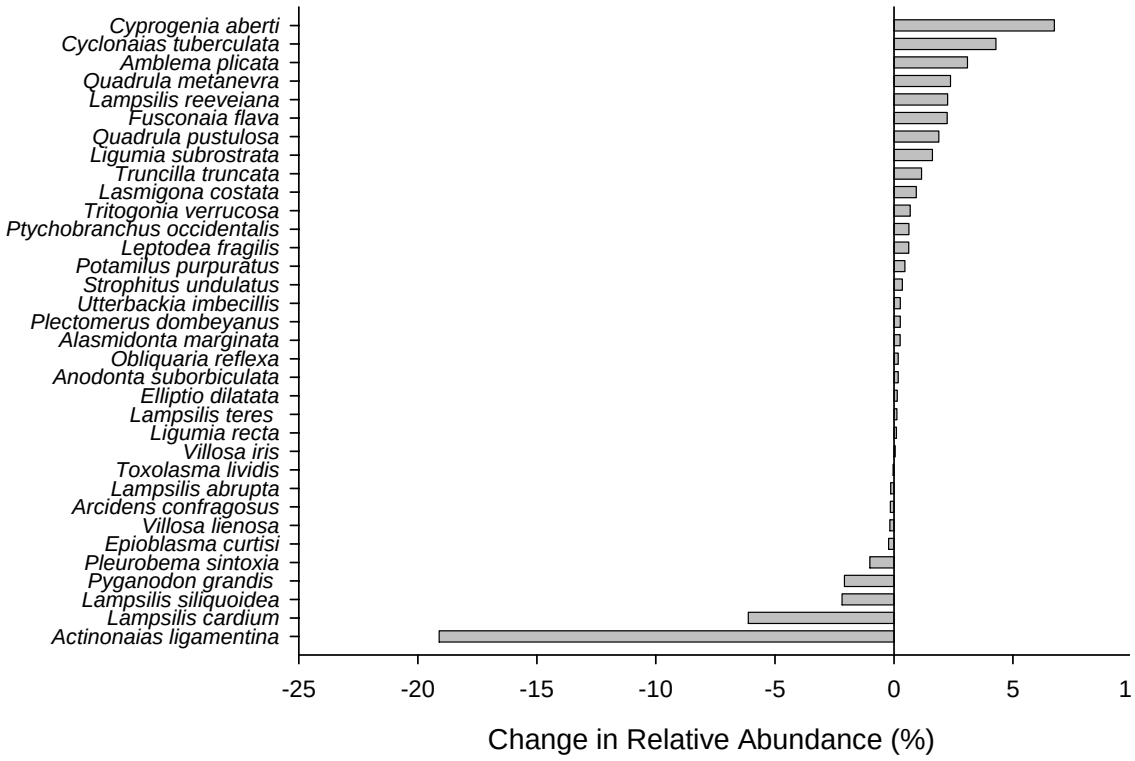

Figure 105. Change in relative abundance (% total live catch) at re-survey sites in the Black River system (see Table 10).

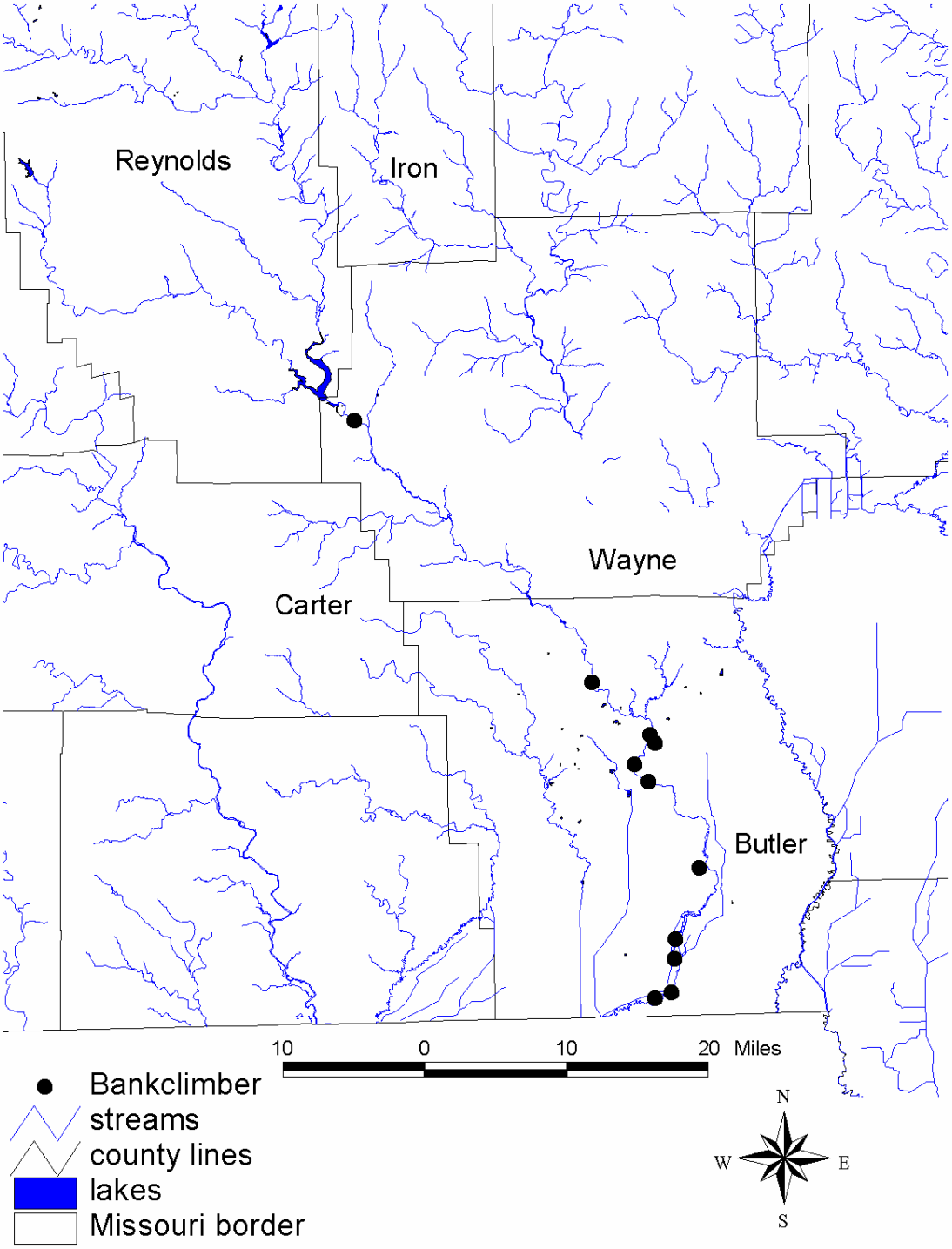

Figure 106. Distribution of the bankclimber in the Black River system.

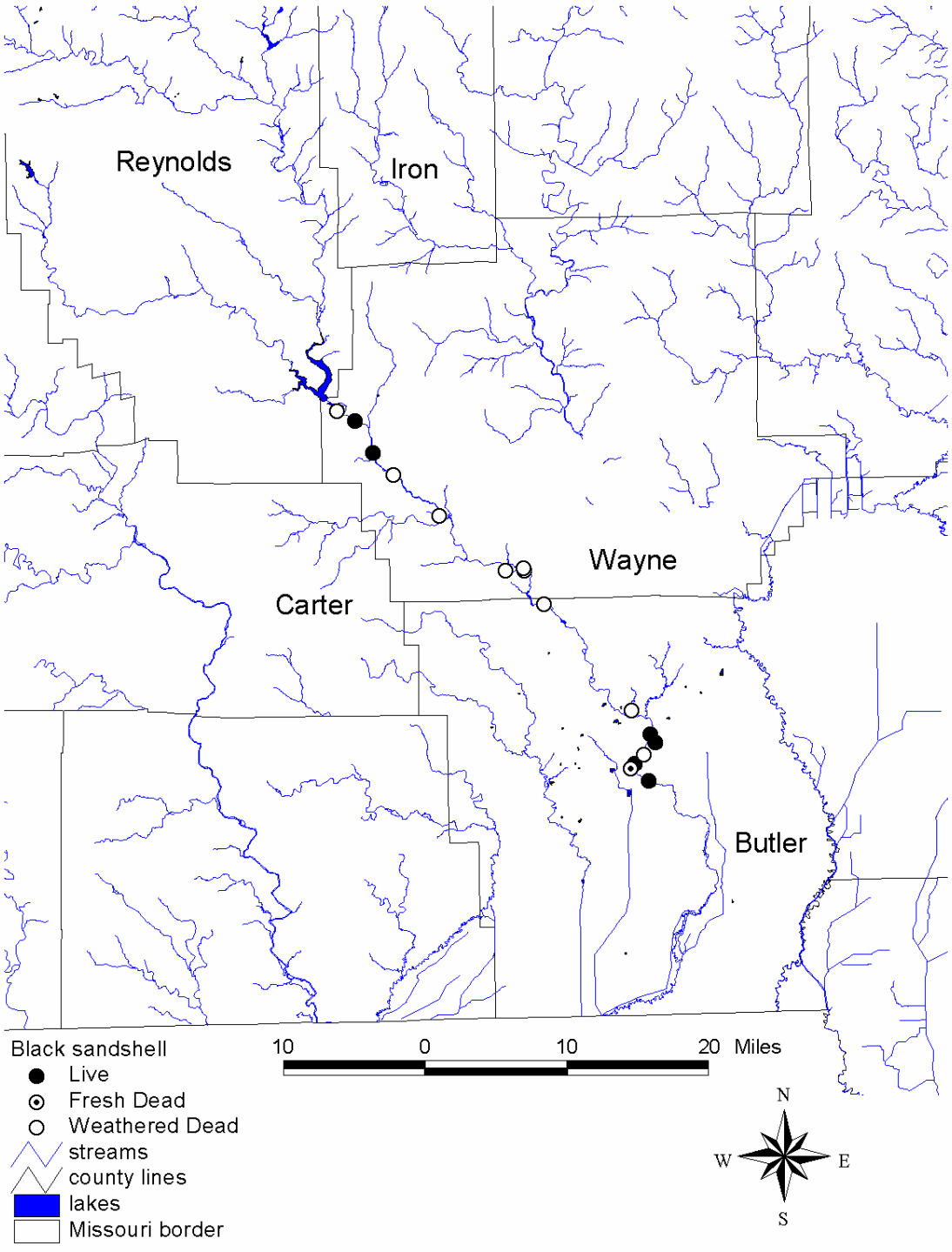

Figure 107. Distribution of the black sandshell in the Black River system.

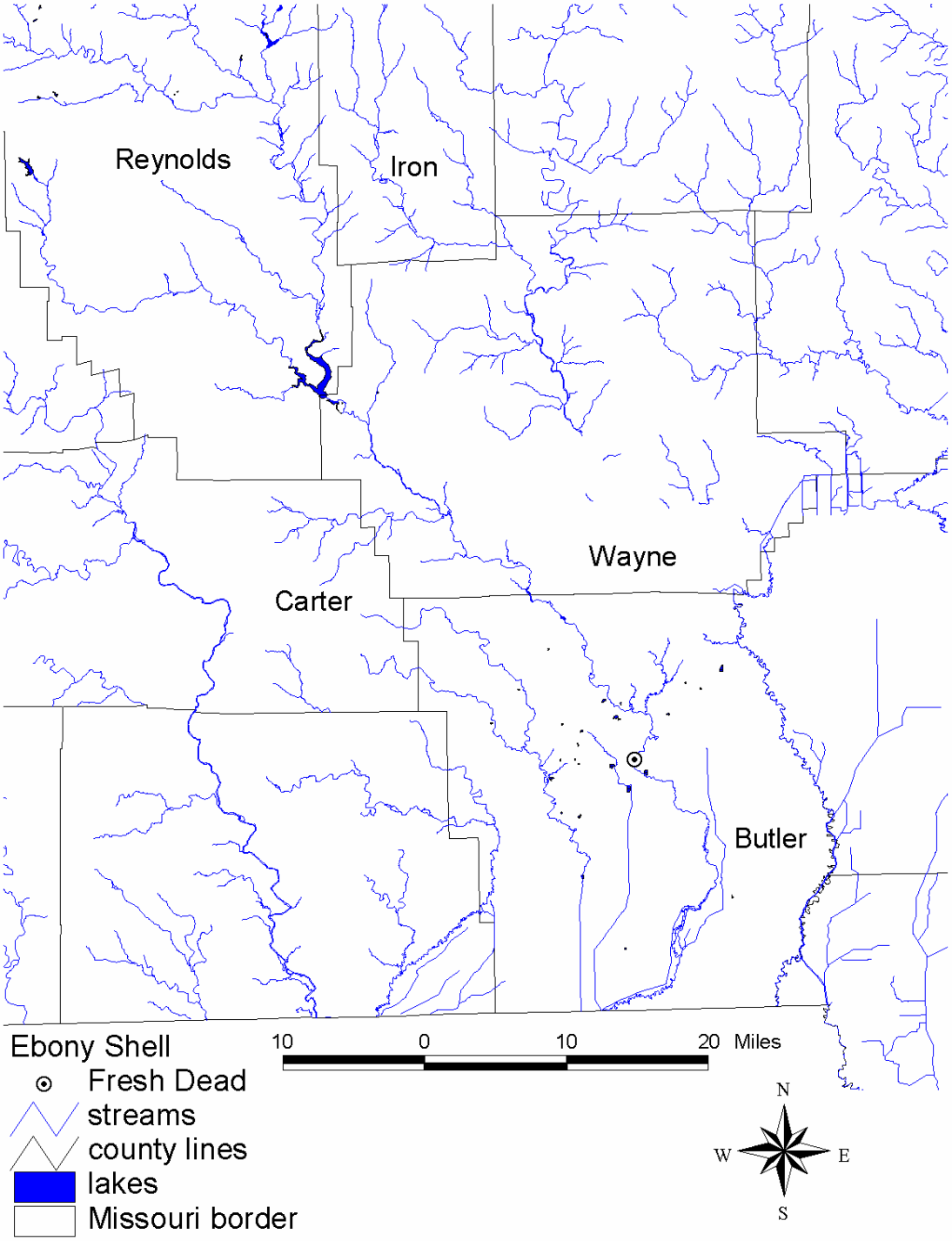

Figure 108. Distribution of the ebonyshell in the Black River basin.

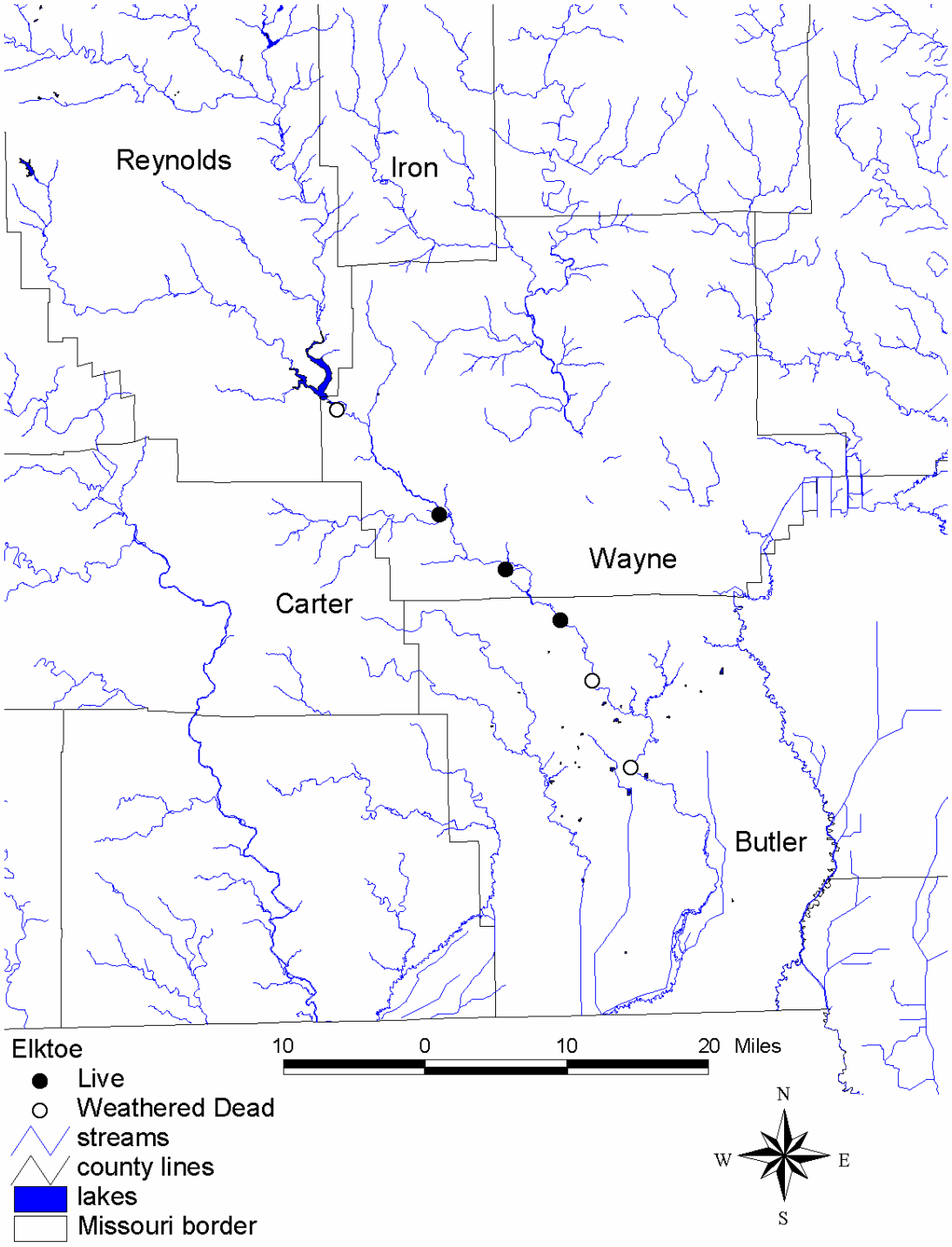

Figure 109. Distribution of the elktoe in the Black River system.

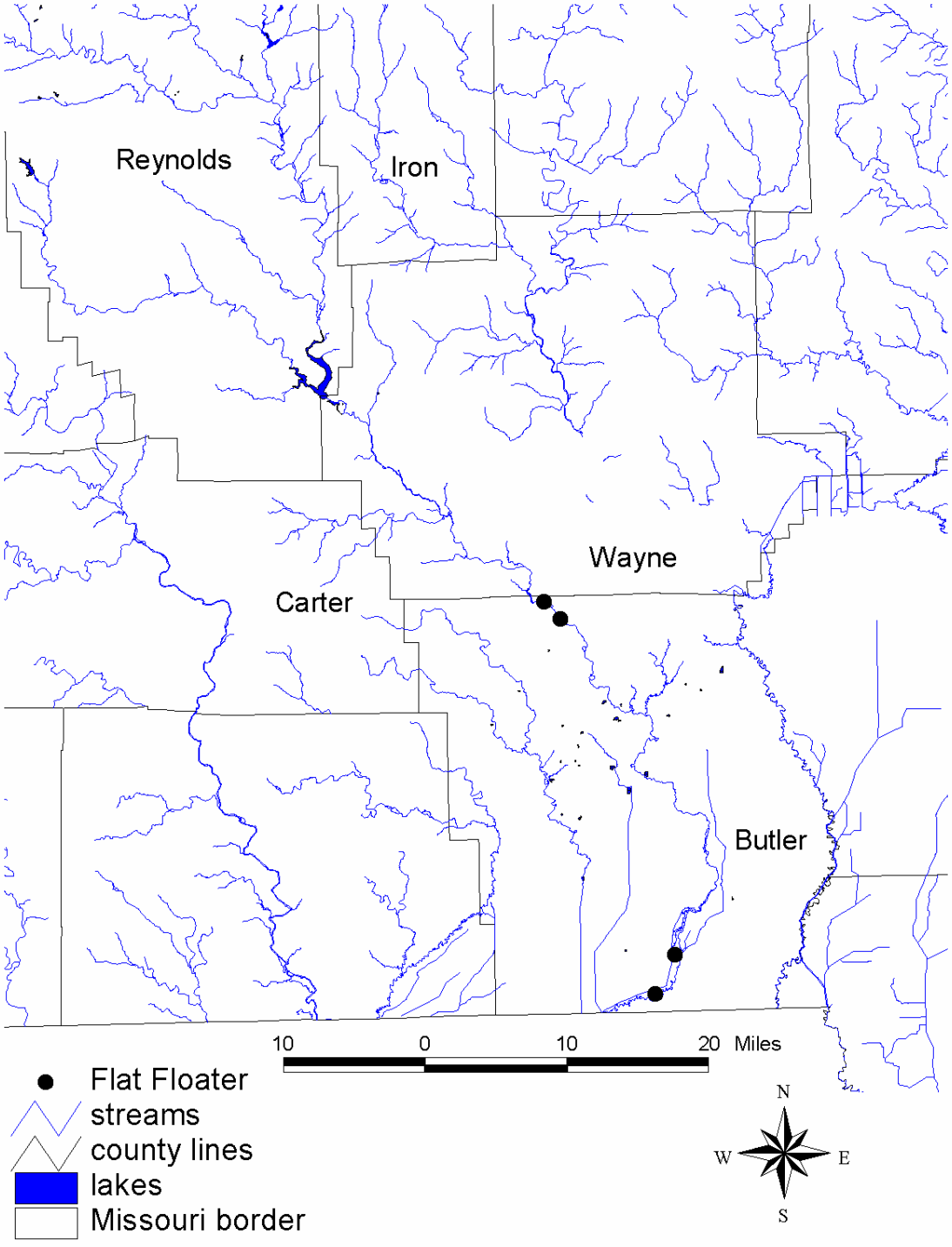

Figure 110. Distribution of the flat floater in the Black River system.

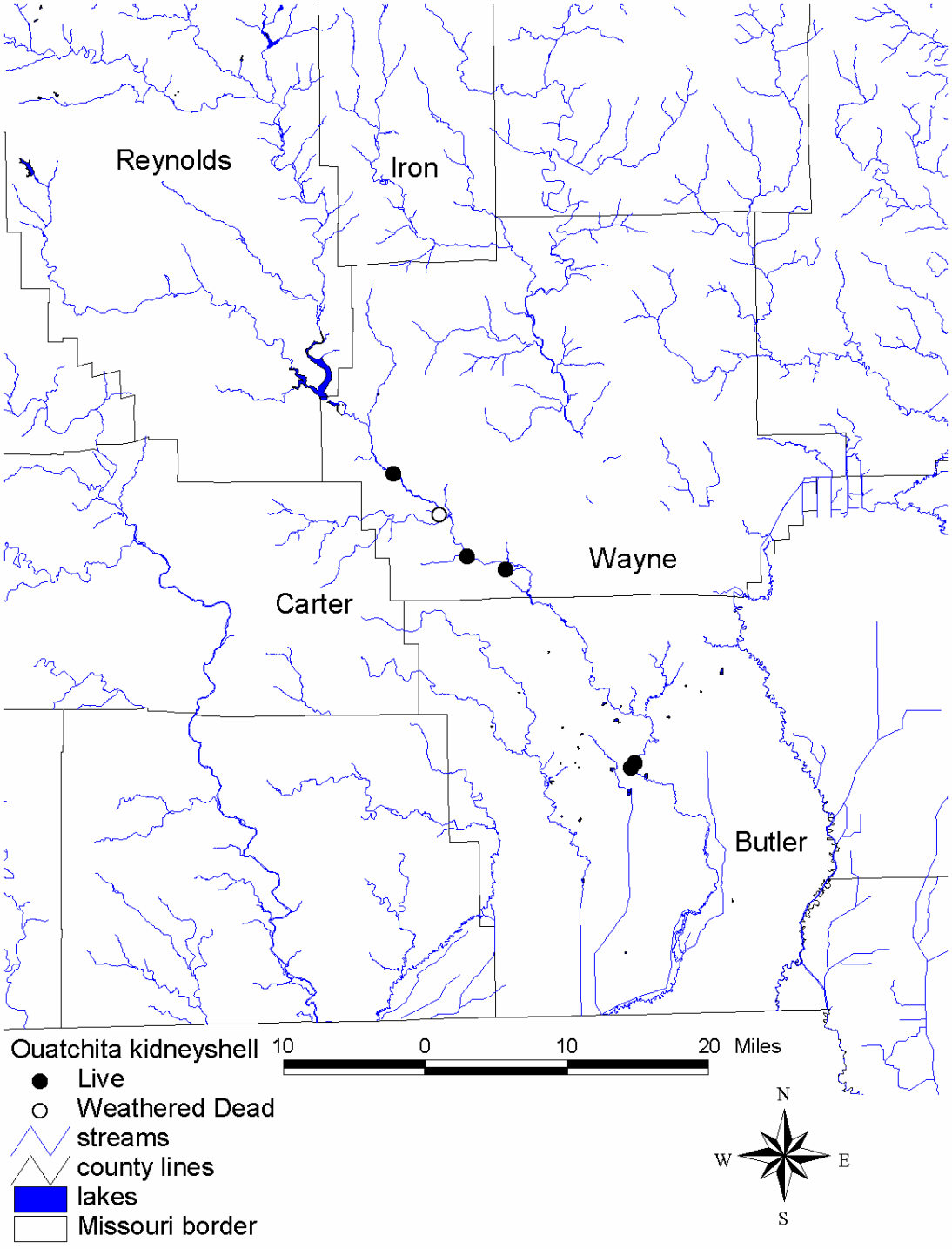

Figure 111. Distribution of the Ouachita kidneyshell in the Black River system.

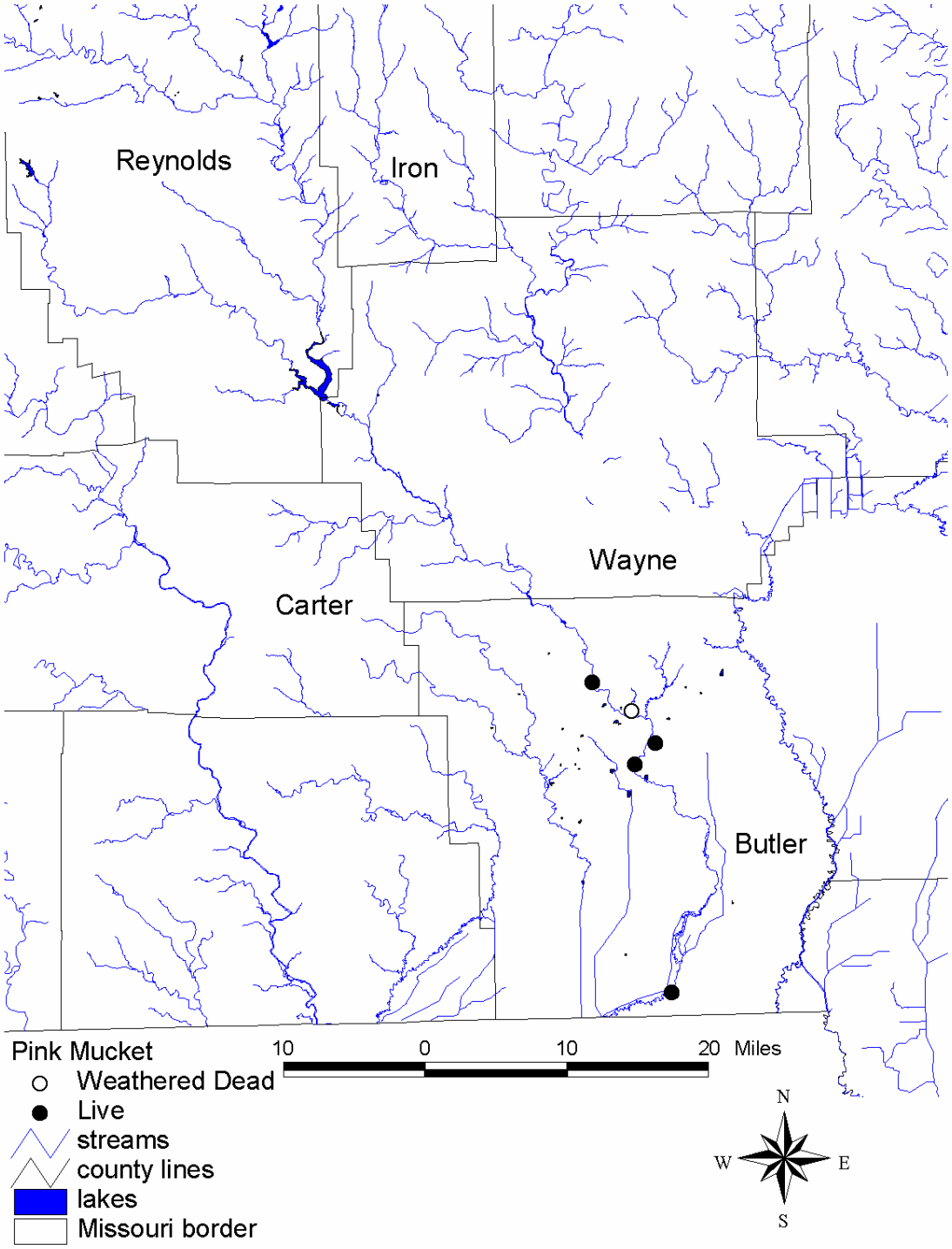

Figure 112. Distribution of the pink mucket in the Black River system.

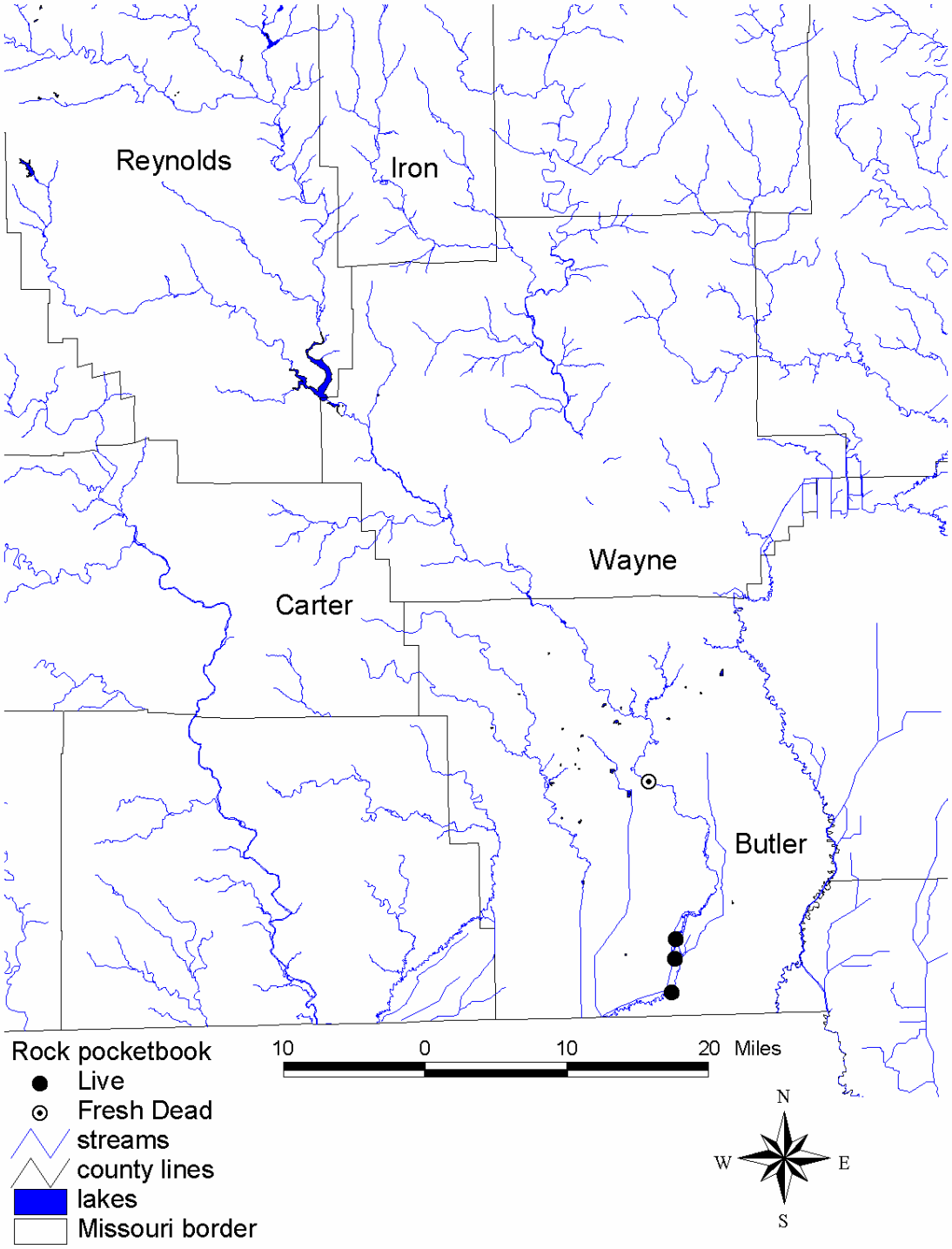

Figure 113. Distribution of the rock pocketbook in the Black River system.

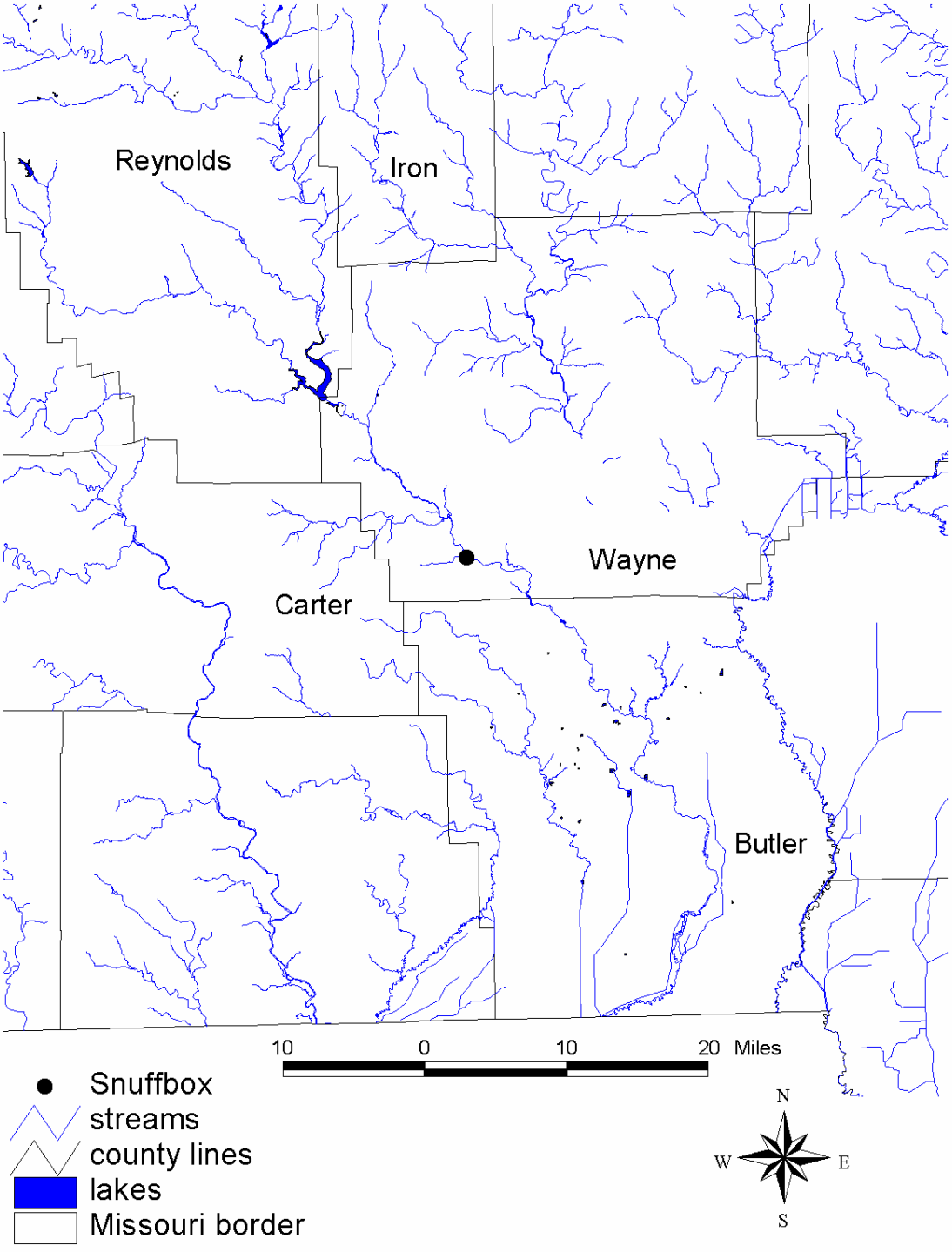

Figure 114. Distribution of the snuffbox in the Black River system.

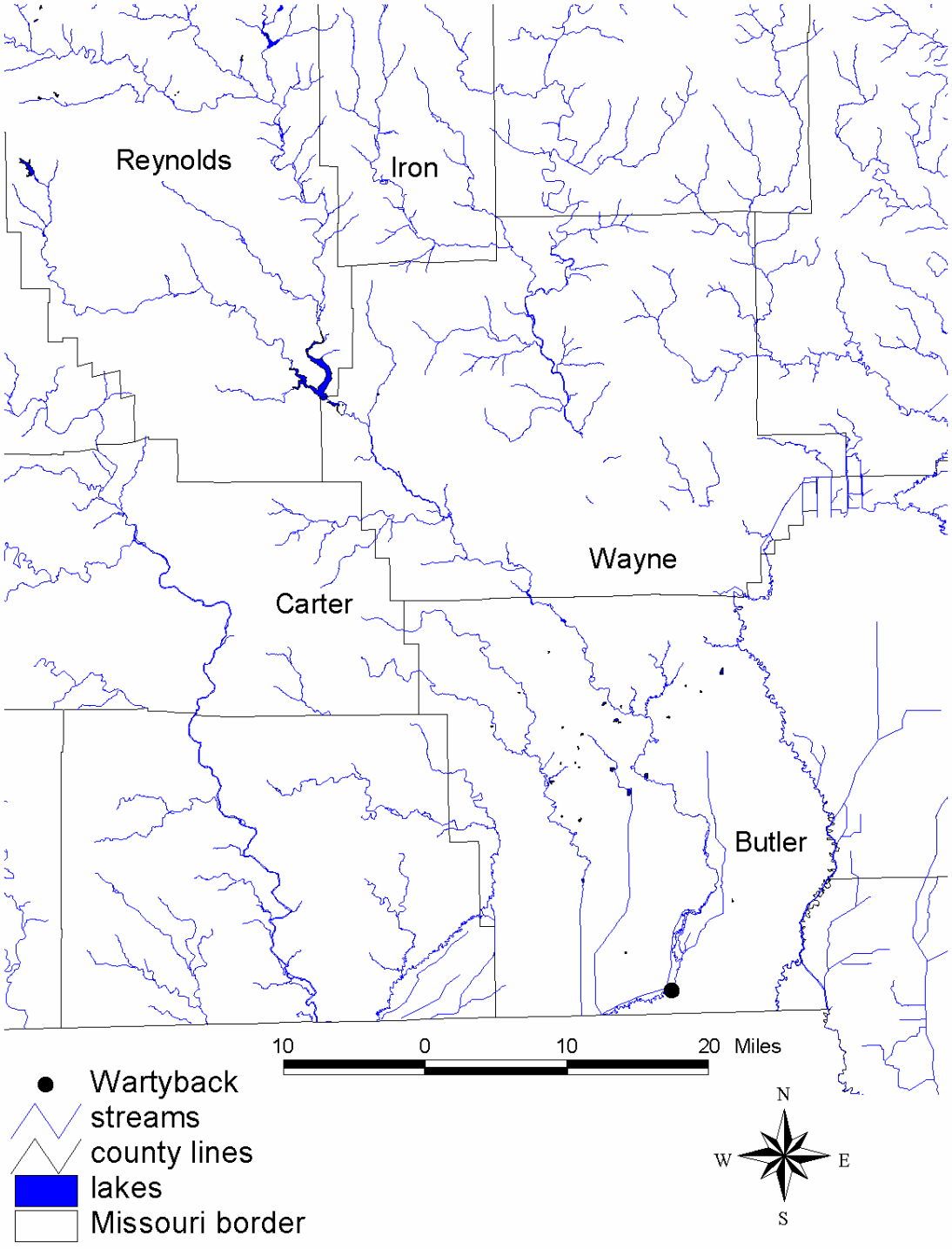

Figure 115. Distribution of the wartyback in the Black River system.

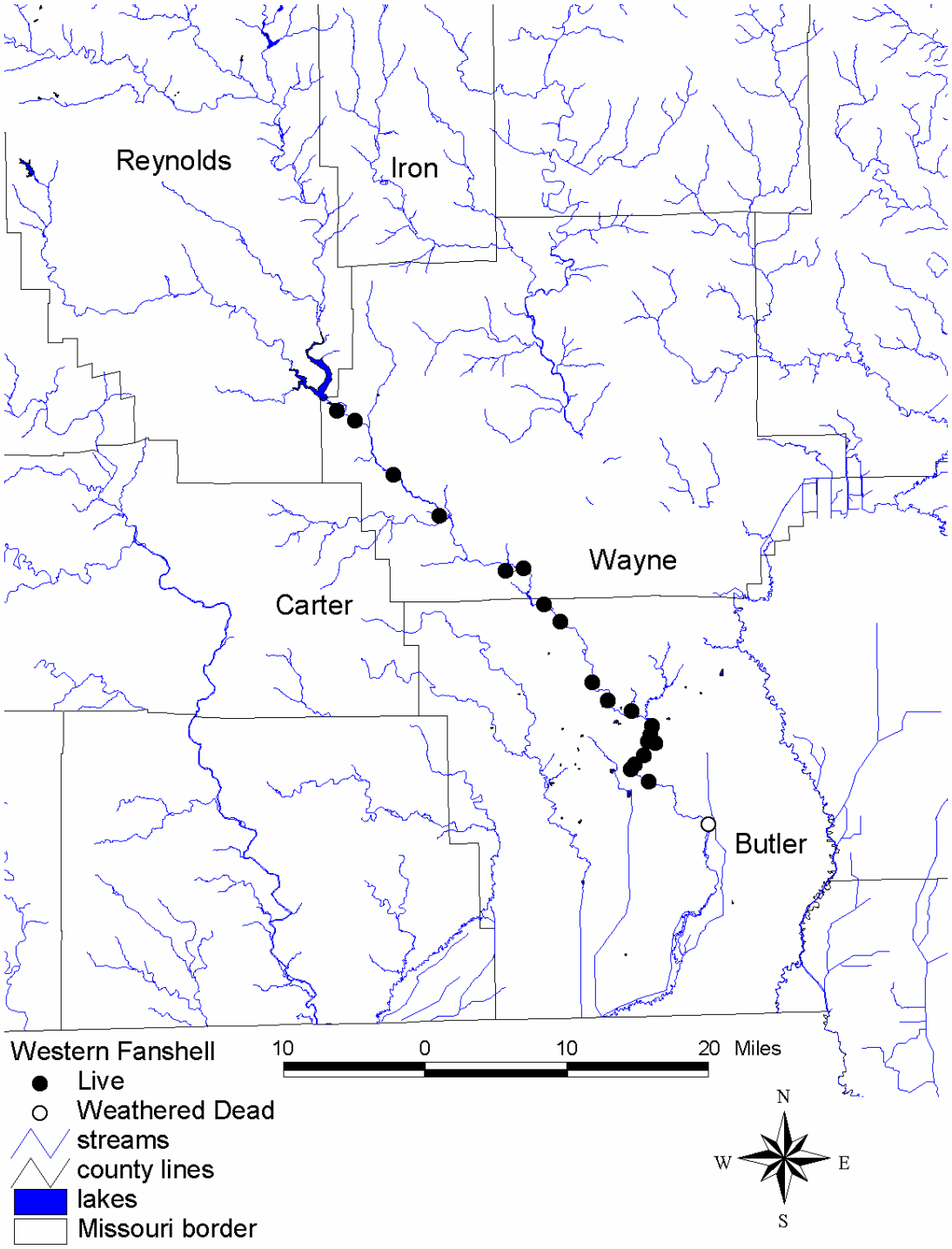

Figure 116. Distribution of the Western fanshell in the Black River system.

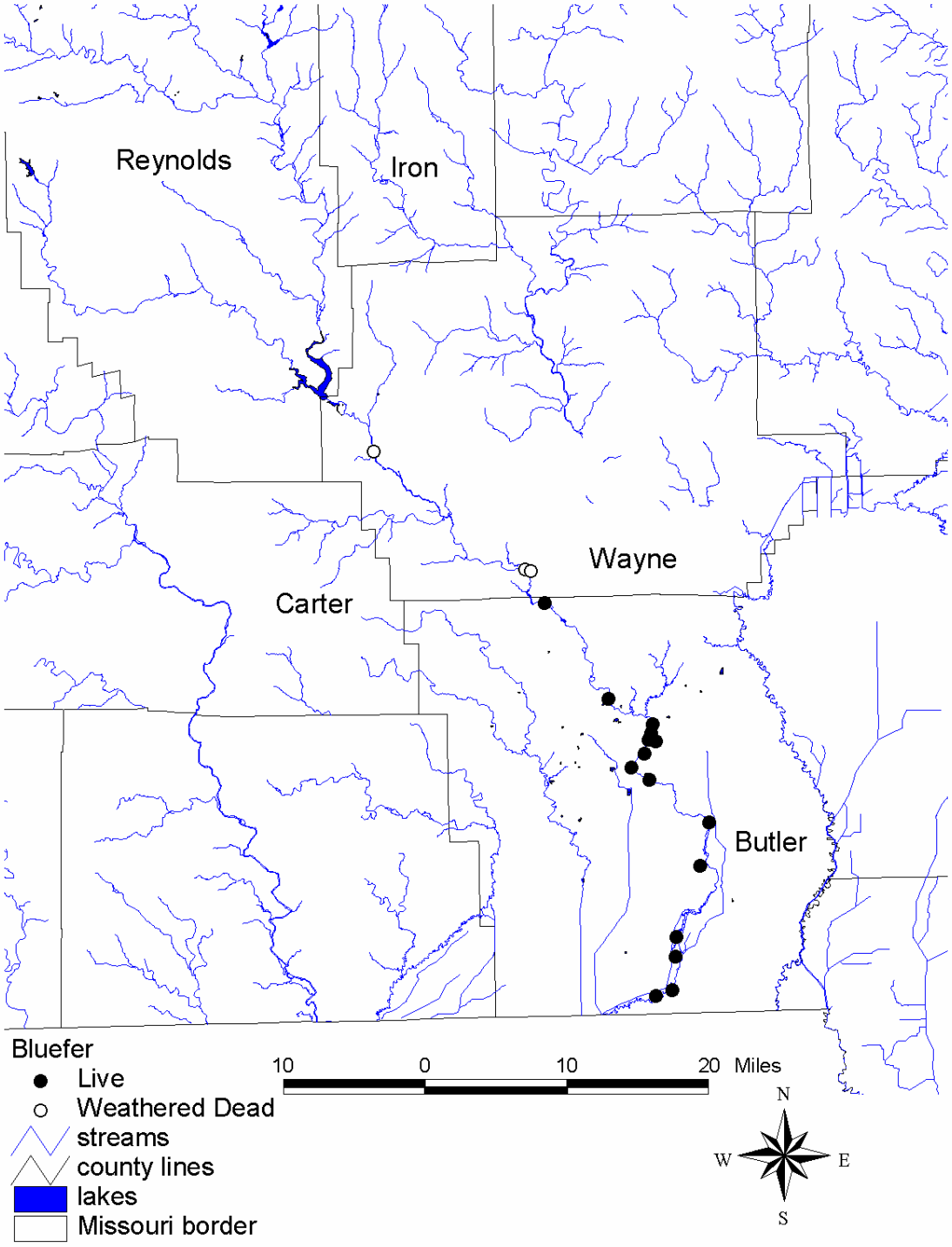

Figure 117. Distribution of the bleufer in the Black River system.

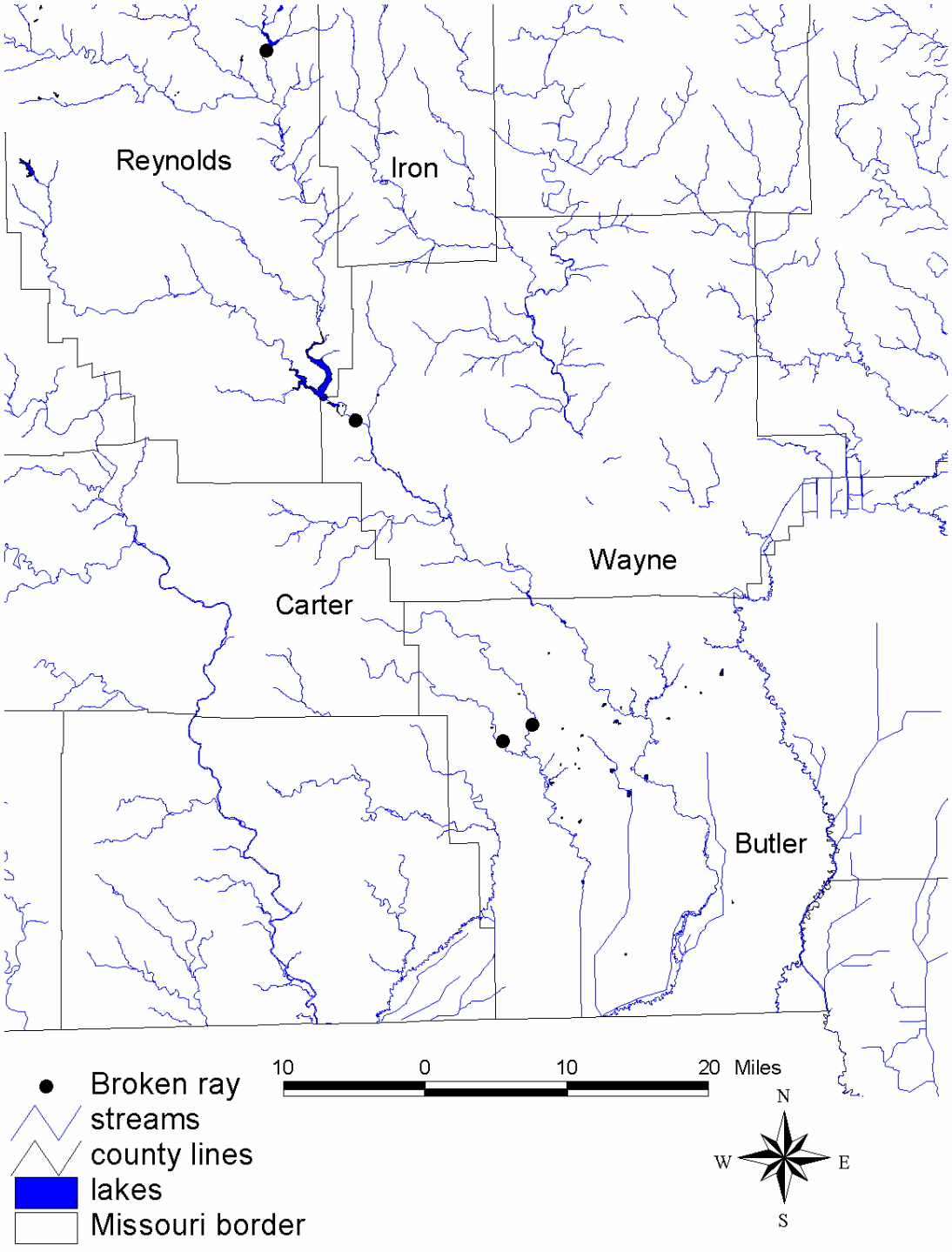

Figure 118. Distribution of the brokenray in the Black River system.

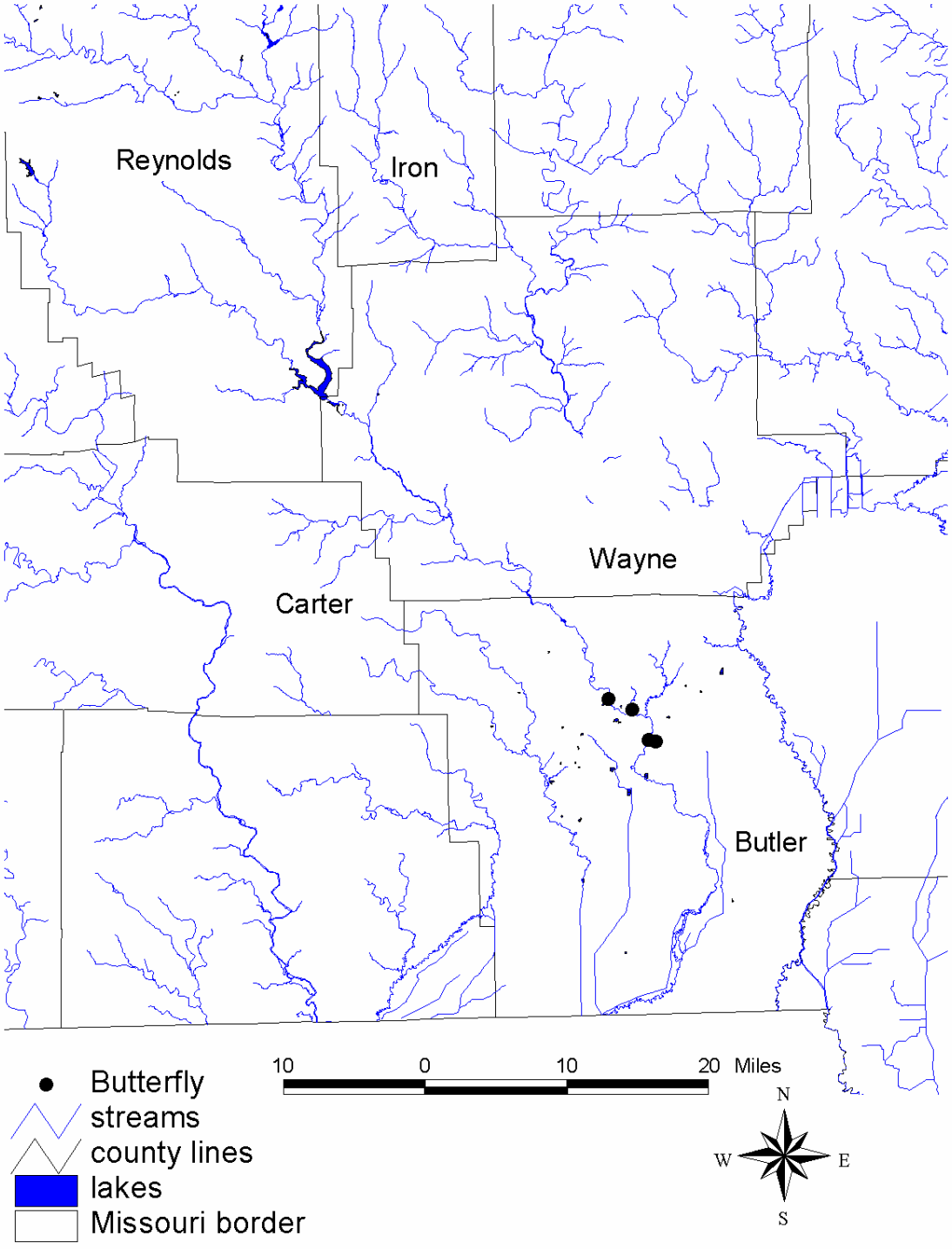

Figure 119. Distribution of the butterfly in the Black River system.

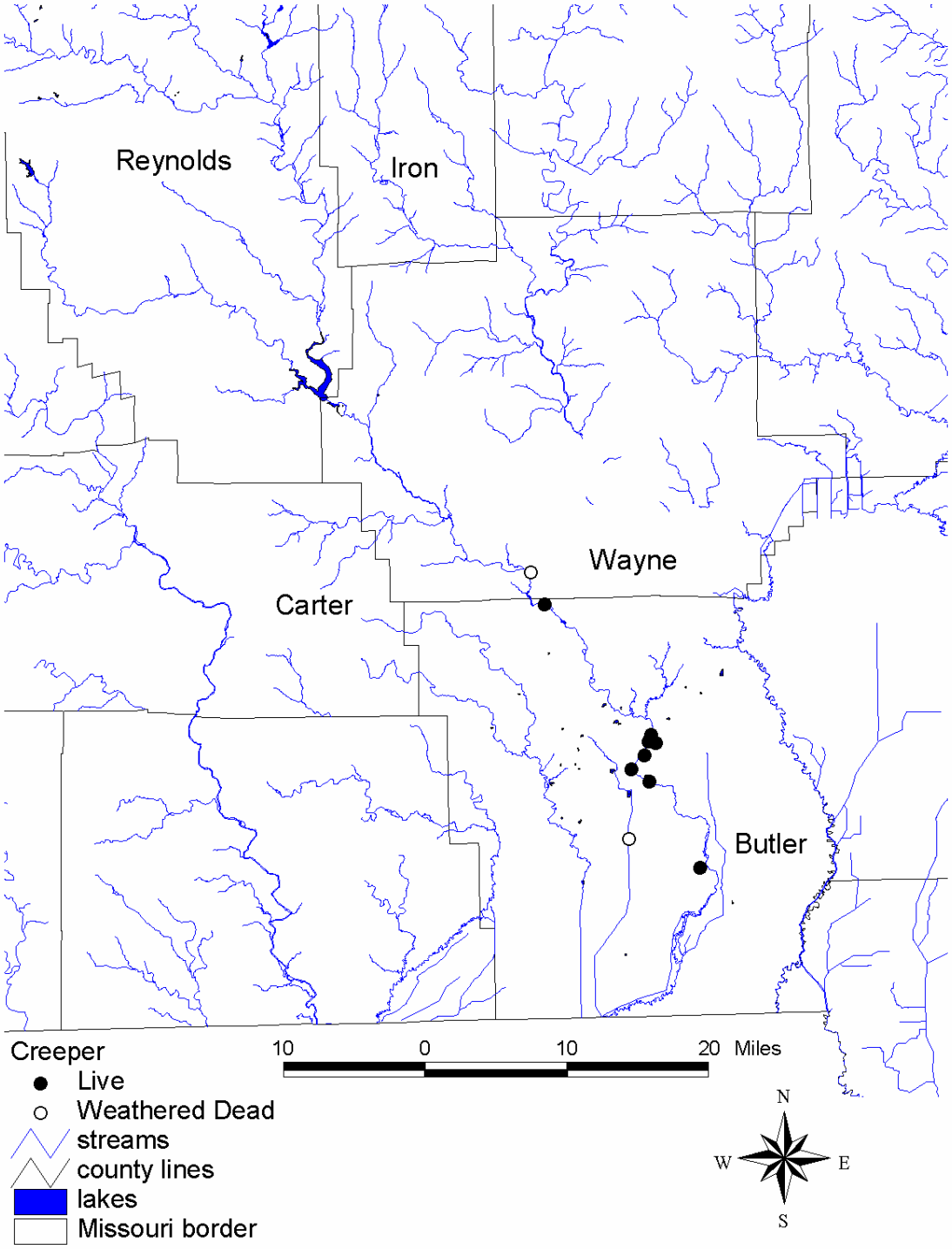

Figure 120. Distribution of the creeper in the Black River system.

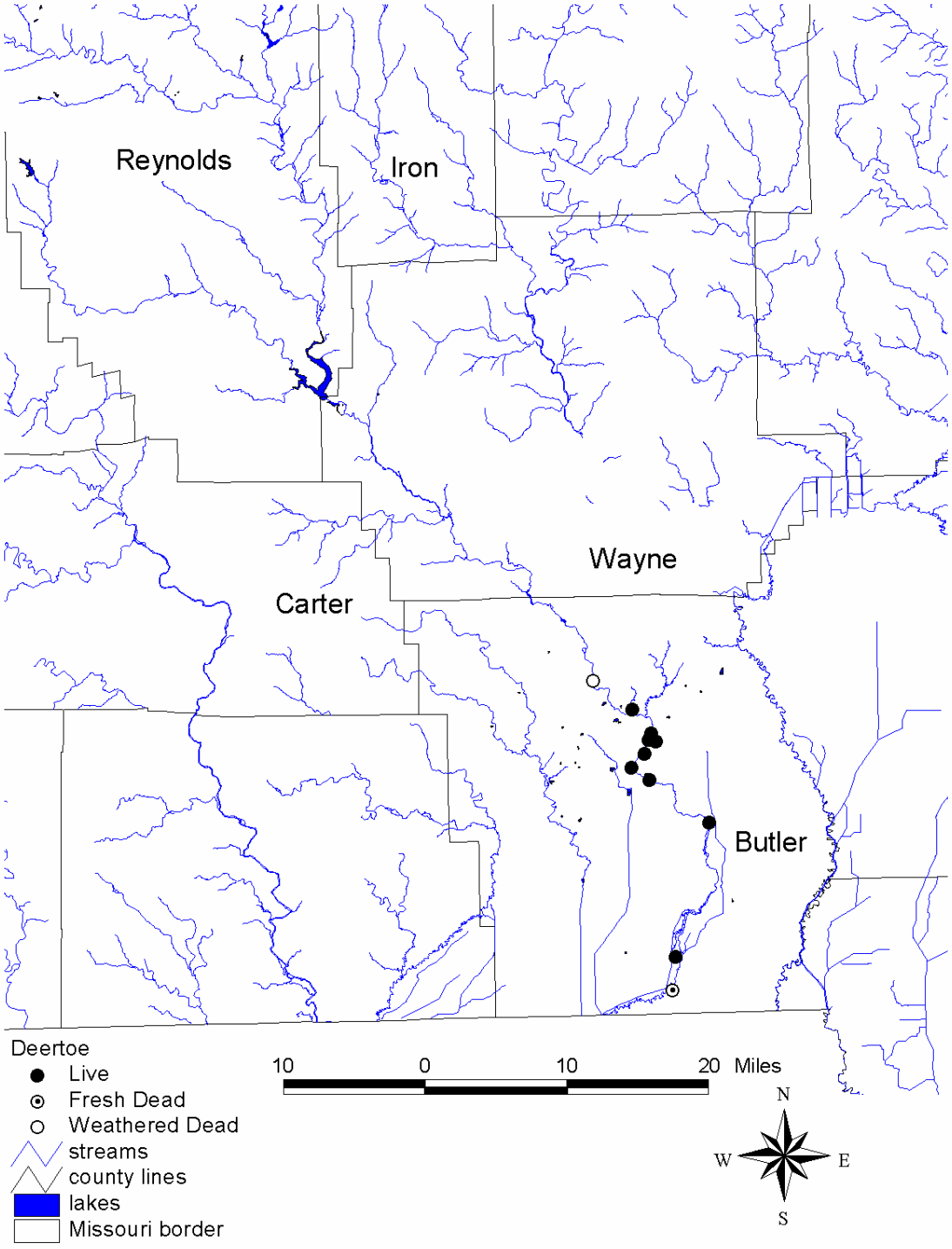

Figure 121. Distribution of the deertoe in the Black River system.

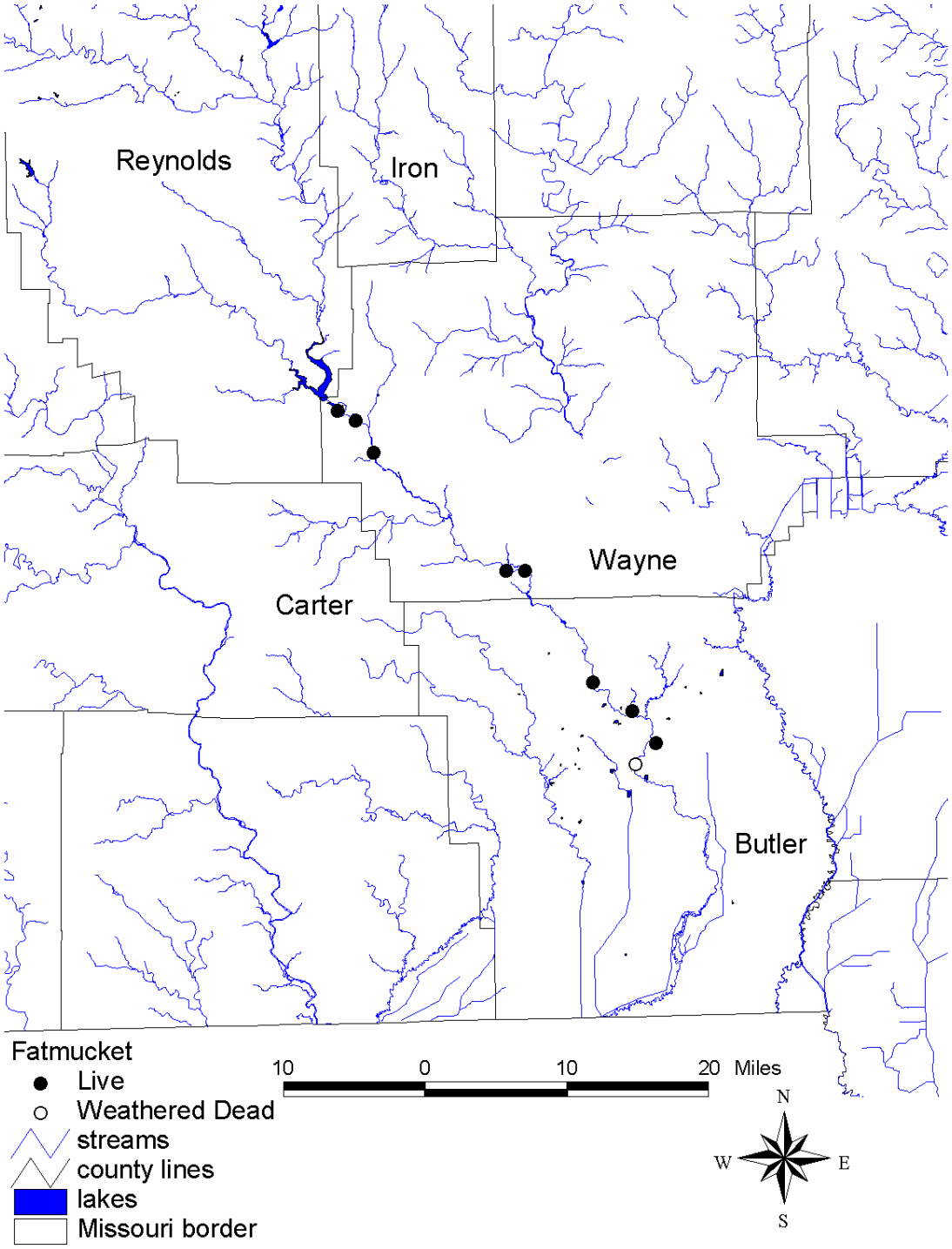

Figure 122. Distribution of the fatmucket in the Black River system.

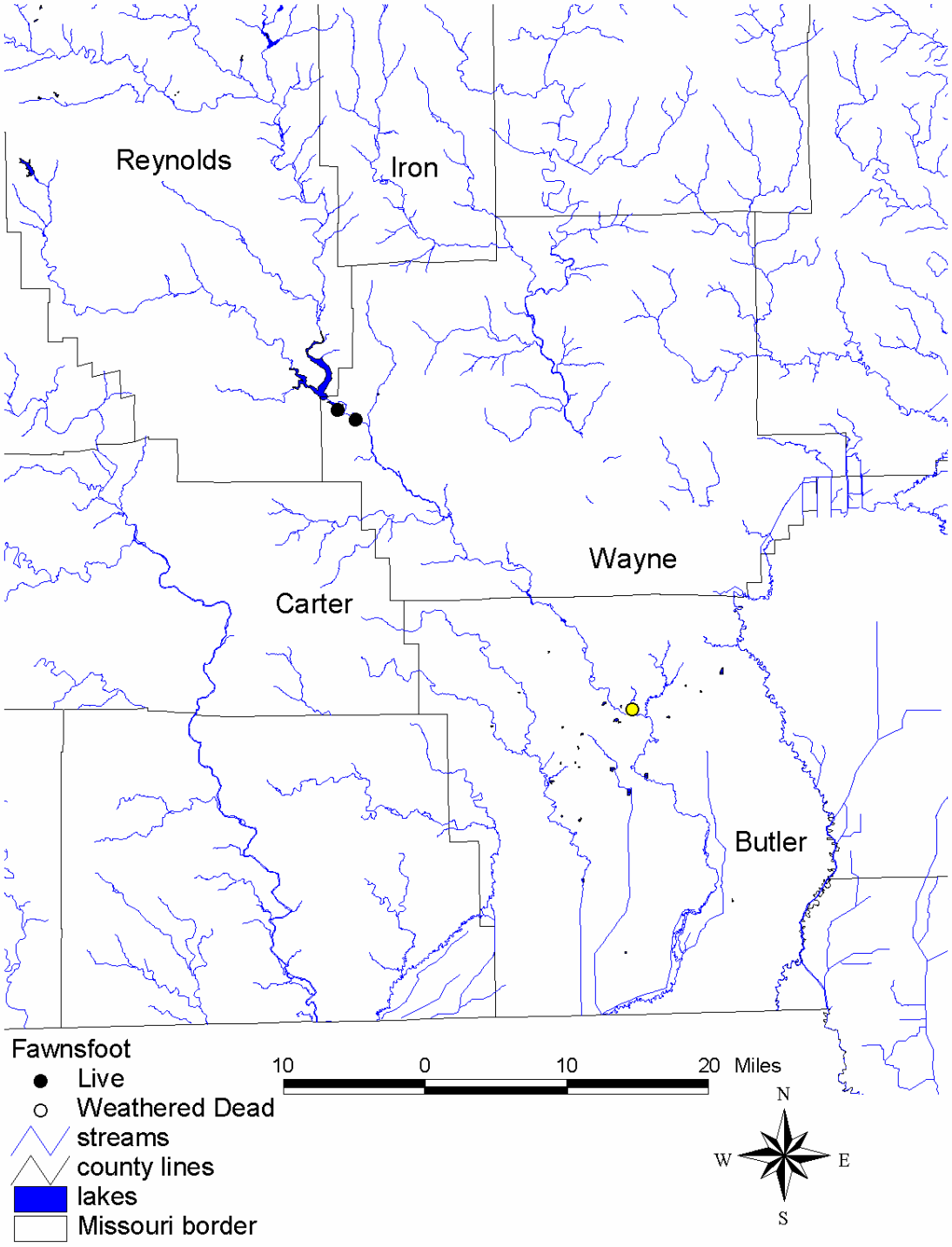

Figure 123. Distribution of the fawnsfoot in the Black River system.

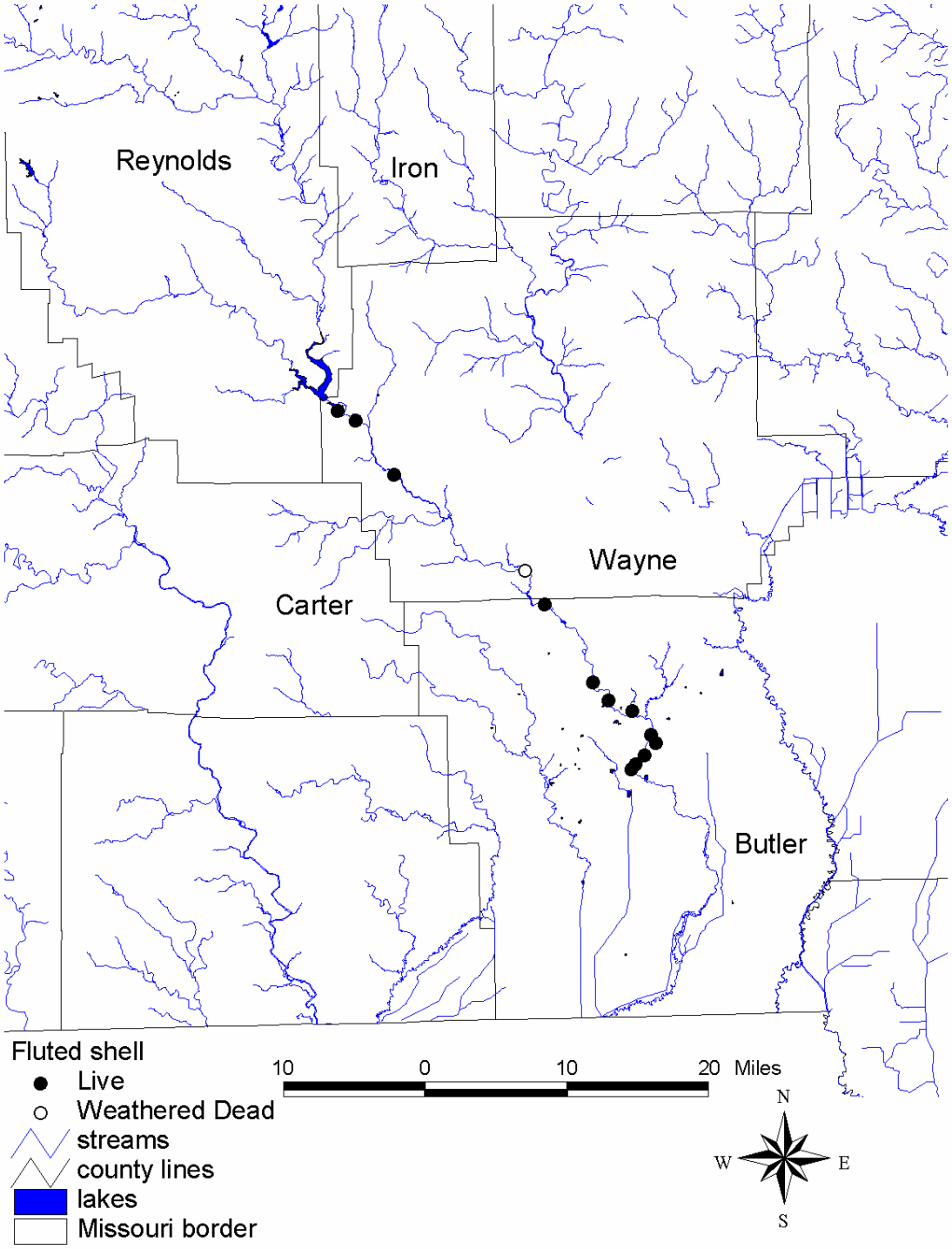

Figure 124. Distribution of the flutedshell in the Black River system.

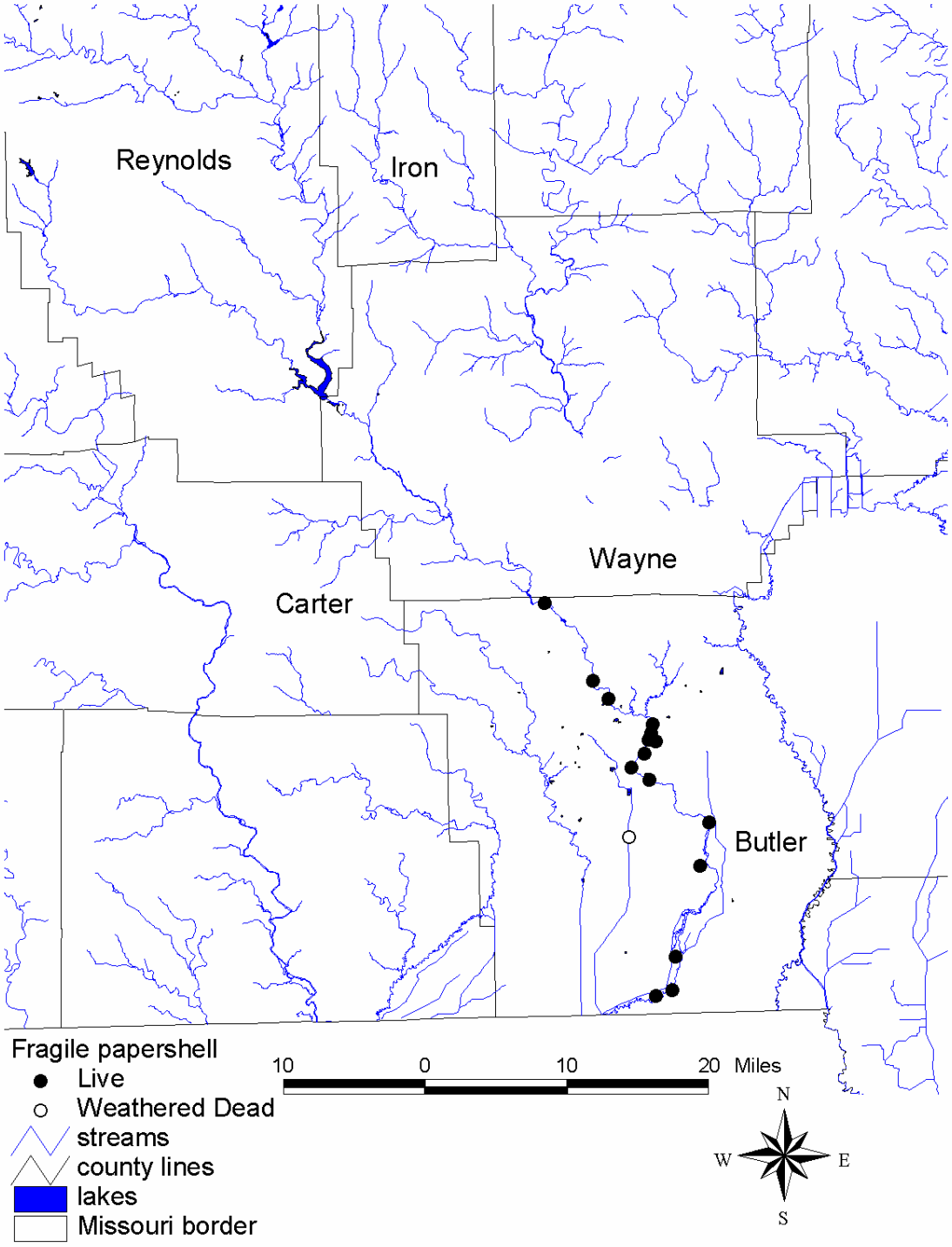

Figure 125. Distribution of the fragile papershell in the Black River system.

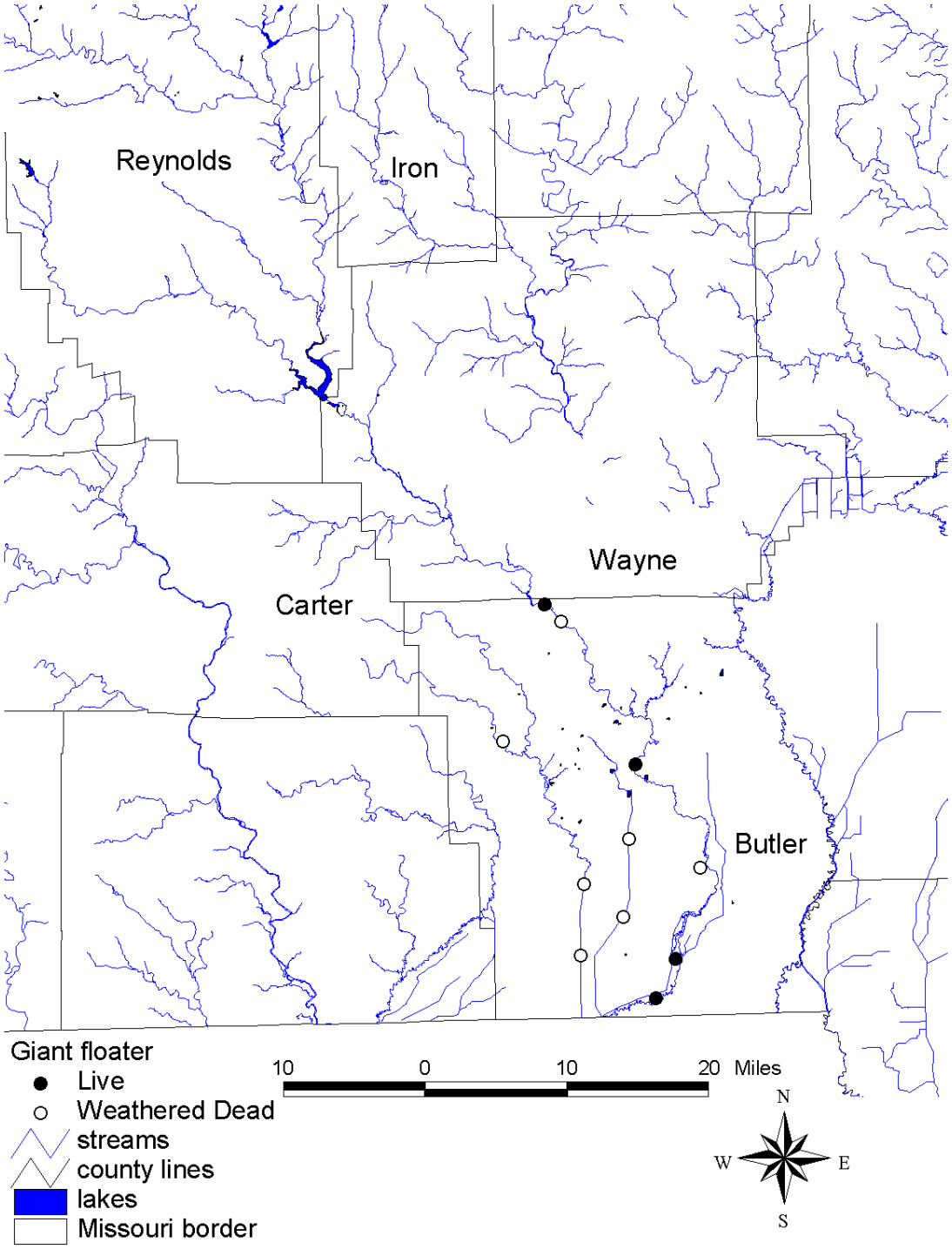

Figure 126. Distribution of the giant floater in the Black River system.

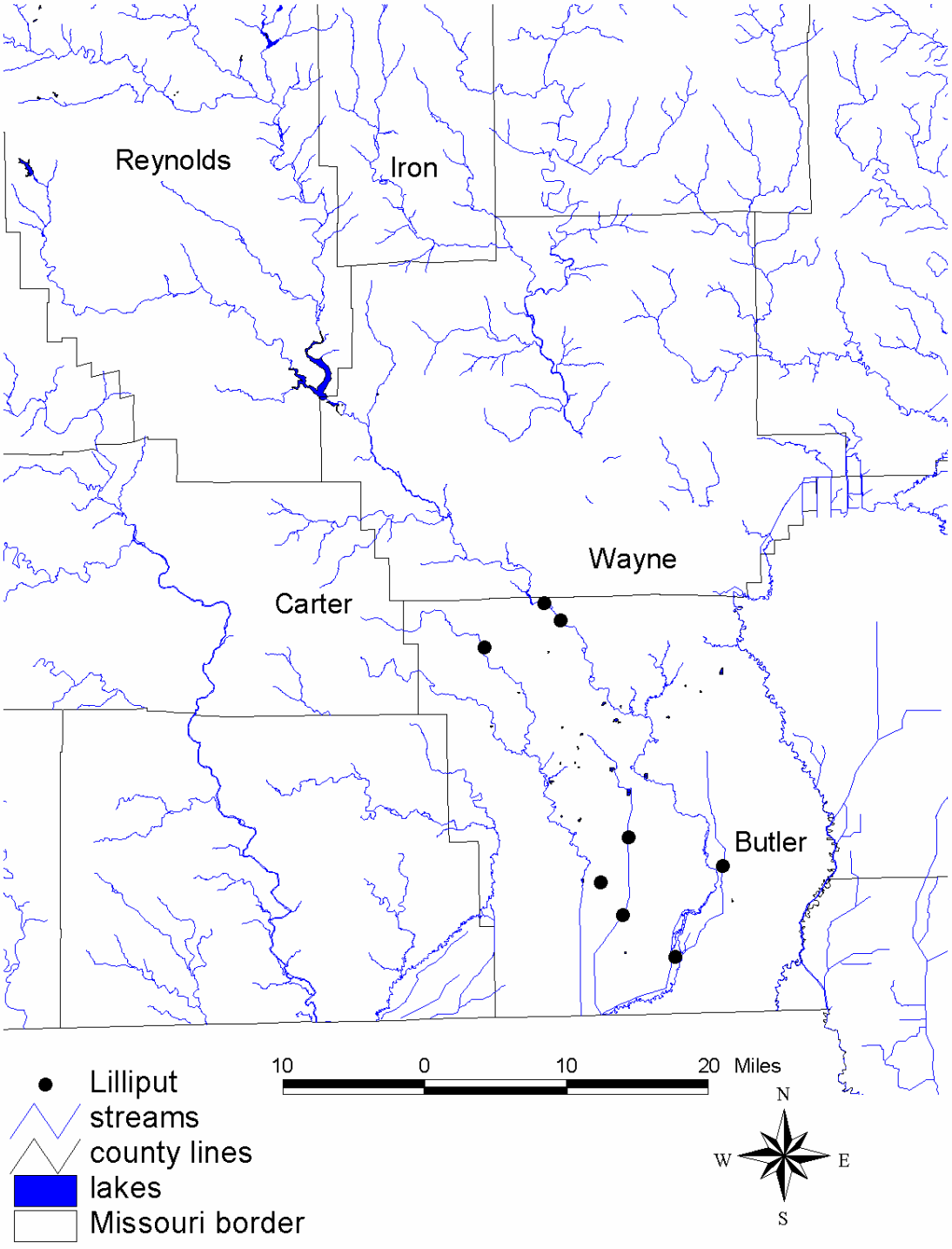

Figure 127. Distribution of the lilliput in the Black River system.

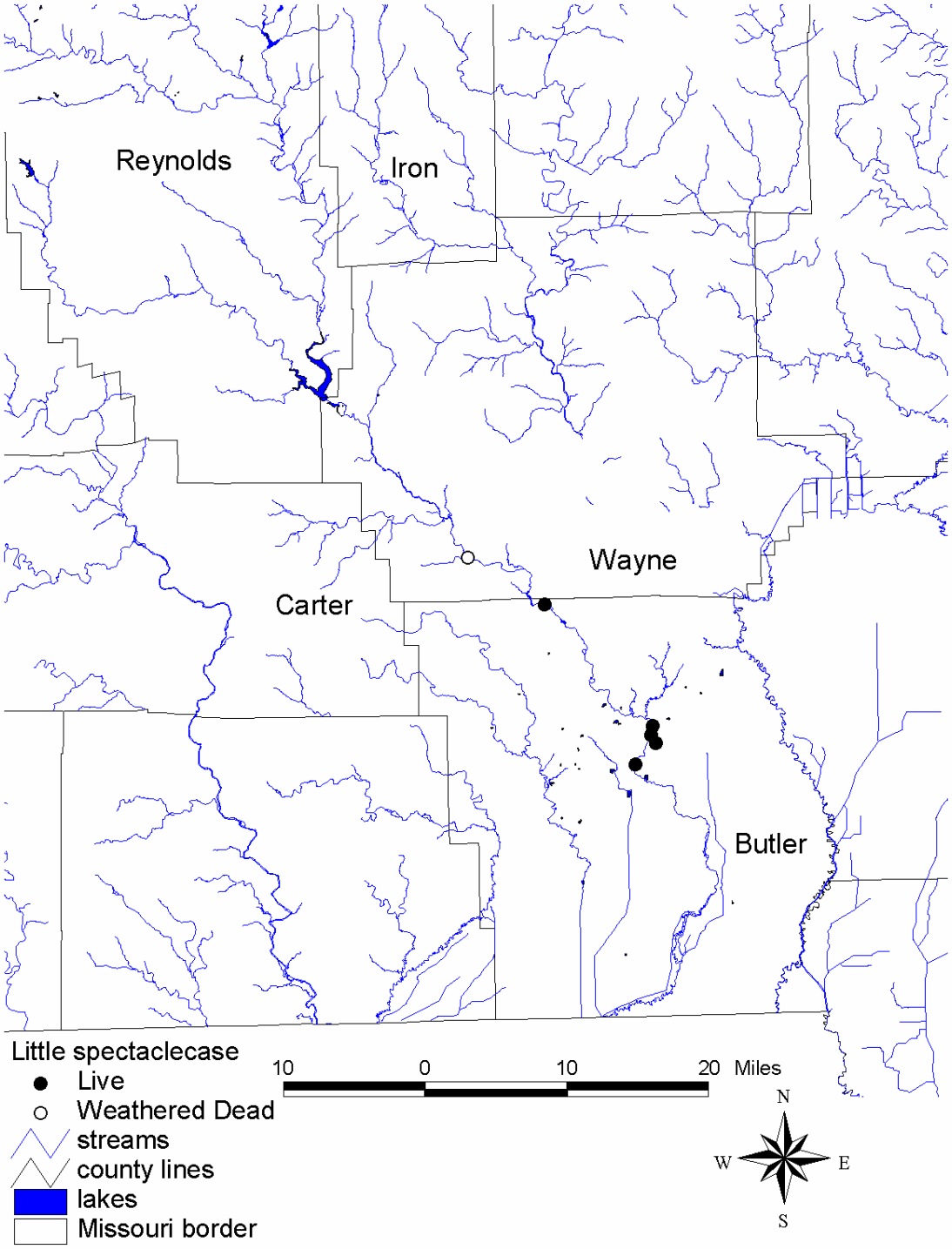

Figure 128. Distribution of the little spectaclecase in the Black River system.

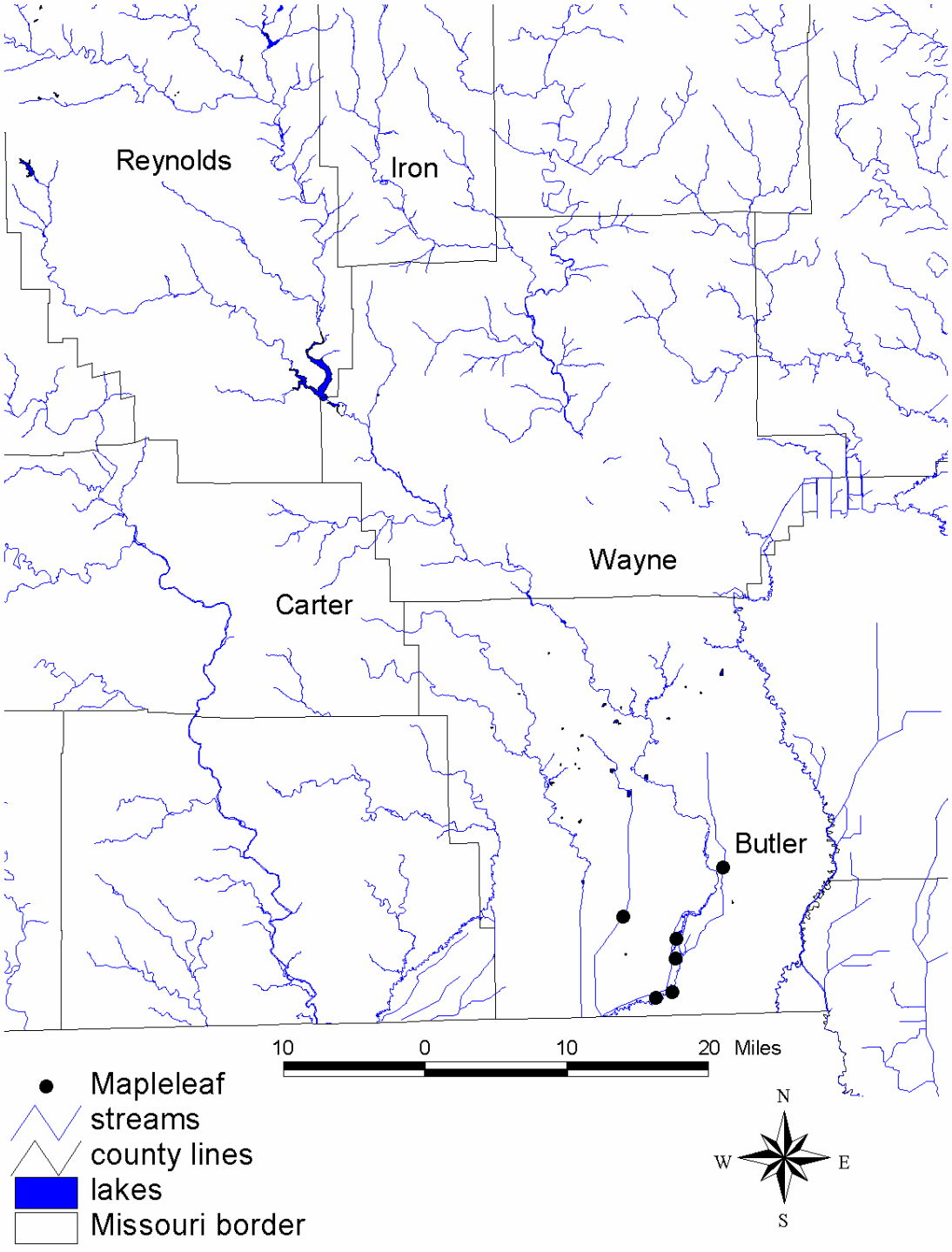

Figure 129. Distribution of the mapleleaf in the Black River system.

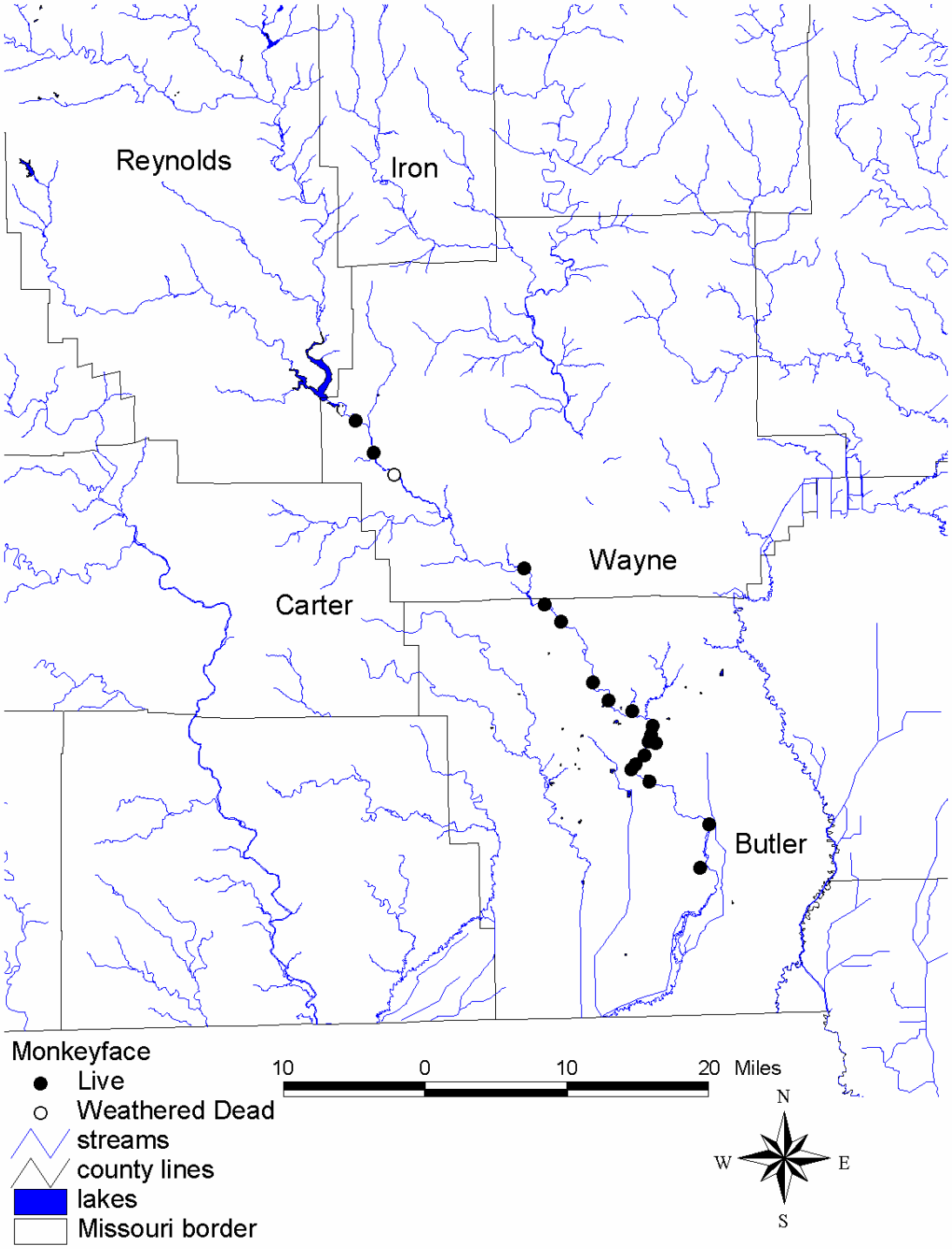

Figure 130. Distribution of the monkeyface in the Black River system.

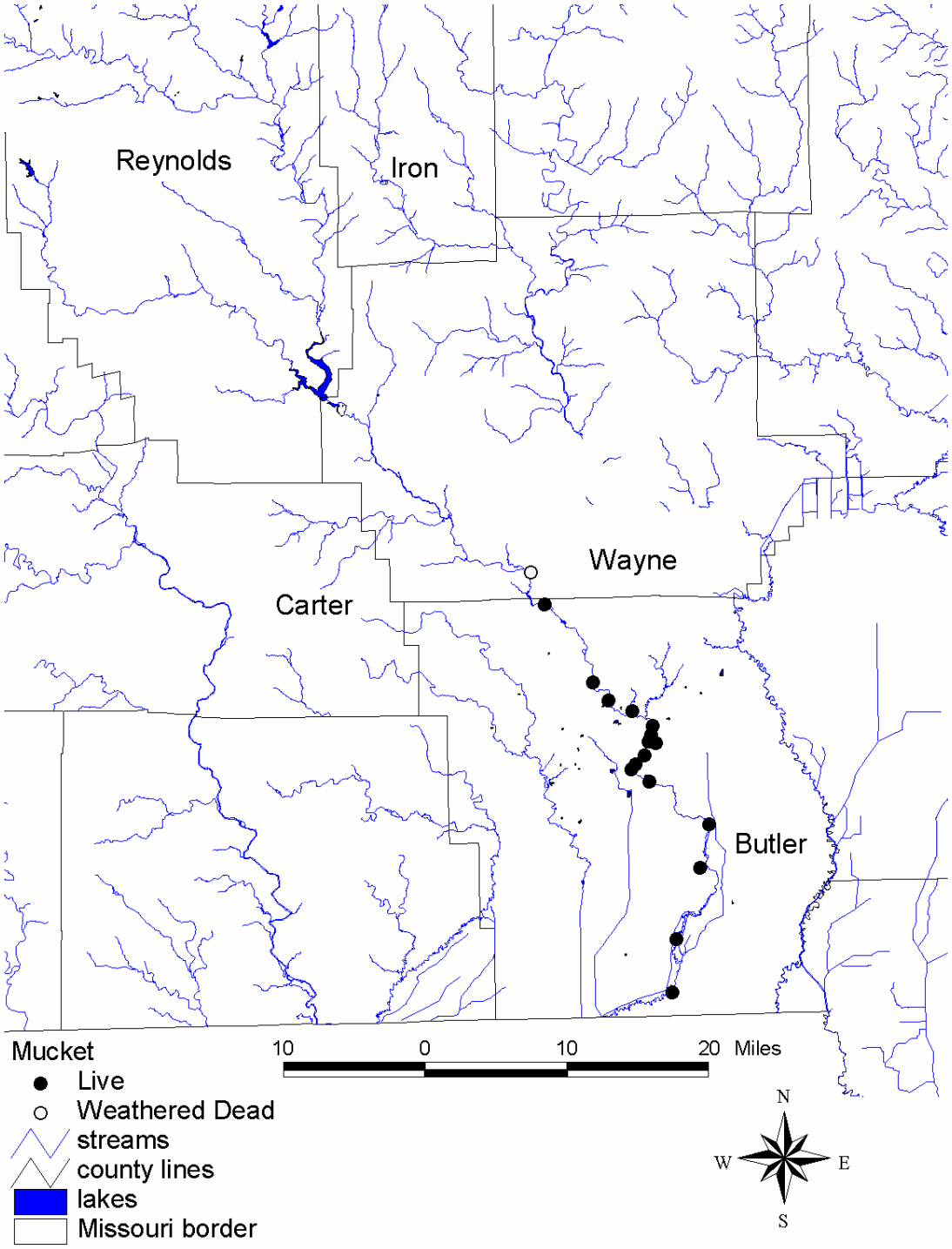

Figure 131. Distribution of the mucket in the Black River system.

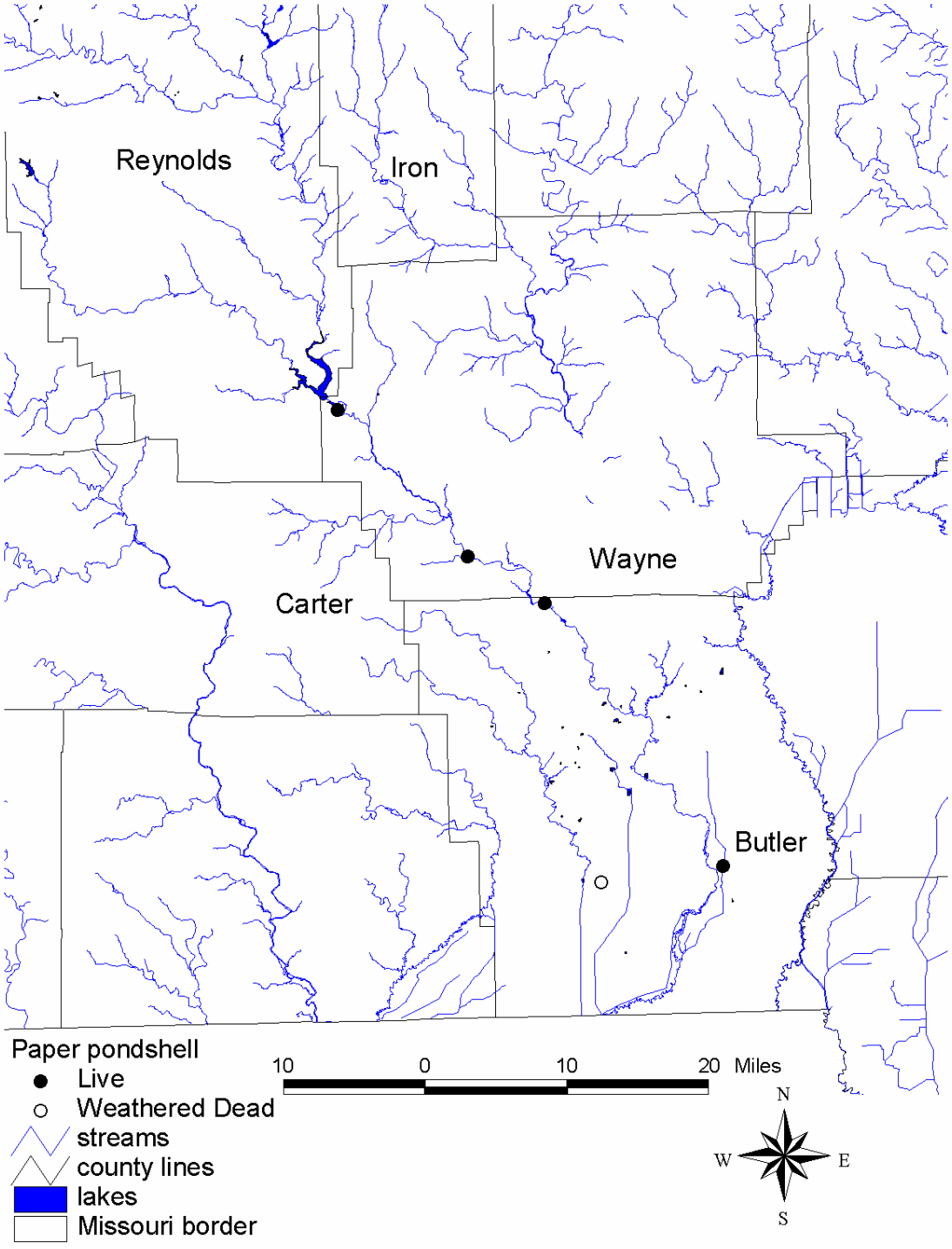

Figure 132. Distribution of the paper pondshell in the Black River system.

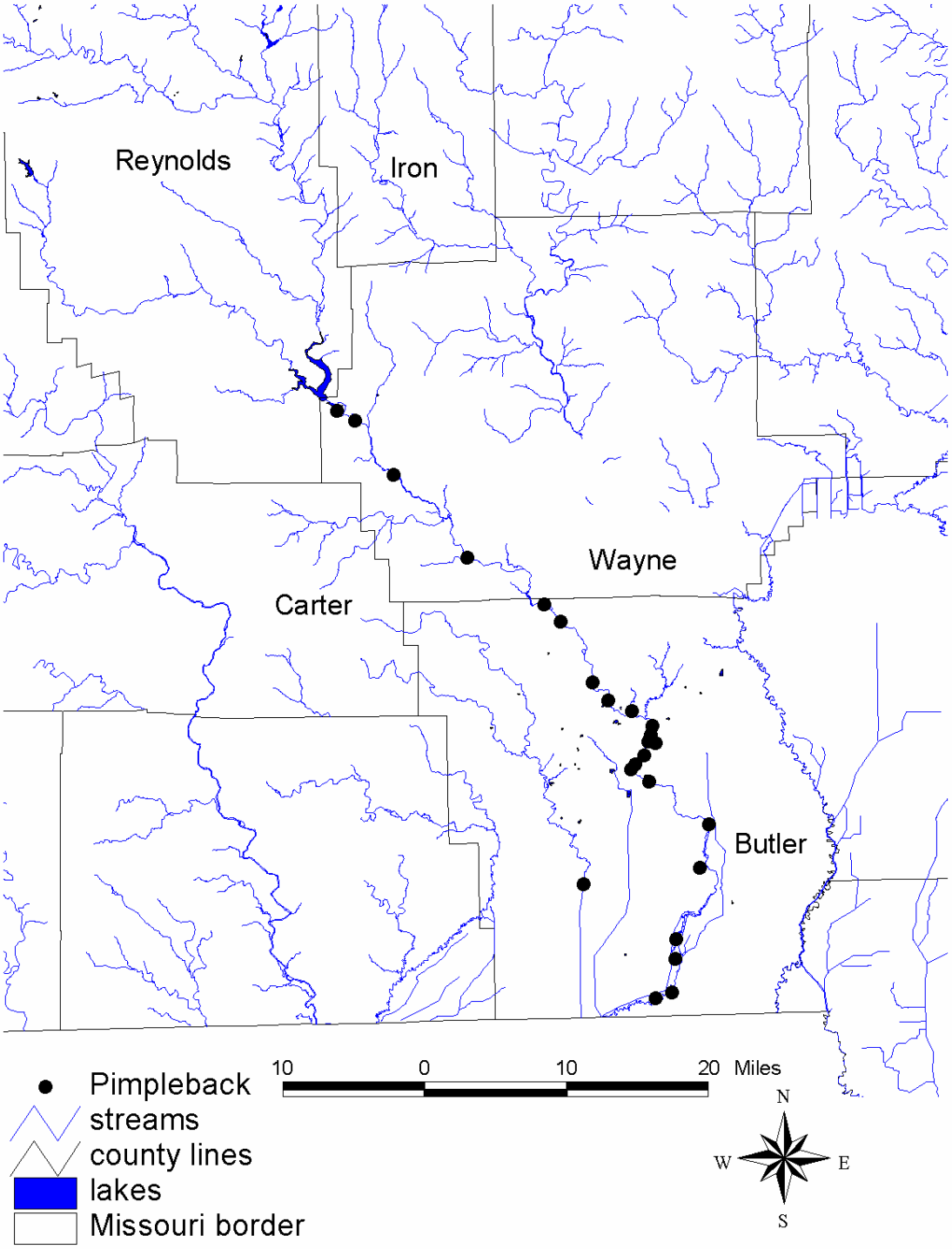

Figure 133. Distribution of the pimpleback in the Black River system.

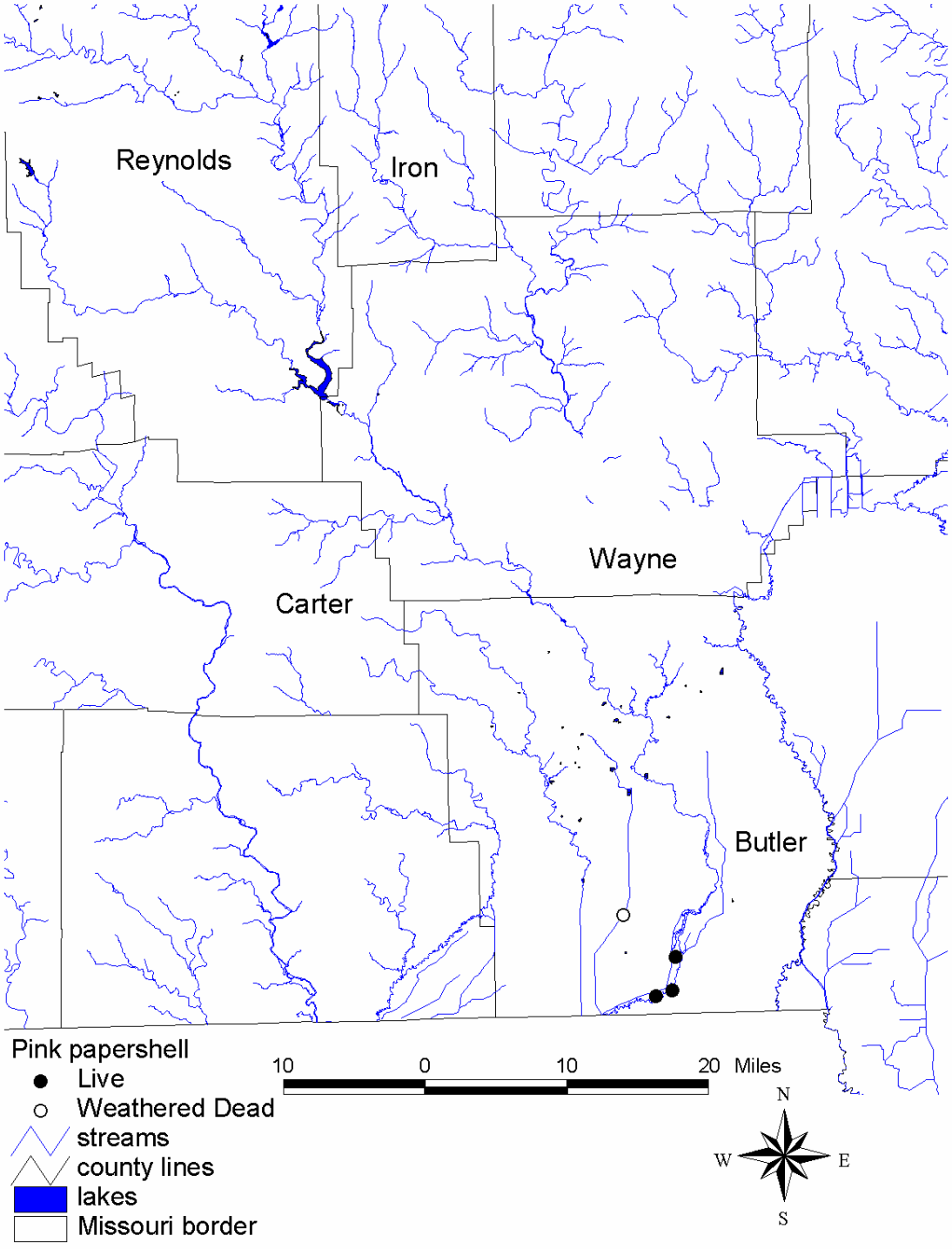

Figure 134. Distribution of the pink papershell in the Black River system.

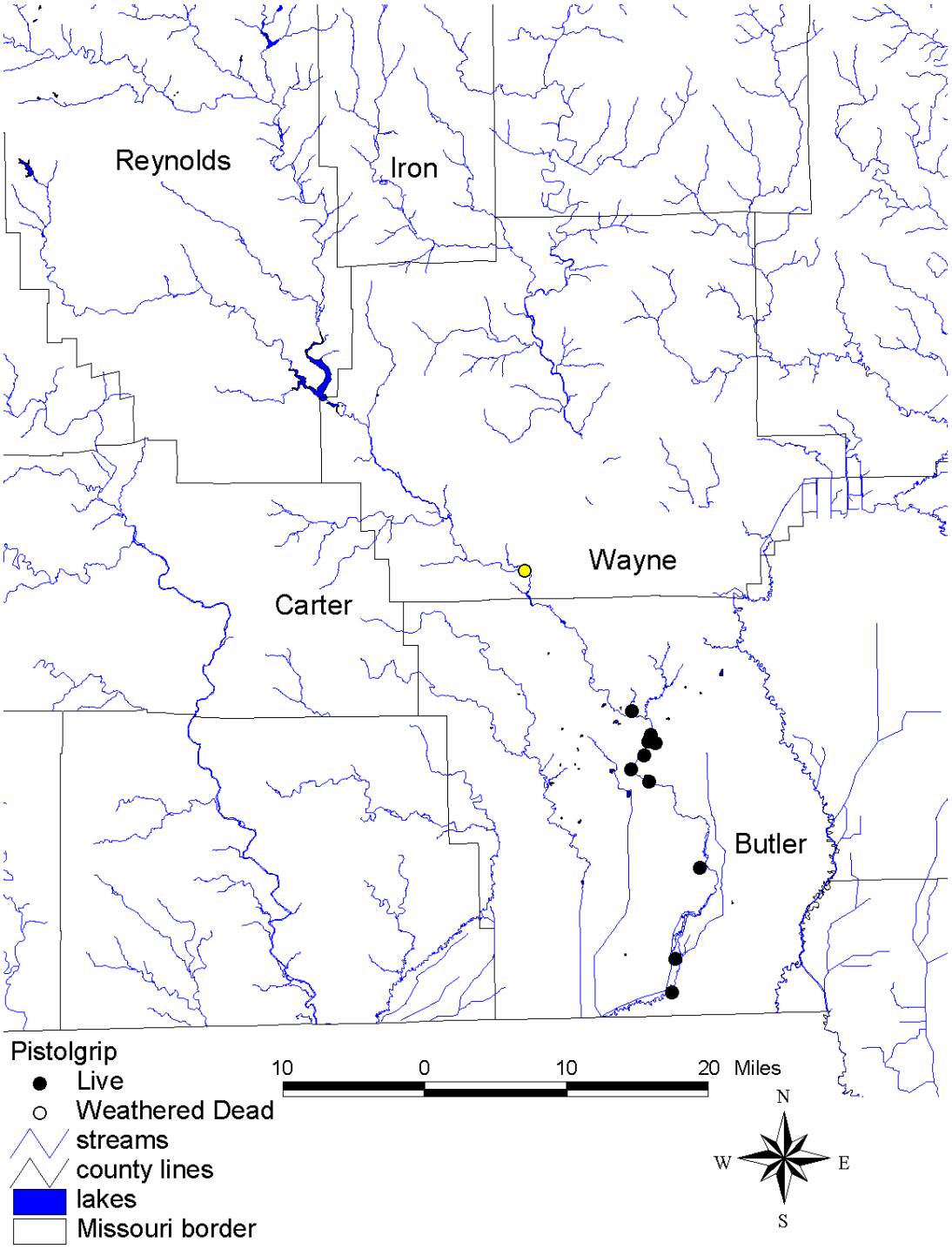

Figure 135. Distribution of the pistolgrip in the Black River system.

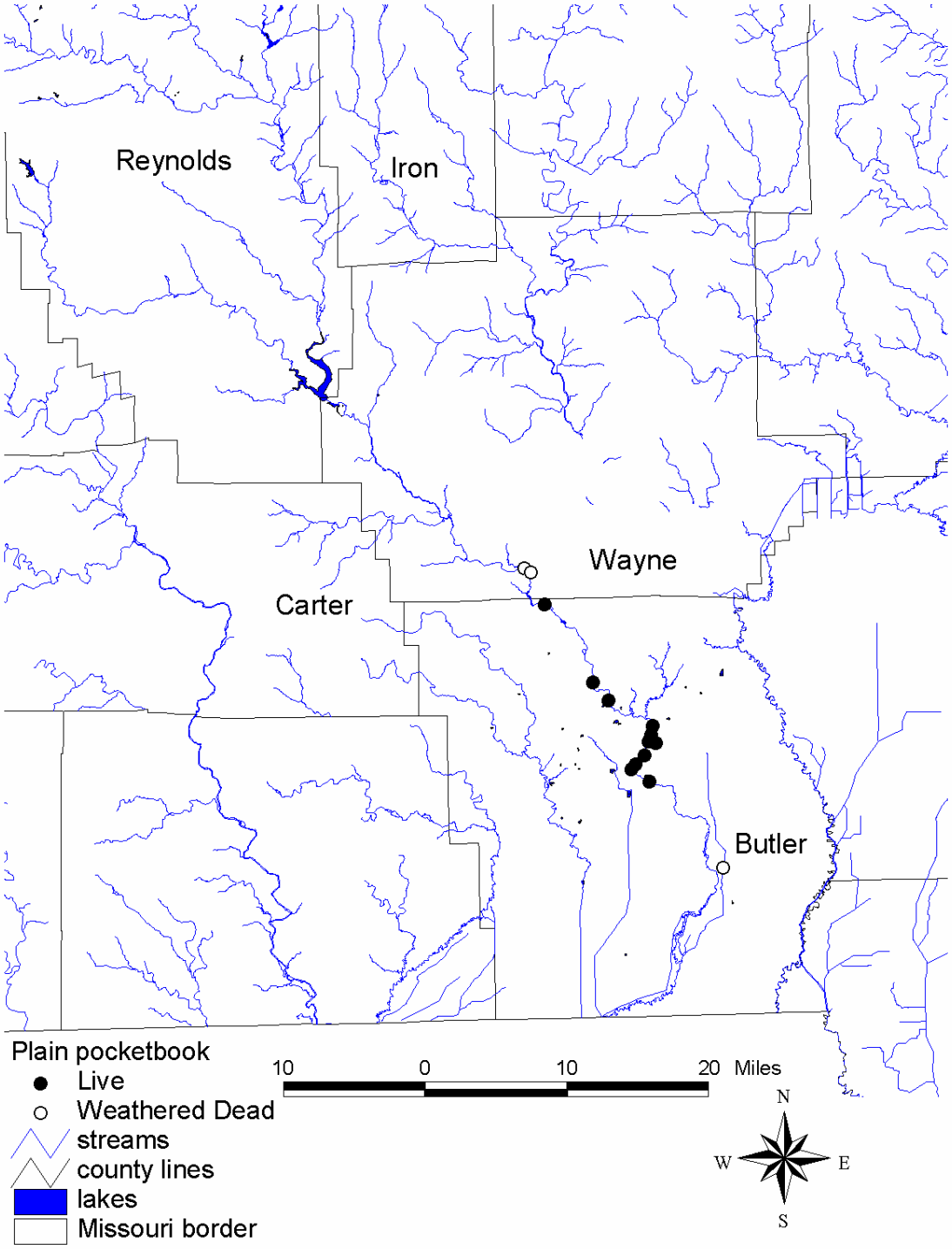

Figure 136. Distribution of the plain pocketbook in the Black River system.

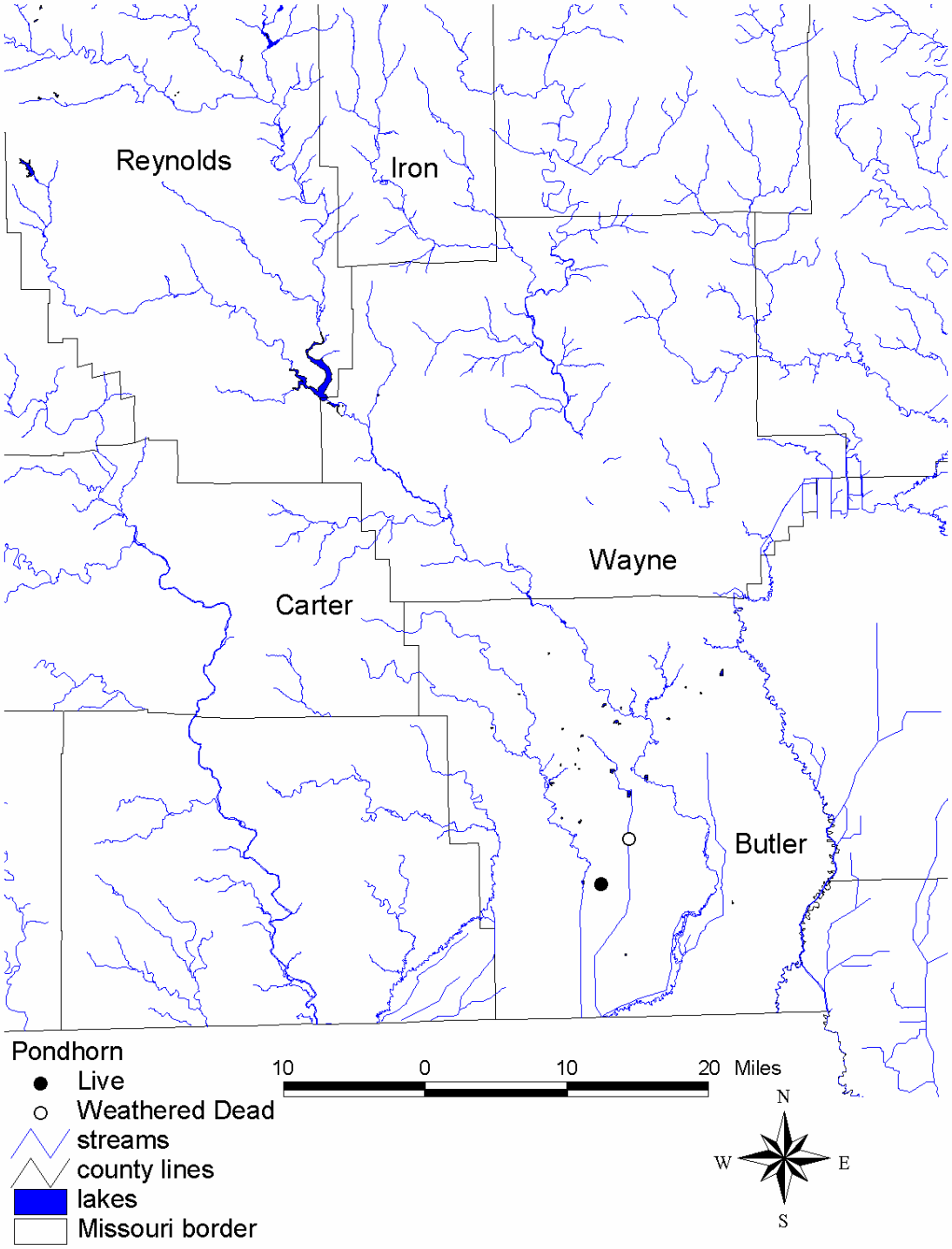

Figure 137. Distribution of the pondhorn in the Black River system.

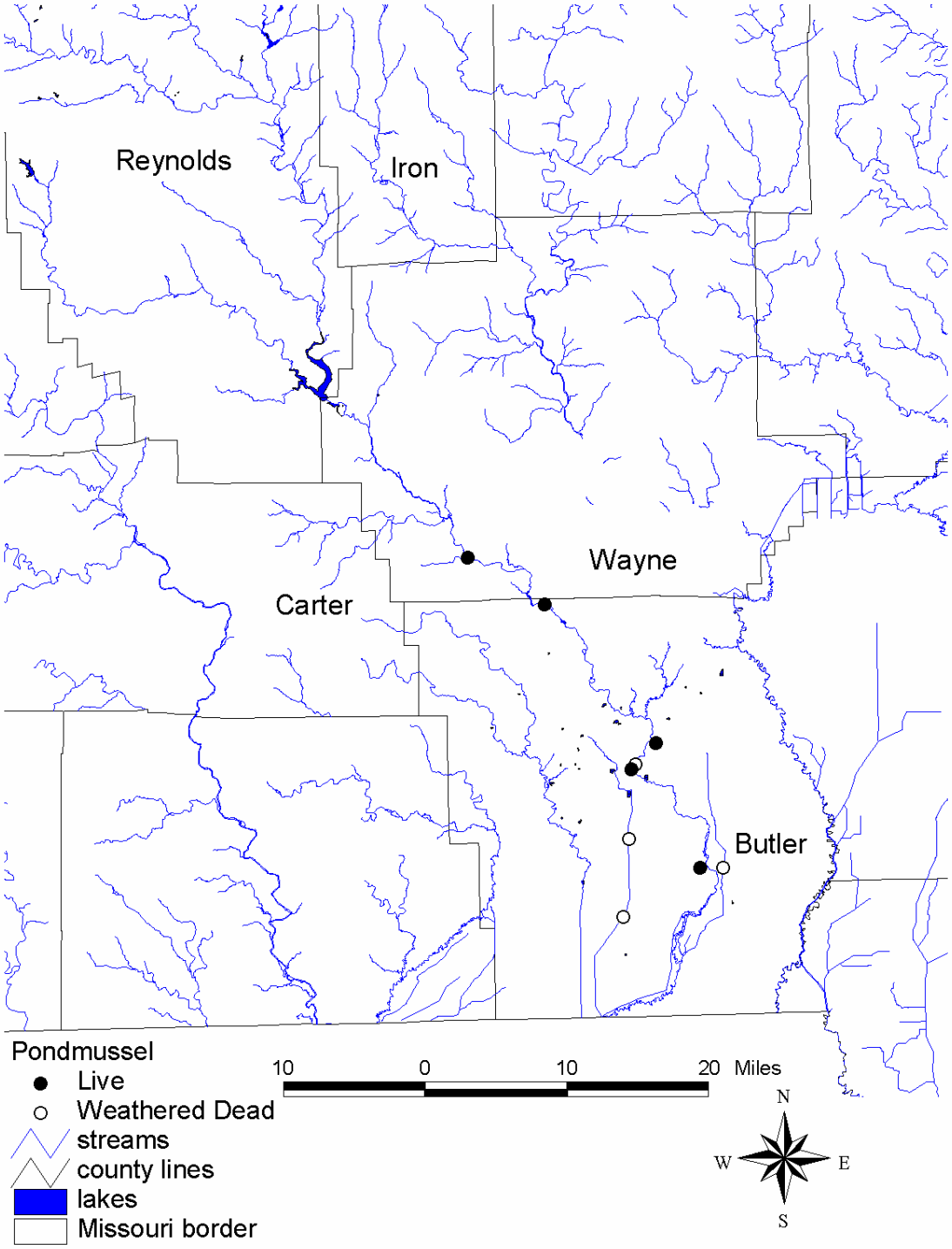

Figure 138. Distribution of the pond mussel in the Black River system.

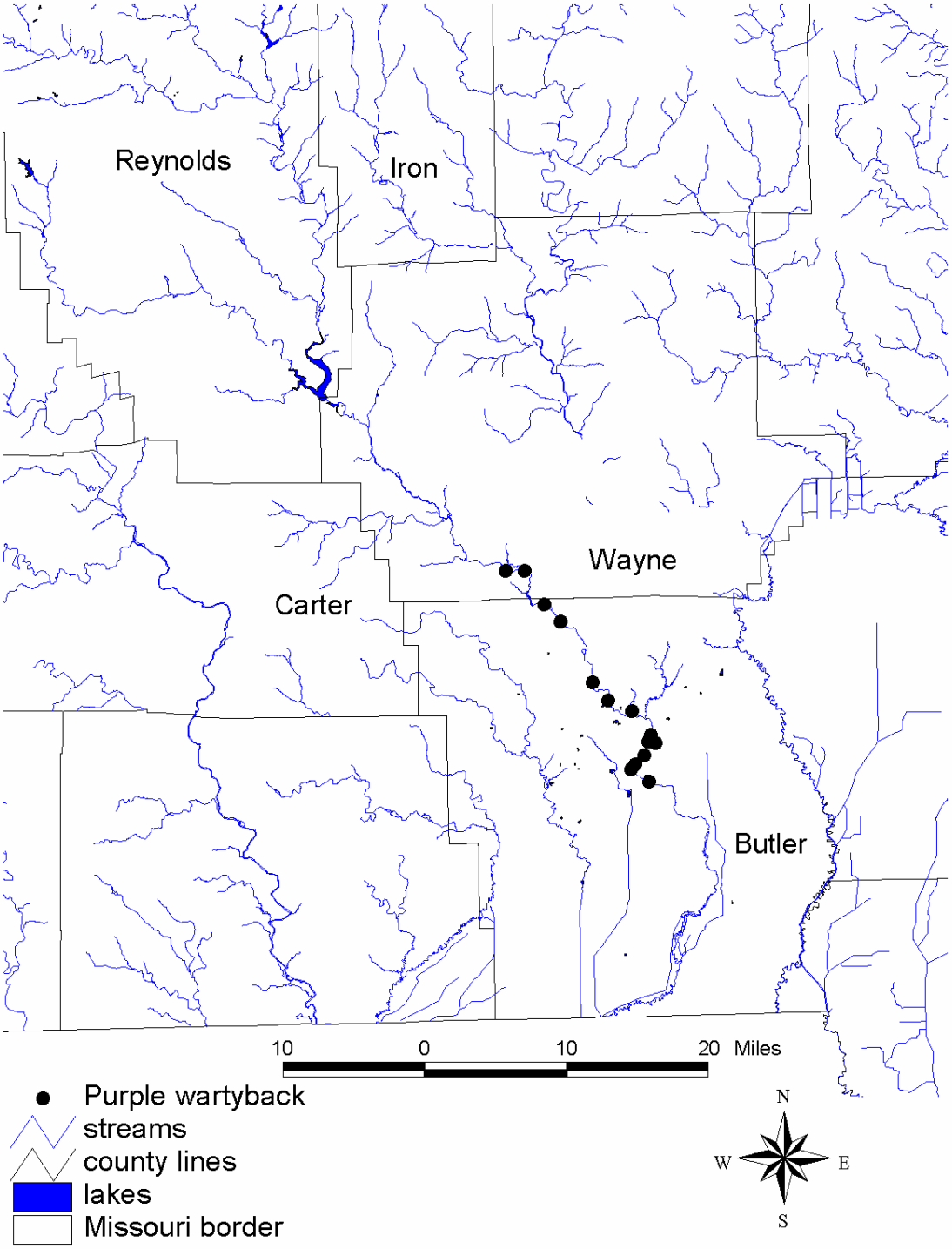

Figure 139. Distribution of the purple wartyback in the Black River system.

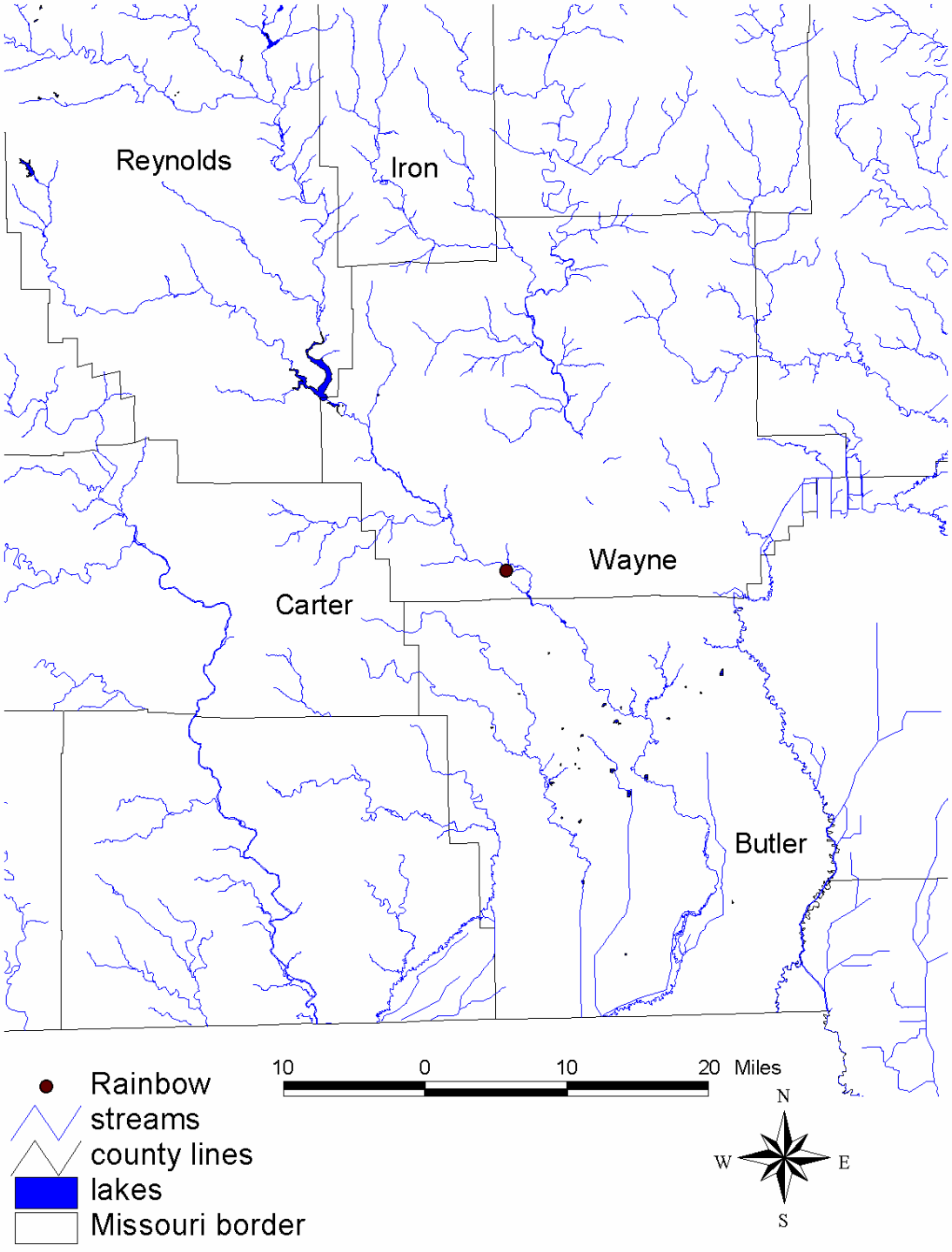

Figure 140. Distribution of the rainbow in the Black River system.

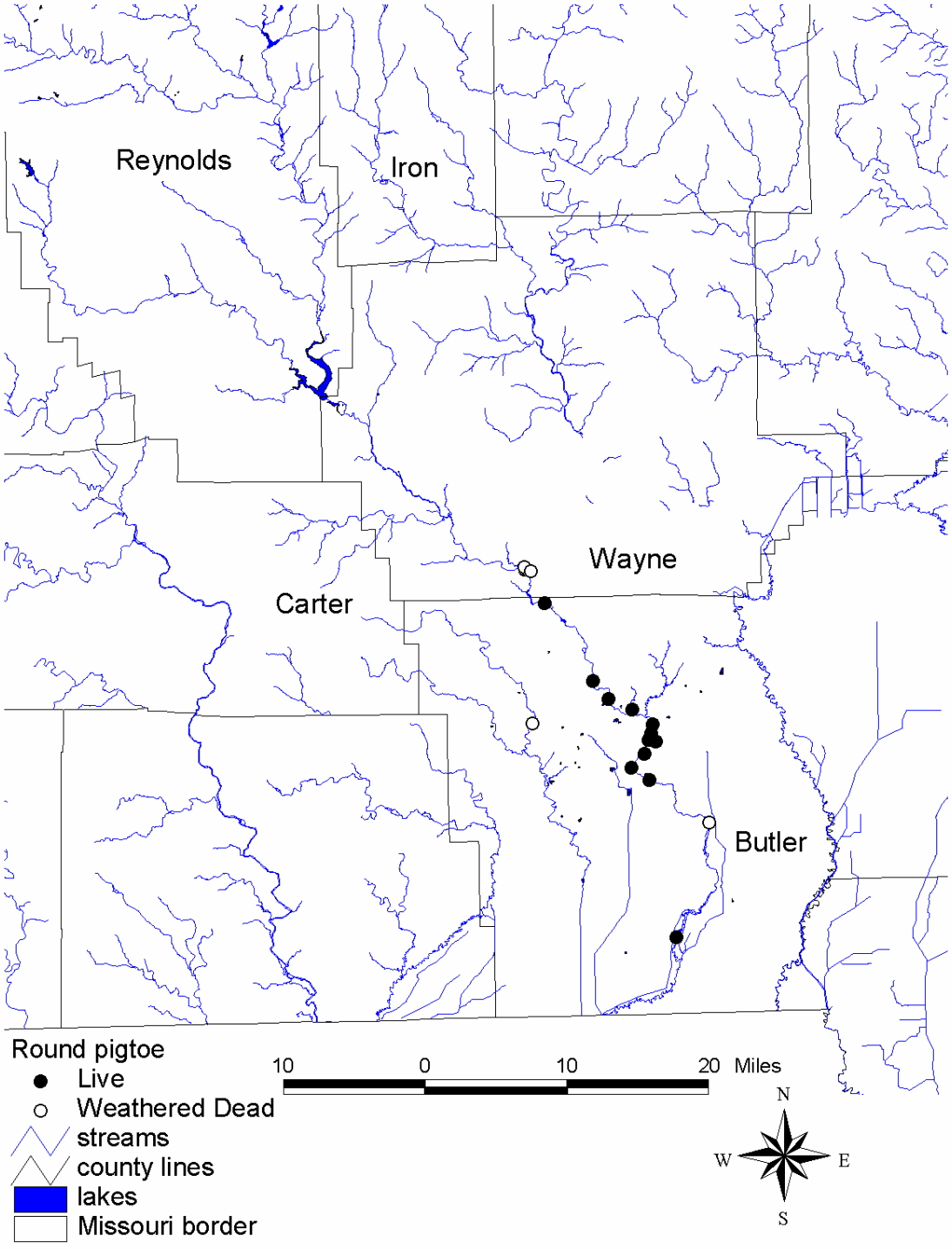

Figure 141. Distribution of the round pigtoe in the Black River system.

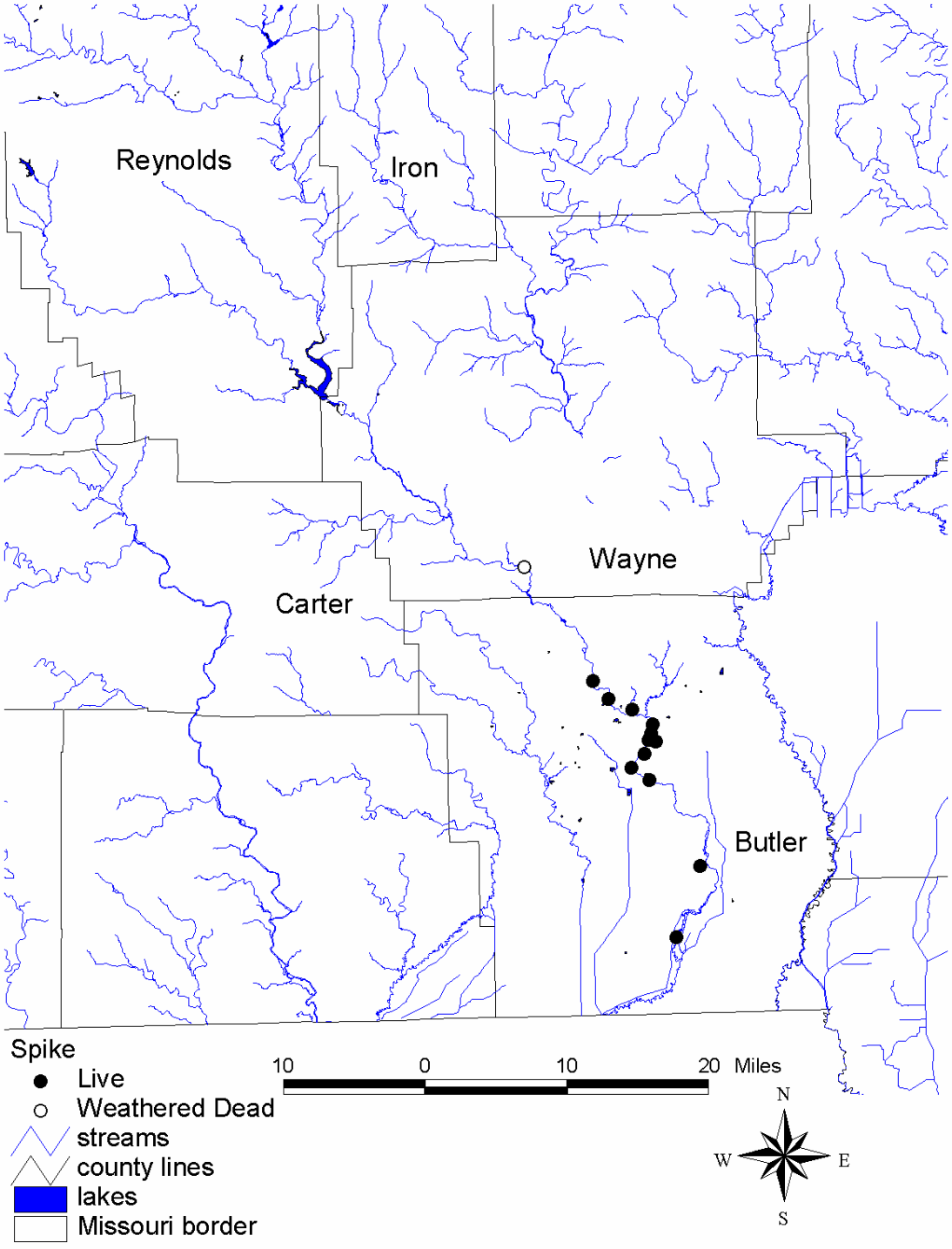

Figure 142. Distribution of the spike in the Black River system.

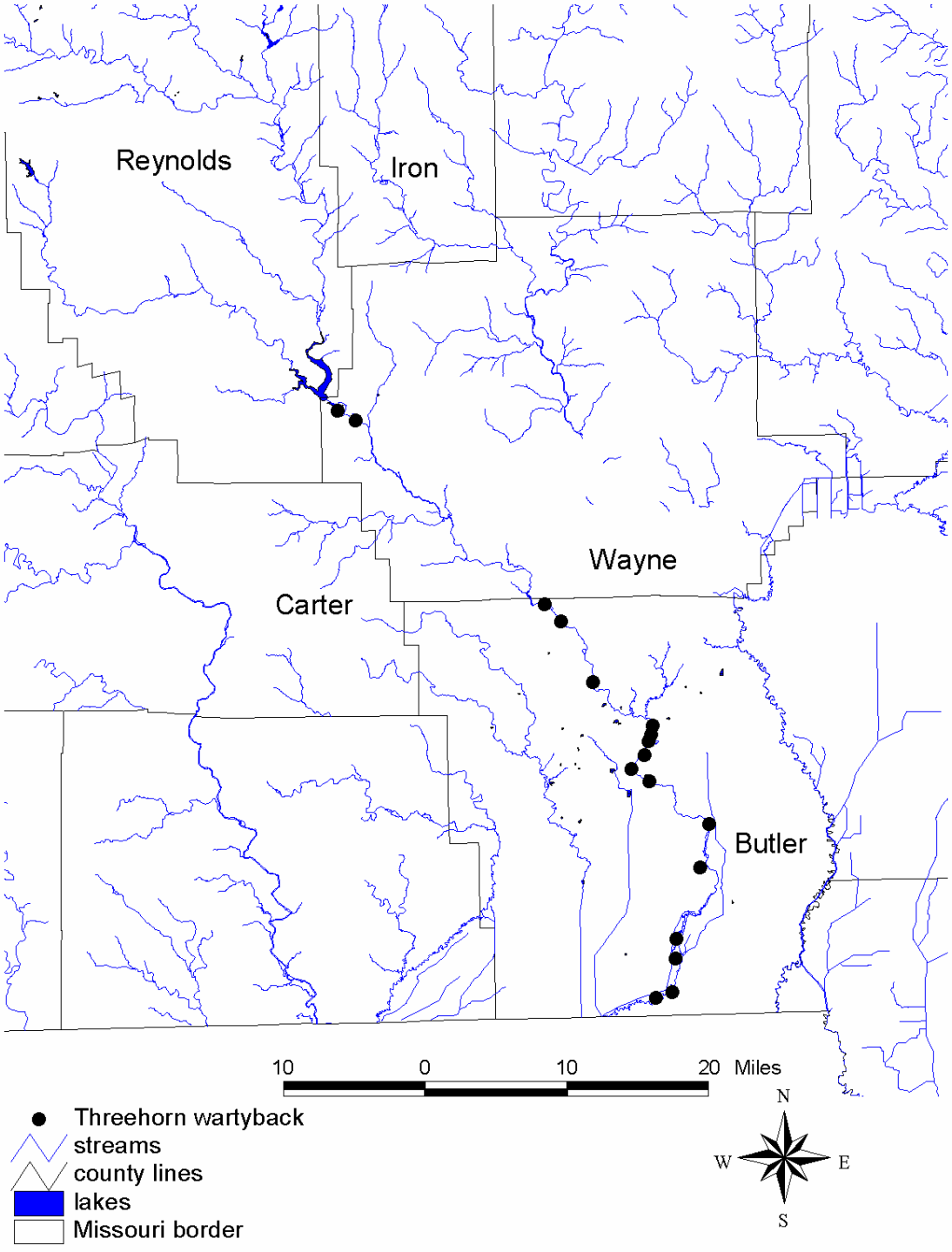

Figure 143. Distribution of the threehorn wartyback in the Black River system.

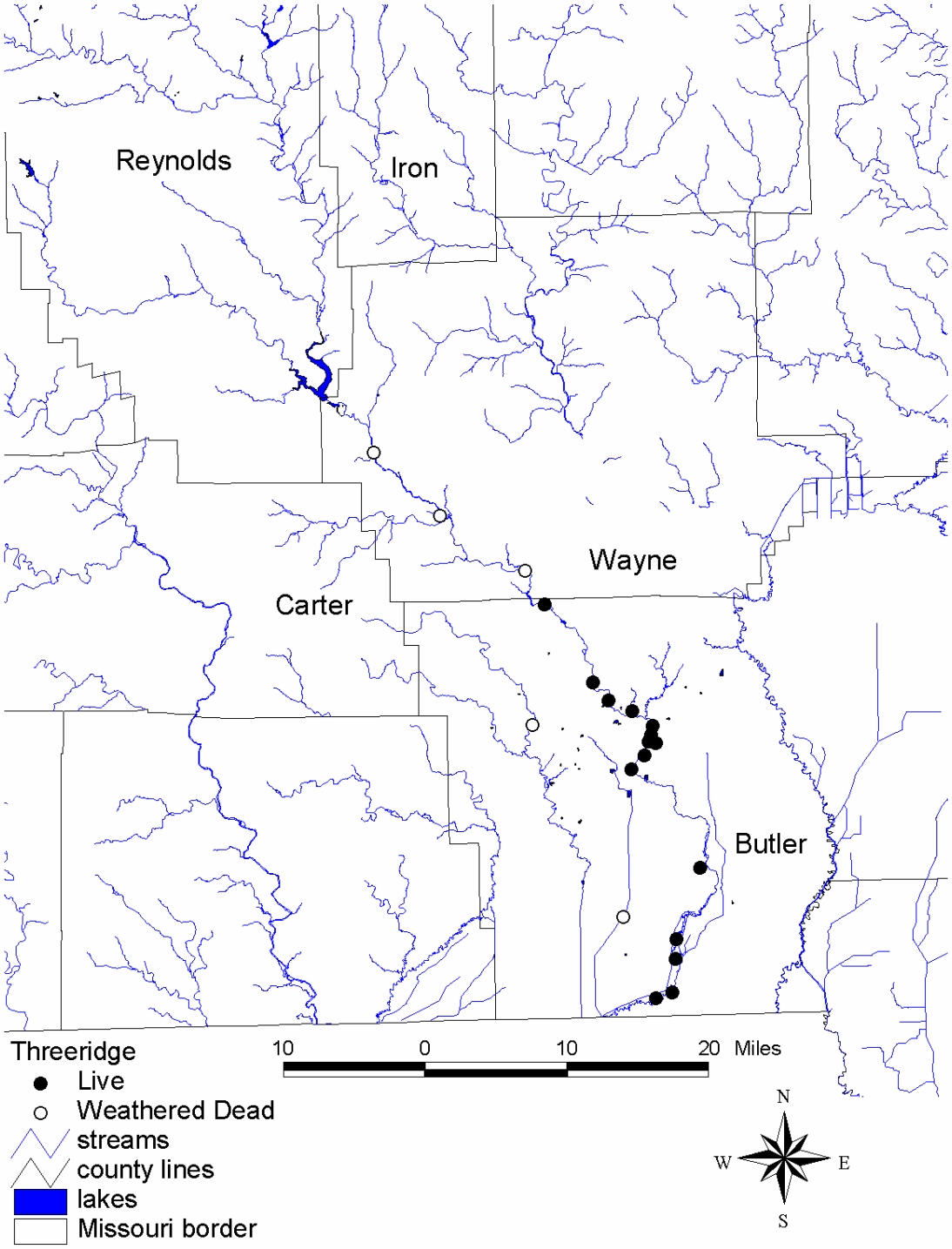

Figure 144. Distribution of the threeridge in the Black River system.

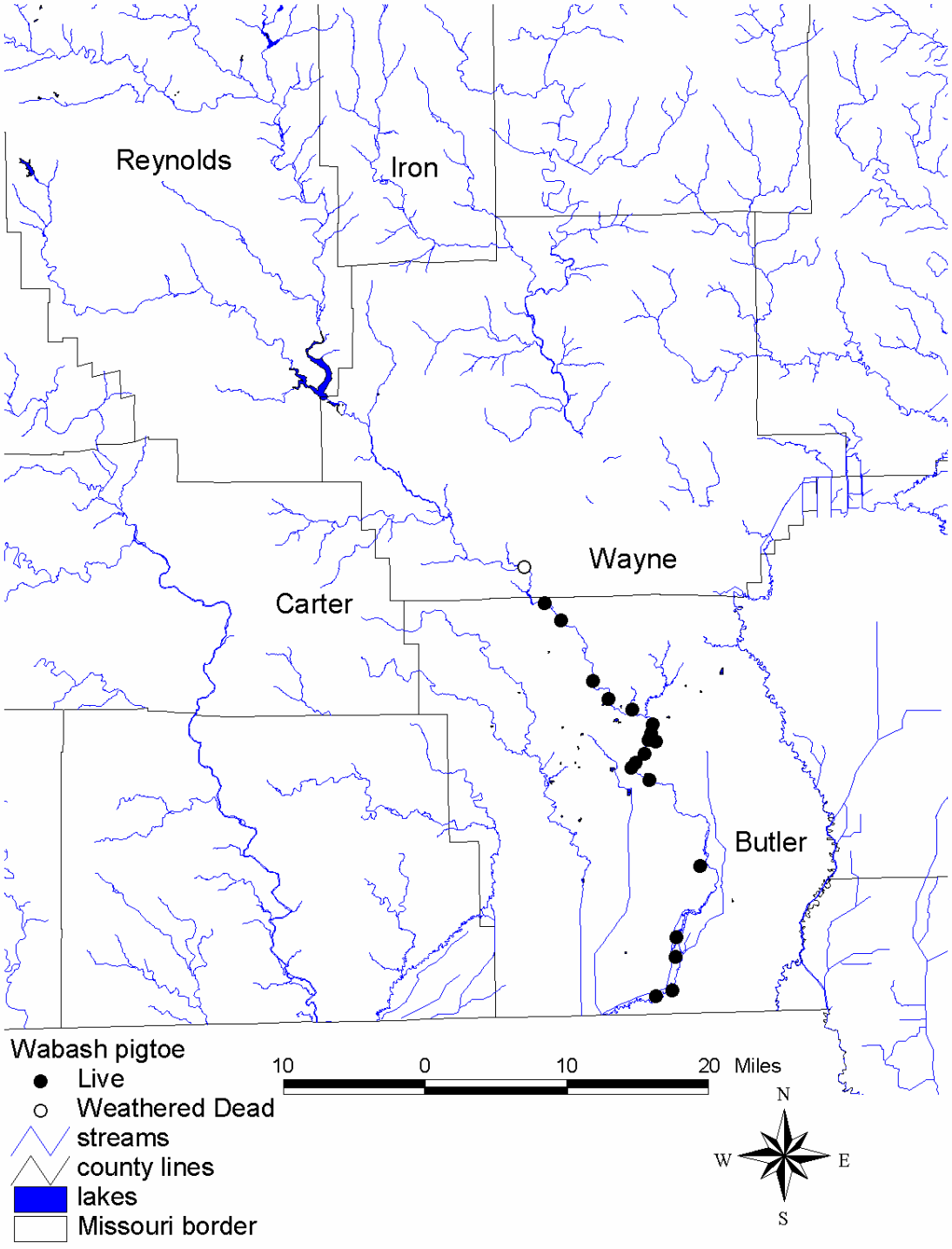

Figure 145. Distribution of the Wabash pigtoe in the Black River system.

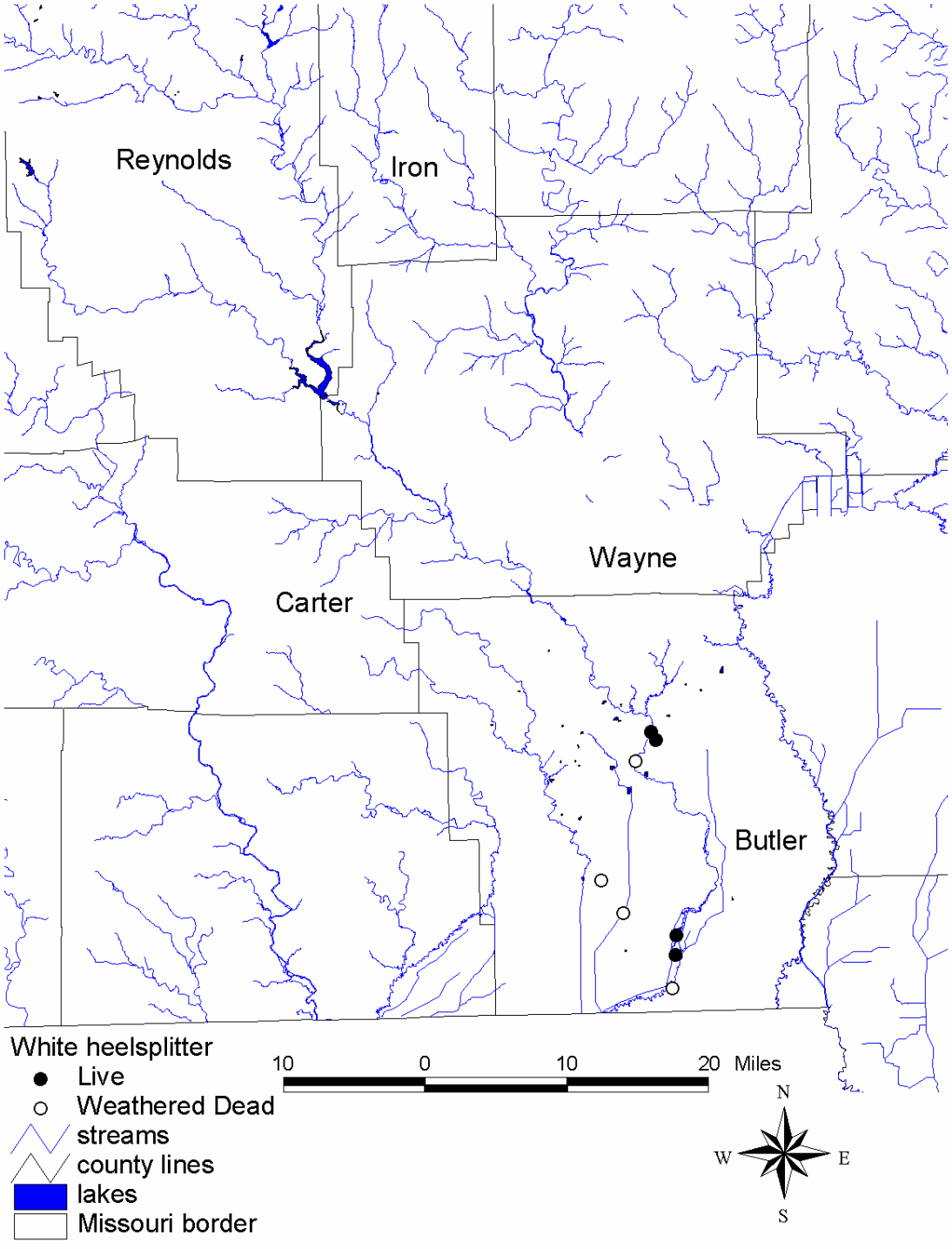

Figure 146. Distribution of the white heelsplitter in the Black River system.

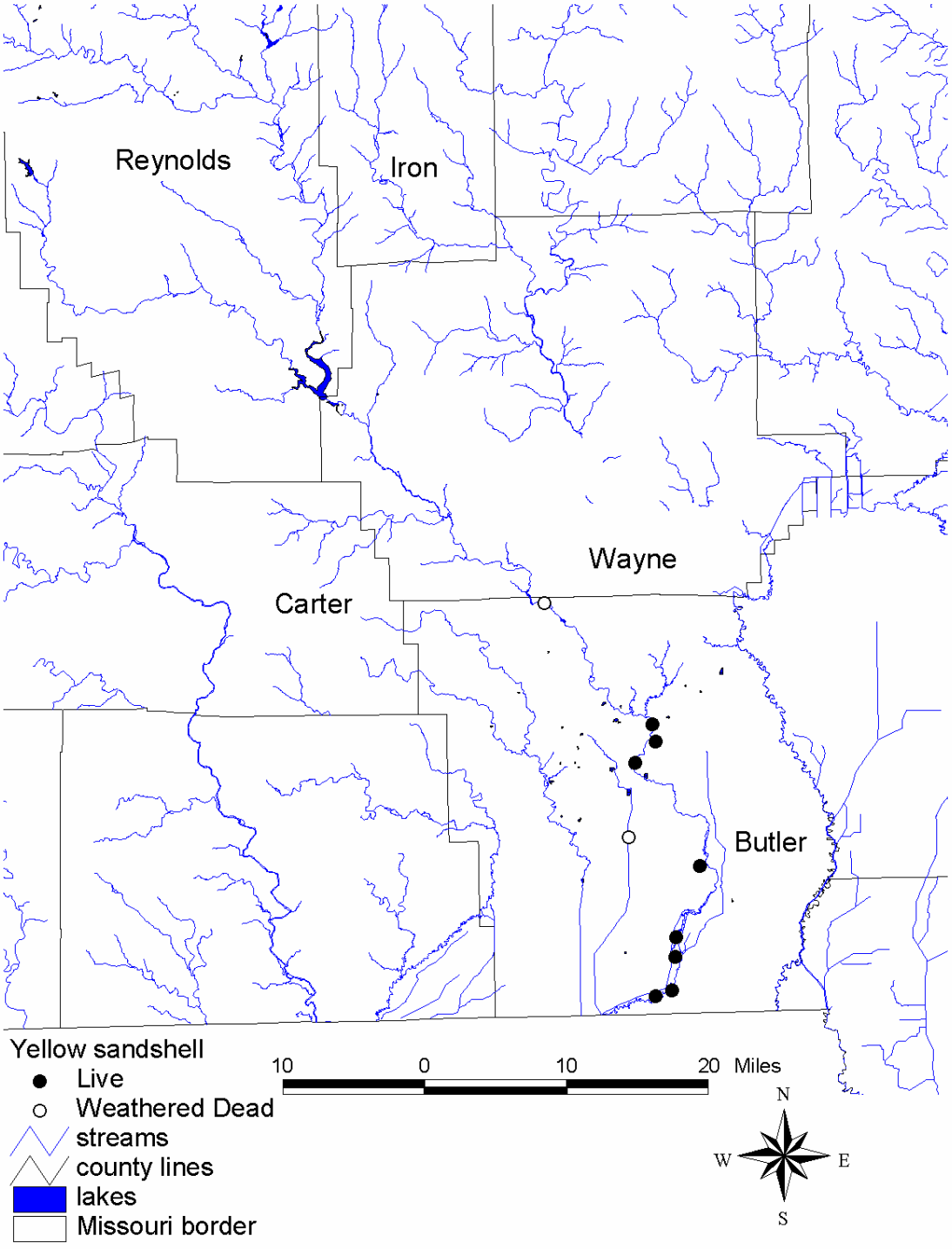

Figure 147. Distribution of the yellow sandshell in the Black River system.

Literature Cited

Ahlstedt, S.A., and J.J. Jenkinson. 1987. Distribution and abundance of *Potamilus capax* and other freshwater mussels in the St. Francis River system, Arkansas and Missouri. U.S. Army Corps of Engineers, Memphis District, Tennessee. Contract No. PD-86-C052. 164 pp.

Anon. 1982. Missouri ex rel. Ashcroft v. Department of the Army, Corps of Engineers. Environmental Law Reporter 12 ELR 20359 15 p.

Anderson, C. L. 1980. Best management practices for soil erosion and sediment control. University of Missouri-Columbia Extension Division and Missouri Department of Natural Resources Manual 117. 51 pp.

Baird, M. 2000. Life history and population structure of the spectaclecase mussel, *Cumberlandia monodonta* (Bivalvia, Margaritiferidae). Master of Science, SMSU.

Barnhart, C., Riusech, F., and M. Baird. 1998. Hosts of the salamander mussel, Simpsonaias ambigua, and snuffbox, *Epioblasma triquetra*, from the Meramec River system, Missouri. Triannual Unionid Report 16:34. Available from: U.S. Fish and Wildlife Service, Ashville, North Carolina.

Barnhart, M.C. 1998. Survey of Mussels in St. John's Basin and the New Madrid Floodway. Report to U.S. Army Corps of Engineers, Memphis District. 70 p.

Barnhart, M. C. 1999. Black sandshell – missing, but not forgotten. Kansas Pearly Mussel Newsline Summer 1999, p. 8. Available from: Kansas Department of Wildlife and Parks, Independence, Kansas.

Bates, J.M., and S.D. Dennis. 1983. Mussel (naiad) survey--St. Francis, White, and Cache rivers Arkansas and Missouri. Final Report. Prepared for U.S. Army Corps of Engineers, Memphis District, Contract No. DACW66-78-C-0147." 89 pp + appendices.

Boone, M. 2001. St. Francis River Inventory and Assessment. Missouri Department of Conservation.

Buchanan, A.C. 1979. Mussels (Naiades) of the Little Black River Basin in Missouri and Arkansas. "Missouri Department of Conservation, Fisheries Research Section." 69 pp.

Buchanan, A.C. 1980. Mussels (Naiades) of the Meramec River Basin, Missouri. Missouri Department of Conservation. Aquatic Series. 17:1-68.

Buchanan, A.C. 1994. A survey of the freshwater mussels of the lower Gasconade River. Report for U.S. Army of Corps of Engineers, Kansas City District, 700 Federal Building, Kansas City, MO 64106.

Buchanan, A.C. 1996. Distribution of naiades in selected streams in Southeastern Missouri. A survey conducted 1981-1982. Unpublished report of the Missouri Department of Conservation. Jefferson City, Missouri. 79pp.

Burch, J.B. 1975. Freshwater Unionacean clams (Mollusca: Pelecypoda) of North America. [Revised Edition]. Malacological Publications. Hamburg, Michigan. 204 pp.

Bruenderman, S. A. J. S. Faiman and A. C. Buchanan. 2001. Final Report: Survey for Endangered and Special Concern Mussel Species in the Gasconade River Basin, Missouri. Missouri Department of Conservation, Columbia Missouri. 97pp.

Cieslewicz, P. 2004. Black River River Watershed Inventory and Assessment. Missouri Department of Conservation, Jefferson City, Missouri.

Clarke, A.H. 1981. The tribe Alasmidontini (Unionidae: Anodontinae), Part I. *Pegias, Alasmidonta, and Arcidens*. Smithsonian Contributions to Zoology. No. 326. iii + 101 pp.

Clarke, A.H. 1985. The tribe Alasmidontini (Unionidae: Anodontinae), Part II: Lasmigona and Simpsonaias. Smithsonian Contributions to Zoology No. 399. iii + 75 pp.

Coker, R.E. 1929. Keokuk Dam and the fisheries of the upper Mississippi River. Bulletin of the Bureau of Fisheries. [Issued separately as U.S. Bureau of Fisheries Document 1063]. 45:87-139.

Cummings, K.S., and C.A. Mayer. 1992. Field guide to freshwater mussels of the Midwest. Illinois Natural History Survey, Manual 5. 194 pp.

Eckert, Nathan. 2003. Reproductive biology and host requirement differences among isolated populations of *Cyprogenia aberti* (Conrad, 1850). Master of Science, SMSU.

Ecological Specialists, Inc. 2003. Osage hydroelectric project (FERC 459) naiade population assessment. Report to Ameren UE.

Environmental Science and Engineering. 1987. Environmental impacts of sand and gravel dredging on benthic macroinvertebrates and mussels in the Meramec River Basin, Missouri. Final Report Prepared for St. Louis District, U.S. Army Core of Engineers. Contract No. DACW43-84-C-0032.

Funk, J. L. 1968. Missouri fishing streams. Missouri Department of Conservation, Jefferson City, Missouri.108 pp.

Grace, T.B., and A.C. Buchanan. 1981. Naiads (mussels) of the lower Osage River, Tavern Creek, and Maries River, Missouri. Final Report. Prepared for the U.S. Army Corps of Engineers. Missouri Department of Conservation. 147 pp.

Groshens, T. P. M. A. Bayless and R. J. Dent, Jr. 1999. Pomme de Terre Inventory and Assessment.

Horton, R. and C. A. Hutson. 2001. Sac River Watershed Inventory and Assessment. Missouri Department of Conservation, Jefferson City, Missouri.

Hubbs, D. 2000. Status of the commercial mussel shell industry. SPC Pearl Oyster Information Bulletin #14. Tennessee Wildlife Resources Agency, PO Box 70, Camden, TN 38320.

Jenkinson, J.J., and S.A. Ahlstedt. 1995. A search for additional populations of Potamilus capax in the St. Francis and Cache river watersheds, Arkansas and Missouri, U.S.A. Walkerana 7(17/18):71-157.

Master L.L., B.A. Stein, L.S Kutner, G.A.Hammerson. 2000. Vanishing assets: Conservation status of U.S. species. Pp. 93-118 in Stein BA, Kutner LS Adams JS Eds Precious Heritage: the status of Biodiversity in the United States. Oxford (UK) Oxford University Press.

Klippel, W.E., G. Celmer, and J.R. Purdue. 1978. The Holocene naiad record at Rogers Shelter in the western Ozark Highland of Missouri. Plains Anthropologist. 23(82): 257-271.

Lopinot, Neal H., Jack H. Ray, and Michael D. Conner. 1998. The 1997 Excavations at the Big Eddy Site (23CE426) in Southwest Missouri. Special Publication No. 2, Center for Archaeological Research, Southwest Missouri State University.

Missouri Department of Conservation. 2004a. Freshwater mussel database. Missouri Department of Conservation, Jefferson City, MO.

Missouri Department of Conservation. 2004b. Natural Heritage Program database. Missouri Department of Conservation, Jefferson City, MO.

Missouri Department of Natural Resources. 1981. Missouri water quality basin plans, Volume 8. Missouri Department of Natural Resources, Jefferson City, Missouri.

Missouri Department of Natural Resources. 1984. Missouri Water Quality Report. Missouri Department of Natural Resources, Jefferson City, Missouri.

Missouri Department of Natural Resources. 1985. Missouri water quality basin plans, Volume 8. Missouri Department of Natural Resources, Jefferson City, Missouri.

Missouri Department of Natural Resources. 1986. Missouri water atlas. Missouri Department of Natural Resources, Jefferson City, Missouri.

Missouri Department of Natural Resources. 1994. Missouri Water Quality Report. Missouri Department of Natural Resources, Jefferson City, Missouri.

Missouri Department of Natural Resources (MDNR) 1995. Missouri water quality basin plans. Basin Plans 63, 64, and 65. Missouri Department of Natural Resources, Jefferson City, Missouri

Missouri Department of Natural Resources. 1996. Missouri water quality basin plans, volume 4. Missouri Department of Natural Resources, Jefferson City, Missouri.

Missouri Department of Natural Resources. 1998. Missouri water quality basin plans, volume 4. Missouri Department of Natural Resources, Jefferson City, Missouri.

Miller, A.C., B.S. Payne, D.J. Shafer, and L.T. Neill. 1993. Techniques for monitoring freshwater bivalve communities and populations in large rivers. pp. 147-158 in K.S. Cummings, A.C. Buchanan, and L.M. Koch. (eds.). Conservation and Management of Freshwater Mussels. Proceedings of a UMRCC Symposium, 12-14 October 1992, St. Louis, Missouri. Upper Mississippi River Conservation Committee, Rock Island, Illinois. 293 pp.

Murray, H.D., and A.B. Leonard. 1962. Handbook of unionid mussels in Kansas. Miscellaneous Publication, Museum of Natural History, University of Kansas. Lawrence, Kansas. No. 28. 184.

Negus, C.L. 1966. A quantitative study of growth and production of unionid mussels in the River Thames at Reading. Journal of Animal Ecology. 35:513-532.

NNMCC (National Native Mussel Conservation Committee). 1998. National strategy for the conservation of native freshwater mussels. Journal of Shellfish Research 17:1419-1428.

Obermeyer, B.K., D.R. Edds, C.W. Prophet, and E.J. Miller. 1997. Freshwater mussels (Bivalvia: Unionidae) in the Verdigris, Neosho, and Spring river basins of Kansas and Missouri, with emphasis on species of concern. American Malacological Bulletin 14(1):41-55.

Oesch, R. D. 1984. Missouri naiades: a guide to mussels of Missouri. Missouri Department of Conservation, Jefferson City, Missouri. 271 pp.

Parmalee P.W. and A.E Bogan. 1998. The freshwater mussels of Tennessee. 1st edition. University of Tennessee Press / Knoxville. 328 pp.

Payne, B.S., and A.C. Miller. 2000. Recruitment of *Fusconaia ebena* (Bivalvia: Unionidae) in relation to discharge of the lower Ohio River. American Midland Naturalist. 144(2):328-341.

Pflieger, W.L. 1997. The fishes of Missouri (revised edition). Missouri Department of Conservation, Jefferson City, Missouri. 372 pp.

Roberts, A.D., A.P. Farnsworth, J. Sternburg. 1997. A search for fat pocketbooks, Potamilus capax, in southeast Missouri. Internal Report. Missouri Department of Conservation, Conservation Research Center, Columbia, Missouri. 34pp.

Roberts, A. and S. Bruenderman. 2000. A qualitative reassessment of freshwater mussels in the Meramec River basin. Missouri Department of Conservation, Columbia Missouri. Prepared for the US Fish and Wildlife Service. October 1999.

Smith, B.J. 1988. Assessment of water quality in non-coal areas of Missouri. U. S. Geological Survey Water Resources Investigations Report 87-4286. Rolla, Missouri

Strayer, DL, Downing JA, Haag WR, King TL, Layzer JB, Newton TJ, Nichols SJ. Changing perspectives on pearly mussels, North America's most imperilled animals. Bioscience 54: 429-439.

Ryck, F.M. 1974. Missouri stream pollution survey. Aquatic series #8. Missouri Department of Conservation, Jefferson City, MO.

Scammon, R.E. 1906. The Unionidae of Kansas, Part I. An illustrated catalogue of the Kansas Unionidae. Kansas University Science Bulletin. 3(9): 279-373 + 21 plates.

Sparks, A. and R. T. Pavlowsky. 2000. Chemical and bacterial analysis of the Little Sac Watershed. Southwest Missouri State University and the Watershed Committee of the Ozarks. Springfield, Missouri. 14pp.

Stansbery, D.H. 1974. Unionid mollusks collected from the Osage River system above Warsaw, Missouri, in August 1973. Ohio State University Museum of Zoology Reports. 1974(5): 1-16.

Strayer, D.L., S. Claypool, and S.J. Sprague. 1997. Assessing unionid populations with quadrats and timed searches. pp. 163-169 in K.S. Cummings, A.C. Buchanan, C.A. Mayer, and 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 Missouri. Upper Mississippi River Conservation Committee, Rock Island, Illinois. 293 pp.

Turgeon, D.D., J.F. Quinn, Jr., A.E. Bogan, E.V. Coan, F.G. Hochberg, W.G. Lyons, P.M. Mikkelsen, R.J. Neves, C.F.E. Roper, G. Rosenberg, B. Roth, A. Scheltema, F.G. Thompson, M. Vecchione, and J.D. Williams.1998. Common and scientific names of aquatic invertebrates from the United States and Canada: Mollusks. 2nd Edition. "American Fisheries Society, Special Publication" 26:ix-526.

United States Fish and Wildlife Service. 1985. Recovery plan for the pink mucket pearly mussel (*Lampsilis orbiculata* (Hildreth, 1828)). United States Fish and Wildlife Service, Atlanta Georgia. 47 pp.

Utterback, W. I. 1915. The naiades of Missouri. The American Midland Naturalist 4(3):41-53; 4(4):69-152; 4(5):189-204, 4(6):244-273.

Utterback, W.I. 1916. The naiades of Missouri. American Midland Naturalist. 4(7):311-327; 4(8):339-354; 4(9):387-400; 4(10):432-464.

Utterback, W.I. 1917. Naiad geography of Missouri. American Midland Naturalist. 5(1):26-30.

Vaughn, C.C., and C.M. Taylor. 1999. Impoundments and the decline of freshwater mussels: a case study of an extinction gradient. Conservation Biology 13(4):912-920.

Watters, G.T. 1996. Small dams as barriers to freshwater mussels (Bivalvia, Unionoida) and their hosts. Biological Conservation 75(1):79-85.

Wixson, B.G. and W.H. Tranter 1972. An investigation of environmental pollution by lead and other heavy metals from industrial developments in southeastern Missouri, in National Telecommunications Conference, Houston Texas, 1972.

Ziegler, Robert J. 1994 Archaeological Monitoring Downstream from Stockton Lake, Cedar and St. Clair Counties, Missouri. U.S. Army Corps of Engineers, Kansas City District.

Appendix A. Site descriptions of 2001-2002 sampling localities in the Sac and Pomme de Terre River River Basins, Missouri.

Stream	Stream Mile	Site Desciption	UTM: X	UTM: Y	Date	County	Collection No.	Locality No.
Sac River	11.3	Approx. 2.1 river miles downstream from Rockhouse Cave.	432873	4200149	04-Nov-01	Cedar	CH01133	CH01133
Sac River	13.4	At Rockhouse Cave. Private land access. Approx. 8.1 river miles downstream of Blackjack Conservation Access.	430106	4199352	05-Nov-01	St. Clair	CH01134	CH01134
Sac River	15.7	Approx. 5.8 river miles downstream of Blackjack Conservation Access.	433539	4198356	11-Nov-01	St. Clair	CH01135	CH01135
Sac River	18.6	Approx. 2.9 river miles downstream of Blackjack Conservation Access.	431897	4195506	19-Sep-01	St. Clair	CH01113	CH01113
Sac River	21.0	Approx. 0.5 river miles downstream of Blackjack Conservation Access.	434776	4194033	22-Aug-01	St. Clair	CH01103	CH01103
Sac River	22.9	Approx. 1.4 river miles upstream of Blackjack Conservation Access.	433105	4193699	26-Aug-01	St. Clair	CH01106	CH01106
Sac River	23.8	Approx. 1.8 river miles upstream of Blackjack Conservation Access.	432010	4193495	25-Aug-01	St. Clair	CH01105	CH01105
Sac River	24.7	Approx. 2.7 river miles upstream of Blackjack Conservation Access.	431239	4193534	27-Aug-01	St. Clair	CH01107	CH01107
Sac River	25.3	Approx. 3.3 river miles upstream of Blackjack Conservation Access.	430355	4193532	23-Aug-01	St. Clair	CH01104	CH01104
Sac River	26.2	Approx. 1.7 river miles downstream of Highway W Bridge.	429250	4193811	15-Sep-01	St. Clair	CH01110	CH01110
Sac River	27.9	Approx. 0.05 river miles upstream of Highway W Bridge.	429415	4191602	16-Sep-01	St. Clair	CH01111	CH01111
Sac River	28.4	Approx. 3.5 river miles downstream of Old Iron Bridge.	429395	4190855	20-Sep-01	Cedar	CH01114	CH01114
Sac River	29.2	Approx. 2.7 river miles downstream of Old Iron Bridge.	428278	4190417	23-Sep-01	Cedar	CH01115	CH01115
Sac River	31.5	Approx. 1.0 river miles downstream of Old Iron Bridge.	427473	4188882	24-Sep-01	Cedar	CH01116	CH01116
Sac River	32.5	At Old Iron Bridge.	426648	4187920	25-Sep-01	Cedar	CH01117	CH01117
Sac River	33.5	Approx. 1.0 river miles upstream of Old Iron Bridge.	426864	4186815	26-Sep-01	Cedar	CH01118	CH01118
Sac River	34.6	Approx. 2.2 river miles downstream of Highway N bridge.	427036	4185230	27-Sep-01	Cedar	CH01119	CH01119

Appendix A cont. Site descriptions of 2001-2002 sampling localities in the Sac and Pomme de Terre River River Basins, Missouri.

Stream	Stream Mile	Site Desciption	UTM: X	UTM: Y	Date	County	Collection No.	Locality No.
Sac River	36.1	Approx. 0.7 river miles downstream of Highway N bridge.	428773	4185263	28-Sep-01	Cedar	CH01120	CH01120
Sac River	36.7	At Highway N bridge.	428959	4184377	28-Sep-01	Cedar	CH01121	CH01121
Sac River	37.2	Approx. 0.5 river miles upstream of Highway N Bridge.	429318	4183783	29-Sep-01	Cedar	CH01122	CH01122
Sac River	39.2	Approx. 1.7 river miles upstream of Caplinger Mill. Located in Horseshoe Bend.	429814	4182288	19-Oct-01	Cedar	CH01125	CH01125
Sac River	41.1	Approx. 3.6 river miles upstream of Caplinger Mill. Located in newly constructed channel cutoff of Horseshoe Bend	430724	4182822	06-Oct-01	Cedar	CH01124	CH01124
Sac River	42.5	Approx. 5.0 river miles upstream of Caplinger Mill. Located on east side of an island.	430986	4181106	21-Oct-01	Cedar	CH01128	CH01128
Sac River	43.0	Approx. 5.5 river miles upstream of Caplinger Mill.	431009	4180427	21-Oct-01	Cedar	CH01127	CH01127
Sac River	45.2	Approx. 2.7 river miles downstream of Highway J bridge.	431158	4178949	27-Oct-01	Cedar	CH01130	CH01130
Sac River	45.6	Approx. 2.3 river miles downstream of Highway J bridge.	430795	4178708	20-Oct-01	Cedar	CH01126	CH01126
Sac River	46.2	Approx. 1.3 river miles downstream of Highway J bridge.	430304	4177713	27-Oct-01	Cedar	CH01129	CH01129
Sac River	46.8	Approx. 0.7 river miles downstream of Highway J bridge.	430530	4177123	30-Sep-01	Cedar	CH01123	CH01123
Sac River	49.8	Approx. 2.0 river miles upstream of Highway J bridge.	434273	4176319	28-Oct-01	Cedar	CH01132	CH01132
Sac River	52.1	At the confluence of Bear Creek and Sac River.	434031	4174698	28-Oct-01	Cedar	CH01131	CH01131
Sac River	53.1	Approx. 1.3 river miles downstream of Stockton Dam.	433312	4173262	17-Aug-01	Cedar	CH01102	CH01102
Sac River	53.5	Approx. 0.9 river miles downstream of Stockton Dam.	433234	4172818	16-Aug-01	Cedar	CH01101	CH01101
Bear Creek (Sac Basin)	7.6	Approx. 7.6 river miles upstream of the confluence with the Sac River. Located just upstream of low-water bridge.	442887	4169220	01-Sep-01	Cedar	CH01109	CH01109

Sac River	53.1	Approx. 1.3 river miles downstream of Stockton Dam.	433312	4173262	17-Aug-01	Cedar	CH01102	CH01102
Sac River	53.5	Approx. 0.9 river miles downstream of Stockton Dam.	433234	4172818	16-Aug-01	Cedar	CH01101	CH01101
Bear Creek (Sac Basin)	7.6	Approx. 7.6 river miles upstream of the confluence with the Sac River. Located just upstream of low-water bridge.	442887	4169220	1-Sep-01	Cedar	CH01109	CH01109

Appendix A cont. Site descriptions of 2001-2002 sampling localities in the Sac and Pomme de Terre River River Basins, Missouri.

Stream	Stream Mile	Site Desciption	UTM: X	UTM: Y	Date	County	Collection No.	Locality No.
Horse Creek (Sac Basin)	13.3	At State Highway CC.	414618	4176335	6-Sep-01	Cedar	CH01108	CH01108
Little Sac River (Sac Basin)	12.1	Just downstream of county road bridge, approx. 1.8 miles south of Morrisville.	461237	4144777	18-Sep-01	Polk	CH01112	CH01112
Pomme de Terre River	22.6	Approx 150m downstream of Slippery-Rock access.	469749	4206748	5-Sep-02	Hickory	CH02049	CH02049
Pomme de Terre River	23.5	Approx. 1 mile upstream of "Slippery-Rock" access.	471499	4205635	14-Jul-02	Hickory	CH02019	CH02019
Pomme de Terre River	24.8	Approx. 2.3 mile upstream of "Slippery-Rock" access.	472966	4156596	13-Jul-02	Polk	CH02020	CH02020
Pomme de Terre River	26.9	Approx 0.8 miles downstream of Cross Timbers Conservation Access	473649	4204416	18-Nov-01	Hickory	CH01141	CH01141
Pomme de Terre River	29.4	Approx 1.7 miles upstream of Cross Timbers Conservation Access	470388	4203497	17-Nov-01	Hickory	CH01140	CH01140
Pomme de Terre River	32.7	Immediately downstream of Hermitage WWTF (Highway 54)	472704	4199888	7-Dec-01	Hickory	CH01142	CH01142
Pomme de Terre River	32.9	Immediately upstream of Hermitage WWTF (Highway 54)	472931	4199682	8-Dec-01	Hickory	CH01143	CH01143
Pomme de Terre River	33.6	Approx. 1.5 miles upstream of Hermitage Conservation Acces	473014	4198662	16-Nov-01	Henry	CH01139	CH01139
Pomme de Terre River	36.7	Approx. 0.8 miles downstream from County Road 273 bridge. A small neighborhood borders the river.	470392	4197413	9-Nov-01	Hickory	CH01138	CH01138
Pomme de Terre River	38.9	Approx. 2.7 miles downstream from Pomme de Terre Dam	471074	4196093	7-Oct-01	Hickory	CH01137	CH01137
Pomme de Terre River	41.4	Approx. 0.2 miles downstream from Pomme de Terre Dam	471612	4195299	9-Dec-01	Hickory	CH01144	CH01144
Pomme de Terre River	73.2	Approx. 300m downstream of Highway D bridge.	467285	4170585	23-Sep-02	Polk	CH02057	CH02057

Appendix B, Table 1. Unionid species and numbers found at sites sampled in the Sac River, Missouri, 2001. "FD"= fresh dead shell, "WD"= weathered dead shell, "SF"= subfossil shell, "F"= fossil shell.

Species	River mile and collection numbers													
	11.3	13.4	15.7	18.6	21.0	22.9	23.8	24.7	25.3	26.2	27.9	28.4	29.2	31.5
	CH01133	CH01134	CH01135	CH01113	CH01103	CH01106	CH01105	CH01107	CH01104	CH01110	CH01111	CH01114	CH01115	CH01116
Anodonta suborbiculata														
Actinonaias ligamentina	SF		9	2	6	26	35	2	34	32	25	54	107	1
Alasmidonta marginata												1		
Amblema plicata	4	11	10	26	56	72	21	45	27	71	72	101	88	2
Arcidens confragosus														
Cumberlandia monodonta	SF						SF				1			
Cyclonaias tuberculata	5	17	63	203	81	104	170	21	211	129	214	73	63	18
Ellipsaria lineolata	18	16	55	61	64	103	30	25	48	65	58	77	31	2
Elliptio dilatata	SF			1	2	3	9	2	25	13	1	7	4	
Fusconaia flava	SF		11	6	52	134	97	2	87	121	10	258		SF
*Fusconaia ozarkensis**														
Lampsilis abrupta					1									
Lampsilis cardium	SF		8	2	5	16	7	18	21	30	1	30	37	3
Lampsilis siliquoidea														
Lampsilis teres														
Lasmigona complanata	1	4	7	7	2	1		3	4		2	2	2	
Lasmigona costata		1			1							3	2	
Leptodea fragilis	2	3	10	13	1		2	1	14	4	14	12	1	
Ligumia recta	SF	2	10	8	1	4	3	11	2		4	4	4	
Megalonaias nervosa	45	30	23	75	56	101	56	3	26	18	54	49	93	2
Obliquaria reflexa		1	9	18	2	24	19	103	12	29	27	25	10	7
Pleurobema sintoxia	SF		1	2	3	16	6	3	4	9	3	5	6	3
Potamilus alatus	3	4	36	20	8	8	10	7	4	11	19	12	7	
Potamilus ohiensis														
Pyganodon grandis														
Quadrula metanevra			7	21	7	20		19	23	54	41	20	39	3
Quadrula pustulosa	4	3	21	85	46	68	82	63	64	60	75	75	34	5
Quadrula quadrula	2		3	10	8	10	12	31	5	4	3	12	3	FD
Tritogonia verrucosa	SF		6	32	15	13	16	12	42	5	39	37	24	
Truncilla trucata			1	3	3		1	1	2	1	1	2	1	FD
Venustaconcha ellipsiformis											2			
No. of living individuals	84	92	290	595	420	723	576	372	655	656	666	859	556	46
No. of live species	9	11	18	19	21	17	17	19	19	17	21	21	19	10
Live and dead species	17	11	18	19	21	17	18	19	19	17	21	21	19	13
Sampling effort (person-hrs.)	3	3	3	3	3	3	3	3.1	3	3	2	3	3	3

Appendix B, Table 1 cont. Unionid species and numbers found at sites sampled in the Sac River, Missouri, 2001. "FD"= fresh dead shell, "WD"= weathered dead shell, "SF"= subfossil shell, "F"= fossil shell.

Species	River mile and collection numbers													
	32.5	33.5	34.6	36.1	36.7	37.2	39.2	41.1	42.5	43.0	45.2	45.6	46.2	46.8
	CH01117	CH01118	CH01119	CH01120	CH01121	CH01122	CH01125	CH01124	CH01128	CH01127	CH01126	CH01130	CH01129	CH01123
Anodonta suborbiculata							6							
Actinonaias ligamentina	2	4	9	3	14	13	SF	WD			5	3		1
Alasmidonta marginata														
Amblema plicata	2	2	2	5	10	20	SF	SF	SF	1	2	12	SF	2
Arcidens confragosus												1		
Cumberlandia monodonta	2	SF								SF	SF			SF
Cyclonaias tuberculata	15	136	120	174	137	226				SF	7	20	SF	67
Ellipsaria lineolata	1	2	2	13	5	7						SF		
Elliptio dilatata	6	1	8	1	3	2				1	4	5		1
Fusconaia flava	WD		1	3	5	10			SF		4	5	SF	2
*Fusconaia ozarkensis**										1				SF
Lampsilis abrupta		SF												
Lampsilis cardium	20	9	17	21	42	46			SF		5			2
Lampsilis siliquoidea	1				2				SF	SF	1	8		
Lampsilis teres														
Lasmigona complanata	1			1		1		1				SF		SF
Lasmigona costata			1		1						1		SF	SF
Leptodea fragilis	7		2	2	5	3		WD	1	SF	SF	1	SF	FD
Ligumia recta	4	SF	5	1	6			WD	SF	SF	SF	SF		SF
Megalonaias nervosa	7	3	5	7	30	41	1	WD			5	19	SF	6
Obliquaria reflexa	1	4	7	23	35	23					2	2		1
Pleurobema sintoxia	WD	2	8	8	20	8					4	6	SF	1
Potamilus alatus	4		2		2	3	1	WD	SF	1	2	1		WD
Potamilus ohiensis												WD		
Pyganodon grandis							SF							
Quadrula metanevra	FD	14	6	19	22	40					1	3		2
Quadrula pustulosa	3		15	15	25	45		SF	SF		8	12		15
Quadrula quadrula			2	1	2	4		SF	1		10	25		9
Tritogonia verrucosa	1		6	1	7	3		WD	SF		1	6		WD
Truncilla trucata			1	1	8	3								WD
Venustaconcha ellipsiformis	1	1												
No. of living individuals	78	178	219	299	381	498	8	1	3	4	62	129	0	109
No. of live species	17	11	19	18	20	19	3	1	3	4	16	16	0	12
Live and dead species	20	14	19	18	20	19	6	10	8	9	19	20	7	21
Sampling effort (person-hrs.)	3	3	3	3	3	3	1	1	1	1	3	3	1	3

Appendix B, Table 1 cont.. Unionid species and numbers found at sites sampled in the Sac River, Missouri, 2001. "FD"= fresh dead shell, "WD"= weathered dead shell, "SF"= subfossil shell, "F"= fossil shell.

Species	River mile and collection numbers			
	49.8	52.1	53.1	53.5
	CH01132	CH01131	CH01102	CH01101
Anodonta suborbiculata				
Actinonaias ligamentina	SF	SF	1	WD
Alasmidonta marginata				
Amblema plicata	SF	1	35	33
Arcidens confragosus				
Cumberlandia monodonta				
Cyclonaias tuberculata	3		3	
Ellipsaria lineolata			2	
Elliptio dilatata	SF		2	1
Fusconaia flava	1		6	
*Fusconaia ozarkensis**				
Lampsilis abrupta				
Lampsilis cardium	SF		20	10
Lampsilis siliquoidea			9	9
Lampsilis teres				
Lasmigona complanata			2	3
Lasmigona costata				
Leptodea fragilis	1			3
Ligumia recta	SF			
Megalonaias nervosa			4	
Obliquaria reflexa			3	3
Pleurobema sintoxia			5	2
Potamilus alatus	SF		3	
Potamilus ohiensis				
Pyganodon grandis				
Quadrula metanevra	SF		1	
Quadrula pustulosa	SF	SF	18	5
Quadrula quadrula			1	
Tritogonia verrucosa			6	4
Truncilla trucata				
Venustaconcha ellipsiformis				
No. of living individuals	5	1	121	73
No. of live species	3	1	17	10
Live and dead species	11	3	17	11
Sampling effort (person-hrs.)	1.5	1.5	3	3

Appendix B Table 2. Unionid species and numbers found at sites sampled in the tributaries if the Sac River, Missouri, 2001. "FD"= fresh dead shell, "WD"= weathered dead shell, "SF"= subfossil shell, "F"= fossil shell.

Species	Stream, stream mile, and collection numbers		
	Bear Creek	Horse Creek	Little Sac River
	7.6	13.3	53.1
	CH01109	CH01108	CH01112
Actinonaias ligamentina			1
Amblema plicata		20	
Elliptio dilatata		14	5
*Fusconaia ozarkensis**		1	
Lampsilis cardium		3	30
Lampsilis siliquoidea	36	52	1
Lasmigona complanata		1	
Leptodea fragilis		7	
Ligumia subrostrata	2	1	
Obliquaria reflexa		3	
Potamilus alatus		23	5
Pyganodon grandis		30	
Quadrula quadrula		9	
Quadrula pustulosa		1	1
Simpsonaias ambigua	1		
Strophitus undulatus	4	4	
Tritogonia verrucosa		49	2
Truncilla trucata		1	
Venustaconcha ellipsiformis	56		
No. of living individuals	99	219	47
No. of live species	5	14	8
Live and dead species	5	14	8
Sampling effort (person-hrs.)	3	4	2

Appendix B, Table 3. Unionid species and numbers found at sites sampled in the Pomme de Terre, Missouri, 2001. "FD"= fresh dead shell, "WD"= weathered dead shell, "SF"= subfossil shell, "F"= fossil shell.

Species	River mile and collection numbers													
	22.6	23.5	24.8	26.9	29.4	32.7	32.9	33.6	36.7	38.9	41.4	73.2	87.2	99.8
	CH02049	CH02019	CH02020	CH01141	CH01140	CH0142	CH01143	CH01139	CH01138	CH01137	CH01144	CH02057	CH02018	CH01136
Anodonta suborbiculata									5					
Actinonaias ligamentina					2	1	2	6			1			
Alasmidonta marginata					1		2	1						1
Amblema plicata	185	262	29	196	52	87	55	35	270	107	120	1		
Arcidens confragosus		2												
Cyclonaias tuberculata	129	19	5	29	8		13	18	1	3				
Ellipsaria lineolata	3		1	1			1							
Elliptio dilatata				1	11		41	49	14			3		4
Fusconaia flava	6		2	7	1	2	6	6					1	
*Fusconaia ozarkensis**									3	2				1
Lampsilis cardium	2	1	2	2	34	65	43	34	78	30	11	4	4	21
Lampsilis siliquoidea				2			1	4	4		2	3	9	20
Lampsilis teres								1						
Lasmigona complanata							2	3						
Lasmigona costata		7		3		1		3	4	4	3			
Leptodea fragilis		2		11	5	5		12	10	12	4	2		3
Ligumia recta	2	3	1	11	3	10	2	9	2	4	1			
Megalonaias nervosa	32		1	12	2	2	3	10	5		1			
Obliquaria reflexa	14	4	3	11	7	3	5	2	6	1	6	1		
Pleurobema sintoxia	8	1		8	9	4	6	3	4			2		
Potamilus alatus	3	1	1	8	1	2	2	14	13	3	15	3	1	4
Pyganodon grandis									1	1				
Quadrula metanevra	8			8		1	1				1			
Quadrula pustulosa	57		6	40	7	9	9	41	11	5	7			
Quadrula quadrula	3	3												
Strophitus undulatus							1							2
Toxolasma parvus									1					
Tritogonia verrucosa	14	15	1	24	9	1	7	23	3	3		4		3
Truncilla trucata	4		1	12	11	25	39	11	16	8	2			
Utterbackia imbecilis										7				
Venustaconcha ellipsiformis	1			5	37	14	36	24	16	1				59
No. of living individuals	471	320	53	390	200	232	277	309	467	194	174	23	15	118
No. of live species	16	12	12	18	17	16	21	21	20	15	13	9	4	10
Live and dead species	16	21	16	18	17	17	21	21	20	15	15	14	8	11
Sampling effort (person-hrs.)	3.5	2.5	2.5	3	3	3	3	3	3.16	3.37	3	2.55	3.5	3.5

Appendix B Table 4. Unionid species and numbers found at sites sampled in the tributaries if the Pomme de Terre River, Missouri, 2001. "FD"= fresh dead shell, "WD"= weathered dead shell, "SF"= subfossil shell, "F"= fossil shell.

Species	Stream, stream mile, and collection numbers
	Lindley Creek
	7.6
	CH02050
Actinonaias ligamentina	
Amblema plicata	5
Elliptio dilatata	1
*Fusconaia ozarkensis**	2
Lampsilis cardium	3
Lampsilis siliquoidea	4
Lasmigona complanata	5
Leptodea fragilis	6
Ligumia subrostrata	7
Obliquaria reflexa	8
Potamilus alatus	9
Pyganodon grandis	10
Quadrula quadrula	11
Quadrula pustulosa	12
Simpsonaias ambigua	13
Strophitus undulatus	14
Tritogonia verrucosa	15
Truncilla trucata	16
Venustaconcha ellipsiformis	17
No. of living individuals	18
No. of live species	19
Live and dead species	20
Sampling effort (person-hrs.)	21

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Actinonais Ligamentina											
15.7	110	20	-	25.3	119	23	-	29.2	112	12	-
15.7	114	17	-	25.3	120	15	-	29.2	120	119	-
15.7	120	19	-	25.3	122	24	-	29.2	120	22	-
15.7	124	22	-	25.3	124	15	-	29.2	120	18	-
15.7	124	19	-	25.3	124	29	-	29.2	122	17	-
15.7	125	19	-	25.3	127	24	-	29.2	123	15	-
15.7	125	22	-	25.3	128	15	-	29.2	124	20	f
15.7	125	21	f	25.3	129	15	-	29.2	126	17	-
15.7	126	22	f	25.3	135	15	-	29.2	128	20	-
15.7	130	21	-	25.3	136	21	-	29.2	129	33	f
18.6	106	15	f	25.3	136	20	-	29.2	129	13	-
18.6	135	20	f	25.3	138	23	-	29.2	131	19	-
21.0	110	14	-	25.3	139	31	-	29.2	132	23	f
21.0	114	15	-	25.3	140	20	f	29.2	133	18	-
21.0	115	15	-	25.3	140	20	-	29.2	133	15	f
21.0	120	15	-	25.3	141	15	-	29.2	134	21	f
21.0	121	10	-	25.3	142	20	-	29.2	134	21	-
21.0	124	15	-	25.3	144	25	-	29.2	137	21	-
21.0	125	15	-	25.3	148	26	-	29.2	144	15	f
21.0	125	15	-	26.2	111	22	-	29.2	150	27	f
21.0	127	15	-	26.2	115	17	-	31.5	123	15	f
21.0	127	17	-	26.2	115	19	-	32.5	104	16	f
21.0	128	15	-	26.2	116	17	-	32.5	128	18	f
21.0	130	20	-	26.2	118	22	-	33.5	99	13	m
21.0	131	15	-	26.2	118	17	-	33.5	124	14	f
21.0	134	20	-	26.2	119	18	-	33.5	124	16	m
21.0	135	15	-	26.2	120	24	-	33.5	130	18	m
21.0	135	15	-	26.2	121	17	-	34.6	111	21	-
21.0	135	15	-	26.2	123	21	-	34.6	114	17	-
21.0	141	20	-	26.2	124	22	-	34.6	115	15	-
21.0	143	20	-	26.2	128	24	-	34.6	115	17	-
21.0	144	20	-	26.2	130	21	-	34.6	116	20	-
22.9	111	16	-	26.2	131	20	-	34.6	120	21	f
22.9	113	14	-	26.2	131	20	-	34.6	121	10	f
22.9	115	18	-	26.2	133	22	-	34.6	122	25	f
22.9	117	13	-	26.2	133	25	-	34.6	138	21	-
22.9	118	19	-	26.2	139	20	-	36.1	107	15	-
22.9	118	14	-	26.2	139	29	-	36.1	117	17	-
22.9	121	17	-	26.2	145	24	-	36.1	127	23	f
22.9	124	20	-	27.9	112	20	f	36.7	100	10	-
22.9	127	-	-	27.9	114	18	f	36.7	104	15	-
22.9	127	21	-	27.9	118	15	-	36.7	104	15	-
22.9	127	15	-	27.9	118	-	-	36.7	107	16	-
22.9	129	22	-	27.9	120	19	m	36.7	109	16	-
22.9	132	20	-	27.9	121	20	-	36.7	113	18	-
22.9	135	27	-	27.9	126	20	m	36.7	116	17	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
22.9	140	20	-	27.9	126	20	-	36.7	116	18	-
22.9	141	15	-	27.9	129	20	f	36.7	118	15	-
22.9	141	20	-	27.9	129	20	f	36.7	119	17	-
22.9	143	25	-	27.9	129	19	m	36.7	120	17	f
22.9	143	19	-	27.9	129	20	f	36.7	126	21	-
22.9	149	20	-	27.9	131	25	f	36.7	130	22	f
23.8	110	20	-	27.9	133	20	f	36.7	138	23	f
23.8	113	24	-	27.9	134	25	m	37.2	109	15	-
23.8	118	18	-	27.9	139	23	f	37.2	117	18	-
23.8	122	24	-	27.9	140	-	f	37.2	119	17	-
23.8	122	25	-	27.9	145	20	-	37.2	121	15	-
23.8	125	20	-	28.4	108	17	-	37.2	122	17	-
23.8	125	15	-	28.4	117	21	-	37.2	122	23	f
23.8	125	20	-	28.4	120	21	-	37.2	125	15	-
23.8	128	22	-	28.4	125	21	-	37.2	126	17	f
23.8	128	19	-	28.4	128	23	f	37.2	127	15	-
23.8	130	20	-	28.4	129	20	-	37.2	129	18	-
23.8	131	20	-	28.4	129	17	-	37.2	129	23	f
23.8	132	23	-	28.4	130	19	f	37.2	133	19	-
23.8	132	15	-	28.4	130	23	-	37.2	136	25	f
23.8	135	20	-	28.4	130	22	-	45.2	97	13	m
23.8	135	15	-	28.4	130	19	f	45.2	104	10	-
23.8	139	27	-	28.4	131	22	f	45.2	105	15	f
23.8	143	20	-	28.4	132	20	-	45.2	107	12	f
23.8	146	23	-	28.4	135	20	f	45.2	108	13	-
23.8	146	20	-	28.4	137	20	-	45.2	108	12	f
23.8	148	20	-	28.4	138	20	f	45.2	109	10	f
23.8	151	26	-	28.4	140	20	-	45.2	109	12	-
24.7	120	19	-	28.4	143	24	f	46.8	105	15	-
24.7	120	15	-	28.4	143	20	f	53.1	123	10	m
25.3	112	10	f	28.4	151	20	f	53.1	123	10	m
Alasmidonta marginata											
28.4	111	20	-								
Amblema plicata											
11.3	103	22	-	13.4	115	-	-	15.7	115	20	-
11.3	104	15	-	13.4	119	25	-	18.6	91	-	-
11.3	111	20	-	13.4	122	-	-	18.6	94	-	-
11.3	115	20	-	15.7	88	10	-	18.6	96	-	-
13.4	94	-	-	15.7	99	18	-	18.6	99	-	-
13.4	105	25	-	15.7	99	13	-	18.6	100	-	-
13.4	107	-	-	15.7	100	25	-	18.6	101	-	-
13.4	108	20	-	15.7	100	-	-	18.6	102	-	-
13.4	110	-	-	15.7	101	-	-	18.6	103	-	-
13.4	110	-	-	15.7	106	15	-	18.6	105	-	-
13.4	112	-	-	15.7	107	21	-	18.6	107	-	-
13.4	115	20	-	15.7	109	20	-	18.6	109	-	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
18.6	109	-	-	22.9	122	20	-	25.3	96	16	-
18.6	109	-	-	22.9	124	20	-	25.3	97	10	-
18.6	110	-	-	22.9	127	20	-	25.3	98	14	-
18.6	112	-	-	23.8	92	-	-	25.3	100	15	-
18.6	114	-	-	23.8	95	19	-	25.3	106	-	-
18.6	119	-	-	23.8	103	15	-	25.3	107	15	-
18.6	120	-	-	23.8	103	20	-	25.3	107	-	-
18.6	121	-	-	23.8	105	20	-	25.3	109	-	-
18.6	129	-	-	23.8	105	20	-	25.3	112	15	-
21.0	75	10	-	23.8	105	20	-	25.3	113	15	-
21.0	84	15	-	23.8	105	15	-	25.3	114	23	-
21.0	86	10	-	23.8	109	20	-	25.3	115	-	-
21.0	92	20	-	23.8	110	20	-	25.3	115	20	-
21.0	98	15	-	23.8	111	15	-	25.3	115	15	-
21.0	99	-	-	23.8	111	15	-	25.3	116	20	-
21.0	100	15	-	23.8	111	20	-	25.3	120	20	-
21.0	100	-	-	23.8	113	15	-	25.3	120	-	-
21.0	101	15	-	23.8	113	20	-	26.2	84	22	-
21.0	113	15	-	23.8	114	15	-	26.2	88	10	-
21.0	114	30	-	23.8	115	20	-	26.2	94	21	-
21.0	119	30	-	23.8	120	15	-	26.2	98	20	-
21.0	120	-	-	23.8	121	15	-	26.2	103	20	-
21.0	120	20	-	23.8	125	30	-	26.2	104	20	-
21.0	121	-	-	24.7	82	11	-	26.2	104	20	-
21.0	123	30	-	24.7	82	10	-	26.2	105	20	-
21.0	125	30	-	24.7	93	14	-	26.2	107	20	-
21.0	125	-	-	24.7	93	16	-	26.2	108	20	-
21.0	128	7	-	24.7	96	20	-	26.2	108	29	-
21.0	130	-	-	24.7	97	-	-	26.2	109	25	-
22.9	83	17	-	24.7	100	10	-	26.2	110	20	-
22.9	95	15	-	24.7	102	19	-	26.2	111	20	-
22.9	100	15	-	24.7	103	-	-	26.2	114	30	-
22.9	101	15	-	24.7	103	19	-	26.2	119	30	-
22.9	105	15	-	24.7	103	17	-	26.2	120	30	-
22.9	107	15	-	24.7	104	16	-	26.2	121	30	-
22.9	109	20	-	24.7	105	10	-	26.2	126	30	-
22.9	110	20	-	24.7	107	15	-	26.2	129	30	-
22.9	111	15	-	24.7	108	15	-	27.9	80	18	-
22.9	111	20	-	24.7	109	15	-	27.9	93	20	-
22.9	112	20	-	24.7	109	-	-	27.9	99	20	-
22.9	113	20	-	24.7	110	17	-	27.9	100	20	-
22.9	116	20	-	24.7	110	-	-	27.9	102	20	-
22.9	117	20	-	24.7	115	19	-	27.9	102	20	-
22.9	118	20	-	25.3	82	13	-	27.9	105	20	-
22.9	119	20	-	25.3	94	10	-	27.9	105	20	-
22.9	120	20	-	25.3	94	17	-	27.9	105	20	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
27.9	105	20	-	29.2	127	19	-	37.2	124	27	-
27.9	106	20	-	29.2	129	20	-	37.2	134	25	-
27.9	107	20	-	29.2	129	20	-	39.2	-	-	-
27.9	109	20	-	29.2	134	20	-	41.1	-	-	-
27.9	110	20	-	29.2	136	20	-	42.5	-	-	-
27.9	111	20	-	31.5	102	-	-	43.0	105	-	-
27.9	112	20	-	31.5	109	-	-	45.2	62	13	-
27.9	113	20	-	32.5	28	7	-	45.2	66	10	-
27.9	113	20	-	32.5	95	15	-	45.2	70	11	-
27.9	114	20	-	33.5	81	11	-	45.2	71	12	-
27.9	123	20	-	33.5	103	13	-	45.2	71	11	-
28.4	97	15	-	34.6	88	12	-	45.2	74	12	-
28.4	97	15	-	34.6	100	13	-	45.2	75	16	-
28.4	103	20	-	36.1	76	10	-	45.2	76	14	-
28.4	105	20	-	36.1	77	12	-	45.2	85	16	-
28.4	108	26	-	36.1	83	13	-	45.2	86	-	-
28.4	108	20	-	36.1	95	18	-	45.2	87	10	-
28.4	108	24	-	36.1	117	15	-	45.2	95	13	-
28.4	109	20	-	36.7	61	9	-	45.2	96	15	-
28.4	109	25	-	36.7	73	14	-	46.2	-	-	-
28.4	110	20	-	36.7	78	14	-	46.8	87	15	-
28.4	115	20	-	36.7	80	16	-	46.8	102	-	-
28.4	115	20	-	36.7	83	16	-	49.8	-	-	-
28.4	116	20	-	36.7	91	19	-	52.1	37	6	-
28.4	118	20	-	36.7	95	15	-	53.1	66	9	-
28.4	118	20	-	36.7	95	16	-	53.1	79	12	-
28.4	119	20	-	36.7	100	15	-	53.1	81	11	-
28.4	120	20	-	36.7	126	15	-	53.1	85	10	-
28.4	122	20	-	37.2	69	11	-	53.1	87	11	-
28.4	126	20	-	37.2	81	15	-	53.1	91	16	-
28.4	128	20	-	37.2	86	16	-	53.1	91	13	-
29.2	101	12	-	37.2	87	18	-	53.1	92	14	-
29.2	103	10	-	37.2	89	14	-	53.1	94	15	-
29.2	104	15	-	37.2	91	20	-	53.1	94	14	-
29.2	109	15	-	37.2	93	18	-	53.1	98	18	-
29.2	110	18	-	37.2	94	12	-	53.1	99	15	-
29.2	111	15	-	37.2	98	17	-	53.1	101	13	-
29.2	112	15	-	37.2	108	15	-	53.1	102	14	-
29.2	112	15	-	37.2	109	15	-	53.1	102	15	-
29.2	113	15	-	37.2	110	15	-	53.1	105	15	-
29.2	116	15	-	37.2	111	15	-	53.1	109	15	-
29.2	119	15	-	37.2	112	15	-	53.1	109	18	-
29.2	120	20	-	37.2	113	15	-	53.1	109	15	-
29.2	120	15	-	37.2	114	15	-	53.1	122	15	-
29.2	124	20	-	37.2	116	15	-	53.5	90	13	-
29.2	126	15	-	37.2	120	25	-	53.5	90	14	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Amblema plicata cont'd.											
53.5	90	13	-	53.5	96	18	-	53.5	106	20	-
53.5	91	16	-	53.5	97	19	-	53.5	107	20	-
53.5	94	17	-	53.5	100	19	-	53.5	108	20	-
53.5	94	22	-	53.5	101	19	-	53.5	110	20	-
53.5	94	16	-	53.5	102	18	-	53.5	111	20	-
53.5	94	14	-	53.5	103	21	-	53.5	120	23	-
Anodonta suborbiculata											
39.2	123	7	-	39.2	155	10	-	39.2	177	12	-
39.2	141	8	-	39.2	172	10	-	39.2	179	15	-
Arcidens confragosus											
45.2	100	16	-								
Cumberlandia monodonta											
27.9	135	-	-	32.5	150	35	-	32.5	166	35	-
Cyclonaias tuberculata											
11.3	55	10	-	15.7	88	22	-	21.0	81	16	-
11.3	80	17	-	15.7	93	20	-	21.0	81	10	-
11.3	88	23	-	15.7	94	22	-	21.0	89	15	-
11.3	91	24	-	15.7	94	-	-	21.0	89	18	-
11.3	98	34	-	15.7	94	20	-	21.0	91	30	-
13.4	80	20	-	15.7	94	-	-	21.0	93	30	-
13.4	80	20	-	15.7	95	17	-	21.0	95	25	-
13.4	80	20	-	15.7	96	25	-	21.0	97	25	-
13.4	82	20	-	15.7	104	29	-	21.0	98	30	-
13.4	87	20	-	18.6	20	3	-	21.0	99	20	-
13.4	90	20	-	18.6	29	5	-	21.0	100	20	-
13.4	91	20	-	18.6	48	11	-	21.0	100	25	-
13.4	92	20	-	18.6	74	15	-	21.0	103	20	-
13.4	93	20	-	18.6	74	20	-	21.0	110	32	-
13.4	95	20	-	18.6	75	19	-	21.0	120	20	-
13.4	95	27	-	18.6	76	18	-	21.0	125	-	-
13.4	95	20	-	18.6	81	15	-	22.9	78	14	-
13.4	95	20	-	18.6	81	22	-	22.9	79	19	-
13.4	95	20	-	18.6	82	20	-	22.9	80	20	-
13.4	100	20	-	18.6	83	28	-	22.9	81	14	-
13.4	100	20	-	18.6	84	18	-	22.9	81	21	-
15.7	68	15	-	18.6	86	-	-	22.9	83	15	-
15.7	69	15	-	18.6	92	23	-	22.9	84	19	-
15.7	70	16	-	18.6	92	30	-	22.9	85	19	-
15.7	75	19	-	18.6	94	23	-	22.9	89	23	-
15.7	75	15	-	18.6	98	25	-	22.9	91	18	-
15.7	78	18	-	18.6	100	25	-	22.9	92	30	-
15.7	80	23	-	18.6	101	30	-	22.9	95	21	-
15.7	81	22	-	21.0	60	8	-	22.9	95	30	-
15.7	82	18	-	21.0	77	13	-	22.9	97	25	-
15.7	85	23	-	21.0	79	15	-	22.9	100	30	-
15.7	88	27	-	21.0	80	25	-	22.9	104	30	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Cyclonaias tuberculata cont'd											
22.9	105	30	-	25.3	74	13	-	27.9	82	19	-
22.9	105	27	-	25.3	76	14	-	27.9	83	-	-
22.9	106	30	-	25.3	78	14	-	27.9	88	20	-
22.9	109	-	-	25.3	80	14	-	27.9	88	21	-
23.8	72	16	-	25.3	85	-	-	27.9	90	21	-
23.8	73	17	-	25.3	85	18	-	27.9	93	20	-
23.8	76	18	-	25.3	87	21	-	27.9	95	20	-
23.8	79	21	-	25.3	89	-	-	27.9	96	20	-
23.8	81	24	-	25.3	90	15	-	27.9	96	20	-
23.8	85	25	-	25.3	90	16	-	27.9	98	20	-
23.8	87	19	-	25.3	91	20	-	27.9	100	30	-
23.8	88	25	-	25.3	91	20	-	27.9	100	30	-
23.8	88	23	-	25.3	92	23	-	27.9	101	30	-
23.8	89	23	-	25.3	93	20	-	27.9	101	30	-
23.8	91	28	-	25.3	94	16	-	27.9	111	30	-
23.8	91	20	-	25.3	99	29	-	28.4	68	13	-
23.8	95	30	-	25.3	101	20	-	28.4	75	21	-
23.8	95	20	-	25.3	104	30	-	28.4	80	17	-
23.8	95	25	-	25.3	107	25	-	28.4	80	19	-
23.8	97	30	-	26.2	25	8	-	28.4	82	19	-
23.8	97	20	-	26.2	49	12	-	28.4	83	19	-
23.8	99	-	-	26.2	71	16	-	28.4	84	23	-
23.8	102	36	-	26.2	75	18	-	28.4	85	21	-
23.8	110	25	-	26.2	76	19	-	28.4	85	25	-
24.7	65	12	-	26.2	80	25	-	28.4	85	19	-
24.7	71	16	-	26.2	85	20	-	28.4	85	21	-
24.7	72	21	-	26.2	86	23	-	28.4	85	20	-
24.7	74	20	-	26.2	88	25	-	28.4	91	30	-
24.7	74	11	-	26.2	88	25	-	28.4	93	23	-
24.7	78	23	-	26.2	90	30	-	28.4	95	30	-
24.7	79	15	-	26.2	91	20	-	28.4	95	30	-
24.7	79	20	-	26.2	95	24	-	28.4	96	20	-
24.7	80	19	-	26.2	95	20	-	28.4	97	30	-
24.7	82	15	-	26.2	95	25	-	28.4	100	23	-
24.7	83	-	-	26.2	103	20	-	28.4	105	30	-
24.7	83	20	-	26.2	103	30	-	29.2	22	4	-
24.7	83	25	-	26.2	104	39	-	29.2	52	9	-
24.7	84	20	-	26.2	104	30	-	29.2	53	11	-
24.7	84	21	-	26.2	109	30	-	29.2	59	10	-
24.7	85	15	-	26.2	110	30	-	29.2	65	9	-
24.7	85	20	-	26.2	121	42	-	29.2	70	12	-
24.7	85	-	-	27.9	71	15	-	29.2	79	16	-
24.7	86	23	-	27.9	76	17	-	29.2	80	16	-
24.7	86	20	-	27.9	80	17	-	29.2	81	22	-
24.7	91	20	-	27.9	81	17	-	29.2	84	21	-
25.3	71	13	-	27.9	82	16	-	29.2	88	19	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Cyclonaias tuberculata cont'd											
29.2	88	17	-	33.5	68	9	-	36.1	72	22	-
29.2	90	20	-	33.5	68	13	-	36.1	73	23	-
29.2	91	18	-	33.5	68	13	-	36.1	74	21	-
29.2	92	17	-	33.5	69	11	-	36.1	75	23	-
29.2	94	23	-	33.5	71	16	-	36.1	80	15	-
29.2	94	18	-	33.5	71	13	-	36.1	80	15	-
29.2	95	16	-	33.5	73	14	-	36.1	85	27	-
29.2	95	19	-	33.5	78	13	-	36.1	87	20	-
29.2	95	19	-	33.5	79	13	-	36.1	89	26	-
29.2	95	14	-	33.5	80	14	-	36.1	90	25	-
29.2	96	20	-	33.5	82	19	-	36.1	96	20	-
29.2	96	15	-	33.5	84	17	-	36.1	96	20	-
29.2	96	20	-	33.5	86	15	-	36.7	35	6	-
29.2	98	21	-	33.5	88	16	-	36.7	61	17	-
29.2	103	21	-	33.5	92	20	-	36.7	70	14	-
31.5	68	12	-	33.5	94	20	-	36.7	70	18	-
31.5	73	17	-	33.5	95	16	-	36.7	71	19	-
31.5	73	10	-	33.5	103	20	-	36.7	71	13	-
31.5	78	18	-	34.6	66	13	-	36.7	73	19	-
31.5	79	15	-	34.6	66	11	-	36.7	73	19	-
31.5	79	18	-	34.6	68	12	-	36.7	74	15	-
31.5	80	10	-	34.6	71	13	-	36.7	75	16	-
31.5	80	-	-	34.6	71	13	-	36.7	77	19	-
31.5	82	17	-	34.6	75	13	-	36.7	77	27	-
31.5	87	10	-	34.6	76	15	-	36.7	82	21	-
31.5	89	19	-	34.6	78	16	-	36.7	83	21	-
31.5	89	10	-	34.6	78	16	-	36.7	83	23	-
31.5	90	12	-	34.6	79	18	-	36.7	85	25	-
31.5	90	13	-	34.6	79	15	-	36.7	85	22	-
31.5	94	-	-	34.6	79	17	-	36.7	90	25	-
32.5	67	11	-	34.6	82	21	-	36.7	91	25	-
32.5	73	17	-	34.6	82	14	-	36.7	93	25	-
32.5	76	13	-	34.6	83	17	-	37.2	60	12	-
32.5	76	-	-	34.6	84	17	-	37.2	71	20	-
32.5	81	14	-	34.6	84	18	-	37.2	71	18	-
32.5	84	12	-	34.6	84	16	-	37.2	78	15	-
32.5	84	-	-	34.6	85	18	-	37.2	79	27	-
32.5	85	15	-	34.6	90	19	-	37.2	80	15	-
32.5	87	16	-	36.1	63	15	-	37.2	84	26	-
32.5	90	17	-	36.1	64	13	-	37.2	84	28	-
32.5	92	-	-	36.1	66	21	-	37.2	85	24	-
32.5	92	16	-	36.1	68	16	-	37.2	86	22	-
32.5	93	15	-	36.1	68	19	-	37.2	86	15	-
32.5	94	23	-	36.1	70	16	-	37.2	88	26	-
33.5	64	11	-	36.1	70	18	-	37.2	88	25	-
33.5	66	10	-	36.1	71	17	-	37.2	92	20	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Cyclonaias tuberculata cont'd											
37.2	92	31	-	45.2	72	15	-	46.8	73	15	-
37.2	92	20	-	45.2	75	17	-	46.8	73	14	-
37.2	94	20	-	45.2	78	-	-	46.8	74	18	-
37.2	96	20	-	45.2	79	17	-	46.8	75	14	-
37.2	100	33	-	45.2	80	17	-	46.8	75	15	-
37.2	102	-	-	45.2	80	15	-	46.8	77	10	-
42.5	58	11	-	45.2	80	15	-	46.8	79	15	-
43.0	-	-	-	45.2	80	15	-	46.8	80	18	-
45.2	60	13	-	45.2	81	16	-	46.8	82	15	-
45.2	61	11	-	45.2	81	23	-	46.8	84	-	-
45.2	63	15	-	45.2	86	19	-	46.8	85	19	-
45.2	64	11	-	45.2	88	20	-	46.8	86	19	-
45.2	64	13	-	45.2	88	20	-	46.8	90	30	-
45.2	64	14	-	45.2	89	20	-	46.8	95	15	-
45.2	65	12	-	46.2	-	-	-	49.8	80	23	-
45.2	66	12	-	46.8	65	12	-	49.8	85	25	-
45.2	68	14	-	46.8	68	14	-	49.8	90	25	-
45.2	70	12	-	46.8	70	14	-	53.1	80	15	-
45.2	71	-	-	46.8	71	15	-	53.1	81	20	-
45.2	71	15	-	46.8	71	32	-	53.1	88	15	-
45.2	71	14	-	46.8	71	18	-	-	-	-	-
Ellipsaria lineolata											
11.3	93	19	-	13.4	108	20	m	15.7	102	18	m
11.3	99	15	-	13.4	109	20	m	15.7	105	17	m
11.3	99	20	-	13.4	109	20	m	15.7	107	19	m
11.3	100	21	-	13.4	110	20	m	15.7	108	16	m
11.3	100	16	-	13.4	110	25	m	15.7	109	18	m
11.3	100	25	-	13.4	110	27	m	18.6	75	21	f
11.3	100	23	-	13.4	112	20	m	18.6	77	18	f
11.3	103	18	-	13.4	115	20	m	18.6	79	19	f
11.3	103	24	-	13.4	118	19	m	18.6	79	24	f
11.3	105	19	-	15.7	70	11	m	18.6	82	21	f
11.3	105	17	-	15.7	72	15	f	18.6	82	20	f
11.3	106	17	-	15.7	75	19	f	18.6	83	20	f
11.3	106	20	-	15.7	75	21	f	18.6	88	20	f
11.3	109	24	-	15.7	78	21	f	18.6	91	29	f
11.3	113	19	-	15.7	79	22	f	18.6	96	18	m
11.3	117	27	-	15.7	79	21	f	18.6	97	17	m
11.3	119	25	-	15.7	79	18	f	18.6	99	19	m
13.4	95	19	f	15.7	80	20	f	18.6	99	20	f
13.4	100	23	m	15.7	80	19	f	18.6	100	17	m
13.4	103	20	m	15.7	82	22	f	18.6	100	20	m
13.4	104	19	m	15.7	95	22	m	18.6	102	21	m
13.4	105	20	m	15.7	99	21	m	18.6	103	24	m
13.4	105	23	m	15.7	100	19	m	18.6	105	16	m
13.4	108	20	m	15.7	100	20	m	18.6	106	20	m

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Ellipsaria lineolata cont'd.											
18.6	111	25	m	23.8	101	19	f	25.3	110	20	m
21.0	82	15	f	23.8	105	15	m	25.3	110	16	m
21.0	85	16	f	23.8	105	15	m	25.3	113	-	m
21.0	85	15	f	23.8	107	15	m	25.3	113	16	m
21.0	85	15	f	23.8	108	15	m	25.3	118	20	m
21.0	90	15	f	23.8	109	21	f	26.2	78	16	f
21.0	100	15	m	23.8	110	21	f	26.2	85	19	f
21.0	105	20	m	23.8	110	19	m	26.2	90	20	f
21.0	106	15	m	23.8	113	24	m	26.2	90	11	f
21.0	109	15	m	23.8	114	18	m	26.2	95	15	f
21.0	109	15	m	23.8	115	15	m	26.2	100	15	f
21.0	110	15	m	23.8	115	16	m	26.2	100	20	f
21.0	110	-	f	23.8	116	17	m	26.2	101	18	m
21.0	110	15	m	23.8	116	16	m	26.2	101	16	f
21.0	113	15	m	23.8	116	-	m	26.2	101	19	f
21.0	114	15	m	24.7	80	20	f	26.2	104	21	f
21.0	116	20	m	24.7	81	20	f	26.2	105	16	f
21.0	120	13	m	24.7	81	22	f	26.2	107	15	f
21.0	120	18	m	24.7	88	26	f	26.2	107	14	m
21.0	138	15	m	24.7	99	31	m	26.2	108	19	m
21.0	165	15	m	24.7	99	25	m	26.2	108	23	m
22.9	76	17	f	24.7	100	28	m	26.2	110	19	f
22.9	94	14	m	24.7	100	28	m	26.2	110	17	m
22.9	98	22	m	24.7	103	26	m	26.2	111	19	m
22.9	98	23	f	24.7	103	27	m	26.2	115	17	f
22.9	98	15	m	24.7	104	26	m	27.9	75	18	f
22.9	102	20	f	24.7	105	31	m	27.9	80	20	f
22.9	102	15	f	24.7	106	28	m	27.9	86	18	f
22.9	104	18	m	24.7	109	30	m	27.9	94	21	m
22.9	106	18	m	24.7	110	26	m	27.9	94	20	m
22.9	108	15	m	24.7	125	33	m	27.9	97	23	m
22.9	108	15	m	25.3	78	17	f	27.9	97	18	m
22.9	109	15	m	25.3	80	11	f	27.9	99	24	m
22.9	110	15	m	25.3	81	15	f	27.9	99	24	m
22.9	111	15	f	25.3	84	13	f	27.9	100	23	f
22.9	111	17	m	25.3	94	14	f	27.9	100	20	m
22.9	111	15	m	25.3	96	18	m	27.9	100	25	m
22.9	112	21	m	25.3	99	14	m	27.9	102	26	m
22.9	112	21	m	25.3	101	17	m	27.9	104	18	m
22.9	112	15	f	25.3	104	19	m	27.9	105	22	m
22.9	115	15	f	25.3	105	16	m	27.9	105	10	m
23.8	80	15	f	25.3	105	10	m	27.9	110	25	m
23.8	85	20	f	25.3	106	20	m	27.9	110	22	m
23.8	85	24	f	25.3	107	14	m	27.9	110	33	m
23.8	89	17	f	25.3	108	15	m	27.9	112	25	m
23.8	101	19	m	25.3	109	16	m	27.9	113	15	m

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Ellipsaria lineolata cont'd.											
28.4	83	19	f	29.2	103	14	m	36.1	93	17	m
28.4	84	18	f	29.2	104	17	m	36.1	93	16	m
28.4	93	15	f	29.2	105	16	m	36.1	94	15	m
28.4	97	19	m	29.2	107	18	m	36.1	95	22	m
28.4	97	16	m	29.2	108	16	m	36.1	96	15	m
28.4	100	16	m	29.2	110	19	m	36.1	96	18	m
28.4	100	18	m	29.2	110	20	m	36.1	98	21	m
28.4	102	18	m	29.2	110	15	m	36.1	98	23	m
28.4	102	17	m	29.2	112	19	m	36.1	101	15	m
28.4	103	17	m	29.2	112	18	m	36.1	105	15	m
28.4	103	14	m	29.2	115	20	m	36.7	85	14	m
28.4	108	24	m	29.2	119	10	m	36.7	87	13	m
28.4	108	15	m	29.2	119	23	m	36.7	91	15	m
28.4	108	15	m	29.2	119	21	m	36.7	93	11	m
28.4	109	19	m	29.2	120	17	m	36.7	105	17	m
28.4	110	15	f	31.5	71	-	m	37.2	92	15	-
28.4	112	20	m	31.5	99	10	m	37.2	93	15	-
28.4	112	20	m	32.5	98	14	m	37.2	98	14	-
28.4	116	16	m	33.5	83	8	m	37.2	98	13	-
28.4	117	18	m	33.5	98	11	m	37.2	100	19	-
29.2	84	14	f	34.6	89	19	m	37.2	102	19	-
29.2	96	14	m	34.6	100	23	m	37.2	109	16	-
29.2	98	14	m	36.1	69	13	f	45.2	-	-	-
29.2	101	16	m	36.1	88	17	m	53.1	93	13	m
29.2	102	16	m	36.1	89	12	m	53.1	93	15	f
Elliptio dilatata											
18.6	91	11	-	25.3	103	19	-	26.2	105	19	-
21.0	111	15	-	25.3	105	15	-	26.2	108	18	-
21.0	122	15	-	25.3	106	19	-	26.2	110	15	-
21.0	131	15	-	25.3	107	15	-	26.2	116	21	-
22.9	97	16	-	25.3	107	19	-	26.2	116	28	-
22.9	106	18	-	25.3	107	15	-	26.2	118	15	-
22.9	109	20	-	25.3	109	17	-	26.2	119	15	-
23.8	90	19	-	25.3	109	15	-	26.2	119	15	-
23.8	98	21	-	25.3	114	15	-	26.2	120	15	-
23.8	100	17	-	25.3	118	-	-	27.9	95	15	-
23.8	100	18	-	25.3	119	-	-	28.4	90	16	-
23.8	108	10	-	25.3	120	15	-	28.4	95	16	-
23.8	109	22	-	25.3	123	19	-	28.4	99	16	-
23.8	111	19	-	25.3	123	15	-	28.4	104	16	-
23.8	114	23	-	25.3	124	-	-	28.4	108	20	-
23.8	118	20	-	25.3	125	18	-	28.4	109	17	-
24.7	110	13	-	25.3	126	-	-	28.4	114	16	-
24.7	117	17	-	25.3	135	15	-	29.2	111	15	-
25.3	98	15	-	26.2	101	15	-	29.2	113	15	-
25.3	102	15	-	26.2	104	18	-	29.2	117	14	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Elliptio dilatata cont'd.											
29.2	135	18	-	34.6	102	10	-	45.2	68	10	-
32.5	92	10	-	34.6	104	15	-	45.2	69	10	-
32.5	96	10	-	34.6	107	17	-	45.2	70	10	-
32.5	97	10	-	34.6	112	15	-	45.2	70	13	-
32.5	99	10	-	34.6	115	22	-	45.2	70	13	-
32.5	100	10	-	34.6	120	15	-	45.2	71	14	-
32.5	106	10	-	36.1	110	13	-	45.2	75	13	-
33.5	78	10	-	36.7	95	14	-	45.2	75	11	-
34.6	72	10	-	36.7	103	16	-	45.2	80	12	-
34.6	79	10	-	36.7	104	17	-	46.8	80	13	-
34.6	81	15	-	37.2	56	7	-	53.1	84	12	-
34.6	91	10	-	37.2	109	14	-	53.1	95	17	-
34.6	94	10	-	43.0	72	14	-	53.5	106	17	-
Fusconaia flava											
15.7	70	17	-	21.0	89	15	-	23.8	82	19	-
15.7	75	15	-	21.0	90	-	-	23.8	83	26	-
15.7	77	21	-	21.0	90	15	-	23.8	84	-	-
15.7	78	20	-	21.0	90	15	-	23.8	85	-	-
15.7	80	25	-	21.0	90	15	-	23.8	85	-	-
15.7	80	21	-	21.0	91	20	-	23.8	85	-	-
15.7	80	21	-	22.9	75	23	-	23.8	85	-	-
15.7	80	22	-	22.9	75	18	-	23.8	85	-	-
15.7	84	22	-	22.9	75	17	-	23.8	86	-	-
15.7	85	25	-	22.9	75	18	-	23.8	87	-	-
15.7	98	20	-	22.9	78	16	-	23.8	87	-	-
18.6	70	18	-	22.9	78	16	-	23.8	88	-	-
18.6	74	-	-	22.9	79	78	-	23.8	88	-	-
18.6	80	-	-	22.9	80	17	-	23.8	89	-	-
18.6	80	15	-	22.9	80	19	-	25.3	77	22	-
18.6	82	20	-	22.9	82	15	-	25.3	77	15	-
18.6	92	20	-	22.9	82	19	-	25.3	81	-	-
21.0	70	8	-	22.9	83	15	-	25.3	82	-	-
21.0	76	15	-	22.9	85	80	-	25.3	82	-	-
21.0	78	-	-	22.9	85	15	-	25.3	82	21	-
21.0	79	-	-	22.9	86	17	-	25.3	83	-	-
21.0	80	10	-	22.9	88	15	-	25.3	84	-	-
21.0	81	10	-	22.9	90	16	-	25.3	84	-	-
21.0	81	16	-	22.9	91	15	-	25.3	85	-	-
21.0	81	10	-	22.9	92	15	-	25.3	85	-	-
21.0	82	10	-	22.9	95	15	-	25.3	88	-	-
21.0	82	-	-	23.8	75	-	-	25.3	89	-	-
21.0	85	15	-	23.8	78	-	-	25.3	89	-	-
21.0	86	15	-	23.8	79	20	-	25.3	90	-	-
21.0	86	15	-	23.8	80	24	-	25.3	90	22	-
21.0	87	-	-	23.8	81	-	-	25.3	90	-	-
21.0	88	16	-	23.8	81	25	-	25.3	94	15	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Fusconaia flava cont'd.											
25.3	94	-	-	28.4	82	17	-	36.7	75	16	-
25.3	96	-	-	28.4	84	15	-	36.7	76	17	-
26.2	75	21	-	28.4	85	15	-	36.7	80	17	-
26.2	75	18	-	28.4	85	15	-	37.2	78	17	-
26.2	76	20	-	28.4	86	15	-	37.2	81	10	-
26.2	76	19	-	28.4	90	-	-	37.2	82	15	-
26.2	79	24	-	28.4	90	15	-	37.2	84	15	-
26.2	80	23	-	28.4	90	21	-	37.2	86	20	-
26.2	81	-	-	28.4	90	-	-	37.2	86	15	-
26.2	81	23	-	28.4	91	15	-	37.2	87	15	-
26.2	81	21	-	29.2	80	20	-	37.2	88	18	-
26.2	81	22	-	29.2	82	14	-	37.2	89	-	-
26.2	82	18	-	29.2	83	-	-	37.2	95	20	-
26.2	82	19	-	29.2	83	10	-	45.2	50	12	-
26.2	83	27	-	29.2	84	18	-	45.2	53	13	-
26.2	83	26	-	29.2	84	-	-	45.2	53	14	-
26.2	83	-	-	29.2	85	14	-	45.2	60	10	-
26.2	84	19	-	29.2	85	18	-	45.2	60	12	-
26.2	85	24	-	29.2	87	17	-	45.2	60	9	-
26.2	85	-	-	29.2	88	18	-	45.2	61	15	-
26.2	87	15	-	29.2	89	15	-	45.2	63	16	-
26.2	91	24	-	29.2	90	16	-	45.2	64	10	-
27.9	76	20	-	29.2	90	20	-	45.2	65	11	-
27.9	79	15	-	29.2	91	20	-	45.2	69	17	-
27.9	80	18	-	29.2	93	15	-	45.2	70	16	-
27.9	89	28	-	29.2	94	15	-	45.2	70	10	-
28.4	68	13	-	29.2	94	23	-	45.2	71	15	-
28.4	70	16	-	29.2	96	17	-	46.8	65	15	-
28.4	73	15	-	29.2	99	-	-	46.8	69	15	-
28.4	73	15	-	29.2	102	-	-	49.8	70	15	-
28.4	80	20	-	34.6	79	18	-	53.1	69	-	-
28.4	80	15	-	36.1	70	16	-	53.1	69	11	-
28.4	81	-	-	36.1	77	17	-	53.1	76	10	-
28.4	82	15	-	36.1	79	19	-	53.1	77	10	-
28.4	82	24	-	36.7	65	10	-	53.1	82	15	-
28.4	82	15	-	36.7	73	10	-	53.1	84	10	-
Fusconaia ozarkensis											
43.0	55	13	-	-	-	-	-	-	-	-	-
Lampsilis abrupta											
21	101	20	f	-	-	-	-	-	-	-	-
Lampsilis cardium											
15.7	101	15	f	15.7	125	15	m	21.0	100	15	f
15.7	109	16	f	15.7	128	15	m	21.0	102	15	f
15.7	112	15	f	15.7	130	23	m	21.0	122	-	m
15.7	116	15	m	18.6	98	-	f	21.0	132	20	m
15.7	118	15	f	18.6	129	15	m	21.0	133	20	m

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Lampsilis cardium cont'd.											
21.0	139	-	m	25.3	120	-	f	28.4	118	-	f
22.9	103	-	f	25.3	120	-	f	28.4	119	-	f
22.9	112	-	f	25.3	120	-	m	28.4	120	-	m
22.9	115	-	f	25.3	122	20	m	28.4	120	-	m
22.9	116	-	m	25.3	122	-	m	28.4	125	-	m
22.9	119	-	f	25.3	122	-	fm	28.4	125	-	m
22.9	120	-	m	25.3	125	-	m	28.4	135	-	m
22.9	123	-	m	25.3	125	-	m	28.4	135	-	m
22.9	125	-	m	25.3	128	19	m	28.4	136	-	m
22.9	128	-	m	25.3	129	-	m	28.4	137	20	m
22.9	130	-	m	25.3	130	24	m	28.4	139	-	m
22.9	131	-	m	25.3	130	20	m	29.2	114	20	f
22.9	132	20	m	25.3	130	20	m	29.2	120	-	f
22.9	134	-	m	25.3	134	-	m	29.2	121	-	f
22.9	136	-	m	25.3	136	-	m	29.2	122	-	m
22.9	137	-	m	25.3	140	-	m	29.2	123	-	m
22.9	139	-	m	26.2	93	12	f	29.2	125	-	m
23.8	105	-	f	26.2	110	-	m	29.2	126	-	f
23.8	106	-	f	26.2	115	-	m	29.2	129	-	f
23.8	111	-	f	26.2	115	19	m	29.2	130	-	f
23.8	118	17	m	26.2	118	-	m	29.2	130	-	m
23.8	130	-	m	26.2	118	-	m	29.2	130	-	m
23.8	131	-	m	26.2	119	-	m	29.2	133	-	m
23.8	140	-	m	26.2	119	19	m	29.2	134	-	m
24.7	99	11	f	26.2	119	-	m	29.2	134	-	m
24.7	100	12	f	26.2	120	-	m	29.2	135	-	m
24.7	100	13	f	26.2	120	-	f	29.2	136	-	m
24.7	111	-	m	26.2	120	-	m	29.2	140	-	m
24.7	111	-	m	26.2	121	-	m	29.2	140	-	m
24.7	115	-	m	26.2	122	-	f	29.2	141	-	m
24.7	115	14	m	26.2	124	-	m	29.2	150	-	m
24.7	119	-	m	26.2	124	-	f	31.5	95	-	f
24.7	120	-	m	26.2	130	-	m	31.5	102	-	f
24.7	120	13	m	26.2	131	-	m	31.5	109	-	m
24.7	120	15	m	26.2	134	-	m	32.5	80	9	f
24.7	122	-	m	26.2	135	-	m	32.5	101	14	f
24.7	124	-	m	27.9	119	-	f	32.5	102	-	f
24.7	124	-	m	28.4	101	-	f	32.5	105	15	f
24.7	126	-	m	28.4	101	-	f	32.5	107	17	m
24.7	126	15	m	28.4	106	-	f	32.5	110	-	f
24.7	128	-	m	28.4	110	-	f	32.5	112	-	m
24.7	137	20	m	28.4	110	-	f	32.5	114	-	m
25.3	100	15	f	28.4	111	-	f	32.5	119	-	m
25.3	111	19	f	28.4	111	-	f	32.5	119	-	m
25.3	112	-	f	28.4	115	-	f	32.5	120	-	m
25.3	119	-	f	28.4	117	-	f	32.5	121	-	m

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Lampsilis cardium cont'd.											
32.5	122	-	m	36.1	126	15	m	37.2	132	20	m
32.5	123	-	m	36.1	126	-	m	37.2	134	20	m
32.5	124	-	m	36.1	126	15	m	37.2	135	20	m
32.5	130	21	m	36.1	127	20	m	45.2	105	-	m
32.5	130	-	m	36.1	127	22	m	45.2	107	-	m
32.5	130	-	m	36.1	129	15	m	45.2	109	19	f
32.5	139	-	m	36.1	130	25	m	45.2	110	10	f
33.5	96	-	f	36.1	145	15	m	45.2	112	-	m
33.5	110	15	f	36.7	91	13	f	45.2	112	-	m
33.5	115	15	m	36.7	101	-	f	45.2	112	-	m
33.5	115	-	m	36.7	105	-	f	45.2	116	-	m
33.5	120	-	m	36.7	105	-	f	45.2	119	-	m
33.5	121	-	m	36.7	106	19	f	45.2	119	-	m
33.5	126	20	m	36.7	109	-	f	45.2	120	-	m
33.5	126	15	m	36.7	109	19	m	45.2	120	-	m
33.5	137	20	m	36.7	110	15	f	45.2	122	-	m
34.6	107	10	m	36.7	110	-	f	46.8	96	13	-
34.6	109	15	m	36.7	110	15	f	46.8	114	-	-
34.6	109	-	f	36.7	114	15	f	53.1	102	15	m
34.6	109	15	f	36.7	119	23	m	53.1	102	12	m
34.6	109	10	f	36.7	120	15	m	53.1	105	-	m
34.6	116	15	m	36.7	122	-	m	53.1	106	-	f
34.6	121	15	m	36.7	124	-	m	53.1	115	15	m
34.6	121	17	m	36.7	125	-	m	53.1	116	15	f
34.6	122	16	m	36.7	126	20	m	53.1	117	-	m
34.6	122	15	f	36.7	128	-	m	53.1	119	-	m
34.6	123	-	m	36.7	129	-	m	53.1	122	15	m
34.6	125	-	m	36.7	135	-	m	53.1	122	-	m
34.6	128	20	m	37.2	100	-	f	53.1	124	-	f
34.6	128	15	m	37.2	109	25	f	53.1	124	-	m
34.6	132	15	m	37.2	111	27	m	53.1	128	-	m
34.6	145	15	m	37.2	114	20	m	53.1	131	-	m
36.1	110	15	m	37.2	114	-	f	53.1	134	15	m
36.1	113	10	m	37.2	116	20	f	53.1	136	-	m
36.1	114	15	m	37.2	116	20	f	53.5	105	18	f
36.1	116	23	m	37.2	117	20	m	53.5	111	20	f
36.1	116	10	m	37.2	122	20	m	53.5	112	15	f
36.1	116	15	m	37.2	123	20	m	53.5	117	13	m
36.1	119	17	m	37.2	124	20	m	53.5	118	20	m
36.1	119	15	m	37.2	126	20	m	53.5	118	20	m
36.1	121	-	m	37.2	126	20	m	53.5	123	14	m
36.1	122	23	m	37.2	126	20	m	53.5	129	20	m
36.1	122	15	m	37.2	126	20	m	53.5	131	20	m
36.1	122	20	m	37.2	127	20	m	53.5	134	20	m
36.1	124	20	m	37.2	129	20	m				

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Lampsilis siliquoidea											
32.5	104	13	-	53.1	125	15	f	53.5	109	14	f
36.7	104	10	f	53.1	128	-	m	53.5	117	10	m
36.7	122	10	m	53.1	129	-	m	53.5	121	12	m
45.2	96	9	f	53.1	132	10	m	53.5	125	17	m
53.1	103	13	m	53.1	132	-	m	53.5	128	18	m
53.1	108	10	f	53.5	106	12	f	53.5	131	15	m
53.1	124	-	m	53.5	107	13	f	53.5	146	15	m
53.1	125	15	m								
Lasmigona complanata											
11.3	169	-	-	18.6	125	15	f	28.4	115	17	-
13.4	145	33	-	18.6	140	17	m	28.4	138	26	-
13.4	152	30	f	18.6	140	20	f	28.4	160	24	-
13.4	155	30	f	18.6	145	20	f	29.2	155	15	-
13.4	180	30	f	18.6	165	-	m	29.2	170	15	-
15.7	142	31	f	21.0	152	20	-	32.5	70	9	-
15.7	145	28	f	21.0	182	20	f	36.1	89	13	-
15.7	147	20	-	22.9	171	35	-	37.2	156	20	-
15.7	150	20	f	24.7	135	17	-	41.1	140	15	-
15.7	152	29	f	24.7	141	25	-	53.1	149	-	-
15.7	155	36	-	24.7	165	24	-	53.1	158	-	-
15.7	156	32	-	25.3	19	4	-	53.5	133	-	-
18.6	109	16	f	25.3	123	25	-	53.5	155	30	-
18.6	120	19	m	27.9	146	15	f	53.5	156	-	-
Lasmigona costata											
13.4	60	10	-	28.4	135	20	-	34.6	145	24	-
21.0	126	10	-	28.4	145	24	-	36.7	125	25	f
22.9	124	15	-	29.2	104	13	-	45.2	100	14	-
28.4	128	27	-	29.2	133	18	-				
Leptodea fragilis											
11.3	135	16	-	18.6	94	9	f	25.3	110	11	-
11.3	149	22	-	18.6	94	11	f	25.3	119	12	-
13.4	72	8	f	18.6	96	9	f	25.3	120	13	-
13.4	105	14	m	18.6	100	12	-	25.3	120	12	-
13.4	130	18	m	18.6	105	10	-	25.3	120	11	-
15.7	62	6	-	18.6	109	10	-	25.3	121	16	-
15.7	72	8	-	18.6	111	13	-	25.3	121	13	-
15.7	95	10	-	18.6	123	15	-	25.3	128	13	-
15.7	99	12	-	18.6	129	15	-	25.3	129	17	-
15.7	100	11	-	18.6	131	17	-	25.3	130	15	-
15.7	110	11	-	18.6	136	15	-	26.2	103	10	-
15.7	110	13	-	21.0	121	15	m	26.2	110	11	-
15.7	121	15	-	24.7	122	9	-	26.2	110	15	-
15.7	124	16	-	25.3	89	9	-	26.2	119	13	f
15.7	125	17	-	25.3	89	8	f	27.9	92	8	-
18.6	76	8	f	25.3	90	8	f	27.9	99	10	-
18.6	83	7	f	25.3	105	9	f	27.9	113	16	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Leptodea fragilis cont'd.											
27.9	115	11	-	28.4	123	14	m	34.6	102	13	f
27.9	120	13	-	28.4	124	13	m	36.1	107	11	-
27.9	120	12	-	28.4	129	14	m	36.1	131	14	-
27.9	120	11	-	28.4	133	17	m	36.7	57	8	f
27.9	125	15	-	28.4	136	17	m	36.7	76	10	f
27.9	125	12	-	28.4	137	17	m	36.7	107	11	m
27.9	127	13	-	28.4	143	17	m	36.7	109	13	f
27.9	130	13	-	29.2	67	6	-	36.7	121	10	m
27.9	132	12	-	32.5	64	8	m	37.2	119	11	-
27.9	136	13	-	32.5	65	6	m	37.2	120	14	-
27.9	140	14	-	32.5	71	9	f	37.2	129	14	-
27.9	140	15	-	32.5	79	8	f	42.5	91	9	-
28.4	87	12	f	32.5	82	10	m	45.2	88	9	f
28.4	103	12	m	32.5	109	11	m	49.8	101	11	m
28.4	109	12	m	32.5	113	10	m	53.5	83	10	m
28.4	110	13	f	34.6	88	9	f	53.5	131	13	m
28.4	115	14	m								
Ligumia recta											
13.4	140	14	f	22.9	159	-	f	28.4	145	19	f
13.4	145	20	f	23.8	140	17	-	28.4	148	19	m
15.7	146	16	f	23.8	145	19	-	28.4	154	15	f
15.7	148	17	m	23.8	154	20	-	29.2	85	7	m
15.7	152	20	m	23.8	166	20	-	29.2	147	15	f
15.7	153	18	f	24.7	123	-	f	29.2	158	15	f
15.7	155	19	f	24.7	144	26	m	29.2	159	-	f
15.7	155	23	m	24.7	147	14	m	32.5	132	18	f
15.7	158	19	m	24.7	153	20	f	32.5	139	18	f
15.7	160	20	f	24.7	155	31	f	32.5	140	16	f
15.7	165	15	m	24.7	156	18	m	32.5	141	16	m
15.7	171	25	m	24.7	156	20	m	34.6	145	19	f
18.6	120	15	f	24.7	156	25	f	34.6	149	15	f
18.6	134	18	f	24.7	171	25	m	34.6	149	24	f
18.6	140	-	f	24.7	180	30	m	34.6	149	27	f
18.6	140	19	f	24.7	184	27	m	34.6	160	20	m
18.6	140	19	f	25.3	164	15	m	36.1	157	20	m
18.6	150	-	f	25.3	166	20	f	36.7	126	16	f
18.6	154	15	f	27.9	145	17	f	36.7	131	16	f
18.6	157	20	f	27.9	151	19	f	36.7	145	10	f
21.0	180	30	m	27.9	160	20	m	36.7	147	17	f
22.9	153	15	f	27.9	160	18	f	36.7	156	17	m
22.9	153	20	m	27.9	178	20	m	36.7	161	19	m
22.9	158	20	m	28.4	145	17	f				
Megalonaias nervosa											
11.3	137	30	-	11.3	149	30	-	11.3	152	30	-
11.3	145	30	-	11.3	150	30	-	11.3	154	30	-
11.3	146	30	-	11.3	151	30	-	11.3	155	30	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Megalonaias nervosa cont'd.											
11.3	155	30	-	15.7	151	35	-	22.9	145	30	-
11.3	156	30	-	15.7	151	30	-	22.9	146	30	-
11.3	158	30	-	15.7	152	30	-	22.9	150	30	-
11.3	158	30	-	15.7	155	47	-	22.9	151	30	-
11.3	158	30	-	15.7	160	35	-	22.9	152	30	-
11.3	160	30	-	18.6	133	30	-	22.9	153	30	-
11.3	164	30	-	18.6	133	30	-	22.9	155	30	-
11.3	166	30	-	18.6	135	30	-	22.9	158	30	-
11.3	170	30	-	18.6	138	30	-	22.9	158	30	-
11.3	171	30	-	18.6	139	30	-	22.9	160	30	-
11.3	178	30	-	18.6	139	30	-	22.9	160	30	-
13.4	139	30	-	18.6	140	30	-	22.9	161	30	-
13.4	141	30	-	18.6	141	30	-	22.9	161	30	-
13.4	145	30	-	18.6	141	30	-	22.9	161	30	-
13.4	147	30	-	18.6	142	30	-	29.2	161	30	-
13.4	149	30	-	18.6	145	30	-	29.2	162	30	-
13.4	149	30	-	18.6	145	30	-	29.2	163	30	-
13.4	149	30	-	18.6	151	30	-	22.9	165	30	-
13.4	152	30	-	18.6	151	30	-	22.9	165	30	-
13.4	154	30	-	18.6	156	30	-	22.9	168	30	-
13.4	155	30	-	18.6	160	30	-	22.9	169	30	-
13.4	155	30	-	18.6	160	30	-	22.9	170	30	-
13.4	156	30	-	18.6	160	30	-	22.9	174	30	-
13.4	162	30	-	18.6	165	30	-	23.8	125	20	-
13.4	163	30	-	18.6	166	30	-	23.8	141	30	-
13.4	165	30	-	21.0	150	30	-	23.8	142	30	-
13.4	166	30	-	21.0	152	30	-	23.8	145	30	-
13.4	166	30	-	21.0	155	30	-	23.8	148	30	-
13.4	169	30	-	21.0	159	21	-	23.8	149	30	-
13.4	170	30	-	21.0	160	24	-	23.8	150	30	-
13.4	170	30	-	21.0	160	30	-	23.8	154	25	-
15.7	130	30	-	21.0	161	30	-	23.8	155	30	-
15.7	132	30	-	21.0	164	30	-	23.8	158	30	-
15.7	135	30	-	21.0	165	25	-	23.8	159	40	-
15.7	135	35	-	21.0	166	25	-	23.8	165	30	-
15.7	137	30	-	21.0	166	25	-	23.8	165	30	-
15.7	139	30	-	21.0	166	30	-	23.8	167	30	-
15.7	140	37	-	21.0	167	30	-	23.8	169	30	-
15.7	140	30	-	21.0	167	35	-	23.8	175	40	-
15.7	143	30	-	21.0	168	25	-	23.8	176	30	-
15.7	144	30	-	21.0	168	30	-	23.8	181	40	-
15.7	145	33	-	21.0	174	30	-	24.7	154	30	-
15.7	145	30	-	21.0	175	27	-	24.7	168	30	-
15.7	145	30	-	21.0	176	21	-	25.3	150	30	-
15.7	150	30	-	21.0	180	30	-	25.3	150	30	-
15.7	150	30	-	21.0	201	30	-	25.3	150	30	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Megalonaias nervosa cont'd.											
25.3	153	30	-	27.9	153	30	-	32.5	142	30	-
25.3	154	30	-	27.9	154	30	-	32.5	146	30	-
25.3	160	30	-	27.9	154	30	-	32.5	148	30	-
25.3	160	30	-	27.9	157	30	-	32.5	149	30	-
25.3	163	30	-	27.9	158	30	-	32.5	153	30	-
25.3	164	30	-	27.9	160	30	-	32.5	164	30	-
25.3	168	30	-	27.9	170	30	-	33.5	150	30	-
25.3	169	30	-	27.9	177	40	-	33.5	150	30	-
25.3	170	30	-	28.4	141	30	-	33.5	150	30	-
25.3	171	30	-	28.4	148	30	-	34.6	139	30	-
25.3	172	30	-	28.4	153	30	-	34.6	143	30	-
25.3	172	30	-	28.4	153	30	-	34.6	145	30	-
25.3	176	30	-	28.4	156	30	-	34.6	147	30	-
25.3	178	30	-	28.4	160	30	-	34.6	159	30	-
25.3	183	30	-	28.4	160	30	-	36.1	139	-	-
25.3	184	30	-	28.4	161	30	-	36.1	142	30	-
25.3	187	30	-	28.4	161	30	-	36.1	143	30	-
26.2	141	25	-	28.4	162	30	-	36.1	149	30	-
26.2	141	30	-	28.4	164	30	-	36.1	150	-	-
26.2	145	25	-	28.4	166	30	-	36.1	154	30	-
26.2	145	25	-	28.4	169	30	-	36.1	162	30	-
26.2	148	30	-	28.4	173	30	-	36.7	137	-	-
26.2	149	30	-	28.4	173	30	-	36.7	141	-	-
26.2	153	30	-	28.4	175	30	-	36.7	145	-	-
26.2	155	35	-	28.4	175	30	-	36.7	146	-	-
26.2	158	35	-	28.4	175	30	-	36.7	148	-	-
26.2	159	30	-	28.4	178	30	-	36.7	150	-	-
26.2	160	30	-	28.4	189	30	-	36.7	151	-	-
26.2	162	30	-	29.2	141	30	-	36.7	152	-	-
26.2	162	30	-	29.2	149	30	-	36.7	153	-	-
26.2	162	30	-	29.2	150	30	-	36.7	153	-	-
26.2	163	30	-	29.2	154	30	-	36.7	157	-	-
26.2	168	30	-	29.2	159	30	-	36.7	157	-	-
26.2	173	40	-	29.2	160	30	-	36.7	158	-	-
27.9	127	20	-	29.2	164	30	-	36.7	162	-	-
27.9	132	30	-	29.2	167	30	-	36.7	163	-	-
27.9	138	30	-	29.2	167	30	-	36.7	164	-	-
27.9	142	30	-	29.2	168	30	-	36.7	165	-	-
27.9	145	30	-	29.2	169	30	-	36.7	166	-	-
27.9	145	30	-	29.2	170	30	-	36.7	167	-	-
27.9	148	30	-	29.2	172	30	-	36.7	170	-	-
27.9	150	30	-	29.2	173	30	-	37.2	148	30	-
27.9	150	30	-	29.2	180	30	-	37.2	148	30	-
27.9	151	30	-	29.2	186	30	-	37.2	152	30	-
27.9	152	30	-	31.5	145	-	-	37.2	155	30	-
27.9	152	30	-	31.5	170	-	-	37.2	155	30	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Megalonaias nervosa cont'd.											
37.2	157	30	-	45.2	126	30	-	45.2	145	30	-
37.2	158	30	-	45.2	130	30	-	45.2	146	30	-
37.2	158	30	-	45.2	130	30	-	45.2	147	30	-
37.2	159	30	-	45.2	131	30	-	45.2	149	30	-
37.2	162	30	-	45.2	132	30	-	45.2	156	30	-
37.2	164	30	-	45.2	133	30	-	45.2	165	30	-
37.2	164	30	-	45.2	134	30	-	46.8	110	25	-
37.2	167	30	-	45.2	135	30	-	46.8	127	25	-
37.2	169	30	-	45.2	136	30	-	46.8	136	30	-
37.2	170	30	-	45.2	136	30	-	46.8	140	30	-
37.2	171	30	-	45.2	136	30	-	46.8	142	30	-
37.2	172	30	-	45.2	136	30	-	46.8	148	30	-
37.2	172	30	-	45.2	137	30	-	53.1	157	30	-
37.2	177	30	-	45.2	138	30	-	53.1	158	30	-
37.2	181	30	-	45.2	142	30	-	53.1	164	30	-
39.2	151	26	-	45.2	142	30	-	53.1	165	30	-
45.2	120	30	-	45.2	143	30	-				
Obliquaria reflexa											
13.4	60	16	-	21.0	46	11	-	23.8	65	17	-
15.7	44	11	-	21.0	70	15	-	23.8	65	16	-
15.7	57	15	-	22.9	55	10	-	23.8	66	17	-
15.7	63	24	-	22.9	56	10	-	23.8	66	15	-
15.7	65	14	-	22.9	57	12	-	23.8	68	15	-
15.7	65	19	-	22.9	58	8	-	23.8	71	15	-
15.7	66	20	-	22.9	59	9	-	23.8	72	18	-
15.7	67	24	-	22.9	60	12	-	23.8	73	19	-
15.7	68	23	-	22.9	62	10	-	23.8	73	15	-
15.7	68	23	-	22.9	65	14	-	23.8	75	16	-
18.6	59	20	-	22.9	66	15	-	23.8	77	15	-
18.6	59	14	-	22.9	66	-	-	23.8	77	-	-
18.6	60	15	-	22.9	67	15	-	23.8	77	20	-
18.6	60	14	-	22.9	68	13	-	24.7	54	18	-
18.6	62	21	-	22.9	69	-	-	24.7	54	11	-
18.6	63	10	-	22.9	69	20	-	24.7	59	13	-
18.6	64	15	-	22.9	70	13	-	24.7	60	22	-
18.6	66	19	-	22.9	71	11	-	24.7	62	23	-
18.6	66	13	-	22.9	73	15	-	24.7	62	15	-
18.6	69	20	-	22.9	73	18	-	24.7	63	15	-
18.6	70	10	-	22.9	75	19	-	24.7	64	15	-
18.6	70	-	-	22.9	76	20	-	24.7	65	20	-
18.6	71	13	-	23.8	24	4	-	24.7	66	20	-
18.6	71	14	-	23.8	55	14	-	24.7	66	25	-
18.6	72	24	-	23.8	60	13	-	24.7	67	24	-
18.6	73	30	-	23.8	60	13	-	24.7	68	23	-
18.6	73	15	-	23.8	62	15	-	24.7	69	25	-
18.6	74	16	-	23.8	65	15	-	24.7	69	18	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Obliquaria reflexa cont.											
24.7	69	28	-	27.9	69	15	-	33.5	61	10	-
24.7	70	25	-	27.9	70	15	-	33.5	70	10	-
24.7	70	26	-	27.9	70	15	-	34.6	53	11	-
24.7	74	15	-	27.9	71	20	-	34.6	55	13	-
24.7	79	30	-	27.9	71	21	-	34.6	55	12	-
25.3	55	14	-	27.9	71	12	-	34.6	55	9	-
25.3	57	17	-	27.9	71	22	-	34.6	57	14	-
25.3	58	14	-	28.4	58	8	-	34.6	58	14	-
25.3	58	18	-	28.4	60	12	-	34.6	61	13	-
25.3	59	16	-	28.4	60	-	-	36.1	47	9	-
25.3	59	15	-	28.4	61	16	-	36.1	50	15	-
25.3	63	25	-	28.4	61	11	-	36.1	51	14	-
25.3	65	21	-	28.4	62	10	-	36.1	52	15	-
25.3	66	16	-	28.4	63	15	-	36.1	53	11	-
25.3	67	33	-	28.4	63	11	-	36.1	53	13	-
25.3	72	16	-	28.4	63	14	-	36.1	54	11	-
26.2	50	9	-	28.4	64	11	-	36.1	57	12	-
26.2	51	7	-	28.4	65	15	-	36.1	59	15	-
26.2	56	10	-	28.4	65	12	-	36.1	59	-	-
26.2	57	12	-	28.4	67	16	-	36.1	59	15	-
26.2	61	15	-	28.4	67	19	-	36.1	60	19	-
26.2	62	9	-	28.4	67	17	-	36.1	60	14	-
26.2	64	11	-	28.4	68	15	-	36.1	63	14	-
26.2	65	13	-	28.4	69	17	-	36.1	63	21	-
26.2	66	16	-	28.4	69	13	-	36.1	64	16	-
26.2	68	16	-	28.4	70	15	-	36.1	64	16	-
26.2	69	13	-	28.4	71	-	-	36.1	65	18	-
26.2	69	12	-	29.2	52	9	-	36.1	65	17	-
26.2	70	12	-	29.2	57	13	-	36.1	66	15	-
26.2	70	15	-	29.2	58	13	-	36.7	47	8	-
26.2	71	11	-	29.2	60	11	-	36.7	52	9	-
26.2	71	14	-	29.2	61	13	-	36.7	53	8	-
26.2	71	11	-	29.2	68	15	-	36.7	55	13	-
26.2	71	15	-	29.2	68	16	-	36.7	55	9	-
26.2	74	14	-	29.2	69	13	-	36.7	56	11	-
26.2	75	14	-	29.2	70	13	-	36.7	56	10	-
27.9	55	15	-	31.5	41	5	-	36.7	59	12	-
27.9	59	18	-	31.5	59	10	-	36.7	60	11	-
27.9	60	-	-	31.5	59	12	-	36.7	60	11	-
27.9	61	17	-	31.5	60	12	-	36.7	61	10	-
27.9	61	24	-	31.5	61	13	-	36.7	62	12	-
27.9	61	15	-	31.5	67	14	-	36.7	62	13	-
27.9	61	-	-	31.5	67	12	-	36.7	63	10	-
27.9	65	19	-	32.5	41	6	-	36.7	66	14	-
27.9	66	-	-	33.5	57	11	-	36.7	67	15	-
27.9	68	21	-	33.5	60	10	-	36.7	69	13	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Obliquaria reflexa cont.											
36.7	71	13	-	37.2	62	21	-	45.2	49	11	-
36.7	73	19	-	37.2	64	18	-	45.2	50	11	-
36.7	74	17	-	37.2	66	15	-	45.2	53	12	-
37.2	56	11	-	37.2	67	19	-	45.2	58	13	-
37.2	56	17	-	37.2	67	17	-	46.8	50	13	-
37.2	58	17	-	37.2	67	27	-	53.1	69	15	-
37.2	59	14	-	37.2	67	15	-	53.1	72	15	-
37.2	59	14	-	37.2	68	18	-	53.1	77	15	-
37.2	60	13	-	37.2	70	22	-	53.5	60	19	-
37.2	60	14	-	37.2	71	21	-	53.5	64	19	-
37.2	61	13	-	37.2	72	24	-	53.5	72	16	-
37.2	62	18	-								
Pleurobema sintoxia											
15.7	90	27	-	26.2	84	17	-	36.1	82	17	-
18.6	74	16	-	26.2	85	15	-	36.1	86	15	-
18.6	80	20	-	26.2	88	20	-	36.7	66	10	-
21.0	85	20	-	26.2	93	15	-	36.7	67	15	-
21.0	87	20	-	26.2	93	15	-	36.7	68	14	-
22.9	59	11	-	27.9	78	20	-	36.7	71	16	-
22.9	69	11	-	28.4	70	17	-	36.7	72	18	-
22.9	75	14	-	28.4	73	19	-	36.7	73	20	-
22.9	76	13	-	28.4	78	-	-	36.7	73	16	-
22.9	78	13	-	28.4	81	10	-	36.7	75	14	-
22.9	81	20	-	28.4	95	15	-	36.7	75	18	-
22.9	87	30	-	29.2	74	14	-	36.7	76	16	-
22.9	88	22	-	29.2	79	12	-	36.7	76	18	-
22.9	89	19	-	29.2	85	20	-	36.7	77	15	-
22.9	91	-	-	29.2	90	15	-	36.7	77	15	-
23.8	70	14	-	29.2	91	15	-	36.7	79	14	-
23.8	71	14	-	29.2	94	25	-	36.7	80	17	-
23.8	72	20	-	31.5	49	7	-	36.7	80	18	-
23.8	79	-	-	31.5	65	15	-	36.7	82	20	-
23.8	85	19	-	31.5	71	10	-	36.7	82	18	-
23.8	88	15	-	33.5	74	10	-	36.7	83	20	-
24.7	74	17	-	33.5	78	10	-	36.7	84	23	-
24.7	76	15	-	34.6	71	14	-	37.2	74	10	-
24.7	79	15	-	34.6	71	16	-	37.2	78	-	-
25.3	85	22	-	34.6	81	17	-	37.2	80	21	-
25.3	89	23	-	34.6	84	19	-	37.2	80	15	-
25.3	91	20	-	34.6	89	21	-	37.2	81	17	-
26.2	75	15	-	36.1	75	13	-	37.2	82	15	-
26.2	80	17	-	36.1	76	16	-	37.2	90	17	-
26.2	81	15	-	36.1	78	17	-	37.2	90	15	-
26.2	81	17	-	36.1	81	15	-	45.2	53	16	-
26.2	82	17	-	36.1	82	16	-	45.2	60	13	-
26.2	84	19	-	36.1	82	17	-	45.2	63	-	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Pleurobema sintoxia cont'd.											
45.2	65	13	-	45.2	73	19	-	53.1	77	10	-
45.2	66	16	-	45.2	80	18	-	53.1	83	10	-
45.2	69	15	-	46.8	71	15	-	53.1	83	10	-
45.2	72	16	-	53.1	73	-	-	53.5	78	-	-
45.2	72	23	-	53.1	76	10	-	53.5	83	15	-
Potamilus alatus											
11.3	130	23	f	18.6	150	15	m	26.2	125	15	f
11.3	145	28	-	18.6	151	15	m	26.2	138	20	m
11.3	146	27	-	18.6	161	20	m	26.2	141	18	f
13.4	103	13	-	18.6	170	25	m	26.2	148	20	f
13.4	129	18	-	18.6	170	20	m	26.2	150	20	m
13.4	143	17	-	21.0	76	-	-	26.2	150	25	f
13.4	150	20	-	21.0	130	15	-	26.2	153	24	f
15.7	100	17	-	21.0	133	-	f	26.2	154	20	m
15.7	100	18	-	21.0	140	-	-	26.2	157	20	f
15.7	105	17	-	21.0	142	-	f	26.2	165	25	m
15.7	106	22	-	21.0	145	-	-	26.2	171	30	m
15.7	108	18	-	21.0	150	-	f	27.9	95	15	f
15.7	109	19	-	21.0	162	-	-	27.9	100	10	f
15.7	114	21	-	22.9	110	21	f	27.9	111	17	f
15.7	120	20	-	22.9	118	18	f	27.9	120	15	f
15.7	125	25	-	22.9	142	20	m	27.9	122	15	m
15.7	126	28	-	23.8	94	15	f	27.9	132	-	m
15.7	129	20	-	23.8	111	10	m	27.9	139	15	f
15.7	129	20	-	23.8	113	16	f	27.9	142	20	m
15.7	131	22	-	23.8	119	10	f	27.9	145	15	m
15.7	140	20	-	23.8	121	25	f	27.9	146	20	m
15.7	141	30	-	23.8	125	20	m	27.9	150	30	m
15.7	145	25	-	23.8	128	15	f	27.9	154	20	-
15.7	145	20	-	23.8	131	20	f	27.9	159	20	m
15.7	150	27	-	23.8	134	15	f	27.9	159	25	m
15.7	152	25	-	23.8	148	20	m	27.9	160	23	m
15.7	154	31	-	24.7	125	22	f	27.9	160	25	m
18.6	80	10	m	24.7	128	25	m	27.9	160	25	m
18.6	86	14	f	24.7	151	25	f	27.9	162	20	m
18.6	99	16	f	24.7	154	24	f	27.9	175	25	m
18.6	99	14	f	24.7	155	15	f	28.4	103	14	f
18.6	110	15	f	24.7	155	15	f	28.4	105	16	f
18.6	110	15	f	24.7	157	13	f	28.4	107	13	f
18.6	114	17	m	25.3	90	15	-	28.4	129	15	f
18.6	115	16	f	25.3	115	19	f	28.4	130	17	m
18.6	125	12	m	25.3	115	19	f	28.4	133	19	f
18.6	128	15	m	25.3	116	19	m	28.4	134	21	m
18.6	130	16	f	25.3	158	25	f	28.4	135	20	m
18.6	135	20	m	25.3	160	25	f	28.4	136	15	f
18.6	145	15	m	25.3	170	20	m	28.4	142	21	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Potamilus alatus cont'd.											
28.4	143	19	m	32.5	88	12	f	37.2	135	20	-
28.4	157	15	m	32.5	99	14	f	39.2	150	15	-
29.2	132	10	m	32.5	105	13	m	43.0	145	15	m
29.2	149	15	m	32.5	110	18	f	45.2	102	15	f
29.2	149	15	m	34.6	60	-	-	45.2	110	10	f
29.2	156	20	f	34.6	134	15	-	45.2	110	16	f
29.2	165	20	m	36.7	130	17	-	53.1	121	15	-
29.2	165	20	m	36.7	134	20	-	53.1	143	15	-
29.2	170	20	m	37.2	100	13	-	53.1	157	15	-
32.5	61	9	m	37.2	128	16	-				
Quadrula metanevra											
15.7	85	17	-	21.0	97	-	-	23.8	103	22	-
15.7	89	17	-	22.9	76	8	-	23.8	105	25	-
15.7	90	13	-	22.9	82	15	-	23.8	105	33	-
15.7	92	19	-	22.9	83	16	-	23.8	105	30	-
15.7	92	22	-	22.9	84	16	-	23.8	107	30	-
15.7	95	16	-	22.9	85	20	-	23.8	108	30	-
15.7	110	18	-	22.9	85	19	-	24.7	66	9	-
18.6	71	11	-	22.9	86	-	-	24.7	77	20	-
18.6	78	23	-	22.9	86	-	-	24.7	86	-	-
18.6	81	11	-	22.9	87	16	-	24.7	86	19	-
18.6	82	13	-	22.9	88	19	-	24.7	86	20	-
18.6	84	15	-	22.9	88	18	-	24.7	89	20	-
18.6	86	-	-	22.9	89	18	-	24.7	89	27	-
18.6	89	20	-	22.9	91	-	-	24.7	89	15	-
18.6	89	14	-	22.9	93	15	-	24.7	90	20	-
18.6	89	20	-	22.9	93	20	-	24.7	91	21	-
18.6	90	16	-	22.9	94	18	-	24.7	91	20	-
18.6	93	82	-	22.9	95	30	-	24.7	92	26	-
18.6	95	-	-	22.9	98	20	-	24.7	93	27	-
18.6	96	15	-	22.9	101	25	-	24.7	93	-	-
18.6	96	15	-	22.9	106	25	-	24.7	94	20	-
18.6	96	17	-	23.8	42	5	-	24.7	97	25	-
18.6	97	24	-	23.8	58	10	-	24.7	98	30	-
18.6	102	-	-	23.8	79	20	-	24.7	98	20	-
18.6	103	25	-	23.8	85	14	-	25.3	71	12	-
18.6	104	22	-	23.8	86	16	-	25.3	83	19	-
18.6	108	25	-	23.8	92	20	-	25.3	84	16	-
21.0	81	10	-	23.8	97	24	-	25.3	84	18	-
21.0	89	13	-	23.8	98	25	-	25.3	89	19	-
21.0	90	20	-	23.8	98	-	-	25.3	89	17	-
21.0	92	20	-	23.8	98	19	-	25.3	90	14	-
21.0	95	16	-	23.8	100	20	-	25.3	91	22	-
21.0	96	18	-	23.8	100	-	-	25.3	92	-	-
21.0	96	-	-	23.8	100	20	-	25.3	92	-	-
21.0	97	15	-	23.8	103	30	-	25.3	92	-	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Quadrula metanevra cont'd.											
25.3	98	20	-	27.9	104	20	-	33.5	79	14	-
25.3	100	20	-	27.9	105	20	-	33.5	80	13	-
25.3	104	-	-	27.9	105	25	-	33.5	84	18	-
25.3	105	20	-	28.4	75	13	-	33.5	84	16	-
25.3	105	-	-	28.4	80	17	-	33.5	85	17	-
25.3	106	23	-	28.4	81	19	-	33.5	88	17	-
25.3	110	-	-	28.4	89	18	-	33.5	90	18	-
25.3	111	-	-	28.4	91	16	-	33.5	91	15	-
25.3	113	-	-	28.4	91	15	-	33.5	93	12	-
26.2	53	10	-	28.4	94	19	-	33.5	93	13	-
26.2	80	18	-	28.4	94	15	-	33.5	93	15	-
26.2	83	21	-	28.4	95	19	-	33.5	118	21	-
26.2	83	25	-	28.4	95	21	-	34.6	70	8	-
26.2	83	25	-	28.4	95	18	-	34.6	76	14	-
26.2	85	15	-	28.4	97	17	-	34.6	82	16	-
26.2	85	21	-	28.4	97	22	-	34.6	82	17	-
26.2	90	17	-	28.4	97	17	-	34.6	92	20	-
26.2	90	22	-	28.4	97	-	-	34.6	96	15	-
26.2	90	19	-	28.4	99	20	-	36.1	73	14	-
26.2	93	21	-	28.4	100	20	-	36.1	74	16	-
26.2	97	29	-	28.4	104	20	-	36.1	75	16	-
26.2	98	25	-	29.2	50	6	-	36.1	75	10	-
26.2	98	18	-	29.2	53	11	-	36.1	79	16	-
26.2	99	27	-	29.2	79	7	-	36.1	79	18	-
26.2	100	17	-	29.2	83	13	-	36.1	80	12	-
26.2	100	19	-	29.2	86	16	-	36.1	81	16	-
26.2	103	20	-	29.2	92	18	-	36.1	82	13	-
26.2	105	30	-	29.2	94	13	-	36.1	82	13	-
26.2	109	20	-	29.2	94	15	-	36.1	84	15	-
27.9	73	14	-	29.2	95	16	-	36.1	86	14	-
27.9	78	15	-	29.2	95	18	-	36.1	89	16	-
27.9	82	14	-	29.2	95	15	-	36.1	89	19	-
27.9	82	-	-	29.2	95	19	-	36.1	91	15	-
27.9	84	17	-	29.2	98	15	-	36.1	93	17	-
27.9	89	18	-	29.2	99	15	-	36.1	93	17	-
27.9	90	16	-	29.2	99	16	-	36.1	96	15	-
27.9	91	-	-	29.2	99	27	-	36.7	65	12	-
27.9	91	-	-	29.2	102	15	-	36.7	69	9	-
27.9	92	15	-	29.2	103	19	-	36.7	74	15	-
27.9	94	20	-	29.2	103	16	-	36.7	75	14	-
27.9	95	-	-	29.2	105	17	-	36.7	80	13	-
27.9	98	20	-	29.2	105	15	-	36.7	81	15	-
27.9	100	-	-	29.2	122	20	-	36.7	83	11	-
27.9	100	20	-	31.5	72	10	-	36.7	83	13	-
27.9	100	20	-	31.5	79	15	-	36.7	85	15	-
27.9	102	20	-	31.5	83	-	-	36.7	86	14	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Quadrula metanevra cont'd.											
36.7	89	16	-	36.7	96	18	-	45.2	79	15	-
36.7	90	19	-	36.7	97	14	-	45.2	81	13	-
36.7	92	19	-	36.7	99	16	-	46.8	74	16	-
36.7	93	19	-	36.7	103	23	-	46.8	82	12	-
36.7	95	18	-	45.2	71	12	-	53.1	88	10	-
36.7	95	20	-	45.2	77	12	-				
Quadrula pustulosa											
11.3	60	19	-	18.6	63	14	-	22.9	63	18	-
11.3	66	18	-	18.6	63	13	-	22.9	65	-	-
11.3	68	22	-	18.6	63	18	-	22.9	65	-	-
11.3	72	20	-	18.6	66	20	-	22.9	66	20	-
13.4	65	23	-	18.6	66	15	-	22.9	66	14	-
13.4	69	19	-	18.6	69	13	-	22.9	66	-	-
13.4	70	15	-	18.6	70	20	-	22.9	68	-	-
13.4	85	14	m	18.6	70	15	-	22.9	68	17	-
15.7	44	10	-	18.6	71	20	-	22.9	69	21	-
15.7	53	14	-	18.6	74	20	-	22.9	70	14	-
15.7	58	13	-	21.0	40	12	-	22.9	71	-	-
15.7	58	16	-	21.0	52	18	-	22.9	73	20	-
15.7	59	13	-	21.0	60	15	-	22.9	74	-	-
15.7	59	17	-	21.0	60	15	-	22.9	75	20	-
15.7	59	20	-	21.0	60	15	-	23.8	31	6	-
15.7	59	20	-	21.0	60	15	-	23.8	34	7	-
15.7	59	18	-	21.0	60	15	-	23.8	50	12	-
15.7	60	16	-	21.0	60	20	-	23.8	52	15	-
15.7	60	15	-	21.0	61	18	-	23.8	54	13	-
15.7	61	18	-	21.0	61	-	-	23.8	56	12	-
15.7	62	18	-	21.0	62	14	-	23.8	56	14	-
15.7	63	22	-	21.0	62	17	-	23.8	57	13	-
15.7	64	19	-	21.0	63	15	-	23.8	57	14	-
15.7	65	16	-	21.0	65	14	-	23.8	58	17	-
15.7	66	20	-	21.0	66	15	-	23.8	58	14	-
15.7	67	18	-	21.0	66	19	-	23.8	59	15	-
15.7	69	15	-	21.0	67	15	-	23.8	60	16	-
15.7	69	19	-	21.0	67	15	-	23.8	61	19	-
15.7	75	20	-	21.0	71	18	-	23.8	61	18	-
18.6	51	10	-	21.0	72	-	-	23.8	62	18	-
18.6	51	9	-	21.0	74	15	-	23.8	65	18	-
18.6	54	21	-	21.0	80	-	-	23.8	72	-	-
18.6	55	11	-	21.0	80	15	-	23.8	73	15	-
18.6	59	14	-	22.9	58	13	-	23.8	76	-	-
18.6	60	11	-	22.9	61	12	-	24.7	36	11	-
18.6	60	10	-	22.9	61	24	-	24.7	52	15	-
18.6	60	13	-	22.9	61	17	-	24.7	55	15	-
18.6	61	11	-	22.9	63	15	-	24.7	56	19	-
18.6	62	16	-	22.9	63	-	-	24.7	58	20	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Quadrula pustulosa cont'd.											
24.7	59	20	-	26.2	66	20	-	28.4	68	16	-
24.7	59	21	-	26.2	67	19	-	28.4	69	15	-
24.7	59	16	-	26.2	69	21	-	28.4	69	-	-
24.7	60	18	-	26.2	70	10	-	28.4	71	-	-
24.7	60	18	-	26.2	70	20	-	29.2	39	6	-
24.7	60	21	-	26.2	72	20	-	29.2	40	9	-
24.7	61	-	-	26.2	73	20	-	29.2	42	8	-
24.7	62	24	-	26.2	73	20	-	29.2	53	13	-
24.7	62	-	-	26.2	74	23	-	29.2	57	14	-
24.7	63	23	-	26.2	76	18	-	29.2	59	16	-
24.7	63	15	-	27.9	54	12	-	29.2	60	10	-
24.7	64	20	-	27.9	60	14	-	29.2	61	16	-
24.7	64	14	-	27.9	60	20	-	29.2	61	13	-
24.7	66	20	-	27.9	61	13	-	29.2	62	10	-
24.7	68	20	-	27.9	66	-	-	29.2	65	19	-
25.3	28	5	-	27.9	68	18	-	29.2	66	14	-
25.3	30	6	-	27.9	70	-	-	29.2	68	16	-
25.3	49	17	-	27.9	70	-	-	29.2	69	18	-
25.3	50	11	-	27.9	70	-	-	29.2	69	19	-
25.3	51	12	-	27.9	70	-	-	29.2	69	15	-
25.3	53	12	-	27.9	71	21	-	29.2	69	15	-
25.3	53	15	-	27.9	72	20	-	29.2	71	18	-
25.3	56	13	-	27.9	72	-	-	29.2	72	14	-
25.3	57	18	-	27.9	72	-	-	29.2	74	21	-
25.3	58	16	-	27.9	74	-	-	29.2	75	19	-
25.3	58	14	-	27.9	74	-	-	31.5	48	10	-
25.3	58	16	-	27.9	74	-	-	31.5	49	8	-
25.3	59	14	-	27.9	75	-	-	31.5	51	9	-
25.3	60	15	-	27.9	75	18	-	31.5	53	13	-
25.3	62	14	-	27.9	76	-	-	31.5	56	10	-
25.3	65	-	-	28.4	53	13	-	32.5	19	4	-
25.3	65	-	-	28.4	55	14	-	32.5	53	14	-
25.3	68	17	-	28.4	57	14	-	32.5	58	11	-
25.3	76	-	-	28.4	58	16	-	34.6	41	10	-
25.3	76	20	-	28.4	58	14	-	34.6	43	9	-
26.2	50	12	-	28.4	58	15	-	34.6	48	10	-
26.2	51	14	-	28.4	59	13	-	34.6	51	10	-
26.2	55	16	-	28.4	61	19	-	34.6	52	11	-
26.2	56	18	-	28.4	62	18	-	34.6	52	12	-
26.2	56	19	-	28.4	63	14	-	34.6	53	11	-
26.2	58	17	-	28.4	64	17	-	34.6	54	10	-
26.2	59	15	-	28.4	64	13	-	34.6	55	12	-
26.2	62	19	-	28.4	65	17	-	34.6	56	13	-
26.2	63	17	-	28.4	66	15	-	34.6	57	11	-
26.2	64	19	-	28.4	67	-	-	34.6	59	13	-
26.2	65	16	-	28.4	67	-	-	34.6	60	10	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Quadrula pustulosa cont'd.											
36.1	37	11	-	37.2	50	10	-	46.8	48	11	-
36.1	40	8	-	37.2	50	16	-	46.8	48	15	-
36.1	41	9	-	37.2	53	15	-	46.8	49	15	-
36.1	49	14	-	37.2	59	16	-	46.8	50	16	-
36.1	50	12	-	37.2	60	18	-	46.8	52	10	-
36.1	53	12	-	37.2	62	15	-	46.8	53	12	-
36.1	55	12	-	37.2	64	18	-	46.8	53	11	-
36.1	56	14	-	37.2	64	16	-	46.8	54	10	-
36.1	56	12	-	37.2	66	15	-	46.8	55	15	-
36.1	57	13	-	37.2	68	21	-	46.8	56	14	-
36.1	58	13	-	37.2	68	26	-	46.8	58	17	-
36.1	59	13	-	37.2	69	21	-	46.8	58	13	-
36.1	60	13	-	37.2	69	17	-	46.8	60	16	-
36.1	62	12	-	37.2	71	17	-	46.8	60	21	-
36.1	67	18	-	37.2	71	25	-	46.8	60	16	-
36.7	42	9	-	37.2	78	30	-	53.1	51	10	-
36.7	42	11	-	37.2	78	29	-	53.1	54	-	-
36.7	43	8	-	45.2	41	10	-	53.1	58	11	-
36.7	44	10	-	45.2	43	12	-	53.1	61	12	-
36.7	51	10	-	45.2	45	9	-	53.1	62	13	-
36.7	52	13	-	45.2	45	11	-	53.1	63	-	-
36.7	53	12	-	45.2	46	12	-	53.1	64	15	-
36.7	53	12	-	45.2	47	12	-	53.1	64	15	-
36.7	53	10	-	45.2	48	12	-	53.1	65	10	-
36.7	53	12	-	45.2	48	12	-	53.1	65	-	-
36.7	55	14	-	45.2	49	11	-	53.1	68	-	-
36.7	56	11	-	45.2	50	11	-	53.1	68	14	-
36.7	56	11	-	45.2	50	11	-	53.1	68	-	-
36.7	56	14	-	45.2	50	17	-	53.1	69	-	-
36.7	57	12	-	45.2	51	14	-	53.1	70	15	-
36.7	59	11	-	45.2	51	13	-	53.1	74	10	-
36.7	60	15	-	45.2	52	13	-	53.1	75	15	-
36.7	61	13	-	45.2	53	16	-	53.5	52	14	-
36.7	61	10	-	45.2	57	15	-	53.5	56	13	-
36.7	63	13	-	45.2	58	15	-	53.5	57	18	-
37.2	20	5	-	45.2	58	-	-	53.5	61	16	-
37.2	40	11	-	45.2	59	17	-	53.5	67	19	-
37.2	47	12	-								
Quadrula quadrula											
11.3	70	11	-	18.6	80	14	-	18.6	96	20	-
11.3	90	27	-	18.6	84	15	-	21.0	85	15	-
15.7	69	19	-	18.6	86	16	-	21.0	88	15	-
15.7	70	18	-	18.6	87	17	-	21.0	89	-	-
15.7	79	15	-	18.6	89	22	-	21.0	90	15	-
18.6	65	18	-	18.6	90	18	-	21.0	90	15	-
18.6	78	11	-	18.6	95	20	-	21.0	94	15	-

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Quadrula quadrula cont.											
21.0	98	-	-	24.7	93	19	-	45.2	63	12	-
21.0	98	20	-	24.7	94	16	-	45.2	65	10	-
21.0	99	20	-	24.7	95	15	-	45.2	69	14	-
22.9	88	24	-	24.7	95	18	-	45.2	69	16	-
22.9	89	20	-	24.7	96	15	-	45.2	69	16	-
22.9	92	17	-	25.3	76	13	-	45.2	70	16	-
22.9	93	20	-	25.3	83	16	-	45.2	71	13	-
22.9	94	21	-	25.3	88	15	-	45.2	71	13	-
22.9	95	20	-	25.3	97	15	-	45.2	72	12	-
22.9	95	22	-	25.3	107	15	-	45.2	73	14	-
23.8	23	3	-	26.2	89	18	-	45.2	74	11	-
23.8	78	14	-	26.2	91	15	-	45.2	75	13	-
23.8	80	20	-	26.2	96	19	-	45.2	75	14	-
23.8	85	15	-	26.2	101	20	-	45.2	79	15	-
23.8	85	19	-	27.9	75	11	-	45.2	80	17	-
23.8	85	16	-	27.9	84	21	-	45.2	80	13	-
23.8	91	15	-	27.9	90	17	-	45.2	80	18	-
23.8	92	14	-	28.4	36	7	-	45.2	81	10	-
23.8	95	19	-	28.4	67	12	-	45.2	82	11	-
23.8	95	15	-	28.4	88	17	-	45.2	84	18	-
23.8	96	15	-	28.4	90	18	-	45.2	85	15	-
23.8	97	19	-	28.4	92	18	-	45.2	86	14	-
24.7	72	15	-	28.4	93	23	-	45.2	86	21	-
24.7	80	-	-	28.4	104	15	-	45.2	89	20	-
24.7	80	17	-	28.4	106	22	-	45.2	90	-	-
24.7	82	15	-	29.2	74	10	-	45.2	90	14	-
24.7	84	15	-	29.2	89	-	-	46.8	64	-	-
24.7	86	17	-	29.2	91	15	-	46.8	69	11	-
24.7	88	15	-	34.6	82	18	-	46.8	69	10	-
24.7	89	15	-	34.6	90	19	-	46.8	74	12	-
24.7	89	19	-	36.1	72	13	-	46.8	75	10	-
24.7	89	15	-	36.7	65	12	-	46.8	76	13	-
24.7	90	16	-	36.7	68	11	-	46.8	79	10	-
24.7	90	15	-	42.5	61	14	-	46.8	80	10	-
24.7	90	18	-	45.2	62	11	-	46.8	89	-	-
24.7	91	17	-	45.2	67	13	-	53.1	82	14	-
24.7	91	15	-	45.2	68	15	-	-	-	-	-
Tritogonia verrucosa											
15.7	81	11	m	18.6	95	15	m	18.6	109	11	m
15.7	95	16	m	18.6	102	10	m	18.6	110	16	m
15.7	100	14	m	18.6	102	10	m	18.6	110	10	m
15.7	105	14	m	18.6	102	13	f	18.6	111	15	m
15.7	121	14	f	18.6	104	-	m	18.6	111	-	m
15.7	125	10	f	18.6	106	-	m	18.6	115	13	f
18.6	29	3	-	18.6	108	-	f	18.6	115	12	f
18.6	94	10	m	18.6	109	14	m	18.6	115	-	f

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Tritogonia verrucosa cont'd.											
18.6	123	15	f	23.8	120	15	m	27.9	91	16	m
18.6	130	-	f	23.8	123	20	f	27.9	100	16	m
21.0	56	7	m	23.8	124	18	f	27.9	100	126	m
21.0	74	8	m	23.8	125	25	f	27.9	100	14	m
21.0	95	10	m	23.8	126	18	f	27.9	101	19	m
21.0	98	15	m	23.8	130	22	f	27.9	102	13	m
21.0	100	10	m	23.8	133	15	f	27.9	103	11	f
21.0	101	15	m	23.8	140	-	f	27.9	104	14	m
21.0	102	10	f	24.7	96	12	m	27.9	104	10	m
21.0	103	10	-	24.7	100	13	m	27.9	107	15	m
21.0	105	16	m	24.7	101	16	m	27.9	115	14	f
21.0	106	10	f	24.7	105	11	m	27.9	115	14	f
21.0	109	15	m	24.7	106	17	m	27.9	115	14	f
21.0	111	20	m	24.7	107	19	m	27.9	116	13	m
21.0	115	15	f	24.7	110	10	m	27.9	117	10	f
21.0	119	15	f	24.7	112	11	m	27.9	118	13	m
21.0	123	10	f	24.7	114	-	m	27.9	120	14	f
22.9	91	14	m	24.7	115	-	m	27.9	124	16	f
22.9	99	15	m	24.7	120	15	f	27.9	125	15	f
22.9	100	-	m	24.7	125	-	f	28.4	41	4	-
22.9	100	17	m	25.3	72	11	m	28.4	68	8	m
22.9	100	-	m	25.3	80	11	f	28.4	80	11	m
22.9	102	13	m	25.3	92	-	m	28.4	86	17	m
22.9	103	-	m	25.3	93	-	m	28.4	91	11	m
22.9	108	12	f	25.3	94	-	f	28.4	95	14	m
22.9	108	10	m	25.3	95	24	m	28.4	96	13	m
22.9	109	-	m	25.3	97	-	m	28.4	96	16	m
22.9	110	10	m	25.3	97	11	f	28.4	97	15	m
22.9	111	10	m	25.3	101	-	m	28.4	100	18	m
22.9	115	14	f	25.3	103	-	m	28.4	100	17	m
22.9	116	16	f	25.3	104	-	m	28.4	100	16	m
22.9	119	12	f	25.3	109	-	f	28.4	101	14	m
22.9	119	-	m	25.3	110	-	f	28.4	103	15	m
22.9	123	10	f	25.3	110	-	m	28.4	104	13	m
23.8	100	10	m	25.3	111	-	m	28.4	105	15	m
23.8	101	13	m	25.3	111	-	f	28.4	105	17	m
23.8	104	16	m	25.3	113	-	f	28.4	111	17	m
23.8	105	-	m	25.3	115	-	m	28.4	117	17	f
23.8	110	-	m	25.3	120	-	f	28.4	125	10	f
23.8	110	18	m	25.3	130	20	f	29.2	32	6	-
23.8	113	19	m	26.2	66	8	m	29.2	88	10	m
23.8	114	-	m	26.2	100	21	m	29.2	95	12	m
23.8	115	16	m	26.2	125	15	f	29.2	99	16	m
23.8	117	17	m	26.2	125	19	f	29.2	101	10	m
23.8	118	15	m	26.2	132	23	f	29.2	103	-	m
23.8	119	21	m	27.9	62	8	m	29.2	103	14	m

Appendix C, Table 1. Lengths, age estimates, and gender of unionids collected from the Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Tritogonia verrucosa cont'd.											
29.2	104	15	m	34.6	91	16	m	37.2	127	14	f
29.2	105	12	m	34.6	94	13	m	37.2	127	13	f
29.2	107	20	m	34.6	101	14	f	45.2	71	9	m
29.2	108	20	m	34.6	118	12	f	45.2	78	10	m
29.2	109	16	m	34.6	125	17	f	45.2	80	11	m
29.2	110	13	f	36.1	100	13	m	45.2	80	11	m
29.2	111	13	f	36.1	104	14	m	45.2	80	11	f
29.2	119	18	f	36.7	70	8	-	45.2	85	11	f
29.2	120	15	f	36.7	83	12	-	45.2	86	10	f
29.2	120	13	f	36.7	94	11	-	53.1	78	15	f
29.2	121	10	f	36.7	98	13	-	53.1	87	16	-
29.2	129	15	f	36.7	103	13	-	53.1	96	10	m
29.2	134	14	f	36.7	109	16	-	53.1	100	10	m
32.5	91	11	m	36.7	117	16	-	53.1	105	-	f
34.6	90	12	m	37.2	50	12	m				
Truncilla truncata											
15.7	67	22	-	25.3	63	10	-	36.7	55	9	-
18.6	50	16	-	26.2	60	16	-	36.7	65	14	-
18.6	59	19	-	27.9	74	15	-	36.7	68	15	-
18.6	59	18	-	28.4	57	11	-	36.7	70	15	-
21.0	53	10	-	28.4	63	13	-	36.7	73	14	-
21.0	62	11	-	29.2	69	14	-	36.7	77	18	-
21.0	63	13	-	34.6	53	12	-	37.2	31	7	-
23.8	21	4	-	36.1	61	14	-	37.2	38	9	-
24.7	49	8	-	36.7	51	10	-	37.2	56	12	-
x	45	14	-	36.7	53	9	-				
Venustaconcha ellipsiformis											
27.9	78	-	m	32.5	71	16	f	33.5	70	-	m
27.9	88	20	m								

Appendix C, Table 2. Lengths, age estimates, and gender of unionids collected from the Horse Creek, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Amblema plicata											
13.3	50	8	-	13.3	92	10	-	13.3	110	15	-
13.3	69	11	-	13.3	96	15	-	13.3	114	15	-
13.3	72	10	-	13.3	96	10	-	13.3	114	-	-
13.3	74	9	-	13.3	97	15	-	13.3	123	-	-
13.3	81	10	-	13.3	97	15	-	13.3	125	15	-
13.3	81	9	-	13.3	105	10	-	13.3	139	-	-
13.3	86	11	-	13.3	107	10	-				
Elliptio dilatata											
13.3	88	7	-	13.3	96	9	-	13.3	111	10	-
13.3	90	7	-	13.3	99	8	-	13.3	113	14	-
13.3	92	8	-	13.3	106	11	-	13.3	115	-	-
13.3	95	8	-	13.3	108	11	-	13.3	119	10	-
13.3	95	8	-								
Fusconaia ozarkensis											
13.3	75	9	-								
Lampsilis cardium											
13.3	89	7	-	13.3	129	14	-	13.3	132	15	-
Lampsilis siliquoidea											
13.3	96	9	f	13.3	110	12	f	13.3	119	13	m
13.3	99	9	f	13.3	113	14	m	13.3	124	10	m
13.3	102	9	f	13.3	113	10	f	13.3	125	15	m
13.3	103	11	f	13.3	115	8	m	13.3	126	-	m
13.3	106	9	f	13.3	115	13	f	13.3	129	13	m
13.3	109	11	f	13.3	116	14	f	13.3	140	-	m
13.3	109	10	f	13.3	119	10	m				
Lasmigona complanata											
13.3	172	20	-								
Leptodea fragilis											
13.3	31	2	-	13.3	101	9	-	13.3	112	10	-
13.3	96	7	-	13.3	112	10	-	13.3	116	11	-
13.3	100	8	-								
Ligumia subrostrata											
13.3	70	13	-								
Obliquaria reflexa											
13.3	44	8	-	13.3	66	13	-	13.3	66	14	-
Potamilus alatus											
13.3	97	9	f	13.3	124	14	f	13.3	135	13	m
13.3	101	9	f	13.3	125	14	f	13.3	136	15	m
13.3	111	13	f	13.3	128	10	m	13.3	136	15	m
13.3	113	13	m	13.3	129	17	m	13.3	136	10	f
13.3	119	10	f	13.3	129	10	m	13.3	141	15	f
13.3	119	12	f	13.3	130	15	m	13.3	160	20	m
13.3	123	10	f	13.3	132	10	f				

Appendix C, Table 2 cont. Lengths, age estimates, and gender of unionids collected from the Horse Creek, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Pyganodon grandis											
13.3	98	6	-	13.3	110	9	-	13.3	119	12	-
13.3	100	8	-	13.3	110	9	-	13.3	119	10	-
13.3	102	7	-	13.3	111	8	-	13.3	120	11	-
13.3	104	7	-	13.3	115	11	-	13.3	125	9	-
13.3	105	10	-	13.3	115	9	-	13.3	125	12	-
13.3	110	9	-	13.3	115	9	-	13.3	139	13	-
13.3	110	9	-	13.3	118	10	-				
Quadrula pustulosa											
13.3	78	20	-	13.3	85	12	-	13.3	96	9	-
13.3	64	8	-	13.3	90	14	-	13.3	98	13	-
13.3	70	9	-	13.3	92	13	-	13.3	105	15	-
13.3	75	7	-								
Strophitus undulatus											
13.3	89	9	-	13.3	99	12	-	13.3	100	10	-
13.3	92	11	-	-	-	-	-	-	-	-	-
Tritogonia verrucosa											
13.3	85	6	m	13.3	115	10	f	13.3	129	9	f
13.3	90	7	m	13.3	117	13	m	13.3	129	10	f
13.3	99	8	f	13.3	123	-	m	13.3	133	10	f
13.3	109	11	m	13.3	123	14	m	13.3	141	10	f
13.3	110	10	m	13.3	123	10	f	13.3	141	10	f
13.3	111	10	m	13.3	126	10	f	13.3	144	13	f
13.3	114	9	m	13.3	126	13	f	-	-	-	-
Truncilla truncata											
13.3	45	5	-	-	-	-	-	-	-	-	-

Appendix C, Table 3. Lengths, age estimates, and gender of unionids collected from the Bear Creek, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Lampsilis siliquoidea											
7.6	59	5	m	7.6	101	11	f	7.6	110	10	m
7.6	75	5	m	7.6	103	10	f	7.6	111	12	f
7.6	75	5	f	7.6	104	8	m	7.6	114	-	m
7.6	79	5	f	7.6	105	10	m	7.6	119	10	f
7.6	89	12	f	7.6	105	9	m	7.6	120	14	f
7.6	100	8	m	7.6	107	11	f	7.6	122	20	f
7.6	101	8	m	7.6	109	11	f	7.6	129	-	m
Ligumia subrostrata											
7.6	59	10	f	7.6	60	11	f				
Simpsonaias ambigua											
7.6	44	7	m								
Strophitus undulatus											
7.6	45	4	-	7.6	70	7	-	7.6	74	9	-
7.6	60	6	-								
Venustaconcha ellipsiformis											
7.6	54	7	f	7.6	58	7	f	-	-	-	-
7.6	55	7	f	7.6	58	8	f	7.6	66	12	f
7.6	55	7	f	7.6	58	7	f	7.6	68	8	m
7.6	55	8	f	7.6	58	8	f	7.6	70	9	m
7.6	56	7	f	7.6	62	7	m	7.6	70	10	m
7.6	57	7	f	7.6	63	8	m	7.6	71	10	m
7.6	57	10	f	7.6	65	7	m	7.6	75	10	m

Appendix C, Table 4. Lengths, age estimates, and gender of unionids collected from the Little Sac River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Actinonais Ligamentina											
12.1	109	14	-								
Elliptio dilatata											
12.1	83	10	-	12.1	91	15	-	12.1	95	18	-
12.1	89	14	-	12.1	92	15	-				
Lampsilis cardium											
12.1	72	9	f	12.1	105	16	f	12.1	117	14	m
12.1	74	10	f	12.1	108	18	m	12.1	121	17	m
12.1	90	17	f	12.1	110	20	f	12.1	126	15	m
12.1	94	17	f	12.1	111	16	f	12.1	135	25	m
12.1	95	18	f	12.1	112	13	m	12.1	142	25	m
12.1	98	15	f	12.1	115	14	m	12.1	142	25	m
12.1	99	15	f								
Lampsilis siliquoidea											
12.1	95	15	m								
Potamilus alatus											
12.1	120	20	f	12.1	135	24	m	12.1	164	30	m
12.1	131	20	f	12.1	141	25	f				
Quadrula pustulosa											
12.1	68	25	-								
Tritogonia verrucosa											
12.1	105	16	m	12.1	115	15	m				
Venustaconcha ellipsiformis											
12.1	71	14	m	12.1	96	15	m				

Appendix C, Table 5. Lengths, age estimates, and gender of unionids collected from the Pomme de Terre River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Actinonais Ligamentina											
23.5	-	-	-	32.9	124	15	f	33.6	120	15	f
29.4	104	17	-	33.6	95	14	-	33.6	122	15	-
29.4	111	14	-	33.6	114	15	-	41.4	123	13	-
32.7	130	18	-	33.6	116	18	f	73.2	-	-	-
32.9	112	15	-	33.6	120	15	-	87.2	-	-	-
Alasmidonta marginata											
29.4	46	8	-	32.9	70	7	-	99.8	88	14	-
32.9	70	7	-	33.6	82	10	-	-	-	-	-
Amblema plicata											
22.6	95	11	-	23.5	104	15	-	26.9	92	24	-
22.6	100	10	-	23.5	104	16	-	26.9	92	33	-
22.6	104	15	-	23.5	105	19	-	26.9	95	-	-
22.6	106	10	-	23.5	106	15	-	26.9	95	19	-
22.6	108	11	-	23.5	110	15	-	26.9	96	18	-
22.6	108	14	-	23.5	126	20	-	26.9	99	25	-
22.6	108	15	-	23.5	131	20	-	26.9	104	22	-
22.6	109	14	-	24.8	88	-	-	26.9	105	24	-
22.6	110	11	-	24.8	88	-	-	26.9	106	14	-
22.6	113	16	-	24.8	94	-	-	26.9	106	22	-
22.6	115	13	-	24.8	95	107	-	26.9	108	23	-
22.6	122	-	-	24.8	96	10	-	26.9	115	25	-
22.6	124	15	-	24.8	100	10	-	26.9	117	25	-
22.6	125	15	-	24.8	100	10	-	29.4	15	3	-
22.6	128	-	-	24.8	102	10	-	29.4	25	5	-
22.6	130	17	-	24.8	103	10	-	29.4	30	7	-
22.6	139	19	-	24.8	108	10	-	29.4	53	9	-
22.6	142	-	-	24.8	109	10	-	29.4	65	11	-
22.6	142	17	-	24.8	110	10	-	29.4	70	13	-
22.6	149	20	-	24.8	112	10	-	29.4	75	12	-
23.5	61	7	-	24.8	112	15	-	29.4	80	15	-
23.5	67	8	-	24.8	115	10	-	29.4	88	15	-
23.5	70	8	-	24.8	116	10	-	29.4	88	16	-
23.5	75	8	-	24.8	119	10	-	29.4	88	17	-
23.5	80	8	-	24.8	123	15	-	29.4	90	16	-
23.5	80	9	-	24.8	128	10	-	29.4	95	20	-
23.5	94	11	-	24.8	134	10	-	29.4	96	18	-
23.5	94	12	-	26.9	20	5	-	29.4	100	19	-
23.5	96	10	-	26.9	37	7	-	29.4	108	20	-
23.5	97	10	-	26.9	40	8	-	29.4	110	20	-
23.5	99	11	-	26.9	46	7	-	29.4	110	20	-
23.5	99	12	-	26.9	47	8	-	29.4	110	22	-
23.5	100	-	-	26.9	75	14	-	29.4	120	-	-
23.5	103	17	-	26.9	90	23	-	32.7	15	2	-

Appendix C, Table 5. Lengths, age estimates, and gender of unionids collected from the Pomme de Terre River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Amblema plicata cont.											
32.7	18	2	-	33.6	60	10	-	38.9	41	10	-
32.7	20	3	-	33.6	68	10	-	38.9	45	7	-
32.7	21	3	-	33.6	74	12	-	38.9	46	12	-
32.7	31	3	-	33.6	81	10	-	38.9	50	11	-
32.7	35	3	-	33.6	82	10	-	38.9	60	9	-
32.7	55	8	-	33.6	85	15	-	38.9	64	13	-
32.7	60	8	-	33.6	85	18	-	38.9	69	17	-
32.7	72	17	-	33.6	90	15	-	38.9	72	14	-
32.7	79	14	-	33.6	91	15	-	38.9	78	21	-
32.7	82	18	-	33.6	92	16	-	38.9	80	18	-
32.7	84	15	-	33.6	93	18	-	38.9	81	13	-
32.7	88	17	-	33.6	100	15	-	38.9	83	11	-
32.7	93	14	-	33.6	112	-	-	38.9	85	20	-
32.7	112	-	-	33.6	112	-	-	38.9	95	20	-
32.7	113	25	-	33.6	113	15	-	38.9	96	14	-
32.7	115	20	-	33.6	115	20	-	38.9	110	25	-
32.7	116	-	-	33.6	116	-	-	38.9	123	30	-
32.7	118	25	-	33.6	118	-	-	38.9	125	25	-
32.7	118	25	-	33.6	120	20	-	38.9	130	30	-
32.7	122	25	-	36.7	18	3	-	41.4	50	8	-
32.9	16	2	-	36.7	28	4	-	41.4	58	11	-
32.9	33	5	-	36.7	31	5	-	41.4	75	14	-
32.9	40	8	-	36.7	36	4	-	41.4	78	13	-
32.9	50	8	-	36.7	46	8	-	41.4	79	13	-
32.9	57	10	-	36.7	55	8	-	41.4	80	13	-
32.9	58	11	-	36.7	57	9	-	41.4	86	14	-
32.9	62	11	-	36.7	70	14	-	41.4	88	17	-
32.9	70	10	-	36.7	80	17	-	41.4	99	-	-
32.9	75	13	-	36.7	85	18	-	41.4	99	15	-
32.9	90	17	-	36.7	88	15	-	41.4	99	16	-
32.9	92	20	-	36.7	89	17	-	41.4	103	20	-
32.9	101	15	-	36.7	95	24	-	41.4	104	22	-
32.9	102	15	-	36.7	97	17	-	41.4	105	19	-
32.9	105	15	-	36.7	97	20	-	41.4	105	23	-
32.9	105	25	-	36.7	98	25	-	41.4	109	21	-
32.9	110	15	-	36.7	108	23	-	41.4	110	25	-
32.9	115	20	-	36.7	110	15	-	41.4	111	20	-
32.9	118	25	-	36.7	110	20	-	41.4	114	24	-
32.9	119	20	-	36.7	111	15	-	41.4	116	25	-
32.9	133	25	-	38.9	37	8	-	73.2	103	10	-
33.6	35	5	-	-	-	-	-	-	-	-	-

Appendix C, Table 5. Lengths, age estimates, and gender of unionids collected from the Pomme de Terre River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Anodonta suborbiculata											
38.9	153	11	-	38.9	162	13	-	38.9	172	12	-
38.9	155	10	-	38.9	169	14	-				
Arcidens confragosus											
23.5	100	13	-	23.5	115	14	-	-	-	-	-
Cyclonaias tuberculata											
22.6	78	9	-	23.5	91	15	-	32.9	23	4	-
22.6	83	11	-	23.5	101	20	-	32.9	38	7	-
22.6	88	13	-	23.5	104	20	-	32.9	43	7	-
22.6	92	14	-	24.8	85	11	-	32.9	65	11	-
22.6	92	15	-	24.8	101	14	-	32.9	72	13	-
22.6	93	18	-	24.8	101	14	-	32.9	79	13	-
22.6	94	13	-	24.8	101	16	-	32.9	79	14	-
22.6	95	17	-	24.8	109	16	-	32.9	84	14	-
22.6	96	21	-	26.9	73	16	-	32.9	90	17	-
22.6	99	-	-	26.9	76	22	-	32.9	90	20	-
22.6	101	-	-	26.9	77	14	-	32.9	95	20	-
22.6	101	14	-	26.9	79	16	-	32.9	99	23	-
22.6	102	19	-	26.9	83	21	-	33.6	60	14	-
22.6	103	18	-	26.9	84	17	-	33.6	79	15	-
22.6	104	13	-	26.9	84	19	-	33.6	81	13	-
22.6	105	16	-	26.9	84	24	-	33.6	81	15	-
22.6	107	21	-	26.9	85	23	-	33.6	81	18	-
22.6	111	20	-	26.9	88	23	-	33.6	82	15	-
22.6	114	-	-	26.9	88	29	-	33.6	84	15	-
22.6	120	17	-	26.9	88	31	-	33.6	85	-	-
23.5	48	7	-	26.9	89	23	-	33.6	88	20	-
23.5	60	9	-	26.9	96	20	-	33.6	90	20	-
23.5	62	8	-	26.9	97	25	-	33.6	92	20	-
23.5	66	11	-	26.9	98	20	-	33.6	93	15	-
23.5	69	11	-	26.9	98	31	-	33.6	94	15	-
23.5	69	11	-	26.9	100	-	-	33.6	95	15	-
23.5	75	12	-	26.9	106	30	-	33.6	95	15	-
23.5	75	13	-	29.4	40	8	-	33.6	95	20	-
23.5	82	15	-	29.4	45	10	-	33.6	101	-	-
23.5	86	19	-	29.4	76	18	-	33.6	111	25	-
23.5	87	17	-	29.4	78	15	-	36.7	76	20	-
23.5	88	20	-	29.4	78	17	-	36.7	83	20	-
23.5	89	19	-	29.4	83	15	-	36.7	89	20	-
23.5	90	18	-	29.4	83	21	-	38.9	69	15	-
23.5	90	19	-	29.4	90	20	-	41.4	-	-	-
23.5	90	20	-	32.9	16	3	-	-	-	-	-

Appendix C, Table 5. Lengths, age estimates, and gender of unionids collected from the Pomme de Terre River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Ellipsaria lineolata											
22.6	110	12	m	22.6	126	13	m	26.9	98	10	m
22.6	120	14	m	24.8	105	9	m	32.9	96	15	m
Elliptio dilatata											
26.9	90	11	-	29.4	83	15	-	32.7	83	10	-
29.4	48	6	-	29.4	84	15	-	32.7	87	7	-
29.4	68	9	-	29.4	84	16	-	32.7	92	15	-
29.4	75	10	-	29.4	87	15	-	33.6	51	5	-
29.4	80	14	-	29.4	89	15	-	33.6	55	5	-
29.4	80	15	-	29.4	95	10	-	33.6	58	7	-
Elliptio dilatata cont.											
33.6	67	9	-	33.6	83	13	-	38.9	84	15	-
33.6	68	10	-	33.6	85	10	-	38.9	84	15	-
33.6	71	8	-	33.6	85	15	-	38.9	89	13	-
33.6	72	8	-	33.6	86	10	-	38.9	89	15	-
33.6	76	10	-	38.9	74	15	-	38.9	90	15	-
33.6	77	11	-	38.9	75	15	-	73.2	95	6	-
33.6	78	12	-	38.9	78	15	-	73.2	95	6	-
33.6	78	14	-	38.9	78	15	-	73.2	110	10	-
33.6	80	10	-	38.9	79	15	-	99.8	77	10	-
33.6	80	10	-	38.9	80	10	-	99.8	83	11	-
33.6	81	11	-	38.9	80	15	-	99.8	87	10	-
33.6	81	12	-	38.9	80	15	-	99.8	88	12	-
33.6	83	10	-	38.9	81	15	-	-	-	-	-
Fusconaia flava											
22.6	82	12	f	26.9	76	20	-	32.9	68	11	-
22.6	84	14	-	26.9	79	17	-	32.9	69	12	-
22.6	88	10	-	26.9	82	21	-	32.9	81	15	-
22.6	90	13	-	26.9	84	-	-	33.6	59	10	-
22.6	93	16	-	26.9	85	15	-	33.6	59	11	-
22.6	100	16	-	29.4	68	16	-	33.6	64	14	-
23.5	-	-	-	32.7	66	10	-	33.6	65	-	-
24.8	73	14	-	32.7	80	-	-	33.6	67	-	-
24.8	85	15		32.9	64	10	-	33.6	78	10	-
26.9	63	14	-	32.9	65	11	-	41.4	-	-	-
26.9	75	19	-	32.9	65	13	-	87.2	78	11	-
Fusconaia ozarkensis											
36.7	36	8	-	38.9	68	11	-	87.2	91	10	-
36.7	68	10	-	38.9	70	14	-	99.8	70	11	-
38.9	67	12	-	73.2	-	-	-	-	-	-	-

Appendix C, Table 5. Lengths, age estimates, and gender of unionids collected from the Pomme de Terre River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Lampsilis cardium											
22.6	123	-	f	32.7	105	20	f	33.6	114	-	m
22.6	140	15	m	32.7	106	10	f	33.6	116	13	m
23.5	148	15	m	32.7	107	22	f	33.6	117	-	f
24.8	127	10	f	32.7	109	15	m	36.7	88	10	-
26.9	80	9	f	32.9	90	9	f	36.7	89	13	-
26.9	124	22	m	32.9	91	12	f	36.7	91	-	-
29.4	92	13	f	32.9	98	12	f	36.7	94	-	-
29.4	92	15	f	32.9	102	10	f	36.7	94	15	-
29.4	97	15	f	32.9	103	-	m	36.7	95	-	-
29.4	100	14	f	32.9	105	-	f	36.7	97	17	-
29.4	100	15	f	32.9	105	18	f	36.7	98	16	-
29.4	100	19	f	32.9	106	-	f	36.7	103	-	-
29.4	105	15	f	32.9	106	14	f	36.7	103	15	-
29.4	105	15	f	32.9	110	-	f	36.7	103	17	-
29.4	109	15	f	32.9	110	18	f	36.7	104	18	-
29.4	110	15	f	32.9	111	15	m	36.7	110	-	-
29.4	110	15	m	32.9	115	17	m	36.7	110	-	-
29.4	112	15	f	32.9	118	16	m	36.7	110	19	-
29.4	115	15	m	32.9	120	-	m	36.7	112	-	-
29.4	120	15	m	32.9	120	10	m	36.7	113	-	-
29.4	120	15	m	32.9	122	-	m	36.7	118	20	-
29.4	120	15	m	32.9	123	10	m	36.7	120	20	-
29.4	122	15	m	32.9	123	15	m	36.7	122	15	-
29.4	123	15	m	32.9	129	18	m	38.9	82	9	f
29.4	125	-	m	32.9	135	19	m	38.9	90	12	f
29.4	126	15	m	33.6	91	-	f	38.9	92	10	f
32.7	85	12	m	33.6	91	-	m	38.9	95	15	f
32.7	92	10	f	33.6	95	-	f	38.9	98	-	f
32.7	100	20	f	33.6	96	-	f	38.9	100	-	f
32.7	100	20	f	33.6	98	15	f	38.9	100	17	f
32.7	100	22	f	33.6	99	-	f	38.9	100	20	f
32.7	100	23	f	33.6	101	-	f	38.9	105	10	f
32.7	104	18	f	33.6	105	-	f	38.9	105	16	f
32.7	109	20	f	33.6	110	-	m	38.9	106	15	f
32.7	115	20	m	33.6	110	14	f	38.9	109	17	m
32.7	116	15	m	33.6	110	15	m	38.9	112	15	m
32.7	117	15	m	33.6	111	15	m	38.9	115	21	m
32.7	119	15	m	33.6	120	15	m	38.9	118	-	f
32.7	120	17	m	33.6	111	17	m	38.9	120	-	m
32.7	125	25	m	33.6	113	15	m	38.9	121	17	m
32.7	125	25	m	33.6	113	16	m	38.9	123	19	m
32.7	129	15	m	33.6	113	17	m	38.9	125	15	m

Appendix C, Table 5. Lengths, age estimates, and gender of unionids collected from the Pomme de Terre River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Lampsilis cardium cont.											
38.9	129	18	m	73.2	131	9	m	99.8	97	11	f
41.4	94	-	f	73.2	137	-	f	99.8	100	11	f
41.4	95	15	f	87.1	88	8	m	99.8	104	13	m
41.4	100	-	f	87.0	104	11	f	99.8	108	11	m
41.4	101	-	f	87.1	121	13	f	99.8	108	13	m
41.4	102	-	f	87.2	130	10	f	99.8	108	15	m
41.4	103	-	f	99.8	81	12	f	99.8	109	14	m
41.4	109	-	f	99.8	89	15	f	99.8	111	10	m
41.4	110	-	m	99.8	90	11	f	99.8	113	14	m
41.4	124	-	m	99.8	91	10	f	99.8	116	14	m
41.4	125	-	m	99.8	91	15	f	99.8	119	14	m
41.4	125	-	m	99.8	93	11	f	99.8	123	15	m
73.2	115	7	m	99.8	95	12	f	99.8	124	15	m
73.2	130	8	m	99.8	96	12	f	-	-	-	-
Lampsilis siliquoidea											
26.9	123	15	m	73.2	130	6	m	99.8	104	15	f
26.9	135	15	m	87.2	111	10	f	99.8	105	11	f
32.9	100	11	m	87.2	114	11	m	99.8	105	15	m
33.6	101	10	m	87.2	115	8	m	99.8	108	14	f
33.6	102	10	f	87.2	115	14	f	99.8	112	14	m
33.6	115	10	m	87.2	116	13	m	99.8	115	13	m
33.6	118	13	m	87.2	117	12	f	99.8	116	10	f
38.9	111	10	f	87.2	125	12	m	99.8	116	15	m
38.9	113	10	m	87.2	128	14	m	99.8	120	14	f
38.9	120	15	m	87.2	130	14	m	99.8	122	16	f
38.9	131	15	f	99.8	88	14	f	99.8	125	11	m
41.4	121	10	f	99.8	99	12	f	99.8	133	16	m
41.4	125	10	m	99.8	103	10	f	99.8	134	15	m
73.2	125	7	f	99.8	104	11	f	99.8	135	15	m
73.2	128	5	m	99.8	104	13	f	99.8	140	14	m
Lampsilis teres											
33.6	95	10	-	-	-	-	-	-	-	-	-
Lasmigona complanata											
23.5	144	15	-	23.5	178	19	-	33.6	131	15	-
23.5	145	14	-	26.9	37	5	-	33.6	139	15	-
23.5	158	16	-	26.9	140	20	-	36.7	130	24	-
23.5	158	16	-	26.9	147	15	-	36.7	132	15	-
23.5	161	18	-	32.7	145	20	-	36.7	140	20	-
23.5	172	18	-	33.6	105	12	-	36.7	146	-	-
38.9	114	20	-	38.9	144	20	-	41.4	159	25	-
38.9	125	24	-	41.4	144	15	-	41.4	170	25	-
38.9	146	30	-	-	-	-	-	-	-	-	-

Appendix C, Table 5. Lengths, age estimates, and gender of unionids collected from the Pomme de Terre River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Lasmigona costata											
32.9	94	12	f	33.6	105	-	-	33.6	115	14	-
33.6	101	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis											
23.5	111	5	m	32.7	108	11	-	36.7	71	11	f
23.5	129	6	m	32.7	120	14	-	36.7	96	18	m
24.8	-	-	-	33.6	47	5	f	36.7	115	15	m
26.9	65	7	f	33.6	50	5	f	38.9	79	6	m
26.9	82	10	m	33.6	67	8	f	38.9	82	7	f
26.9	84	8	m	33.6	73	10	f	38.9	82	8	f
26.9	86	10	m	33.6	75	8	m	38.9	90	9	f
26.9	88	11	f	33.6	75	9	f	38.9	97	-	-
26.9	95		m	33.6	77	7	m	38.9	104	11	m
26.9	95	10	m	33.6	92	11	m	38.9	112	15	m
26.9	95	11	m	33.6	95	11	m	38.9	115	19	m
26.9	106	13	m	33.6	107	10	m	38.9	119	10	m
26.9	110	14	m	33.6	121	17	m	38.9	135	13	m
26.9	115	10	m	36.7	53	8	m	41.4	62	5	f
29.4	47	5	m	36.7	54	7	f	41.4	65	5	f
29.4	47	5	m	36.7	57	9	f	41.4	74	7	f
29.4	68	8	f	36.7	60	9	f	41.4	88	6	m
29.4	84	10	m	36.7	60	10	f	73.2	25	1	-
29.4	90	11	m	36.7	62	11	f	73.2	32	2	-
32.7	61	4	-	36.7	63	10	f	99.8	58	8	f
32.7	77	6	-	36.7	64	11	m	99.8	106	11	-
32.7	98	13	-	36.7	66	11	f	99.8	118	10	-
Ligumia recta											
22.6	151	11	m	29.4	127	20	f	33.6	133	15	f
23.5	144	16	f	29.4	145	22	f	33.6	135	15	m
23.5	148	12	f	29.4	146	20	m	33.6	135	17	m
23.5	149	15	f	32.7	143	15	f	33.6	145	15	f
24.8	163	10	m	32.7	147	-	f	33.6	149	-	m
26.9	131	15	f	32.7	147	15	f	33.6	150	-	m
26.9	135	17	f	32.7	149	18	m	33.6	155	15	m
26.9	142	15	f	32.7	152	18	m	33.6	162	15	m
26.9	144	18	m	32.7	152	25	f	36.7	83	12	m
26.9	145	-	m	32.7	153	21	m	36.7	89	12	m
26.9	145	15	m	32.7	156	20	m	36.7	114	15	m
26.9	146	15	m	32.7	159	20	f	36.7	141	19	m
26.9	147	15	m	32.7	160	15	f	38.9	135	15	f
26.9	154	15	m	32.9	155	15	m	38.9	136	19	m
26.9	155	18	m	32.9	160	18	m	41.4	142	14	m
26.9	160	20	m	33.6	130	15	f	-	-	-	-

Appendix C, Table 5. Lengths, age estimates, and gender of unionids collected from the Pomme de Terre River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Megalonaias nervosa											
22.6	162	24	-	22.6	203	30	-	32.9	166	30	-
22.6	167	25	-	24.8	168	20	-	32.9	175	30	-
22.6	173	25	-	26.9	135	30	-	33.6	132	30	-
22.6	175	26	-	26.9	140	30	-	33.6	140	30	-
22.6	180	28	-	26.9	141	30	-	33.6	147	30	-
22.6	180	30	-	26.9	145	30	-	33.6	150	30	-
22.6	181	26	-	26.9	148	30	-	33.6	161	30	-
22.6	182	26	-	26.9	150	30	-	33.6	162	30	-
22.6	182	33	-	26.9	152	30	-	33.6	165	30	-
22.6	183	30	-	26.9	154	30	-	33.6	167	30	-
22.6	185	29	-	26.9	156	30	-	33.6	171	30	-
22.6	185	30	-	26.9	160	30	-	33.6	183	30	-
22.6	185	30	-	26.9	161	41	-	38.9	163	30	-
22.6	187	25	-	26.9	162	30	-	38.9	165	30	-
22.6	188	30	-	29.4	125	32	-	38.9	170	30	-
22.6	189	28	-	29.4	154	30	-	38.9	179	30	-
22.6	189	30	-	32.7	132	24	-	38.9	182	30	-
22.6	192	30	-	32.7	169	50	-	41.4	161	35	-
22.6	195	30	-	32.9	155	30	-	-	-	-	-
Obliquaria reflexa											
22.6	58	10	-	26.9	48	13	-	32.9	34	4	-
22.6	58	13	-	26.9	54	14	-	32.9	45	7	-
22.6	59	11	-	26.9	57	16	-	32.9	48	8	-
22.6	60	15	-	26.9	57	16	-	32.9	57	11	-
22.6	61	12	-	26.9	58	15	-	32.9	67	13	-
22.6	63	12	-	26.9	61	17	-	33.6	47	9	-
22.6	64	13	-	26.9	62	16	-	33.6	53	10	-
22.6	65	13	-	26.9	64	19	-	36.7	57	20	-
22.6	69	11	-	26.9	66	-	-	38.9	50	14	-
22.6	70	13	-	26.9	69	18	-	38.9	51	13	-
22.6	73	10	-	26.9	71	29	-	38.9	53	15	-
22.6	73	12	-	29.4	49	9	-	38.9	56	-	-
22.6	74	14	-	29.4	50	14	-	38.9	58	18	-
22.6	78	-	-	29.4	59	12	-	38.9	65	19	-
23.5	67	8	-	29.4	59	14	-	41.4	50	10	-
23.5	67	14	-	29.4	60	10	-	41.4	58	14	-
23.5	69	14	-	29.4	62	18	-	41.4	62	15	-
23.5	74	15	-	32.7	46	8	-	41.4	69	15	-
24.8	56	13	-	32.7	60	14	-	41.4	69	15	-
24.8	60	9	-	32.7	62	13	-	73.2	73	10	-
24.8	69	12	-	-	-	-	-	-	-	-	-

Appendix C, Table 5. Lengths, age estimates, and gender of unionids collected from the Pomme de Terre River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Pleurobema sintoxia											
22.6	71	13	-	26.9	85	15	-	32.9	15	2	-
22.6	79	13	-	29.4	43	11	-	32.9	37	6	-
22.6	81	14	-	29.4	58	13	-	32.9	45	10	-
22.6	84	14	-	29.4	60	15	-	32.9	65	12	-
22.6	89	15	-	29.4	63	17	-	32.9	78	14	-
22.6	91	12	-	29.4	63	18	-	33.6	46	8	-
22.6	91	12	-	29.4	66	17	-	33.6	68	10	-
22.6	109	16	-	29.4	70	19	-	33.6	74	10	-
23.5	80	13	-	29.4	70	23	-	38.9	24	5	-
26.9	31	7	-	29.4	74	15	-	38.9	37	7	-
26.9	37	8	-	32.7	50	7	-	38.9	52	10	-
26.9	70	19	-	32.7	64	12	-	38.9	73	15	-
26.9	72		-	32.7	68	15	-	41.4	75	16	-
26.9	72	16	-	32.7	84	20	-	73.2	90	12	-
26.9	75	19	-	32.9	15	2	-	73.2	102	11	-
26.9	78	20	-	-	-	-	-	-	-	-	-
Potamilus alatus											
22.6	129	11	f	33.6	108	10	m	41.4	138	15	-
22.6	129	11	f	33.6	109	10	f	41.4	140	15	-
22.6	158	-	m	33.6	117	10	m	41.4	140	15	-
23.5	145	13	m	33.6	127	-	m	41.4	141	-	-
24.8	95	7	-	33.6	134	19	m	41.4	150	20	-
26.9	94	15	f	33.6	145	-	m	73.2	120	7	f
26.9	107	17	-	33.6	146	15	m	73.2	122	6	f
26.9	110	14	-	36.7	57	9	-	73.2	180	15	-
26.9	110	15	f	36.7	103	18	f	87.2	131	13	-
26.9	118	17	f	36.7	109	19	f	99.8	96	14	f
26.9	125	14	m	36.7	111	19	f	99.8	120	21	-
26.9	133	20	-	36.7	119	21	m	99.8	126	15	-
26.9	136	19	-	36.7	125	24	m	99.8	135	17	-
29.4	58	9	-	38.9	96	14	m	38.9	155	20	m
32.7	118	15	-	38.9	105	14	m	38.9	162	24	m
32.7	140	20	-	38.9	107	10	f	41.4	105	12	-
32.9	122	10	-	38.9	109	13	f	41.4	108	12	f
32.9	166	14	f	38.9	112	10	f	41.4	112	10	-
33.6	97	10	f	38.9	112	16	f	41.4	114	13	-
33.6	98	10	f	38.9	124	15	m	41.4	128	16	-
33.6	98	10	m	38.9	125	15	m	41.4	129	15	-
33.6	99	10	f	38.9	126	15	m	41.4	129	15	f
33.6	100	13	f	38.9	129	15	m	41.4	132	23	-
33.6	101	10	m	38.9	137	21	m	41.4	135	17	-
33.6	103	10	f	41.4	135	20	-	-	-	-	-

Appendix C, Table 5. Lengths, age estimates, and gender of unionids collected from the Pomme de Terre River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Pyganodon grandis											
36.7	99	21	-	38.9	143	13	f	-	-	-	-
Quadrula metanevra											
22.6	93	15	-	22.6	111	14	-	26.9	95	22	-
22.6	101	14	-	22.6	122	25	-	26.9	97	25	-
22.6	105	12	-	26.9	84	16	-	26.9	117	25	-
22.6	105	13	-	26.9	85	18	-	26.9	120	25	-
22.6	108	14	-	26.9	88	17	-	32.7	165	12	-
22.6	110	17	-	26.9	90	22	-	32.9	105	20	-
Quadrula pustulosa											
22.6	47	7	-	23.5	72	22	-	29.4	41	-	-
22.6	53	9	-	23.5	73	14	-	29.4	48	12	-
22.6	60	8	-	23.5	79	18	-	29.4	63	10	-
22.6	60	9	-	23.5	79	20	-	29.4	65	13	-
22.6	62	9	-	23.5	80	17	-	29.4	68	20	-
22.6	62	11	-	23.5	81	21	-	32.7	51	14	-
22.6	62	12	-	24.8	69	13	-	32.7	53	13	-
22.6	63	10	-	24.8	70	14	-	32.7	53	14	-
22.6	65	9	-	24.8	70	15	-	32.7	55	20	-
22.6	67	10	-	24.8	75	15	-	32.7	60	17	-
22.6	68	8	-	24.8	77	10	-	32.7	62	14	-
22.6	69	12	-	24.8	80	15	-	32.7	64	15	-
22.6	70	9	-	26.9	29	8	-	32.7	64	19	-
22.6	71	10	-	26.9	54	18	-	32.7	66	18	-
22.6	71	10	-	26.9	55	15	-	32.9	58	11	-
22.6	72	12	-	26.9	58	15	-	32.9	60	11	-
22.6	78	11	-	26.9	59	19	-	32.9	64	9	-
22.6	78	11	-	26.9	59	20	-	32.9	68	12	-
22.6	87	15	-	26.9	60	16	-	32.9	68	14	-
22.6	98	18	-	26.9	60	18	-	32.9	69	10	-
23.5	53	11	-	26.9	61	23	-	32.9	70	-	-
23.5	61	15	-	26.9	62	17	-	32.9	70	12	-
23.5	62	13	-	26.9	63	18	-	32.9	80	-	-
23.5	63	17	-	26.9	63	18	-	32.9	118	11	-
23.5	63	18	-	26.9	63	19	-	33.6	42	11	-
23.5	64	13	-	26.9	65	22	-	33.6	54	14	-
23.5	65	15	-	26.9	71	19	-	33.6	57	10	-
23.5	66	14	-	26.9	71	24	-	33.6	58	17	-
23.5	66	14	-	26.9	72	20	-	33.6	60	15	-
23.5	68	15	-	26.9	76	27	-	33.6	60	15	-
23.5	68	17	-	26.9	78	-	-	33.6	62	-	-
23.5	69	19	-	26.9	81	-	-	33.6	63	15	-
23.5	71	15	-	29.4	36	7	-	33.6	63	15	-
23.5	71	17	-	29.4	37	7	-	33.6	63	18	-

Appendix C, Table 5. Lengths, age estimates, and gender of unionids collected from the Pomme de Terre River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Quadrula pustulosa cont.											
33.6	65	15	-	36.7	58	18	-	38.9	63	23	-
33.6	66	15	-	36.7	58	24	-	38.9	69	23	-
33.6	68	-	-	36.7	61	15	-	38.9	69	23	-
33.6	68	15	-	36.7	68	-	-	38.9	71	21	-
33.6	69	-	-	38.9	42	11	-	41.4	60	12	-
33.6	72	-	-	38.9	57	16	-	41.4	60	12	-
33.6	72	-	-	38.9	59	15	-	41.4	65	-	-
33.6	73	15	-	38.9	59	19	-	41.4	66	10	-
33.6	75	-	-	38.9	60	14	-	41.4	67	-	-
33.6	75	-	-	38.9	61	17	-	41.4	68	-	-
36.7	28	5	-	38.9	62	-	-	41.4	71	-	-
Quadrula quadrula											
22.6	90	11	-	22.6	96	13	-	23.5	79	12	-
22.6	95	16	-	23.5	78	12	-	23.5	97	16	-
Strophitus undulatus											
32.9	108	12	-	99.8	68	13	-	99.8	89	15	-
Toxolasma parvus											
38.9	19	7	-	-	-	-	-	-	-	-	-
Tritogonia verrucosa											
22.6	85	8	m	23.5	111	12	m	26.9	98	10	m
22.6	101		m	23.5	112	11	m	26.9	99	11	m
22.6	105	10	m	23.5	121	14	m	26.9	102	10	m
22.6	106	-	m	23.5	122	14	m	26.9	103	15	m
22.6	110	-	m	23.5	125	13	f	26.9	105	10	m
22.6	110	8	m	23.5	126	13	m	26.9	108	13	m
22.6	110	11	m	24.8	104	8	m	26.9	114	13	f
22.6	110	11	m	24.8	109	9	m	26.9	115	15	m
22.6	111	10	f	24.8	125	10	f	26.9	119	10	f
22.6	115	-	m	24.8	127	10	m	26.9	119	17	f
22.6	120	-	m	24.8	127	10	m	26.9	125	10	f
22.6	121	13	m	24.8	129	13	m	29.4	55	7	-
22.6	122	9	f	24.8	130	10	m	29.4	75	9	-
22.6	124	11	f	24.8	132	15	m	29.4	82	12	-
23.5	75	7	m	26.9	55	8	-	29.4	83	11	-
23.5	92	9	m	26.9	89	10	m	29.4	94	13	-
23.5	96	8	m	26.9	89	13	m	29.4	100	10	-
23.5	96	8	m	26.9	92	11	f	29.4	100	12	-
23.5	97	7	m	26.9	94	12	f	29.4	101	12	-
23.5	100	11	m	26.9	94	12	f	29.4	115	20	-
23.5	106	12	m	26.9	94	12	m	32.7	98	15	m
23.5	108	11	m	26.9	95	8	m	32.9	85	9	m
23.5	111	12	f	26.9	95	13	m	32.9	88	9	m

Appendix C, Table 5. Lengths, age estimates, and gender of unionids collected from the Pomme de Terre River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Tritogonia verrucosa cont.											
32.9	94	10	m	33.6	97	15	m	36.7	89	-	m
32.9	95	11	f	33.6	100	10	f	36.7	94	-	m
32.9	102	13	m	33.6	102	-	m	38.9	95	-	m
32.9	104	-	m	33.6	103	-	m	38.9	101	-	m
32.9	108	10	f	33.6	104	-	m	38.9	115	13	m
33.6	78	13	m	33.6	104	15	f	73.2	64	4	m
33.6	85	11	m	33.6	107	-	m	73.2	68	4	m
33.6	90	-	m	33.6	108	-	f	73.2	98	7	m
33.6	93	-	m	33.6	108	-	f	73.2	114	9	m
33.6	93	-	m	33.6	110	-	f	99.8	76	9	m
33.6	94	-	m	33.6	114	-	m	99.8	93	12	m
33.6	95	-	m	33.6	115	-	f	99.8	101	13	m
33.6	97	-	m	36.7	53	7	m	-	-	-	-
Truncilla truncata											
22.6	39	5	-	32.7	22	3	-	32.9	50	10	-
22.6	39	5	-	32.7	23	3	-	32.9	51	12	-
22.6	58	8	-	32.7	24	3	-	32.9	52	13	-
22.6	74	10	-	32.7	24	3	-	32.9	53	13	-
24.8	51	6	-	32.7	27	4	-	32.9	53	13	-
26.9	17	4	-	32.7	30	6	-	32.9	55	12	-
26.9	23	7	-	32.7	33	6	-	32.9	57	15	-
26.9	31	8	-	32.7	36	6	-	32.9	60	13	-
26.9	32	10	-	32.7	36	7	-	32.9	60	14	-
26.9	34	6	-	32.7	38	8	-	32.9	66	17	-
26.9	39	8	-	32.7	39	11	-	33.6	18	2	-
26.9	45	10	-	32.7	42	7	-	33.6	18	2	-
26.9	47	11	-	32.7	42	10	-	33.6	20	3	-
26.9	51	11	-	32.7	43	10	-	33.6	20	3	-
26.9	53	12	-	32.7	44	9	-	33.6	30	5	-
26.9	57	14	-	32.7	58	10	-	33.6	32	5	-
26.9	62	19	-	32.7	60	-	-	33.6	33	5	-
29.4	27	8	-	32.7	60	10	-	33.6	48	8	-
29.4	28	8	-	32.7	71	15	-	33.6	48	10	-
29.4	29	8	-	32.9	20	3	-	33.6	57	10	-
29.4	30	9	-	32.9	20	3	-	33.6	59	-	-
29.4	30	10	-	32.9	21	4	-	36.7	22	4	-
29.4	34	12	-	32.9	22	4	-	36.7	25	4	-
29.4	38	12	-	32.9	30	6	-	36.7	26	5	-
29.4	39	15	-	32.9	30	6	-	36.7	26	5	-
29.4	44	16	-	32.9	31	6	-	36.7	31	6	-
29.4	45	17	-	32.9	34	7	-	36.7	33	6	-
29.4	46	19	-	32.9	39	10	-	36.7	38	7	-
32.7	13	2	-	32.9	48	9	-	36.7	43	11	-

Appendix C, Table 5. Lengths, age estimates, and gender of unionids collected from the Pomme de Terre River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Truncilla truncata cont.											
38.9	25	6	-	38.9	50	12	-	38.9	62	20	-
38.9	31	12	-	38.9	52	13	-	38.9	63	21	-
38.9	36	9	-	38.9	56	15	-	38.9	66	20	-
38.9	37	10	-	38.9	57	10	-	38.9	70	20	-
38.9	43	12	-	38.9	60	18	-	41.4	46	10	-
38.9	49	14	-	38.9	60	20	-	41.4	50	11	-
Utterbackia imbecillis											
38.9	50	5	-	38.9	64	8	-	38.9	69	6	-
38.9	60	6	-	38.9	65	6	-	38.9	70	7	-
38.9	64	6	-	-	-	-	-	-	-	-	-
Venustaconcha ellipsiformis											
26.9	37	6	m	32.7	65	12	m	33.6	57	10	f
26.9	65	14	m	32.7	67	10	m	33.6	58	10	f
26.9	66	10	m	32.7	67	14	f	33.6	62	10	f
26.9	72	15	f	32.7	70	14	m	33.6	62	10	m
26.9	72	16	m	32.7	70	15	m	33.6	63	10	m
29.4	34	7	f	32.7	70	16	f	33.6	64	10	m
29.4	37		m	32.7	79	12	m	33.6	65	10	f
29.4	44	9	m	32.9	55	-	f	33.6	65	10	m
29.4	45	9	m	32.9	58	10	m	33.6	65	10	m
29.4	45	9	m	32.9	61	-	f	33.6	65	10	m
29.4	47	9	f	32.9	62	10	f	33.6	66	10	m
29.4	50	11	m	32.9	65	-	m	33.6	67	10	f
29.4	59	10	f	32.9	65	10	m	33.6	67	10	m
29.4	59	17	f	32.9	67	-	m	33.6	67	10	m
29.4	60		f	32.9	67	11	f	33.6	68	10	m
29.4	60	15	f	32.9	67	11	m	33.6	71	10	f
29.4	64	19	f	32.9	68	-	m	36.7	60	14	m
29.4	65	17	m	32.9	68	-	m	38.9	60	-	f
29.4	67	15	m	32.9	68	10	f	38.9	62	-	m
29.4	68	15	f	32.9	68	10	f	38.9	63	-	m
29.4	69	14	m	32.9	68	11	m	38.9	64	-	m
29.4	70		m	32.9	68	13	f	38.9	64	-	m
29.4	73	15	m	32.9	68	13	m	38.9	65	-	m
29.4	79	15	m	32.9	69	-	f	38.9	67	-	f
32.7	58	14	f	32.9	69	-	m	38.9	67	-	m
32.7	60	13	f	32.9	70	10	m	38.9	69	-	m
32.7	60	15	f	32.9	70	14	m	38.9	70	-	m
32.7	61	12	f	33.6	44	9	f	38.9	70	-	m
32.7	63	15	f	33.6	51	10	f	38.9	70	-	m
32.7	64	11	m	33.6	54	10	f	38.9	70	-	m
32.7	65	12	m	33.6	56	10	f	38.9	70	-	m

Appendix C, Table 5. Lengths, age estimates, and gender of unionids collected from the Pomme de Terre River, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Venustaconcha ellipsiformis cont.											
38.9	71	-	m	99.8	50	9	f	99.8	61	6	m
38.9	73	-	f	99.8	50	10	f	99.8	63	9	m
99.8	41	5	f	99.8	54	10	f	99.8	65	9	m
99.8	45	8	f	99.8	55	10	f	99.8	66	12	m
99.8	45	8	f	99.8	56	9	m	99.8	67	12	m
99.8	47	8	f	99.8	58	9	m	99.8	68	12	m
99.8	48	8	f	99.8	58	9	m	99.8	81	10	m
99.8	48	9	f	-	-	-	-	-	-	-	-

Appendix C, Table 6. Lengths, age estimates, and gender of unionids collected from Lindley Creek, Missouri, 2001

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Amblema plicata											
21.9	72	5	-	21.9	123	-	-	21.9	141		-
21.9	115	-	-	21.9	129	-	-	21.9	-	-	-
Elliptio dilatata											
21.9	104	11	-	-	-	-	-	-	-	-	-
Fusconaia ozarkensis											
21.9	91	10	-	-	-	-	-	-	-	-	-
Lampsilis cardium											
21.9	93	5	m	21.9	121	9	m	21.9	133	8	m
21.9	106	7	f	21.9	124		f	21.9	138	9	m
21.9	116	8	f	21.9	125	9	f	-	-	-	-
Lampsilis siliquoidea											
21.9	85	4	f	21.9	123	8	m	21.9	140		m
21.9	119	7	f	21.9	128	7	f	21.9	143		m
Leptodea fragilis											
21.9	105	7	m	-	-	-	-	-	-	-	-
Potamilus alatus											
21.9	153	12	-	21.9	184	20	-	-	-	-	-
Pimpleback											
21.9	88	15	-	-	-	-	-	-	-	-	-
Tritogonia verrucosa											
101	6	m	-	-	-	-	-	-	-	-	-

Appendix D. Site descriptions of 2002 sampling localities in the St. Francis River Basin, Missouri.

Stream	Stream Mile	Site Description	UTM: X	UTM: Y	Date	County	Collection No.	Locality No.
St. Francis River	4	Approx. 0.5 river miles downstream from US. Highway 412.	738892	3991800	19-Sep-02	Dunkllin	CH02056	CH02056
St. Francis River	20	Approx. 1.0 river mile downstream from Ben Cash Access.	750993	4008207	16-Sep-02	Dunklin	CH02051	80022
St. Francis River	28.5	Approx. 1.2 river miles upstream from Highway 85.	758096	4014747	16-Sep-02	Dunklin	CH02052	CH02052
St. Francis River	98	At Highway U	755627	4061195	01-Sep-02	Stoddard	CH02047	CH02047
St. Francis River	107.5	At County Road 622 at "horse-shoe bend"	752000	4070100	01-Sep-02	Stoddard	CH02046	79090
St. Francis River	113	Approx. 0.25 river miles downstream from Highway 51.	749809	4073797	03-Aug-02	Butler	CH02035	79082
St. Francis River	114	At Highway 60	749601	4075520	03-Aug-02	Butler	CH02036	79053
St. Francis River	126	Where County Road 697A runs adjacent to river	746023	4082816	31-Aug-02	Stoddard	CH02043	79022
St. Francis River	127	Where County Road 635 intersects with another country road and is adjacent to river	745003	4083735	31-Aug-02	Stoddard	CH02044	77084
St. Francis River	128	At confluence of Mud Creek and river	744670	4084404	31-Aug-02	Stoddard	CH02045	79021
St. Francis River	138	Approx. 0.5 river miles downstream from Wappapello Dam.	742591	4089977	04-Aug-02	Wayne	CH02037	6450 (Oesch)
St. Francis River	167	At Highway 34	721600	4119100	26-Jul-02	Wayne	CH02025	81025
St. Francis River	172.1	At Boyscout Camp	722800	4123900	20-Jul-02	Wayne	CH02024	81027
St. Francis River	181.5	Approx. 0.5 river miles downstream from Coldwater Access.	724055	4131462	02-Oct-02	Wayne	CH02060	CH02060
St. Francis River	182	At Coldwater Access	724590	4131678	26-Jul-02	Wayne	CH02026	81026
St. Francis River	183	Approx. 1.0 river mile upstream from Coldwater Access.	725699	4132964	01-Oct-02	Wayne	CH02059	CH02059
St. Francis River	183.5	Approx. 1.5 river miles upstream from Coldwater Access.	725978	4133698	01-Oct-02	Wayne	CH02058	CH02058

Appendix D cont. Site descriptions of 2002 sampling localities in the St. Francis River Basin, Missouri.

Stream	Stream Mile	Site Description	UTM: X	UTM: Y	Date	County	Collection No.	Locality No.
St. Francis River	190.5	Approx. 0.25 river miles upstream from Shelton Ford.	724055	4131462	03-Oct-02	Wayne	CH02061	CH02061
St. Francis River	194	At Highway C	723538	4140307	28-Jun-02	Madison	CH02012	81008
St. Francis River	207	At Highway E, adjacent to the "boulders"	722885	4149883	27-Jul-02	Madison	CH02027	77090
St. Francis River	207.8	At Highway E, 0.8 river miles upstream of the "boulders"	723124	4151038	27-Jul-02	Madison	CH02028	78001
St. Francis River	211	At Highway E	724786	4153498	30-Jun-02	Madison	CH02017	81023
St. Francis River	215	At Highway D	726574	4159122	30-Jun-02	Madison	CH02016	72025
St. Francis River	218	Just upstream from the access at Millstream Gardens	723258	4161480	29-Jun-02	Madison	CH02015	80086
St. Francis River	219.3	Just downstream from the access at Roselle	720947	4163516	29-Jun-02	Madison	CH02014	85002
St. Francis River	231	At Syenite Access	728033	4173391	22-Jun-02	St. Francis	CH02006	81033
St. Francis River	238	At Gruner Ford Access	726626	4179765	22-Jun-02	St. Francis	CH02005	83034
St. Francis River	241.2	At Highway W	723249	4182590	22-Jun-02	St. Francis	CH02004	83011
St. Francis River	244.9	At Highway B	718951	4183722	21-Jun-02	St. Francis	CH02003	83019
St. Francis River	252.3	At Highway N	710177	4179906	21-Jun-02	St. Francis	CH02002	83020
St. Francis River	257.7	At County Road low-water bridge off of Highway U	706422	4173911	21-Jun-02	Iron	CH02001	83021
Battle Shell Lake	na	At Battle Shell Lake in Mingo NWR	744778	4091494	02-Aug-02	Butler	CH02033	CH02033
Big Creek	2.3	At Sam A. Baker State Park	721160	4126531	19-Jul-02	Wayne	CH02023	81016

Appendix D cont. Site descriptions of 2002 sampling localities in the St. Francis River Basin, Missouri.

Stream	Stream Mile	Site Description	UTM: X	UTM: Y	Date	County	Collection No.	Locality No.
Big Creek	11.2	At Highway 143	710204	4129790	19-Jul-02	Iron	CH02022	81015
Big Creek	17	At Highway 49	706361	4136035	19-Jul-02	Iron	CH02021	81014
Ditch at CR 642	4.4	At Country Road 642 bridge	756777	4071450	17-Aug-02	Stoddard	CH02040	CH02040
East Fork, Lost Creek	2.4	At Highway D	741101	4102036	02-Sep-02	Wayne	CH02048	CH02048
Indian Hill Slough	na	At local access off of Highway V	747570	4001688	17-Sep-02	Dunklin	CH02053	CH02053
Indian Hill Slough	na	Approx. 0.5 river miles downstream from Local Access.	746794	4000488	17-Sep-02	Dunklin	CH02055	CH02055
Little St. Francis River	5.2	At Whitener Ford	730733	4158490	23-Jun-02	Madison	CH02008	81024
Little St. Francis River	9.9	At Thompson Ford	733121	4159755	28-Jun-02	Madison	CH20009	77091
Little St. Francis River	12.9	At Highway 67	736505	4158569	22-Jun-02	Madison	CH02007	83018
Marble Creek	5	At Highway E	717762	4147672	29-Jun-02	Madison	CH02013	78172
May Pond	na	At May Pond in Mingo NWR	749067	4098471	02-Aug-02	Butler	CH02032	CH02032
Mingo River	1.6	At County Road 691	754037	4070644	17-Aug-02	Stoddard	CH02041	CH02041
Mingo River	2.8	Where County Road 697 intersects with Country Road 691	752947	4072167	16-Aug-02	Stoddard	CH02039	CH02039
Mingo River	10	At County Road 448	748694	4081735	30-Aug-02	Stoddard	CH02042	CH02042
Mingo River	16.3	At Spillway in Mingo NWR	747280	4091413	02-Aug-02	Butler	CH02034	CH02034
Mingo River	18.4	At the border of the Federal Wildlife Preserve in Mingo NWR	747792	4093631	02-Aug-02	Butler	CH02031	CH02031

Appendix D cont. Site descriptions of 2002 sampling localities in the St. Francis River Basin, Missouri.

Stream	Stream Mile	Site Description	UTM: X	UTM: Y	Date	County	Collection No.	Locality No.
Otter Creek	5.9	At Highway 67	727175	4096729	28-Jul-02	Madison	CH02030	81010
Otter Creek	14.2	At Highway A	719853	4100183	28-Jul-02	Madison	CH02029	81009
Dudley Main Ditch	1.2	At Otter Slough CA	756576	4066206	16-Aug-02	Stoddard	CH02038	80087
12 Mile Creek	1	At Highway C	726530	4138244	28-Jun-02	Madison	CH02011	81012
12 Mile Creek	6	At County Road 411	733120	4138453	28-Jun-02	Madison	CH02010	81013

Appendix E, Table 1. Unionid species and numbers found at sites sampled in the St. Francis River, 2002. "FD"= fresh dead, "WD"= weathered dead, "SF"= subfossil, "F"= fossil shell.

Species	River mile and collection numbers													
	4	20	28.5	98	107.5	113	114	126	127	128	138	167	172.1	181.5
	CH02056	CH02051	CH02052	CH02047	CH02046	CH02035	CH02036	CH02043	CH02044	CH02045	CH02037	CH02025	CH02024	CH02060
Actinonaias ligamentina					wd	wd	sf			sf	sf	wd	286	9
Alasmidonta marginata													6	
Anodonta suborbiculata														
Amblema plicata		2	17	2		3			wd	9	167		8	
Arcidens confragosus		1									sf			
Cyclonaias tuberculata													5	
Cyprogenia aberti											5		127	7
Elliptio dilatata				sf									62	9
Epioblasma triquetra												wd	7	1
Fusconaia flava			4	wd			fd			4	wd		11	2
Lampsilis cardium		2	1	3		4	1	4	1	4	5	1	41	
Lampsilis siliquoidea													2	
Lampsilis teres	3	7	27	11	3	6	1	3	2	2	fd		1	
Lasmigona complanata			1	1						1	5			
Lasmigona costata												wd	1	2
Lampsilis reeveiana brittsi												1	14	4
Leptodea fragilis	1	3		3	3	3	2	1	1	5			1	
Ligumia recta													1	
Ligumia subrostrata												wd		
Obliquaria reflexa		12	12	14			1			2	24		1	
Plectomerus dombeyanus				fd	sf	1	fd		2	1	23			
Pleurobema sintoxia				wd			sf		1	1	sf		35	2
Potamilus purpuratus	4	7	13	2	2	1	1	4	7	7	4		3	1
Potamilus ohiensis	8		3	1	1	2	1		6	3	1			
Ptychobranchus occidentalis												wd	643	78
Pyganodon grandis			2				1			3				
Quadrula cylindrica													11	
Quadrula nodulata														
Quadrula pustulosa		20	52	12		8	3	2	7	33	486	wd	9	wd
Quadrula quadrula		3	1	7		1				1	24			
Strophitus undulatus		wd		wd			sf		1		2			wd
Toxolasma lividis														wd
Toxolasma parvus														
Toxolasma texasensis														
Tritogonia verrucosa										1	2		1	
Truncilla donaciformis		4	wd								wd			
Truncilla trucata											2			
Uniomerus tetralasmus														
Utterbackia imbecillis														
Venustaconcha ellipsiformis												wd		wd
Villosa iris												wd	4	6
Villoso lienosa			1									wd		
No. of living individuals	16	61	134	56	9	29	11	14	28	77	750	2	1280	121
No. of live species	4	10	11	10	4	9	8	5	9	15	13	2	23	11
Live and dead species	4	11	12	15	6	10	13	5	10	16	19	11	23	15
Sampling effort (prs-hrs.)	2	3.5	2.1	3	2	3	2	3	2	3	3	2	4	3

Appendix E, Table 1. Unionid species and numbers found at sites sampled in the St. Francis River, 2002. "FD"= fresh dead, "WD"= weathered dead, "SF"= subfossil, "F"= fossil shell.

Species	River mile and collection numbers													
	182	183	183.5	190.5	194	207	207.8	211	215	218	219.3	231	238	241.2
	CH02026	CH02059	CH02058	CH02061	CH02012	CH02027	CH0	CH0201	CH0201	CH0201	CH0201	CH0200	CH0200	CH0200
Actinonaias ligamentina	47	531	40	83	32	15	220			17	7	1		
Alasmidonta marginata	fd						1		1	1				
Anodonta suborbiculata														
Amblema plicata	4	38	2	3	1	1	39	1		4	4	wd		
Arcidens confragosus														
Cyclonaias tuberculata														
Cyprogenia aberti	8	11	8	15	5	1	48		1	9				
Elliptio dilatata	28	12	3	14		8	55			5	6	wd		
Epioblasma triquetra	4													
Fusconaia flava		6		11		3	12		1	9	10	1		
Lampsilis cardium	20	30	14	3	7	6	43	3	3	19	14	6	wd	1
Lampsilis siliquoidea	4	1				6	18	6		12	12	14	fd	wd
Lampsilis teres														
Lasmigona complanata														
Lasmigona costata	4	4	fd	1		wd	11		2	4	4		fd	
Lampsilis reeveiana brittsi	12	2		9	8	3	11		13	2	wd		wd	1
Leptodea fragilis	2		1			1		1				1		
Ligumia recta														
Ligumia subrostrata						wd	wd				1			1
Obliquaria reflexa		1												
Plectomerus dombeyanus														
Pleurobema sintoxia	1	4		41	2		4			1	3			
Potamilus purpuratus	4	2	1		1		2	1				3		
Potamilus ohiensis														
Ptychobranchus occidentalis	80	45	23	597	206	9	306	3	23	88	36			
Pyganodon grandis														
Quadrula cylindrica		3		2										
Quadrula nodulata														
Quadrula pustulosa		11												
Quadrula quadrula														
Strophitus undulatus	wd	1		3	fd		2		1		wd			
Toxolasma lividis	3		1			wd				1				
Toxolasma parvus				sf							wd			
Toxolasma texasensis														
Tritogonia verrucosa														
Truncilla donaciformis														
Truncilla trucata														
Uniomerus tetralasmus														
Utterbackia imbecillis										1		wd		
Venustaconcha ellipsiformis	2			1	4				8	1	2			fd
Villosa iris	2				fd		1		1					
Villoso lienosa	1				fd	2				wd	wd			
No. of living individuals	226	702	93	783	266	55	773	15	54	174	99	26	0	3
No. of live species	16	16	9	13	9	10	15	6	10	15	11	6	0	3
Live and dead species	18	16	10	14	12	13	16	6	10	16	15	9	4	5
Sampling effort (person-hrs.)	5	3	2.5	3	2	2.16	4.5	2	3	3	3	2.5	1.5	2

Appendix E, Table 1. Unionid species and numbers found at sites sampled in the St. Francis River, 2002. "FD"= fresh dead, "WD"= weathered dead, "SF"= subfossil, "F"= fossil shell.

Species	River mile and collection numbers		
	244.9 CH02003	252.3 CH02002	257.7 CH02001
Actinonaias ligamentina			
Alasmidonta marginata			
Anodonta suborbiculata			
Amblema plicata	22	5	
Arcidens confragosus			
Cyclonaias tuberculata			
Cyprogenia aberti			
Elliptio dilatata			
Epioblasma triquetra			
Fusconaia flava	3	1	
Lampsilis cardium	6	5	
Lampsilis siliquoidea	12	5	
Lampsilis teres			
Lasmigona complanata			
Lasmigona costata	1		
Lampsilis reeveiana brittsi	1	fd	
Leptodea fragilis		fd	
Ligumia recta			
Ligumia subrostrata			
Obliquaria reflexa			
Plectomerus dombeyanus			
Pleurobema sintoxia	1		
Potamilus purpuratus		1	
Potamilus ohiensis			
Ptychobranchus occidentalis			
Pyganodon grandis	1	1	
Quadrula cylindrica			
Quadrula nodulata			
Quadrula pustulosa			
Quadrula quadrula			
Strophitus undulatus	fd	1	
Toxolasma lividis			
Toxolasma parvus			
Toxolasma texasensis			
Tritogonia verrucosa			
Truncilla donaciformis			
Truncilla trucata			
Uniomerus tetralasmus			
Utterbackia imbecillis	fd	fd	
Venustaconcha ellipsiformis	1		
Villosa iris			
Villoso lienosa		wd	
No. of living individuals	48	19	0
No. of live species	9	7	0
Live and dead species	13	11	0
Sampling effort (person-hrs.)	3	2	1

Appendix E Table 2. Unionid species and numbers found at sites sampled in the tributaries of the St. Francis Rive, 2002. "FD"= fresh dead, "WD"= weathered dead, "SF"= subfossil, "F"= fossil.

Species	Stream, stream mile, and collection numbers													
	Battle Shell Lake	Big Creek	Big Creek	Big Creek	Ditch at CR 642	E. Fork, Lost Creek	Indian Hill Slough	Indian Hill Slough	Indian Hill Slough	Little St. Francis River	Little St. Francis River	Little St. Francis River	Marble Creek	May Pond
	na	2.3	11.2	17	4.4	2.4	na	na	na	5.2	9.9	12.9	5	na
	CH02033	CH02023	CH02022	CH02021	CH02040	CH02048	CH02053	CH02053	CH02055	CH02008	CH20009	CH02007	CH02013	CH02032
Actinonaias ligamentina										fd	1			
Alasmidonta marginata														
Anodonta suborbiculata	fd						5							
Amblema plicata									4	fd	1	wd		
Arcidens confragosus									2					
Cyclonaias tuberculata														
Cyprogenia aberti														
Elliptio dilatata												fd		
Epioblasma triquetra														
Fusconaia flava									4					
Lampsilis cardium										2	10	2		
Lampsilis siliquoidea											39	wd		
Lampsilis teres					wd		5		4					
Lasmigona complanata									1					
Lasmigona costata											1			
Lampsilis reeveiana brittsi												wd	sf	
Leptodea fragilis					wd		4		3					
Ligumia recta										wd				
Ligumia subrostrata	fd										4	wd		
Obliquaria reflexa							wd		9					
Plectomerus dombeyanus														
Pleurobema sintoxia														
Potamilus purpuratus					wd		2		17					
Potamilus ohiensis					wd									
Ptychobranchus occidentalis													sf	
Pyganodon grandis	fd				4		34		6		1	fd		
Quadrula cylindrica														
Quadrula nodulata									1					
Quadrula pustulosa							1		31					
Quadrula quadrula					1		2		5					
Strophitus undulatus											1			
Toxolasma lividis														
Toxolasma parvus														
Toxolasma texasensis							24							
Tritogonia verrucosa										wd				
Truncilla donaciformis														
Truncilla trucata									2					
Uniomerus tetralasmus														5
Utterbackia imbecillis							3		1					
Venustaconcha ellipsiformis										1	1		sf	
Villosa iris														
Villoso lienosa										1				
No. of living individuals	0	0	0	0	5	0	80	0	90	4	59	2	0	5
No. of live species	0	0	0	0	2	0	9	0	14	3	9	1	0	1
Live and dead species	3	0	0	0	6	0	9	0	13	8	9	7	3	1
Sampling effort (person-hrs.)	1.5	1.5	1.5	1.5	2	1	2.1	1.5	3	2.5	2.5	2	1	1

Appendix E Table 2. Unionid species and numbers found at sites sampled in the tributaries of the St. Francis Rive, 2002. "FD"= fresh dead, "WD"= weathered dead, "SF"= subfossil, "F"= fossil.

Species	Stream, stream mile, and collection numbers									
	Mingo River	Mingo River	Mingo River	Mingo River	Mingo River	Otter Creek	Otter Creek	Dudley Main Ditch	12 Mile Creek	12 Mile Creek
	1.6	2.8	10	16.3	18.4	5.9	14.2	1.2	1	6
	CH02041	CH02039	CH02042	CH02034	CH02031	CH02030	CH02029	CH02038	CH02011	CH02010
Actinonaias ligamentina										
Alasmidonta marginata										
Anodonta suborbiculata				fd						
Amblema plicata	223	395								
Arcidens confragosus	1	2								
Cyclonaias tuberculata										
Cyprogenia aberti										
Elliptio dilatata										
Epioblasma triquetra										
Fusconaia flava	2	29								
Lampsilis cardium		23		1						
Lampsilis siliquoidea										
Lampsilis teres	11	16	15	9						
Lasmigona complanata			wd	1						
Lasmigona costata										
Lampsilis reeveiana brittsi										
Leptodea fragilis	19	47	2							
Ligumia recta										
Ligumia subrostrata	1									
Obliquaria reflexa	1	2								
Plectomerus dombeyanus	2	4								
Pleurobema sintoxia										
Potamilus purpuratus	78	58	wd	5						
Potamilus ohiensis		1		fd						
Ptychobranchus occidentalis										
Pyganodon grandis		2		2						
Quadrula cylindrica										
Quadrula nodulata										
Quadrula pustulosa	87	182		1						
Quadrula quadrula	233	74	3	9						
Strophitus undulatus	3									
Toxolasma lividis										
Toxolasma parvus		1								
Toxolasma texasensis										
Tritogonia verrucosa	6	2								
Truncilla donaciformis		3								
Truncilla truncata	1	2								
Uniomerus tetralasmus	fd									
Utterbackia imbecillis	fd			4						
Venustaconcha ellipsiformis										
Villosa iris										
Villosa lienosa	wd									
No. of living individuals	668	843	20	32	0	0	0	0	0	0
No. of live species	14	17	3	8	0	0	0	0	0	0
Live and dead species	17	17	4	10	0	0	0	0	0	0
Sampling effort (person-hrs.)	3	2.5	3	2.5	1	1	1	1	2	1.5

Appendix F, Table 1. Lengths, age estimates, and gender of unionids collected from the St. Francis River, Missouri, 2002.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Actinonaias ligamentina											
107.5				182	99	8		183.5	142	9	
113				182	105	8		183.5	144		
114				182	105	9		183.5	144	10	
128				182	109	9		183.5	145	12	
138				182	109	10		183.5	147	10	
167				182	112	11	m	183.5	150		
172.1	65	4		182	114	12		183.5	150	12	
172.1	71	5		182	116	12		183.5	151	10	
172.1	76	5		182	117	13	m	183.5	155	13	
172.1	82	5		182	120	14		183.5	157		
172.1	85	6		182	121	10		183.5	163	14	
172.1	93	8		182	123			190.5	52	3	
172.1	100	10		182	135	15		190.5	68	4	
172.1	108	8		182	139	12		190.5	98	6	
172.1	120			182	146	15		190.5	101	6	
172.1	120	11		183	102	6		190.5	114	8	
172.1	122			183	109	7	f	190.5	115		
172.1	126	10		183	113	6	f	190.5	116	8	
172.1	128	12		183	119	7	f	190.5	117	8	
172.1	130			183	121	6		190.5	118	9	
172.1	130	13		183	123	8		190.5	119	10	
172.1	131	14		183	129	8		190.5	121		
172.1	133	16		183	131	9	f	190.5	122		
172.1	135			183	133	7		190.5	123		
172.1	141			183	135	7		190.5	127		
172.1	141	12		183	135	9	f	190.5	129		
181.5	82	4		183	137	7		190.5	129		
181.5	84	5		183	138	8	f	190.5	130		
181.5	93	5		183	138	9	f	190.5	131		
181.5	94	5		183	139	7		190.5	131	10	
181.5	115			183	141	8		190.5	135	11	
181.5	119			183	143	8		194	81	6	
181.5	120			183	145	9	f	194	87	7	
181.5	123	9		183	151	11		194	88	8	
181.5	127			183	152	10	f	194	103	10	
182	16	1		183.5	116	8		194	107	12	
182	35	2		183.5	122	8		194	110	12	
182	36	2		183.5	130	11		194	111	10	
182	40	2		183.5	134	8		194	114	11	
182	73	5		183.5	134	10		194	114	12	
182	88	7		183.5	140	11		194	115	10	
182	88	7		183.5	141			194	117	10	
182	93	6		183.5	142			194	117	10	
182	95	9		183.5	142			194	119	10	

Appendix F, Table 1. Lengths, age estimates, and gender of unionids collected from the St. Francis River, Missouri, 2002.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Actinonaias ligamentina cont.											
194	120	10		207.8	113	10		218	128	10	m
194	120	10		207.8	116	11		218	130		m
194	121	10		207.8	117	10		218	130	10	m
194	123	15		207.8	119	9		218	130	14	f
194	125	13		207.8	120	10		218	134	14	f
194	131	10		207.8	124	10		218	135	10	m
194	132	15		207.8	125	12		218	135	10	m
207	85	5		207.8	125	12		218	136	12	f
207	95	6		207.8	126	10		218	136	12	m
207	116	12		207.8	129	12		218	141	10	f
207	120	11		207.8	134			218	143	10	m
207	121	12		207.8	134	14		218	157		f
207	121	13		207.8	136	11		218	161	15	f
207	123	11		207.8	137	12		219.3	119		f
207	125	9		207.8	138	16		219.3	129		f
207	129	12		207.8	139	12		219.3	130	10	m
207	131	11		207.8	142	10		219.3	133	12	m
207	131	12		207.8	143	14					
207	136	14		207.8	154	15		219.3	138	13	f
207	138	15		218	120		m	219.3	139	13	f
207	143	13		218	121	11	f	219.3	153		m
207	144	188		218	124	10	m	231	104	9	
207.8	103	6		218	126	8	m				
Alasmidonta marginata											
172.1	71	3		172.1	92	8		207.8	97	11	
172.1	72	5		172.1	99	8		215	58	3	
172.1	80	4		182				218	100	8	
172.1	82	6									
Amblema plicata											
20	22	2		28.5	113	12		128	98	8	
20	60	4		28.5	116	11		128	99	9	
28.5	62	4		28.5	119	13		128	110	10	
28.5	83	8		28.5	137	15		128	110	12	
28.5	90	8		28.5	137	15		128	119	10	
28.5	93	7		113	89	10		128	124	11	
28.5	102	9		98	22	12		138	68	7	
28.5	103	8		98	61	5		138	72	8	
28.5	104	10		113	102	13		138	74	8	
28.5	105	9		113	110	11		138	85	5	
28.5	107	10		127				138	85	12	
28.5	108	10		128	51	3		138	87	9	
28.5	111	10		128	67	5		138	87	10	
28.5	111	11		128	77	6		138	87	13	

Appendix F, Table 1. Lengths, age estimates, and gender of unionids collected from the St. Francis River, Missouri, 2002.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Amblema plicata cont.											
138	94	9		183	114	10		218	103	10	
138	94	13		183	115			218	121	10	
138	95	13		183	117	8		218	122		
138	95	15		183	121	8		218	130	15	
138	95	15		183	121	9		219.3	80	4	
138	97	11		183	129	10		219.3	99		
138	104			183	115	10		219.3	105		
138	104	12		183	117			219.3	112	10	
138	104	14		183.5	105	8		219.3	114	10	
138	105	15		183.5	124	10		231			
138	106	11		190.5	93			244.9	64	10	
138	111			190.5	96			244.9	79	12	
172.1	94			190.5	97			244.9	89	10	
172.1	95			194	95	10		244.9	92	20	
172.1	105	10		207	85	9		244.9	98	20	
172.1	107			207.8	75	6		244.9	99	20	
172.1	109			207.8	77	7		244.9	101	15	
172.1	109	10		207.8	84	10		244.9	101	20	
172.1	114	10		207.8	85	8		244.9	105	16	
172.1	115			207.8	86	9		244.9	106	20	
182	123			207.8	87	9		244.9	106	20	
183	82	5		207.8	88			244.9	108	20	
183	98			207.8	90	9		244.9	109	20	
183	104			207.8	91	10		244.9	110	20	
183	107			207.8	92	10		244.9	111	20	
182	99	10		207.8	94	9		244.9	113	20	
182	101	13		207.8	96	11		244.9	119	20	
182	105			207.8	97	12		244.9	119	20	
183	107			207.8	98	10		244.9	120	20	
183	108	7		207.8	101	13		244.9	121	20	
183	109	10		207.8	104	13		252.3	107	12	
183	110	9		207.8	108			252.3	112	10	
183	110	9		207.8	111	11		252.3	113	10	
183	111			207.8	117	12		252.3	122	13	
183	113			207.8	117	15		252.3	140	15	
183	114			211	104	13					
Arcidens confragosus											
138				20	157	13					
Cyclonaias tuberculata											
172.1	55	6		172.1	78	12		172.1	83	10	
172.1	70	8		172.1	82	10		172.1	89	15	
172.1	78	8									

Appendix F, Table 1. Lengths, age estimates, and gender of unionids collected from the St. Francis River, Missouri, 2002.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Cyprogenia aberti											
138	53	8		182	60	8		194	43	8	
138	58	8		182	62	9		194	51	9	
138	66	9		183	20	1		207	55	8	
138	67	12		183	25	1		207.8	16	1	
138	74	11		183	30	2		207.8	18	1	
172.1	38	4		183	31	2		207.8	18	1	
172.1	42	7		183	41	4		207.8	19	1	
172.1	48	5		183	52	7		207.8	20	1	
172.1	49	4		183	53	5		207.8	23	2	
172.1	58	7		183	60	6		207.8	36	3	
172.1	58	7		183	60	6	f	207.8	37	3	
172.1	58	8		183	60	6	f	207.8	40	4	
172.1	58	8		183	62	9		207.8	42	4	
172.1	58	8		183.5	39	4	f	207.8	42	4	
172.1	59	10		183.5	48	5		207.8	43	5	
172.1	60	9		183.5	50	5		207.8	52	7	
172.1	60	9		183.5	50	5	f	207.8	58	7	
172.1	62	10		183.5	55	5		207.8	58	8	
172.1	62	10		183.5	55	6		207.8	58	8	
172.1	65	10		183.5	58	6		207.8	59	8	
172.1	66	9		183.5	60	5	f	207.8	60		
172.1	66	10		190.5	35	3	f	207.8	60	6	
172.1	66	12		190.5	45	5		207.8	61	6	
172.1	68	8		190.5	47	5		207.8	61	7	
172.1	70	14		190.5	48	5		207.8	62	10	
172.1	74			190.5	48	5		207.8	63	10	
181.5	31	3		190.5	48	5	f	207.8	64	11	
181.5	33	3		190.5	49	5		207.8	65	8	
181.5	35	3		190.5	50	5		207.8	65	10	
181.5	42	5		190.5	50	6		215	56	6	
181.5	45	5	f	190.5	51			218	17	1	
181.5	49	7		190.5	51	5		218	48	9	
181.5	53	8		190.5	51	5		218	50	7	
182	18	1		190.5	51	5		218	51	6	
182	21	1		190.5	52	5		218	51	8	
182	39	5		190.5	55	6		218	54	10	
182	52	7		194	23	2		218	60	13	
182	56	8		194	24	3		218	61	11	
182	58	10		194	27	3		218	62	12	
182	60										

Appendix F, Table 1. Lengths, age estimates, and gender of unionids collected from the St. Francis River, Missouri, 2002.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Elliptio dilatata											
98			sf	182	61	4		207	78	8	
172.1	66	4		182	73	7		207	83	7	
172.1	68	5		182	79	9		207	84	10	
172.1	70	6		182	80	7		207	84	10	
172.1	72	5		182	81	8		207	88	8	
172.1	82	9		182	81	9		207	92	7	
172.1	87	9		182	85	10		207	93	10	
172.1	90	11		182	88	10		207.8	55	4	
172.1	91	9		182	88	11		207.8	73	6	
172.1	91	11		182	89	12		207.8	80	7	
172.1	92	9		183	47	3		207.8	83	8	
172.1	92	10		183	48	3		207.8	86	7	
172.1	95	8		183	51	3		207.8	87		
172.1	95	9		183	81	6		207.8	88	8	
172.1	96	13		183	81	6		207.8	88	11	
172.1	96	10		183	85	5		207.8	89	9	
172.1	98	11		183	85	6		207.8	89	11	
172.1	99	10		183	88	5		207.8	91	9	
172.1	100	11		183	88	5		207.8	93	10	
172.1	105	14		183	92	6		207.8	93	11	
172.1	110	13		183	92	8		207.8	94	10	
181.5	39	2		183	98	8		207.8	95	12	
181.5	40	2		183.5	38	2		207.8	96	11	
181.5	41	2		183.5	44	2		207.8	96	11	
181.5	53	3		183.5	62	3		207.8	97	8	
181.5	64	4		190.5	51	4		207.8	98	12	
181.5	65	4		190.5	58	4		207.8	99	12	
181.5	65	4		190.5	58	4		218	50	4	
181.5	74	6		190.5	62	4		218	52	4	
181.5	76	6		190.5	63	4		218	69	5	
182	26	2		190.5	64	4		218	85	8	
182	30	2		190.5	68	4		218	95	10	
182	38	2		190.5	69	5		219.3	68	6	
182	38	2		190.5	71	6		219.3	78		
182	42	3		190.5	72	5		219.3	80		
182	45	3		190.5	78	6		219.3	86	11	
182	46	3		190.5	79	8		219.3	87	8	
182	48	3		190.5	80	7		219.3	90	11	
182	50	4		190.5	88	9		231			
182	60	5		207	70	7					

Appendix F, Table 1. Lengths, age estimates, and gender of unionids collected from the St. Francis River, Missouri, 2002.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Epioblasma triquetra											
167				172.1	60	6	m	182	22	2	
172.1	43	3	m	172.1	62	7	m	182	36	4	f
172.1	50	5	m	172.1	64	11	m	182	42	4	m
172.1	53	5	m	181.5	41	4	m	182	54	6	m
172.1	56	6	m								
Fusconaia flava											
28.5	88	11		183	84			207.8	97	13	
28.5	91	9		183	84			215	60	5	
28.5	96	12		183	85			218	64	11	
28.5	100	12		190.5	65			218	72	8	
98			wd	190.5	65			218	77	10	
114				190.5	68			218	87		
128	68	6	f	190.5	80			218	89	10	
128	69	6		190.5	82			218	90	11	
128	81	8		190.5	83			218	91		
128	83	11		190.5	85			218	95	20	
138				190.5	86			218	100	20	
172.1	60	8		190.5	88			219.3	52	6	
172.1	62	9		190.5	89			219.3	66	9	
172.1	67	10		190.5	103			219.3	76	11	
172.1	69	9		194	83			219.3	80	10	
172.1	72	9		207	69	11		219.3	86	11	
172.1	74			207	74	11		219.3	88	11	
172.1	75			207	80	12		219.3	90	12	
172.1	79	14		207.8	65	8		219.3	95	10	
172.1	80	10		207.8	72	10		219.3	95	14	
172.1	80	12		207.8	73	11		219.3	108	14	
172.1	84	10		207.8	77	12		231	86	10	
181.5	72			207.8	79	10		244.9	63	10	
181.5	75			207.8	80	12		244.9	64	10	
183	78			207.8	82			244.9	69	11	
183	80			207.8	83	10		252.3	91	10	
183	84			207.8	83	14					
Lampsilis cardium											
20	142	14	m	126	116	11	f	138	133	22	f
20	145	12	m	126	122	7	f	138	142	16	m
28.5	121	11	f	126	124	10	m	167	82	5	f
98	96	6	f	126	128	8	f	167	108	7	m
98	109	8	f	127	51	3		172.1	79	5	f
98	134	8	m	128	70	4	m	172.1	88	4	f
113	121	6	m	128	112		f	172.1	88	5	m
113	121	12	f	128	133	9	f	172.1	90	6	f
113	130	20	f	128	134	12	f	172.1	99	7	m
113	139	8	m	138	119	15	f	172.1	100	10	f
114	102	9	m	138	131	13	m	172.1	103		f

Appendix F, Table 1. Lengths, age estimates, and gender of unionids collected from the St. Francis River, Missouri, 2002.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Lampsilis cardium cont.											
172.1	105		f	183	132		m	207.8	105	10	m
172.1	105	10	f	183	132	7	m	207.8	106	10	m
172.1	110	8	m	183	133		m	207.8	109		m
172.1	110	10	f	183	133		m	207.8	110		m
172.1	112		f	183	134	9	m	207.8	110	11	m
172.1	112	13	f	183	135	8	m	207.8	111		m
172.1	115	8	m	183	139	12	m	207.8	114		m
172.1	115	10	f	183	141		m	207.8	115		m
172.1	118	10	m	183	146		m	207.8	117	14	m
172.1	124		m	183.5	106			207.8	118	14	m
172.1	125	10	m	183.5	106	7		207.8	121		m
172.1	127	10	m	183.5	110	6		207.8	121	15	mm
172.1	128	12	m	183.5	110	6		207.8	125	15	m
172.1	130		g	183.5	118	6		207.8	137		m
182	81	6	m	183.5	119			211	101		f
182	89		f	183.5	124			211	123	10	m
182	91		f	183.5	124	8		211	132	11	m
182	99	8	m	183.5	127	11		215	66	3	m
182	100	11	f	183.5	130	8		215	74	4	m
182	104	6	m	183.5	131	9		215	86	7	f
182	106		m	183.5	133	12		218	85	6	f
182	106	9	m	183.5	140	10		218	91	9	f
182	107		f	183.5	143			218	92	7	f
182	107		m	190.5	95	6	f	218	94		
182	108	9	m	190.5	102	7	f	218	95	8	f
182	110	11	m	190.5	110	9	m	218	98	7	f
182	112	11	m	194	71	4	m	218	100	11	f
182	113		m	194	87	6	m	218	119	10	m
182	115		m	194	97	8	m	218	120	16	m
182	118	10	m	194	103		m	218	121	10	m
182	122		m	194	114	11	m	218	122		m
182	124		m	194	115		m	218	125	11	m
182	125	13	m	194	115	14	m	218	126	15	m
182	133	13	m	207	66	4		218	127	14	m
183	58	4	m	207	93	7	f	218	129	12	m
183	112	9	f	207	95	12	f	218	130	10	m
183	116		f	207	105		f	218	134	12	m
183	120	10	f	207	122	13	m	218	134	15	m
183	121		m	207	129	16	m	218	146		m
183	122	9	m	207.8	81	6	f	219.3	99	10	m
183	125	7	m	207.8	93		f	219.3	110	11	m
183	125	8	m	207.8	95		m	219.3	112		m
183	127	7	m	207.8	96	9	f	219.3	115	15	m
183	129		m	207.8	101	7	m	219.3	116	11	m
183	131	8	m	207.8	103	14	f	219.3	118	13	m

Appendix F, Table 1. Lengths, age estimates, and gender of unionids collected from the St. Francis River, Missouri, 2002.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Lampsilis cardium cont.											
219.3	119	10	m	231	95	6	m	244.9	114	10	f
219.3	120	11	m	231	97	8	f	244.9	114	10	m
219.3	123	10	f	231	121	11	m	244.9	120	15	f
219.3	124		m	231	121	13	m	244.9	125		m
219.3	125	10	f	231	125	11	m	252.3	95		f
219.3	129		m	238				252.3	114	10	m
219.3	136	10	m	241.2	110	9	m	252.3	116	10	m
219.3	141		m	244.9	99	8	m	252.3	131		m
231	87	9	f	244.9	106	11	m	252.3	136	15	m
Lampsilis reeveiana											
167	59	5	f	182	61	6	f	207.8	74	7	m
172.1	58	4	f	182	62	5	f	207.8	75	6	m
172.1	61	4	f	182	69	9	f	207.8	75	7	m
172.1	62	4	f	183	60	6	f	207.8	76	8	f
172.1	68	8	f	183	80	5		207.8	82		m
172.1	69	7	f	190.5	58	5	f	207.8	82	7	m
172.1	72	5	m	190.5	60	4	m	207.8	84	8	m
172.1	73	8	m	190.5	68	5	m	207.8	84	9	m
172.1	74	6	m	190.5	69		m	215	45	2	m
172.1	75	7	f	190.5	70		m	215	50	2	m
172.1	75	7	m	190.5	71		f	215	54	3	f
172.1	77	7	m	190.5	74		m	215	55	3	f
172.1	78	6	m	190.5	76	7	m	215	56	3	m
172.1	78	8	m	190.5	79	5	m	215	58	3	m
172.1	92	11	m	194	40	4	f	215	58	3	m
181.5	52	4	f	194	46	4	f	215	62	3	m
181.5	58	4	m	194	52	4	m	215	64	4	f
181.5	73	5	m	194	55	5	m	215	65	4	m
181.5	75	6	m	194	55	5	m	215	67	4	f
182	30	2	m	194	58	7	f	215	70	4	m
182	35	2	m	194	63	5	f	215	70	5	f
182	38	2	m	194	65	7	m	218	50	3	f
182	41	2	m	207	72	6	f	218	70	6	f
182	43	2	m	207	76	7	m	219.3			
182	45	2	m	207	77	6	m	238			
182	53	4	f	207.8	63	8	f	241.2	52	6	f
182	60	4	f	207.8	65	5	m	244.9	48	5	
182	61	5	m	207.8	67	6	m	252.3			fd
Lampsilis siliquoidea											
172.1	118	12	f	182	88	6	f	207	106	9	m
172.1	120	13	m	182	92	6	f	207	110	12	m
182	42	2	m	182	104	8	f	207	117	11	m
182	45	3	m	183	119		m	207	119	10	m
182	48	3	m	207	72	6	f	207.8			
182	55	3	m	207	99	8	m	207.8	62	3	m

Appendix F, Table 1. Lengths, age estimates, and gender of unionids collected from the St. Francis River,

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Lampsilis siliquoidea cont.											
207.8	62	3	m	218	105	8	m	231	104	7	f
207.8	88	8	f	218	110		m	231	104	8	m
207.8	94	8	m	218	115	10	m	231	105	9	f
207.8	95	10	m	218	127		m	231	105	9	m
207.8	103	7	f	218	130		m	231	109		m
207.8	103	9	f	218	130	15	m	231	115	9	m
207.8	103	10	m	218	135		m	231	123		m
207.8	104	10	m	218	141		m	238			
207.8	105	11	m	218	160		m	241.2			
207.8	106	10	f	219.3	64	3	m	244.9	95	10	f
207.8	107	10	m	219.3	75	4	f	244.9	96		m
207.8	110	11	m	219.3	75	4	m	244.9	99		m
207.8	112	11	m	219.3	79	5	f	244.9	100	10	m
207.8	115	10	m	219.3	84	4	m	244.9	101	13	m
207.8	115	11	m	219.3	99		m	244.9	104	11	m
207.8	116	13	m	219.3	110	9	m	244.9	106		m
207.8	118	12	m	219.3	114	8	m	244.9	107	13	m
207.8	120	13	m	219.3	130	15	m	244.9	109		f
211	85	5	m	219.3	136	15	m	244.9	111	10	m
211	94	7	m	219.3	140	12	m	244.9	113	16	m
211	94	8	m	231	84	6	f	244.9	114	10	m
211	100	7	m	231	94	7	m	252.3	91	7	f
211	105	9	f	231	96	6	m	252.3	98	8	m
211	111	10	f	231	96	8	f	252.3	101	8	f
218	81	6	m	231	97	8	f	252.3	114	810	m
218	87	7	f	231	101	8	m	252.3	115	12	m
218	100		m	231	102	7	m				
Lampsilis teres											
4	131	7	m	28.5	126	7	m	98	110	9	f
4	137	6	f	28.5	128	7	m	98	112	8	f
4	154	8	f	28.5	130	8	f	98	115	8	f
20	29	2	m	28.5	131	6	m	98	119	9	m
20	64	4	m	28.5	145	8	f	98	120	9	m
20	121	6	f	28.5	147	7	f	98	122	8	f
20	137	7	m	28.5	147	7	m	107.5	95	5	m
20	142	8	f	28.5	155	7	m	107.5	106	6	f
20	148	9	f	28.5	155	9	m	107.5	107	3	m
28.5	95	5	f	28.5	156	11	f	113	81	5	
28.5	100	6	m	28.5	158	12	f	113	84	5	
28.5	108	6	m	28.5	162	10	f	113	120	7	
28.5	117	6	f	98	72	6	f	113	130	6	
28.5	122	6	m	98	75	5	f	113	135	10	
28.5	124	6	m	98	78	5	f	114	121	10	m
28.5	124	7	m	98	80	6	m	126	112	7	f
28.5	125	6	m	98	106	8	f	126	145	8	f

Appendix F, Table 1. Lengths, age estimates, and gender of unionids collected from the St. Francis River, Missouri, 2002.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Lampsilis teres cont.											
127	101	5		128	121	6	f	138			
127	142	8	f	128	137	7	m	172.1	87	4	m
127	144	8									
Lasmigona complanata											
28.5	105	6		138	72	4		138	161	14	
98	106	6		138	136	11		138	179	20	
128	94	5		138	158	12					
Lasmigona costata											
167				190.5	91	5		207.8	105	11	
172.1	112	10		207				215	86	7	
181.5	46	3		207.8	87			215	102	8	
181.5	46	3		207.8	91			218	82	7	
182	90	11		207.8	92	9		218	84	8	
182	91	10		207.8	93	8		218	104		
182	95	8		207.8	94	10		218	133		
182	103	9		207.8	94	11		219.3	95		
183	48	3		207.8	96			219.3	104	12	
183	105			207.8	97	11		219.3	105		
183	114			207.8	99	10		219.3	112	12	
183	120	8		207.8	102	12		238			
183.5				207.8	103	10		244.9	110	12	
Leptodea fragilis											
4	50	3	f	107.5	72	4	f	128	106	5	f
20	84	4	f	107.5	79	5	f	128	112	5	m
20	101	4	f	107.5	101	7	f	128	115	5	f
20	124	6	m	113	86	5	f	172.1	76	4	f
28.5	20	1		113	108	5	f	182	68	6	
28.5	40	3	f	113	139	9	m	182	92	8	
28.5	41	3	f	114	27	2		183.5	99	5	m
28.5	72	5	f	114	81	4	f	207	91	9	f
28.5	120	7	m	126	123	6	m	211	104	7	m
98	82	5	m	127	93	5		231	70	6	m
98	86	5	m	128	85	4	f	252.3			fd
98	110	7	m	128	92	4	m				
Ligumia recta											
172.1											
Ligumia subrostrata											
167				218				241.2	68	6	f
207				219.3	64	11	f				
Obliquaria reflexa											
20	17	1		20	42	4		20	47	4	
20	25	2		20	46	5		20	49	4	
20	36	3		20	47	4		20	52	6	
20	40	4		20	47	4		20	52	6	

Appendix F, Table 1. Lengths, age estimates, and gender of unionids collected from the St. Francis River, Missouri, 2002.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Obliquaria reflexa cont.											
28.5	52	6		98	62	10		138	62	8	
28.5	57	7		98	63	8		138	62	8	f
28.5	60	6		98	65	5		138	63	7	
28.5	62	8	f	98	66	8		138	63	9	
28.5	65	9		98	66	9	f	138	63	9	
28.5	68	9		98	67	9		138	65	8	
28.5	68	9	f	98	70	8		138	66	11	f
28.5	68	10		98	71	9		138	66	15	
28.5	69	9		98	72	11		138	67	10	
28.5	72	8		114	60	7	f	138	67	10	f
28.5	72	9		128	38	3		138	71	10	
28.5	73	8		128	45	4		138	71	13	
98	31	3		138	52	7		138	73	11	
98	41	4		138	55	5		138	74	17	f
98	60	7		138	55	7	f	138	76	16	
98	60	7	f	138	60	9		172.1	52	6	
98	62	6		138	62	7		183	54	5	
Plectomerus dombeyanus											
98			fd	138	116	15		138	127	15	
107.5			sf	138	121	11		138	129	16	
113	132	10		138	121	12		138	131	13	
114				138	121	13		138	131	14	
127	133	13		138	122	12		138	132	12	
127	142	12		138	122	13		138	135	16	
128	85	9		138	124	14		138	137	17	
138	111	10		138	126	13		138	140	17	
138	115	10		138	127	13		138	147	17	
Pleurobema sintoxia											
98			wd	172.1	91	12		190.5	79		
114				172.1	91	12		190.5	79	8	
127	61	8		172.1	92	14		190.5	80		
128	80	9		172.1	93	12		190.5	80		
138				172.1	96	10		190.5	81		
172.1	72	9		172.1	97	10		190.5	82		
172.1	77	8		172.1	100	12		190.5	82	9	
172.1	78	11		172.1	106	15		190.5	83		
172.1	79	8		181.5	83			190.5	84		
172.1	80	9		181.5	91	8		190.5	84		
172.1	81	8		182	81	10	m	190.5	84		
172.1	85	11		183	85	6		190.5	85		
172.1	90	11		183	97	6		190.5	85		
172.1	90	12		183	99	7		190.5	85		
172.1	90	13		183	118	7		190.5	87		
172.1	90	13		190.5	73	9		190.5	90		

Appendix F, Table 1. Lengths, age estimates, and gender of unionids collected from the St. Francis River, Missouri, 2002.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Pleurobema sintoxia cont.											
190.5	90			207.8	85	11		219.3	90	14	
190.5	90	10		207.8	90	13		219.3	95	16	
190.5	95			207.8	95	9		219.3	97	18	
194	84	18		207.8	98	12		244.9	81	21	
194	85	19		218	100						
Potamilus ohiensis											
4	76	4		28.5	128	6		127	75	4	
4	95	4	f	28.5	141	7		127	105	6	
4	128	5		98	108	6		127	108	6	
4	133	7		107.5	147	9		127	124	9	
4	146	10	f	113	63	4		128	40	2	
4	154	8		113	128	8		128	45	2	
4	170	7		114	31	2		128	138	6	
4	171	9		127	42	3		138	132	7	
28.5	115	6		127	71	4					
Potamilus puppuratus											
4	47	4		98	84	7	f	128	151	13	f
20	55	3		98	141	12	m	138	119	13	f
20	96	7	f	107.5	104	9	f	138	123	11	f
20	115	10	f	107.5	117	10	f	138	128	14	
20	121	10	f	113	141	15	m	138	129	14	f
20	147	11	m	126	109	8	f	172.1	44	3	f
20	155	13	m	126	125	7	m	172.1	97	7	f
20	155	14	m	126	132	8	m	172.1	104	9	m
28.5	38	4		126	143	11	f	181.5	30	2	
28.5	52	4		127	99	6		182	32	2	f
28.5	55	4		127	133	9		182	54	4	f
28.5	93	7	f	127	140	10		183	90	5	f
28.5	105	8	f	127	142	12		183	121	7	m
28.5	107	8	f	127	144	10		183.5	139	9	m
28.5	122	8	f	127	150	11		194	105	15	f
28.5	128	9	f	127	155	13		207.8	104	14	m
28.5	144	13	f	128	105	7	f	207.8	107	10	m
28.5	148	11	m	128	111	8	f	211	135	11	m
28.5	156	11	m	128	112	8	m	231	94	11	f
28.5	157	12	m	128	135	8	f	231	141	14	m
28.5	173	16	m	128	140	9	m	231	155	20	m
28.5	177	17	m	128	143	9	m				
Ptychobranchus occidentalis											
167				172.1	80	6		172.1	85	7	
172.1	72	7		172.1	80	7		172.1	85	8	
172.1	74	7		172.1	81	8		172.1	85	11	
172.1	75	5		172.1	83	8		172.1	88	9	
172.1	78	5		172.1	84	8		172.1	88	13	

Appendix F, Table 1. Lengths, age estimates, and gender of unionids collected from the St. Francis River, Missouri, 2002.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Ptychobranchus occidentalis cont.											
172.1	90	7		182	85	9		183.5	105	8	f
172.1	90	9		182	86	9		183.5	105	9	f
172.1	91	9		182	93	12		183.5	106		f
172.1	91	13		182	95	12		190.5	32	2	
172.1	93	9		182	97	10		190.5	35	2	
172.1	104	14		182	100	13		190.5	38	2	
181.5	24	1		182	102	10		190.5	43	3	
181.5	27	2		182	105			190.5	51	4	f
181.5	33	2		183	45	2		190.5	59	4	
181.5	37	2		183	47	3		190.5	65	4	
181.5	48	3		183	54	5		190.5	66	5	
181.5	62	4		183	62	4	f	190.5	71	5	
181.5	63	4	f	183	65	4		190.5	71	5	f
181.5	64	5		183	75	5		190.5	72	6	
181.5	73	6		183	78	5		190.5	75	6	
181.5	77			183	78	5		190.5	78	6	
181.5	80	6	f	183	79	5	f	190.5	78	6	f
181.5	81			183	80	5		190.5	78	8	
181.5	81	8		183	81	5		190.5	84	7	
181.5	85			183	88	5		190.5	85	7	
181.5	85	8		183	88	5		190.5	87	10	
181.5	87	9	f	183	91	6		190.5	90	10	f
181.5	88			183	94	7		190.5	101	12	
181.5	94		f	183	94	7		194	18	2	
181.5	102		f	183	95	6	f	194	34	3	
181.5	103			183	105	9	f	194	41	3	
182	32	2		183	105	9	f	194	45	4	
182	34	2		183	122			194	51	5	
182	34	2		183.5	46	3		194	55	4	
182	35	2		183.5	65	4		194	63	6	
182	36	2		183.5	75	5	f	194	65	6	
182	43	3		183.5	75	5	f	194	68	6	
182	47	4		183.5	76	5		194	80		
182	48	4		183.5	79	5		194	80	13	
182	51	4		183.5	81			194	81	8	
182	52	5		183.5	81	6		194	81	9	
182	56	5		183.5	83	6		194	84	9	
182	57	6		183.5	85	6		194	85	8	
182	61	5		183.5	85	6		194	85	10	
182	63	6		183.5	88	7		194	88	10	
182	69	7		183.5	88	7	f	194	90		
182	75	6		183.5	90	7		194	91	9	
182	78	7		183.5	91	9		194	95	12	
182	78	8		183.5	95	10		207	64	8	
182	83	10		183.5	97	8	f	207	75	7	

Appendix F, Table 1. Lengths, age estimates, and gender of unionids collected from the St. Francis River, Missouri, 2002.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Ptychobranchus occidentalis cont.											
207	78	8		207.8	110	12		218	68	8	
207	78	9		207.8	117	16		218	70	6	
207	80	10		211	72	6		218	73	6	
207	84	10		211	85	9		218	74	6	
207	85	8		211	102			218	78	8	
207	92			215	23	1		218	80	9	
207	97			215	24	1		218	81	8	
207.8	6	0		215	25	1		218	82	9	
207.8	10	0		215	28	1		218	85		
207.8	22	1		215	28	1		218	85	9	
207.8	27	2		215	33	1		218	86	11	
207.8	29	2		215	55	4		218	90	9	
207.8	31	2		215	56	3		218	90	11	
207.8	38	2		215	57	3		218	93	10	
207.8	38	3		215	58	4		218	100	10	
207.8	38	3		215	58	4		219.3	66	6	
207.8	41	3		215	75	5		219.3	68	6	
207.8	58	4		215	75	6		219.3	70	5	
207.8	65	4		215	76	7		219.3	70	5	
207.8	72	7		215	77	7		219.3	73	7	
207.8	75	7		215	80	5		219.3	74	6	
207.8	75	7		215	80	7		219.3	76	8	
207.8	75	11		215	80	8		219.3	76	8	
207.8	76	7		215	85	9		219.3	85	11	
207.8	80	8		215	86	8		219.3	88	9	
207.8	80	9		215	88	7		219.3	89	9	
207.8	83	9		215	89	7		219.3	90	8	
207.8	87			215	91	9		219.3	90	9	
207.8	87			218	20	1		219.3	99	11	
207.8	91	10		218	23	1		219.3	100		
207.8	94	10		218	23	1		219.3	106	14	
207.8	96	9		218	24	1		219.3	108		
207.8	97	10		218	24	1		219.3	110		
207.8	97	10		218	45	2		219.3	110	10	
207.8	103	12		218	65	6		219.3	110	10	
207.8	109	13		218	68	7					
Pyganodon grandis											
28.5	121	7		114	130	12		128	139	8	
28.5	142	9		128	66	3		252.3	110	11	
113	115	8		128	126	7		244.9	111	7	
114	108	11									

Appendix F, Table 1. Lengths, age estimates, and gender of unionids collected from the St. Francis River, Missouri, 2002.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Quadrula cylindrica											
172.1	98			172.1	112	12		183	110	8	
172.1	107	9		172.1	115	10		183	121		
172.1	110			172.1	118			183	123	8	
172.1	110	13		172.1	120	13		190.5	105		
172.1	112			172.1	124	16		190.5	112		
172.1	112	10									
Quadrula pustulosa											
20	19	2		28.5	78	12		128	48	5	
20	20	2		28.5	78	13		128	51	6	
20	21	2		98	28	3		128	56	4	
20	21	2		98	37	4		128	57	6	
20	22	2		98	37	4		128	58	6	
20	25	3		98	61	8		128	58	10	
20	30	3		98	61	10		128	59	8	
20	38	4		98	62	9		128	60	8	
20	39	4		98	63	7		128	61	7	
20	40	4		98	65	9		128	65	7	
20	40	5		98	66	8		128	68	7	
20	50	6		98	67	10		128	71	9	
20	51	6		98	68	8		128	75	9	
20	56	7		98	73	11		128	76	11	
20	58	8		113	53	7		128	77	8	
20	62	8		113	55	8		128	80	9	
20	62	9		113	58	9		138	33	4	
20	65	8		113	60	8		138	39	6	
20	67	8		113	62	8		138	45	6	
20	71	10		113	63	8		138	47	7	
28.5	53	7		113	63	11		138	48	6	
28.5	55	8		113	81	12		138	52	7	
28.5	55	8		114	21	2		138	53	8	
28.5	55	9		114	37	4		138	60	11	
28.5	56	7		114	57	12		138	60	11	
28.5	58	7		126	61	8		138	61	10	
28.5	60	8		126	64	9		138	63	12	
28.5	61	8		127	40	5		138	65	11	
28.5	62	10		127	49	7		138	65	11	
28.5	63	9		127	50	7		138	66	12	
28.5	64	11		127	53	9		138	74	11	
28.5	67	10		127	54	9		138	74	13	
28.5	69	10		127	62	9		138	75	10	
28.5	71	12		127	64	8		138	78	10	
28.5	71	13		128	22	2		138	82	14	
28.5	72	11		128	30	2		138	92	15	
28.5	73	14		128	30	2		167			
28.5	74	11		128	47	6		172.1	62	8	

Appendix F, Table 1. Lengths, age estimates, and gender of unionids collected from the St. Francis River, Missouri, 2002.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Quadrula pustulosa cont.											
172.1	62	11		172.1	80	10		183	75		
172.1	64	15		181.5				183	78		
172.1	66	9		183	40	4		183	78	1	
172.1	70			183	47	4		183	81	8	
172.1	70	9		183	52			183	82	9	
172.1	76	10		183	65	7		183	94		
172.1	77			183	70						
Quadrula quadrula											
20	62	5		128	34	3		138	111	11	
20	80	6		128	38	3		138	114	13	
20	88	7		138	74	7		138	115	15	
28.5	98	10		138	91	11		138	116	11	
98	51	4		138	94	10		138	116	15	
98	87	8		138	94	11		138	117	15	
98	88	8		138	97	11		138	121	17	
98	92	10		138	97	13		138	122	15	
98	98	10		138	101	14		138	122	16	
98	101	10		138	104	13		138	125	21	
98	102	11		138	107	14		138	127	17	
113	82	9									
Strophitus undulatus											
20				182				207.8	30	2	
98				183	71	4		207.8	51	3	
114				190.5	40	3		215	43	3	
127	135	9		190.5	45	3		219.3			
138	105	9		190.5	48	3		244.9			
138	116	11		194				252.3	78	8	
181.5											
Toxolasma lividis											
182	25	3		207				183.5	55	4	m
182	27	3		181.5				190.5			
Toxolasma parvus											
219.3											
Tritogonia verrucosa											
128	142	11	f	138	113	11	m	172.1			
138	90	7	m								
Truncilla donaciformis											
20	4	0		20	38	4		28.5			
20	31	3		20	44	5		138			
Truncilla truncata											
138	61	9		138	62	10					

Appendix F, Table 1. Lengths, age estimates, and gender of unionids collected from the St. Francis River, Missouri, 2002.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Utterbackia imbecillis											
218	30	1		244.9				252.3			
231											
Venustaconcha ellipsiformis											
167				194	73	9	m	215	70	4	m
181.5				215	48	3	f	215	75	4	m
182	77	10	m	215	64	5	m	218	74	7	m
182	81	11		215	65	5	f	219.3	65	5	m
190.5	52	5	m	215	67	4	m	219.3	72	6	m
194	68	7	m	215	70		m	241.2			
194	72	9	m	215	70		m	244.9	71	11	
194	73	8	m								
Villosa iris											
167				181.5	43	3	m	182	44	4	f
172.1				181.5	51	4	f	194			
172.1	40	3	m	181.5	51	5	m	207.8	58	7	m
181.5	15	1		181.5	75	8	m	215	48	5	
181.5	40	4	f	182	25	3	m				
Villosa iris											
167				182	28	3	f	207	55	6	
172.1	38	2	m	182	48	5	f	218	57	7	m
172.1	38	2	m	194				219.3			
182	27	3	f	207	39	4		252.3			wd

Appendix F, Table 2. Lengths, age estimates, and gender of unionids collected from the Battle Shell Lake, Missouri, 2002

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Anodonta suborbiculata											
na			fd								
Ligumia subrostrata											
na			fd								
Pyganodon grandis											
na			fd								

Appendix F, Table 2. Lengths, age estimates, and gender of unionids collected from the Ditch at CR 642, Missouri, 2002

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Lampsilis teres											
4.4			wd								
Leptodea fragilis											
4.4			wd								
Potamilus ohiensis											
4.4			wd								
Potamilus purpuratus											
4.4			wd								
Pyganodon grandis											
4.4	68	4		4.4	75	4		4.4	99	5	
4.4	73	4									
Quadrula quadrula											
4.4	74	10									

Appendix F, Table 2. Lengths, age estimates, and gender of unionids collected from the Indian Hill Slough, Missouri, 2002

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Amblema plicata											
2	88	7		2	111	12		2	116	11	
2	106	10									
Arcidens confragosus											
2	131	9		2	150	11					
Anodonta suborbiculata											
1	43	3		1	55	4		1	122	9	
1	43	3		1	60	5		1			
Fusconaia flava											
2	42	4		2	72	10		2	83	11	
2	70	8									
Lampsilis cardium											
2	128	10		2	140	8		2	159	13	
2	139	9		2	147	9					
Lampsilis teres											
1	85	4	m	1	125	7	m	2	35	2	
1	101	5	f	1	126	7	f	2	101	6	
1	115	6	f	2	6	0		2	103	6	
Lasmigona complanata											
2	109	5									
Leptodea fragilis											
1	31	2		1	107	6		2	110	5	
1	32	2		2	103	5		2	118	5	
1	105	6									
Obliquaria reflexa											
1			wd	2	58	9		2	73	9	
2	52	8		2	62	8		2	78	10	
2	57	6		2	64	8		2	85	10	
2	57	7									
Potamilus purpuratus											
1	108	8		2	125	11		2	141	11	
1	181	15		2	133	10		2	142	12	
2	91	5		2	136	7		2	142	13	
2	104	7		2	138	8		2	164	13	
2	119	7		2	139	8		2	169	12	
2	119	8		2	140	8		2	169	13	
2	121	9									

Appendix F, Table 2. Lengths, age estimates, and gender of unionids collected from the Indian Hill Slough, Missouri, 2002

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Pyganodon grandis											
1	40	3		1	62			1	141	10	
1	46	3		1	63	5		1	143	8	
1	51	3		1	73	5		1	146	10	
1	52	5		1	82	6		1	155	5	
1	53	11		1	137	10		1	155	9	
1	55	4		1	138	9		1	167	12	
1	57	4		1	138	11					
Quadrula nodulata											
2	78	10									
Quadrula pustulosa											
1	60	9		2	59	7		2	66	8	
2	46	7		2	59	7		2	68	8	
2	55	6		2	60	5		2	72	10	
2	55	7		2	60	8		2	73	10	
2	57	6		2	61	8		2	85	10	
2	58	7		2	62	9					
Quadrula quadrula											
1	60	5		2	96	9		2	108	15	
1	111	13		2	100	13		2	109	16	
2	85	10									
Toxolasma texasensis											
1	25	2	m	1	35	5	f	1	47	4	m
1	25	2	m	1	36	4	f	1	48	6	m
1	26	2	m	1	41	5	f	1	49	5	m
1	32	3	f	1	43	5	f	1	50	5	m
1	32	4	f	1	44	5	f	1	50	5	m
1	35	4	f	1	45	4	m	1	50	5	m
1	35	4	m	1	46	5	f				
Truncilla truncata											
2	31	3		2	58	7		2	71	8	
Utterbackia imbecillis											
1	35	3		1	38	4		1	51	3	
1	38	3									

Appendix F, Table 2. Lengths, age estimates, and gender of unionids collected from the Little St. Francis River, Missouri, 2002

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Actinonaias ligamentina											
9.9	129	12	m								
Amblema plicata											
9.9	105	10									
Elliptio dilatata											
12.9			fd								
Lampsilis cardium											
5.2	123	9	m	9.9	93	12	f	9.9	119	10	m
5.2	129	10	m	9.9	98	13	f	9.9	123	16	m
9.9	82	10	f	9.9	100	15	f	12.9	105	9	m
9.9	90	11	f	9.9	103	13	m	12.9	110	11	m
9.9	90	12	f	9.9	107	11	m				
Lampsilis reeviana											
12.9			wd								
Lampsilis siliquoidea											
9.9	83	7	f	9.9	95	9	f	9.9	104	10	m
9.9	85	8	m	9.9	95	9	m	9.9	106	10	m
9.9	88	8	f	9.9	100	11	f	9.9	108	10	m
9.9	91	9	f	9.9	100	11	m	9.9	120	13	m
9.9	91	12	m	9.9	101	7	m	9.9	125	13	m
9.9	92	8	m	9.9	101	9	m	9.9	135	16	m
9.9	93	7	m	9.9	101	10	f				
Ligumia recta											
5.2			wd								
Ligumia subrostrata											
9.9	57	8	f	9.9	64	9	m	9.9	74	11	m
9.9	58	8	m								
Pyganodon grandis											
9.9	74	7									
Strophitus undulatus											
9.9	100	11									
Venustaconcha ellipsiformis											
5.2	36	4	m	9.9	55	7					
Villosa lienosa											
5.2	56	7	f								

Appendix F, Table 2. Lengths, age estimates, and gender of unionids collected from May Pond, Missouri, 2002

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Uniomerus tetralasmus											
na	47	3		na	75	7		na	78	7	
na	74	7		na	75	7					

Appendix F, Table 2. Lengths, age estimates, and gender of unionids collected from Mingo River, Missouri, 2002

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Actinonaias ligamentina											
2.8	138	9									
Amblema plicata											
1.6	9	10		1.6	99	11		2.8	47	4	
1.6	50	4		1.6	101	11		2.8	54	5	
1.6	53	4		1.6	102	10		2.8	58	5	
1.6	64	7		1.6	106	12		2.8	74	6	
1.6	78	7		1.6	107	11		2.8	77	7	
1.6	80	8		1.6	122	15		2.8	77	7	
1.6	82	8		2.8	22	2		2.8	78	7	
1.6	82	10		2.8	33	3		2.8	82	6	
1.6	86	8		2.8	37	3		2.8	85	9	
1.6	88	9		2.8	39	3		2.8	91	9	
1.6	89	11		2.8	39	3		2.8	95	10	
1.6	90	10		2.8	40	3		2.8	97	9	
1.6	97	12		2.8	40	3		2.8	103	10	
1.6	98	11									
Arcidens confragosus											
1.6	110	9		2.8	49	4		2.8	65	5	
Fusconaia flava											
1.6	74	11		2.8	58	6		2.8	71	8	
1.6	80	10		2.8	60	6		2.8	71	12	
2.8	35	3		2.8	62	8		2.8	75	8	
2.8	35	3		2.8	64	7		2.8	75	10	f
2.8	38	3		2.8	65	8		2.8	75	11	
2.8	51	5		2.8	65	9		2.8	78	12	
2.8	54	7	f	2.8	68	8		2.8	85	11	f
2.8	57	6									
Lampsilis cardium											
2.8	51	3	m	2.8	77	5	f	2.8	125	10	m
2.8	51	3	m	2.8	77	5	f	2.8	129	11	m
2.8	51	3	m	2.8	81	6	f	2.8	130	10	m
2.8	52	3	m	2.8	84	5	f	2.8	134	12	m
2.8	53	3	m	2.8	102	8	f	2.8	135	11	m
2.8	53	3	m	2.8	115	11	m	2.8	135	12	m
2.8	54	3	m	2.8	124	8	m	16.3	48	4	
Lampsilis teres											
1.6	55	2	m	2.8	47	3		2.8	110	7	m
1.6	73	4	m	2.8	48	3		2.8	110	7	m
1.6	88	5	m	2.8	50	3		2.8	117	9	m
1.6	106	8	m	2.8	51	3		10	7	0	
1.6	111	10	f	2.8	55	3		10	9	0	
1.6	111	13	m	2.8	57	4		10	10	0	
1.6	112	7	m	2.8	58	4		10	10	0	
1.6	112	8	m	2.8	60	4		10	10	0	
1.6	120	8	f	2.8	60	4		10	11	0	
1.6	122	9	f	2.8	61	4		10	11	0	
1.6	127	11	m	2.8	64	4		10	11	0	
2.8	45	3		2.8	101	7	m	10	11	0	

Appendix F, Table 2. Lengths, age estimates, and gender of unionids collected from Mingo River, Missouri, 2002

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Lampsilis teres cont.											
10	11	0		10	23	1		16.3	103	7	f
10	12	0		16.3	51	3	m	16.3	111	5	f
10	12	0		16.3	62	4	f	16.3	112	6	m
10	14	1		16.3	94	4	f	16.3	113	7	m
10	18	1		16.3	102	6	f	16.3	118	8	m
Lasmigona complanata											
2.8	114	7		16.3	133	7					
Leptodea fragilis											
1.6	60	3	m	1.6	127	10	m	2.8	58	4	m
1.6	78	4	m	1.6	130	10	f	2.8	62	5	m
1.6	80	4	m	1.6	135	10	m	2.8	62	5	m
1.6	82	4	f	1.6	136	9	m	2.8	63	4	m
1.6	88	6	f	1.6	144	11	m	2.8	64	5	m
1.6	90	5	f	2.8	50	3	m	2.8	65	5	f
1.6	91	5	f	2.8	51	4	f	2.8	65	5	f
1.6	94	6	m	2.8	55	3	m	2.8	65	5	m
1.6	96	5	m	2.8	55	4	f	2.8	71	5	f
1.6	110	7	m	2.8	55	4	m	2.8	71	5	m
1.6	110	15	m	2.8	55	4	m	2.8	110	9	m
1.6	115	8	m	2.8	56	4	m	10	8	0	
1.6	119	9	m	2.8	58	4	f	10	39	3	
1.6	120	11	m	2.8	58	4	f				
Ligumia subrostrata											
1.6	63	4	m								
Obliquaria reflexa											
1.6	52	6		2.8	51	5		2.8	53	6	
Plectomerus dombeyanus											
1.6	109	10		2.8	104	8		2.8	115	8	
1.6	112	10		2.8	105	9		2.8	119	10	
Potamilus ohiensis											
2.8	70	4									
Potamilus purpuratus											
1.6	114	11	f	1.6	143	13	m	2.8	104	9	f
1.6	115	9	f	1.6	148	10	m	2.8	109	10	f
1.6	120	7	m	1.6	160	19	m	2.8	109	10	f
1.6	122	9	f	1.6	161	20	m	2.8	113	10	m
1.6	122	10	f	1.6	162	17	m	2.8	114	10	f
1.6	123	9	f	2.8	57	4	m	2.8	119		f
1.6	129	9	f	2.8	59	4	m	2.8	127	10	m
1.6	130	8	m	2.8	65	4	m	2.8	127	14	m
1.6	130	9	f	2.8	72	5	f	2.8	132	12	m
1.6	131	10	f	2.8	74	5	f	2.8	144	15	f
1.6	132	12	m	2.8	85	7	f	16.3	101	13	f
1.6	138	12	m	2.8	87	6	m	16.3	111	12	f
1.6	140	10	m	2.8	96	8	m	16.3	117	1	f
1.6	141	11	m	2.8	99	7	f	16.3	155	14	m
1.6	143	10	m	2.8	100	8	m	16.3	162	18	m

Appendix F, Table 2. Lengths, age estimates, and gender of unionids collected from Mingo River,

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Pyganodon grandis											
2.8	55	3		16.3	144	13		16.3	145	14	
2.8	77	5									
Quadrula pustulosa											
1.6	25	3		1.6	60	8		2.8	46	5	
1.6	26	3		1.6	60	12		2.8	47	5	
1.6	30	4		1.6	63	9		2.8	49	5	
1.6	33	4		1.6	64	12		2.8	51	8	
1.6	40	6		1.6	66	10		2.8	52	6	
1.6	41	5		1.6	102	13		2.8	55	7	
1.6	45	4		2.8	27	2		2.8	56	7	
1.6	46	7		2.8	31	3		2.8	59	8	
1.6	49	9		2.8	32	3		2.8	63	10	
1.6	52	9		2.8	33	4		2.8	64	8	
1.6	55	9		2.8	40	5		2.8	65	10	
1.6	55	10		2.8	42	4		2.8	67	9	
1.6	56	10		2.8	42	5		16.3	45	6	
1.6	59	10		2.8	43	5					
Quadrula quadrula											
1.6	32	9		1.6	105	13		2.8	77	8	
1.6	42	4		1.6	110	14		2.8	81	9	
1.6	46	4		2.8	34	3		2.8	84	8	
1.6	54	5		2.8	38	3		2.8	98	10	
1.6	68	7		2.8	38	4		2.8	108	11	
1.6	68	7		2.8	38	4		10	62	6	
1.6	73	6		2.8	40	3		10	104	9	
1.6	85	8		2.8	45	4		10	111	12	
1.6	88	12		2.8	66	7		16.3	78	8	
1.6	90	9		2.8	67	7		16.3	92	7	
1.6	90	9		2.8	68	7		16.3	96	10	
1.6	90	11		2.8	71	7		16.3	101	10	
1.6	91	11		2.8	71	7		16.3	108	11	
1.6	92	11		2.8	73	6		16.3	109	11	
1.6	99	11		2.8	75	7		16.3	109	11	
1.6	100	12		2.8	75	8		16.3	112	14	
1.6	100	13		2.8	77	7		16.3	115	13	
1.6	105	8									
Strophitus undulatus											
1.6	66	5		1.6	85	7		1.6	104	10	
Toxolasma parvus											
2.8	35	4	f								
Tritogonia verrucosa											
1.6	58	4	m	1.6	92	9	m	2.8	91	8	
1.6	80	6	m	1.6	96	9	m	2.8	104	9	
1.6	92	8	m	1.6	104	9	m				

Appendix F, Table 2. Lengths, age estimates, and gender of unionids collected from Mingo River, Missouri, 2002

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Truncilla donaciformis											
2.8	25	3		2.8	31	3		2.8	32	3	
Truncilla truncata											
1.6	38	4		2.8	38	3		2.8	48	4	
Utterbackia imbecillis											
16.3	25	2		16.3	31	2		16.3	34	3	
16.3	27	2									

Appendix G. Re-survey collection data for the St. Francis River system, Missouri 2003

Collector	Hutson	MDC	Oesch	Hutson	MDC	Hutson	Oesch	MDC	Oesch
Collection Date	2002	1980	1976	2002	1979	2002	1980	1979	1976
Water Body	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis
River Mile	20	20	20	107.5	107.5	113	113	113	113
Actinonaias ligamentina				wd	p	wd			
Alasmidonta marginata									
Anodonta suborbiculata			10						
Amblema plicata	2		6		p	3	5		18
Arcidens confragosus	1		2						2
Cyclonaias tuberculata									
Cyprogenia aberti								fd	12
Elliptio dilatata					p		4		2
Epioblasma triquetra									
Fusconaia flava			2		p		1	fd	28
Lampsilis abrupta									
Lampsilis cardium	2				p	4	2		8
Lampsilis reeveiana brittsi									
Lampsilis siliquoidea									
Lampsilis teres	7			3		6			
Lasmigona complanata									
Lasmigona costata									
Leptodea fragilis	3	fd		3	p	3		fd	
Ligumia recta									
Ligumia subrostrata			23						
Obliquaria reflexa	12		6						
Megalonaias nervosa							2		
Obovaria jacksoniana									
Plectomerus dombeyanus				sf	p	1			
Pleurobema sintoxia									
Potamilus purpuratus	7		14	2	p	1	7	fd	12
Potamilus ohiensis		fd		1		2			
Ptychobranchus occidentalis									
Pyganodon grandis									
Quadrula cylindrica									
Quadrula metanevra							1		4
Quadrula nodulata									
Quadrula pustulosa	20				p	8			
Quadrula quadrula	3		12			1	1		
Strophitus undulatus	wd								
Toxolasma lividis									
Toxolasma parvus									
Toxolasma texasensis									
Tritogonia verrucosa							2		2
Truncilla donaciformis	4								
Truncilla trucata									
Uniomerus tetralasmus					p				
Utterbackia imbecillis									
Venustaconcha ellipsiformis									
Villosa iris									
Villoso lienosa									
No. of living individuals	61	0	75	9		29	25		88
No. of live species	10	0	8	4	10	9	9		9
Live and dead species	11	1		6		10		4	
Effort (person-hrs.)	3.5	2.83		2		3			
CPUE	17.42857	0		4.5		9.666667			

Appendix G. Re-survey collection data for the St. Francis River system, Missouri 2003

Collector	Hutson	MDC	Hutson	MDC	Hutson	Oesch
Collection Date	2002	1979	2002	1979	2002	1969
Water Body	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis
River Mile	114	114	126	126	138	138
Actinonaias ligamentina	sf	75		41	sf	
Alasmidonta marginata						
Anodonta suborbiculata						
Amblema plicata		22		p	167	3
Arcidens confragosus					sf	
Cyclonaias tuberculata						
Cyprogenia aberti		12			5	
Elliptio dilatata		wd				
Epioblasma triquetra						
Fusconaia flava	fd	39		31	wd	2
Lampsilis abrupta						
Lampsilis cardium	1	9	4	p	5	10
Lampsilis reeveiana brittsi						
Lampsilis siliquoidea		1				
Lampsilis teres	1	3	3		fd	3
Lasmigona complanata		1				
Lasmigona costata					5	
Leptodea fragilis	2	1	1			
Ligumia recta		1				10
Ligumia subrostrata						
Obliquaria reflexa	1				24	
Megalonaias nervosa						
Obovaria jacksoniana						
Plectomerus dombeyanus	fd	4			23	
Pleurobema sintoxia	sf	27		p	sf	
Potamilus purpuratus	1	10	4		4	5
Potamilus ohiensis	1				1	
Ptychobranchus occidentalis						1
Pyganodon grandis	1					
Quadrula cylindrica						
Quadrula metanevra		14		p		1
Quadrula nodulata						
Quadrula pustulosa	3	36	2	p	486	
Quadrula quadrula		2		p	24	
Strophitus undulatus	sf	fd			2	
Toxolasma lividis						
Toxolasma parvus						
Toxolasma texasensis						
Tritogonia verrucosa		1			2	1
Truncilla donaciformis					wd	
Truncilla trucata					2	
Uniomerus tetralasmus						
Utterbackia imbecillis						
Venustaconcha ellipsiformis						
Villosa iris						
Villoso lienosa		wd				
No. of living individuals	11	258	14	72	750	36
No. of live species	8	18	5	8	13	9
Live and dead species	13	20	5	8	19	
Effort (person-hrs.)	2	2.25	3		3	
CPUE	5.5	114.66667	4.6666667		250	

Appendix G. Re-survey collection data for the St. Francis River system, Missouri 2003

Collector	Hutson	MDC	Oesch	Oesch	Oesch	Hutson	MDC	MDC
Collection Date	2002	1981	1977	1977	1972	2002	2001	1981
Water Body	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis
River Mile	167	167	167	167	167	172.1	172.1	172.1
Actinonaias ligamentina	wd	410				286	32	613
Alasmidonta marginata				1	4	6		sf
Anodonta suborbiculata								
Amblema plicata		SF		1	6	8		6
Arcidens confragosus								
Cyclonaias tuberculata						5		
Cyprogenia aberti		13	2	1	68	127	12	7
Elliptio dilatata		26	24	1	2	62	3	90
Epioblasma triquetra	wd					7	5	
Fusconaia flava		12		1	18	11	2	23
Lampsilis abrupta					4			
Lampsilis cardium	1	42		1	6	41	12	19
Lampsilis reeveiana brittsi	1	2		1	6	14	4	fd
Lampsilis siliquoidea						2		
Lampsilis teres						1		
Lasmigona complanata								
Lasmigona costata	wd			1	6	1		1
Leptodea fragilis						1		fd
Ligumia recta				1		1		sf
Ligumia subrostrata	wd				7			
Obliquaria reflexa						1		
Megalonaias nervosa								
Obovaria jacksoniana								
Plectomerus dombeyanus								
Pleurobema sintoxia		6				35		13
Potamilus purpuratus				1		3		
Potamilus ohiensis								
Ptychobranchus occidentalis	wd	4	49	1	73	643	43	1
Pyganodon grandis								
Quadrula cylindrica		16				11	8	35
Quadrula metanevra								sf
Quadrula nodulata								
Quadrula pustulosa	wd	5				9		7
Quadrula quadrula				1				
Strophitus undulatus								1
Toxolasma lividis								
Toxolasma parvus					4			
Toxolasma texasensis								
Tritogonia verrucosa						1		sf
Truncilla donaciformis					5			
Truncilla trucata		SF		1	4			
Uniomerus tetralasmus								
Utterbackia imbecillis								
Venustaconcha ellipsiformis	wd							
Villosa iris	wd					4	1	
Villoso lienosa	wd							
No. of living individuals	2	536	75		213	1280	122	829
No. of live species	2	10	3		14	23	10	14
Live and dead species	11	13	3			23	10	18
Effort (person-hrs.)	2	3.5				4	1.75	3.5
CPUE	1	153.14286				320	69.714286	236.85714

Appendix G. Re-survey collection data for the St. Francis River system, Missouri 2003

Collector	Hutson	MDC	MDC	Hutson	MDC	Hutson	MDC
Collection Date	2002	2001	1981	2002	1981	2002	1977
Water Body	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis
River Mile	182	182	182	194	194	207	207
Actinonaias ligamentina	47	69	273	32	33	15	2
Alasmidonta marginata	fd						sf
Anodonta suborbiculata							
Amblema plicata	4	2	8	1	3	1	sf
Arcidens confragosus							
Cyclonaias tuberculata							
Cyprogenia aberti	8	2	10	5	5	1	2
Elliptio dilatata	28	2	38		6	8	3
Epioblasma triquetra	4		wd				
Fusconaia flava		2	10		15	3	
Lampsilis abrupta							
Lampsilis cardium	20	14	71	7	27	6	sf
Lampsilis reeveiana brittsi	12	1	4	8	1	3	
Lampsilis siliquoidea	4	1	9		7	6	
Lampsilis teres							
Lasmigona complanata							
Lasmigona costata	4	2	6		4	wd	sf
Leptodea fragilis	2					1	
Ligumia recta			1		wd		sf
Ligumia subrostrata			wd			wd	
Obliquaria reflexa							
Megalonaias nervosa							
Obovaria jacksoniana					wd		
Plectomerus dombeyanus							
Pleurobema sintoxia	1	1	3	2	1		sf
Potamilus purpuratus	4		16	1	fd		sf
Potamilus ohiensis							
Ptychobranchus occidentalis	80	71	28	206	12	9	
Pyganodon grandis			1				sf
Quadrula cylindrica			9				
Quadrula metanevra							
Quadrula nodulata							
Quadrula pustulosa			1		4		
Quadrula quadrula							
Strophitus undulatus	wd			fd			
Toxolasma lividis	3					wd	
Toxolasma parvus							
Toxolasma texasensis							
Tritogonia verrucosa			sf				
Truncilla donaciformis							
Truncilla trucata			sf				
Uniomerus tetralasmus							
Utterbackia imbecillis							
Venustaconcha ellipsiformis	2			4			1
Villosa iris	2	1		fd			
Villoso lienosa	1		1	fd	fd	2	
No. of living individuals	226	174	492	266	91	55	7
No. of live species	16	12	17	9	12	10	4
Live and dead species	18	12	21	12	12	13	12
Effort (person-hrs.)	5	2.58	3.5	2	4.25	2.16	1.75
CPUE	45.2	67.44186	140.57143	133	21.411765	25.462963	4

Appendix G. Re-survey collection data for the St. Francis River system, Missouri 2003

Collector	Hutson	MDC	Hutson	MDC	Hutson	MDC	MDC	MDC	Oesch
Collection Date	2002	1978	2002	1981	2002	2001	1983	1981	1975
Water Body	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis
River Mile	207.8	207.8	211	211	215	215	215	215	215
Actinonaias ligamentina	220	31		76				4	
Alasmidonta marginata	1	sf		3	1				1
Anodonta suborbiculata									
Amblema plicata	39	1	1	5		sf			1
Arcidens confragosus									
Cyclonaias tuberculata									
Cyprogenia aberti	48	26		11	1		wd	1	1
Elliptio dilatata	55	41		3		sf		4	1
Epioblasma triquetra									
Fusconaia flava	12	5		wd	1			1	1
Lampsilis abrupta									
Lampsilis cardium	43	5	3	78	3	sf	10	53	1
Lampsilis reeveiana brittsi	11	10		5	13	fd	fd	4	1
Lampsilis siliquoidea	18	2	6	81		wd		19	
Lampsilis teres									
Lasmigona complanata									
Lasmigona costata	11	4		24	2			1	1
Leptodea fragilis		sf	1	wd					
Ligumia recta		sf		sf			1		1
Ligumia subrostrata	wd	sf		1			wd	2	1
Obliquaria reflexa									
Megalonaias nervosa									
Obovaria jacksoniana									
Plectomerus dombeyanus									
Pleurobema sintoxia	4	sf				wd	wd	1	
Potamilus purpuratus	2		1	11			wd		1
Potamilus ohiensis									
Ptychobranchus occidentalis	306		3	22	23	fd		7	1
Pyganodon grandis		sf							
Quadrula cylindrica									
Quadrula metanevra									
Quadrula nodulata									
Quadrula pustulosa		sf							
Quadrula quadrula									
Strophitus undulatus	2	1		wd	1			wd	
Toxolasma lividis									
Toxolasma parvus				wd			wd		
Toxolasma texasensis									
Tritogonia verrucosa								sf	
Truncilla donaciformis									
Truncilla trucata		1		wd					
Uniomerus tetralasmus									
Utterbackia imbecillis									
Venustaconcha ellipsiformis					8				
Villosa iris	1				1			fd	
Villoso lienosa		1		wd				fd	
No. of living individuals	773	131	15	323	54	0	11	106	
No. of live species	15	15	6	14	10	0	2	14	
Live and dead species	16	23	6	21	10	6	8	16	
Effort (person-hrs.)	4.5	2.75	2	3.5	3			2.5	
CPUE	171.77778	47.636364	7.5	92.285714	18			42.4	

Appendix G. Re-survey collection data for the St. Francis River system, Missouri 2003

Collector	Hutson	MDC	MDC	MDC	Hutson	MDC	Hutson	MDC
Collection Date	2002	2001	1982	1980	2002	1985	2002	1981
Water Body	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis
River Mile	218	218	218	218	219.3	219.3	231	231
Actinonaias ligamentina	17	10		3	7	1	1	
Alasmidonta marginata	1			wd				
Anodonta suborbiculata								
Amblema plicata	4	2		wd	4	3	wd	
Arcidens confragosus								
Cyclonaias tuberculata								
Cyprogenia aberti	9	6	wd	fd		wd		
Elliptio dilatata	5	5	fd	6	6	1	wd	
Epioblasma triquetra								
Fusconaia flava	9	2	fd	fd	10	1	1	
Lampsilis abrupta								
Lampsilis cardium	19	15	fd	1	14	4	6	
Lampsilis reeveiana brittsi	2	3		3	wd	1		
Lampsilis siliquoidea	12	5	fd	2	12	5	14	
Lampsilis teres								
Lasmigona complanata								
Lasmigona costata	4	1	wd	2	4	1		
Leptodea fragilis							1	
Ligumia recta								
Ligumia subrostrata				1	1	2		
Obliquaria reflexa								
Megalonaias nervosa								
Obovaria jacksoniana								
Plectomerus dombeyanus								
Pleurobema sintoxia	1	5		3	3	fd		
Potamilus purpuratus						fd	3	
Potamilus ohiensis								
Ptychobranchus occidentalis	88	58		5	36	3		
Pyganodon grandis				wd		1		3
Quadrula cylindrica								
Quadrula metanevra								
Quadrula nodulata								
Quadrula pustulosa								
Quadrula quadrula								
Strophitus undulatus					wd	fd		
Toxolasma lividis	1							
Toxolasma parvus					wd			
Toxolasma texasensis								
Tritogonia verrucosa						sf		
Truncilla donaciformis								
Truncilla trucata						fd		
Uniomerus tetralasmus								
Utterbackia imbecillis	1						wd	1
Venustaconcha ellipsiformis	1				2			
Villosa iris								
Villoso lienosa	wd				wd	fd		2
No. of living individuals	174	112	0	26	99	25	26	6
No. of live species	15	11	4	12	11	16	6	3
Live and dead species	16	11	6	14	15	18	9	3
Effort (person-hrs.)	3	2.75			3	1.5	2.5	0.25
CPUE	58	40.727273			33	16.666667	10.4	24

Appendix G. Re-survey collection data for the St. Francis River system, Missouri 2003

Collector	Hutson	MDC	Hutson	MDC	Hutson	MDC	Hutson	MDC
Collection Date	2002	1981	2002	1983	2002	1983	2002	1983
Water Body	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis	St. Francis
River Mile	238	238	241.2	241.2	244.9	244.9	252.3	252.3
Actinonaias ligamentina								
Alasmidonta marginata		3						
Anodonta suborbiculata								
Amblema plicata		wd		sf	22	95	5	9
Arcidens confragosus								
Cyclonaias tuberculata								
Cyprogenia aberti								
Elliptio dilatata								
Epioblasma triquetra								
Fusconaia flava		1		wd	3	13	1	
Lampsilis abrupta								
Lampsilis cardium	wd	5	1	wd	6	38	5	18
Lampsilis reeveiana brittsi	wd	5	1	1	1	12	fd	fd
Lampsilis siliquoidea	fd	56	wd	2	12	77	5	134
Lampsilis teres						fd		
Lasmigona complanata								
Lasmigona costata	fd				1	2		
Leptodea fragilis		fd					fd	
Ligumia recta								
Ligumia subrostrata			1					
Obliquaria reflexa								
Megalonaias nervosa								
Obovaria jacksoniana								
Plectomerus dombeyanus								
Pleurobema sintoxia		2			1	fd		
Potamilus purpuratus						wd	1	wd
Potamilus ohiensis								
Ptychobranchus occidentalis								
Pyganodon grandis		fd		fd	1	1	1	5
Quadrula cylindrica								
Quadrula metanevra								
Quadrula nodulata								
Quadrula pustulosa								
Quadrula quadrula								
Strophitus undulatus		1		fd	fd	5	1	2
Toxolasma lividis						fd		
Toxolasma parvus		3						1
Toxolasma texasensis								
Tritogonia verrucosa								
Truncilla donaciformis								
Truncilla trucata								
Uniomerus tetralasmus		1						
Utterbackia imbecillis		1			fd	fd	fd	fd
Venustaconcha ellipsiformis			fd		1			
Villosa iris		1						
Villoso lienosa		1		wd		7	wd	5
No. of living individuals		87	3	3	48	251	19	174
No. of live species	0	14	3	5	9	14	7	9
Live and dead species	4	15	5	9	13	15	11	10
Effort (person-hrs.)	1.5	2	2	2	3	3.5	2	2.25
CPUE	0	43.5	1.5	1.5	16	71.714286	9.5	77.333333

Appendix G. Re-survey collection data for the St. Francis River system, Missouri 2003

Collector	Hutson	MDC	Hutson	MDC	Hutson	MDC	Hutson	MDC
Collection Date	2002	1983	2002	1981	2002	1981	2002	1981
Water Body	St. Francis	St. Francis	Big Creek	Big Creek	Big Creek	Big Creek	Little St. ncis	Little St. ncis
River Mile	257.7	257.7	2.3	2.3	17	17	5.2	5.2
Actinonaias ligamentina		fd					fd	
Alasmidonta marginata								
Anodonta suborbiculata								
Amblema plicata							fd	
Arcidens confragosus								
Cyclonaias tuberculata								
Cyprogenia aberti		wd						
Elliptio dilatata		wd						1
Epioblasma triquetra								
Fusconaia flava								
Lampsilis abrupta								
Lampsilis cardium							2	2
Lampsilis reeveiana brittsi								
Lampsilis siliquoidea		fd						4
Lampsilis teres								
Lasmigona complanata								
Lasmigona costata								
Leptodea fragilis								
Ligumia recta							wd	
Ligumia subrostrata								
Obliquaria reflexa								
Megalonaias nervosa								
Obovaria jacksoniana								
Plectomerus dombeyanus								
Pleurobema sintoxia								
Potamilus purpuratus								1
Potamilus ohiensis								
Ptychobranchus occidentalis		wd						
Pyganodon grandis								8
Quadrula cylindrica								
Quadrula metanevra								
Quadrula nodulata								
Quadrula pustulosa								
Quadrula quadrula								
Strophitus undulatus								wd
Toxolasma lividis								
Toxolasma parvus								wd
Toxolasma texasensis								
Tritogonia verrucosa							wd	
Truncilla donaciformis								
Truncilla trucata								
Uniomerus tetralasmus								sf
Utterbackia imbecillis								
Venustaconcha ellipsiformis							1	
Villosa iris								
Villoso lienosa							1	wd
No. of living individuals		0		0		0	4	16
No. of live species	0	2	0	0	0	0	3	5
Live and dead species	0	5	0	0	0	0	8	9
Effort (person-hrs.)	1	1.5	1.5		1.5		2.5	1.5
CPUE	0	0	0		0		1.6	10.666667

Appendix G. Re-survey collection data for the St. Francis River system, Missouri 2003

Collector	Hutson	MDC	Hutson	MDC	Hutson	MDC
Collection Date	2002	1977	2002	1983	2002	1980
Water Body	Little St. Francis	Little St. Francis	Little St. Francis	Little St. Francis	Otter Slough	Otter Slough
River Mile	9.9	9.9	12.9	12.9	1.2	1.2
Actinonaias ligamentina	1	37		fd		
Alasmidonta marginata		3				
Anodonta suborbiculata						fd
Amblema plicata	1		wd			
Arcidens confragosus						
Cyclonaias tuberculata						
Cyprogenia aberti						
Elliptio dilatata			fd			
Epioblasma triquetra						
Fusconaia flava						
Lampsilis abrupta						
Lampsilis cardium	10	184	2			
Lampsilis reeveiana brittsi		1	wd			
Lampsilis siliquoidea	39	68	wd	2		
Lampsilis teres						
Lasmigona complanata						
Lasmigona costata	1	2				
Leptodea fragilis						
Ligumia recta						
Ligumia subrostrata	4	wd	wd			wd
Obliquaria reflexa						
Megalonaias nervosa						
Obovaria jacksoniana						
Plectomerus dombeyanus						
Pleurobema sintoxia						
Potamilus purpuratus						
Potamilus ohiensis						
Ptychobranchus occidentalis		2				
Pyganodon grandis	1	27	fd	fd		fd
Quadrula cylindrica						
Quadrula metanevra						
Quadrula nodulata						
Quadrula pustulosa						
Quadrula quadrula						
Strophitus undulatus	1	36				
Toxolasma lividis						
Toxolasma parvus		2				
Toxolasma texasensis						
Tritogonia verrucosa						
Truncilla donaciformis						
Truncilla trucata						
Uniomerus tetralasmus						
Utterbackia imbecillis						
Venustaconcha ellipsiformis	1					
Villosa iris						
Villoso lienosa		4				
No. of living individuals	59	366	2	2		0
No. of live species	9	12	1	1	0	2
Live and dead species	9	13	7	3	1	3
Effort (person-hrs.)	2.5	3.25	2	1.5	1	
CPUE	23.6	112.61538	1	1.3333333	0	0

Appendix H. Site descriptions of 2003 sampling localities in the Black River Basin, Missouri.

Stream	Stream Mile	Site Description	UTM: X	UTM: Y	Date	County	Collection No.	Locality No.
Black	9	Approximately 1.0 mile downstream of lower Coon Island MDC Access	735287	4044408	13-Aug-03	Butler	CH03041	CH03041
Black	10.5	Approximately 1.5 miles upstream of lower Coon Island MDC Access	737118	4045012	13-Aug-03	Butler	CH03040	CH03040
Black	13	Approximately 0.75 mile downstream of upper Coon Island MDC Access	737454	4048857	12-Aug-03	Butler	CH03039	CH03039
Black	15.5	Approximately 1.75 miles upstream of upper Coon Island MDC Access	737603	4051049	12-Aug-03	Butler	CH03038	CH03038
Black	20	At Hargrove Bridge Historical Site	740315	4059115	28-Aug-03	Butler	CH03049	CH03049
Black	24.9	Approximately 4 miles downstream of Dan River MDC Access	741299	4064102	14-Aug-03	Butler	CH03043	CH03043
Black	33.7	Approximately 4.75 miles upstream of Dan River MDC Access	734493	4068931	14-Aug-03	Butler	CH03042	CH03042
Black	35.3	Adjacent to Ray Clinton Park	732493	4070330	25-Aug-03	Butler	CH03044	CH03044
Black	36	At the Business Highway 60 bridge at Poplar Bluff	732946	4070921	17-Jul-03	Butler	CH03031	81061
Black	37	At Sportsman's Park MDC Access	733960	4071868	27-Aug-03	Butler	CH03048	CH03048
Black	38	Approximately 1.25 miles upstream of Sportsman's Park Access	734425	4073506	27-Aug-03	Butler	CH03047	CH03047
Black	39	Approximately 2 miles upstream of Sportsman's Park Access	735243	4073278	26-Aug-03	Butler	CH03046	CH03046
Black	40	Approximately 0.8 miles downstream of Highway 60 bridge	734692	4074183	26-Aug-03	Butler	CH03045	CH03045
Black	43	Approximately 2.25 miles downstream of Hilliard MDC Access	732570	4076906	01-Aug-03	Butler	CH03035	CH03035
Black	45.8	At the Highway W bridge (Hilliard Access)	729862	4078134	31-Jul-03	Butler	CH03033	CH03033
Black	48.5	Approximately 2.2 miles upstream of Hilliard MDC Access	728127	4080196	31-Jul-03	Butler	CH03032	CH03032
Black	51	At the highway 60 bridge	734897	4075290	01-Aug-03	Butler	CH03034	CH03034

Appendix H. Site descriptions of 2003 sampling localities in the Black River Basin, Missouri.

Stream	Stream Mile	Site Description	UTM: X	UTM: Y	Date	County	Collection No.	Locality No.
Black	55	At highway 67 bridge	724500	4087000	16-Jul-03	Butler	CH03029	81054
Black	57	Approximately 1.75 miles upstream of Highway 67	722655	4088934	08-Aug-03	Butler	CH03037	CH03037
Black	59.5	Approximately 2.5 miles downstream of Bradley Hammer MDC Access	721058	4092543	08-Aug-03	Butler	CH03036	CH03036
Black	60	Approximately 2 miles downstream of CR 417 bridge	720400	4092700	03-Jul-03	Wayne	CH03024	82079
Black	60.5	Approximately 1.5 miles downstream of Bradley Hammer MDC Access	720330	4093038	16-Jul-03	Wayne	CH03030	CH03030
Black	62	At County Road 417 bridge	718200	4092700	02-Jul-03	Wayne	CH03023	81052
Black	65.5	At Highway A bridge	714000	4094200	01-Jul-03	Wayne	CH03021	78002
Black	69.4	Approximately 4 miles downstream of Highway 49 bridge	710800	4099000	01-Jul-03	Wayne	CH03022	81059
Black	74.6	At the Markum Springs Bridge	705600	4103600	15-Jul-03	Wayne	CH03028	81003
Black	77	At the Highway 34 bridge at Leeper	703274	4106097	15-Jul-03	Wayne	CH03027	81002
Black	80	Approximately 2 miles downstream of Clearwater Dam	701200	4109800	14-Jul-03	Wayne	CH03025	81058
Black	82	Approximately 0.5 miles downstream of Clearwater Dam	699182	4110874	14-Jul-03	Wayne	CH03026	CH02026
Black	93.3	Near the confluence of Clearwater Lake and the Black River	697600	4123600	03-Jun-03	Reynolds	CH03019	81020
Black	107	At County Road 335 Bridge	694400	4137800	03-Jun-03	Reynolds	CH03020	85003
Big Brushy Creek	2.0	At Highway 49 bridge	708633	4098316	29-May-03	Wayne	CH03015	CH03015
Cane Creek	0.7	At County Road 142 bridge	727051	4057286	27-May-03	Butler	CH03008	CH03008
Cane Creek	20	At CR 472 Bridge bridge	723712	4066225	14-May-03	Butler	CH03005	CH03005
Cane Creek	29	At PP highway bridge	721182	4075333	13-May-03	Butler	CH03003	80004

Appendix H. Site descriptions of 2003 sampling localities in the Black River Basin, Missouri.

Stream	Stream Mile	Site Description	UTM: X	UTM: Y	Date	County	Collection No.	Locality No.
Cane Creek	34.5	At County Road 411 bridge	718070	4081508	18-Sep-03	Butler	CH03051	CH03051
Cane Creek	37.8	Approximately 0.25 miles upstream of County Road 410	715798	4083956	18-Sep-03	Butler	CH03050	CH03050
Cane Creek Ditch	3	At County Road 142 bridge	726748	4049166	27-May-03	Butler	CH03006	CH03006
Craven Ditch	3.5	At County Road 142 bridge	729021	4057307	27-May-03	Butler	CH03007	CH03007
East fork, Black	0.9	Approximately .25 miles downstream of Taum Sauk Dam	692100	4146800	02-Jun-03	Reynolds	CH03017	85004
East fork, Black	4.8	At Highway 21 bridge	691100	4151700	02-Jun-03	Reynolds	CH03018	81057
Indian Creek	1.7	At bridge at Stephen J. Sun Conservation Area	734048	4077741	28-May-03	Butler	CH03012	CH03012
Lake Slough	3.0	At County Road 654 bridge	742851	4059150	28-May-03	Butler	CH03010	CH03010
Logan Creek	4.3	Access is near the confluence of Clearwater Lake and Logan Creek just off of CR 410	693385	4116784	13-May-03	Reynolds	CH03002	81018
Main Ditch	7.8	At County Road 142 bridge	731557	4053544	27-May-03	Butler	CH03009	CH03009
Main Ditch	13.5	At County Road 322 bridge	732165	4062394	28-May-03	Butler	CH03011	CH03011
McKensie Creek	2.2	Just downstream of Highway HH bridge	703590	4112027	29-May-03	Wayne	CH03016	CH03016
MIddle Brushy Creek	0.1	At County Road 443 Bridge	705273	4098534	29-May-03	Wayne	CH03014	CH03014
Middle Fork, Black	0.5	Near Lesterville at CR 134 bridge.	689989	4147200	12-May-03	Reynolds	CH03001	CH03001
Miller Creek	0.8	At closest bridge to confluence to Black River	719418	4090670	29-May-03	Butler	CH03013	CH03013
Ten Mile Creek	2.5	At TT highway bridge	717900	4073500	14-May-03	Butler	CH03004	80006

Appendix I, Table 1. Unionid species and numbers found at sites sampled in the Black River, 2003. "FD"= fresh dead shell, "WD"= weathered dead, "SF"= subfossil, "F"= fossil.

Species	River mile and collection numbers									
	9	10.5	13	15.5	20	24.9	33.7	35.3	36	37
	CH03040	CH03041	CH03039	CH03038	CH03049	CH03043	CH03042	CH03044	CH03031	CH03048
Actinonaias ligamentina	11			3	5	1	44	101	84	13
Alasmidonta marginata								wd		
Anodonta suborbiculata		7	2							
Amblema plicata	65	47	31	23	13			4	3	7
Arcidens confragosus	1		10	1			fd			
Cyclonaias tuberculata							9	14	14	6
Cyprogenia aberti						wd	47	10	72	29
Elliptio dilatata				1	1		4	6	21	3
Ellipsaria lineolata										
Epioblasma triquetra										
Fusconaia ebena									fd	
Fusconaia flava	14	10	1	13	41		15	34	20	39
Lampsilis abrupta		1							1	
Lampsilis cardium							10	12	7	3
Lampsilis reeveiana brittsi										
Lampsilis siliquoidea									wd	
Lampsilis teres	16	3	42	1	2				1	
Lasmigona complanata	1		23	6					wd	
Lasmigona costata								1	2	1
Leptodea fragilis	7	1	6		3	1	2	2	4	1
Ligumia recta							2	fd	1	1
Ligumia subrostrata					2			1	wd	
Obliquaria reflexa	3	1	5	1	7	1	5	3		7
Plectomerus dombeyanus	57	52	8	1	1		1		2	
Pleurobema sintoxia				1		wd	18	17	49	44
Potamilus purpuratus	32	4	76	5	12	4	2	9	1	3
Potamilus ohiensis	6	1	8							
Ptychobranchus occidentalis								1	3	
Pyganodon grandis	wd	28	17		wd					
Quadrula metanevra					1	2	16	13	23	17
Quadrula nodulata	1									
Quadrula pustulosa	18	19	2	18	45	9	14	12	13	18
Quadrula quadrula	2	1	10	1						
Strophitus undulatus					10		2	2	2	
Toxolasma parvus										
Tritogonia verrucosa	1		2		25		6	5	7	2
Truncilla donaciformis										
Truncilla truncata	fd		1			1	7		6	3
Uniomeros tetralasmus										
Utterbackia imbecillis										
Villosa iris										
Villosa lienosa									1	
No. of living individuals	235	175	244	75	168	19	204	247	337	197
No. of live species	15	13	16	13	14	7	17	18	22	17
Live and dead species	18	8	16	13	15	9	17	20	26	17
Sampling effort (hrs.)	2	2	2	2	2	1.5	2	3	5	2

Appendix I, Table 1. Unionid species and numbers found at sites sampled in the Black River, 2003. "FD"= fresh dead shell, "WD"= weathered dead shell, "SF"= subfossil shell, "F"= fossil.

Species	River mile and collection numbers									
	38	39	40	43	45.8	48.5	51	55	57	59.5
	CH03047	CH03046	CH03045	CH03035	CH03033	CH03032	CH03034	CH03029	CH03037	CH03036
Actinonaias ligamentina	40	167	85	80	394	428	15	13	11	wd
Alasmidonta marginata						wd		2		
Anodonta suborbiculata								2	6	
Amblema plicata	4	13	15	7	4	3	9	16	16	
Arcidens confragosus										
Cyclonaias tuberculata	10	13	11	3	4	3		3	3	
Cyprogenia aberti	68	86	171	31	98	44	5	8	41	
Elliptio dilatata	15	4	9	5	5	2	10	2		
Ellipsaria lineolata	2	4		1	2					
Epioblasma triquetra										
Fusconaia ebena										
Fusconaia flava	94	351	436	98	162	14	114	9	25	
Lampsilis abrupta		1		wd		1				
Lampsilis cardium	6	6	7		3	5	9	9	5	wd
Lampsilis reeveiana brittsi										
Lampsilis siliquoidea		1		1		3				
Lampsilis teres		3					3		wd	
Lasmigona complanata		2	1						1	
Lasmigona costata		3	1	1	3	2			2	
Leptodea fragilis	1	1	1		1	2	2		1	
Ligumia recta		1	1	wd					wd	
Ligumia subrostrata		1							16	
Obliquaria reflexa	9		3			1	2	1	1	
Plectomerus dombeyanus		1	1			1				
Pleurobema sintoxia	84	427	503	544	511	133	19	16	61	wd
Potamilus purpuratus	3	2	2		3	8	9	3	1	wd
Potamilus ohiensis										
Ptychobranchus occidentalis										
Pyganodon grandis								wd	2	
Quadrula metanevra	28	34	41	15	9	94	6	32	21	
Quadrula nodulata										
Quadrula pustulosa	40	21	43	69	52	43	41	15	13	
Quadrula quadrula										
Strophitus undulatus	1	4	4	1		1	1	2	2	wd
Toxolasma parvus								3	5	
Tritogonia verrucosa	12	10	52	10	11	7	10			
Truncilla donaciformis				wd						
Truncilla truncata	18	3		1	1	wd	3	4		
Uniomeros tetralasmus										
Utterbackia imbecillis									6	
Villosa iris										
Villosa lienosa		5	1				1		2	
No. of living individuals	435	1164	1388	867	1263	795	259	140	241	0
No. of live species	17	25	20	15	16	19	17	17	21	0
Live and dead species	17	25	20	18	16	21	17	18	23	5
Sampling effort (hrs.)	2	3	3	3	3	3	3	4	2	1

Appendix I, Table 1. Unionid species and numbers found at sites sampled in the Black River, 2003.

Species	**River mile and collection numbers**										
	60	60.5	62	65.5	69.4	74.6	77	80	82	93.3	107
	CH03024	CH03030	CH03023	CH03021	CH03022	CH03028	CH03027	CH03025	CH03026	CH03019	CH03020
Actinonaias ligamentina	4	1	72		42	12	1	16	5		
Alasmidonta marginata			2		1				wd		
Anodonta suborbiculata											
Amblema plicata	wd		1	6	wd		wd	31	22		
Arcidens confragosus											
Cyclonaias tuberculata	1		58								
Cyprogenia aberti		54	18		2	2	wd	2	6		
Elliptio dilatata		wd	2			2	2				
Ellipsaria lineolata											
Epioblasma triquetra				1							
Fusconaia ebena											
Fusconaia flava	4	wd	14	1	5	1	1	1	2		
Lampsilis abrupta											
Lampsilis cardium	1	wd	7	6	5	1	1	8	4		
Lampsilis reeveiana brittsi								wd			
Lampsilis siliquoidea	1		1				1	1	1		
Lampsilis teres			1	1							
Lasmigona complanata											
Lasmigona costata	wd		13		2	1		1	1		
Leptodea fragilis				2			1	1	1		
Ligumia recta	wd	wd	sf		wd	wd	1	5	wd		
Ligumia subrostrata				18							
Obliquaria reflexa								1	7		
Plectomerus dombeyanus								1			
Pleurobema sintoxia	9	wd	41	4	4	2		1	3		
Potamilus purpuratus	wd		1	1			wd	3			
Potamilus ohiensis											
Ptychobranchus occidentalis			1	2	wd	1					
Pyganodon grandis				3							
Quadrula metanevra	2	2	10	1	9	wd	1	9			
Quadrula nodulata											
Quadrula pustulosa				1		1		4	9		
Quadrula quadrula											
Strophitus undulatus			1					1			
Toxolasma parvus											
Tritogonia verrucosa	wd		1		1			7	4		
Truncilla donaciformis									1		
Truncilla truncata			1					4	2		
Uniomeros tetralasmus											
Utterbackia imbecillis				3					2		
Villosa iris			1								
Villosa lienosa				wd							
No. of living individuals	22	57	246	50	71	23	9	97	70	0	0
No. of live species	7	3	19	14	9	9	8	18	15	0	0
Live and dead species	12	8	20	15	12	11	11	19	17	0	0
Sampling effort (hrs.)	2	2	2	4	2	2	2	4	2	2	2

Appendix I, Table 1. Unionid species and numbers found at sites sampled in the Black River, 2003. "FD"= fresh dead, "WD"= weathered dead, "SF"= subfossil, "F"= fossil.

Species	Stream, stream mile, and collection numbers									
	B. Brushy Creek	Cane Creek	Cane Creek	Cane Creek	Cane Creek	Cane Creek	Cane Creek Ditch	Craven Ditch	East fork, Black	East fork, Black
	2	0.7	20	29	34.5	37.8	3	3.5	0.9	4.8
	CH03015	CH03008	CH03005	CH03003	CH03051	CH03050	CH03006	CH03007	CH03018	CH03017
Actinonaias ligamentina										
Alasmidonta marginata										
Anodonta suborbiculata										
Amblema plicata				sf						
Arcidens confragosus										
Cyclonaias tuberculata										
Cyprogenia aberti										
Elliptio dilatata										
Ellipsaria lineolata										
Epioblasma triquetra										
Fusconaia ebena										
Fusconaia flava										
Lampsilis abrupta										
Lampsilis cardium				1						
Lampsilis reeveiana brittsi				1						26
Lampsilis siliquoidea										
Lampsilis teres		1					4			
Lasmigona complanata								wd		
Lasmigona costata										
Leptodea fragilis										
Ligumia recta										
Ligumia subrostrata								7		
Obliquaria reflexa										
Plectomerus dombeyanus										
Pleurobema sintoxia				sf						
Potamilus purpuratus							1			
Potamilus ohiensis										
Ptychobranchus occidentalis										
Pyganodon grandis		wd					wd	3		
Quadrula metanevra										
Quadrula nodulata										
Quadrula pustulosa		1								
Quadrula quadrula										
Strophitus undulatus										
Toxolasma parvus						3		4		
Tritogonia verrucosa										
Truncilla donaciformis										
Truncilla truncata										
Uniomeros tetralasmus								wd		
Utterbackia imbecillis										
Villosa iris										
Villosa lienosa										
No. of living individuals	0	2	0	2	0	3	5	14	0	26
No. of live species	0	2	0	2	0	1	2	3	0	1
Live and dead species	0	3	0	0	0	1	3	5	0	1
Sampling effort (person-hrs.)	2	1	1	2	1	1	2	2	2	3

Appendix I, Table 1. Unionid species and numbers found at sites sampled in the Black River, 2003. "FD"= fresh dead, "WD"= weathered dead, "SF"= subfossil, "F"= fossil.

Species	Stream, stream mile, and collection numbers					
	13.5	2.2	0.1	0.5	0.8	2.5
	Main Ditch	McKensie Creek	MIddle Brushy Creek	M. Fork Black	Miller Creek	Ten Mile Creek
	CH03011	CH03016	CH03014	CH03001	CH03013	CH03004
Actinonaias ligamentina						
Alasmidonta marginata						
Anodonta suborbiculata						
Amblema plicata						
Arcidens confragosus						
Cyclonaias tuberculata						
Cyprogenia aberti						
Elliptio dilatata						
Ellipsaria lineolata						
Epioblasma triquetra						
Fusconaia ebena						
Fusconaia flava						
Lampsilis abrupta						
Lampsilis cardium						2
Lampsilis reeveiana brittsi						4
Lampsilis siliquoidea						1
Lampsilis teres	wd					
Lasmigona complanata						
Lasmigona costata						
Leptodea fragilis	wd					
Ligumia recta						
Ligumia subrostrata	wd					
Obliquaria reflexa						
Plectomerus dombeyanus						
Pleurobema sintoxia						
Potamilus purpuratus						
Potamilus ohiensis						
Ptychobranchus occidentalis						
Pyganodon grandis	wd					wd
Quadrula metanevra						
Quadrula nodulata						
Quadrula pustulosa						
Quadrula quadrula						
Strophitus undulatus	wd					
Toxolasma parvus	12					
Tritogonia verrucosa						
Truncilla donaciformis						
Truncilla truncata						
Uniomeros tetralasmus	wd					
Utterbackia imbecillis						
Villosa iris						
Villosa lienosa						
No. of living individuals	12	0	0	0	0	7
No. of live species	1	0	0	0	0	3
Live and dead species	7	0	0	0	0	4
Sampling effort (person-hrs.)	2	2	1	1.5	1	2

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Actinonaias ligamentina											
10.5	148	20		35.3	109	12	f	38	55	4	
10.5	149	20		35.3	115	12		38	57	4	f
10.5	152	20		35.3	116			38	58	4	
10.5	152	20		35.3	116	10	f	38	66	4	
10.5	153	20		35.3	117		f	38	73	5	
10.5	153	20		35.3	117			38	88	6	
10.5	155	20		35.3	117	11	f	38	89	6	
10.5	159	20		35.3	119			38	98	7	
10.5	162	20		35.3	120		f	38	99	8	
10.5	162	20		35.3	120	12	f	38	100	8	
10.5	170	20		35.3	124			38	101	8	f
15.5	102	7		35.3	130	15	f	38	104	9	
15.5	103	9		35.3	133	15	f	38	111	8	
15.5	127	12		35.3	134	12		38	112	10	
20	110	11		36	42	4	f	38	113	9	f
20	119	12		36	65	5	f	38	115	8	f
20	144	14		36	90	9	f	38	116	11	f
20	146	17		36	92	11		38	124	13	
20	152	17		36	94	9		38	130	12	
24.9	97	9		36	95	9		38	131		f
33.7	48	3		36	95	10		39	43	3	f
33.7	53	4		36	96	9		39	85	9	f
33.7	53	4		36	98			39	90	9	
33.7	63	5		36	102	11		39	91	10	
33.7	87	6		36	104	10		39	94	10	
33.7	87	7		36	105	11		39	102	8	f
33.7	95	8		36	105	12		39	109	15	
33.7	96	7		36	115	14		39	110	12	
33.7	98	8		36	125	15		39	115		f
33.7	98	9		36	134	15		39	120	15	
33.7	99	8		36	135			39	122		
33.7	105	9		36	138			39	123		
33.7	114	10		36	143	15		39	123	15	
33.7	119		f	37	41	3		39	124		
33.7	121		f	37	84	4		39	125		
33.7	122	11	f	37	100	6		39	127		
33.7	125			37	104	8		39	128	15	
33.7	132			37	105	8		39	133		
33.7	139		f	37	108	8	f	39	133	15	
33.7	150	13		37	109	8		39	138		
35.3	68	6		37	110	10		40	54	3	
35.3	70	4		37	112	11	f	40	77	5	f
35.3	85	6	f	37	112	11		40	81	6	f
35.3	99	9	f	37	117	10	f	40	83	5	
35.3	100	12		37	129	12		40	84	8	
35.3	108	10		37	137	15		40	85	6	

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Actinonaias ligamentina cont.											
40	91	8		45.8	117	13		55	104		
40	99	9		45.8	118	9		55	107	9	
40	104	11		45.8	120			55	114		
40	105	9		45.8	120	10		55	114	10	
40	108	10		45.8	123	14		55	115		f
40	112	9		45.8	124			55	120		
40	117	11		45.8	125			55	120		
40	122			45.8	126	13		55	122		
40	123			45.8	128	14		55	122		
40	123	15	f	48.5	95	8		55	127		
40	124	10		48.5	95	9		55	127		
40	125		f	48.5	97	8		55	143		
40	129	12		48.5	102	8		57	108	10	
40	132	11	f	48.5	102	9		57	108	10	
43	84	6		48.5	105	10		57	111	11	
43	90	9	f	48.5	110	11		57	113		
43	91	10		48.5	112	8		57	115	11	
43	94	12		48.5	112	9		57	118	10	
43	95	8		48.5	112	10		57	119		
43	95	14		48.5	115			57	122		
43	102	9		48.5	115			57	122	12	
43	102	10		48.5	115			57	123		
43	104	8		48.5	118			57	125		
43	105	11		48.5	122			59.5			
43	105	12		48.5	123			60	113		
43	106	10		48.5	125	12		60	115		
43	106	12		48.5	131			60	116	10	
43	111			48.5	131	11		60	120	12	
43	114	10		48.5	132			60.5	82	9	
43	121			51	25	2		62	105		
43	124			51	40	3		62	105	12	
43	125			51	62	4		62	107		
43	126			51	99	11		62	107		
43	135			51	102	10		62	111	10	
45.8	88	8		51	110	11		62	112	13	
45.8	95	7		51	112	10		62	115		
45.8	105	9		51	113	10		62	115		
45.8	110	10		51	116			62	115	15	
45.8	112	8		51	117			62	116	12	
45.8	112	10		51	118			62	116	14	
45.8	112	11		51	124			62	117		
45.8	113			51	125			62	117		
45.8	115			51	125			62	117	13	
45.8	115			51	132			62	118		
45.8	116	11		55	94	9		62	120		

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Actinonaias ligamentina cont.											
62	122			69.4	130			80	125		
62	124			69.4	130	15		80	131	11	
62	128			69.4	131			80	132		
62	129			69.4	138	15		80	135	15	
69.4	99	12		74.6	106	15		80	135	15	
69.4	110	10		74.6	115			80	136		
69.4	115	15		74.6	117			80	137		
69.4	118	10		74.6	118			80	138	10	
69.4	118	10		74.6	121			80	139		
69.4	118	11		74.6	122			80	139	15	
69.4	119	12		74.6	122			80	140	11	
69.4	119	13	f	74.6	124			80	142		
69.4	120			74.6	125			80	150		
69.4	120	13		74.6	127	13		80	163		f
69.4	120	15		74.6	129			82	125		f
69.4	121			74.6	131			82	135		
69.4	125	11		74.6	134			82	144		f
69.4	125	15		77	100	9		82	145		
69.4	127	12		80	124			82	160		
69.4	129	13									
Alasmidonta marginata											
55	62	7		62	58	5		69.4	55	6	
55	68	7		62	71	7					
Amblema plicata											
8	71	6		10.5	98	10		13	71	7	
8	89	9		10.5	99	12		13	71	8	
8	98	8		10.5	103	12		13	75	8	
8	99			10.5	104	15		13	79	7	
8	104			10.5	104	15		13	79	8	
8	105			10.5	105	15		13	80	7	
8	105			10.5	106	15		13	80	8	
8	105	12		10.5	106	15		13	81	7	
8	108			10.5	107	15		13	82	8	
8	108	15		10.5	108	15		13	83	8	
8	111			10.5	109	15		13	84	8	
8	111	12		10.5	109	15		13	90	7	
8	112	15		10.5	109	15		13	91	10	
8	113	14		10.5	110	15		13	95	10	
8	115	15		10.5	111	15		13	111	10	
8	115	15		10.5	112			13	115	10	
8	117	18		10.5	116	15		13	116	10	
8	122	15		13	50	4		13	118	10	
8	123	15		13	64	5		15.5	51	5	
10.5	63	8		13	65	5		15.5	64	6	
10.5	88	13		13	66	6		15.5	71	7	
10.5	92	10		13	71	6		15.5	74	8	

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Amblema plicata											
15.5	77	8		38	79	5		51	70	8	
15.5	80	9		38	87	10		51	80	9	
15.5	81	8		39	25	8		51	82	8	
15.5	81	9		39	62	7		51	84	10	
15.5	84	9		39	70	8		51	85	11	
15.5	85	9		39	70	11		51	86	10	
15.5	87	10		39	71	12		51	87	10	
15.5	92	15		39	73	7		55	49	9	
15.5	94	12		39	74	10		55	52	9	
15.5	101	15		39	75	8		55	55	10	
15.5	103	15		39	78	10		55	57	7	
15.5	104	12		39	81	12		55	64	8	
15.5	107	16		39	82	10		55	65	11	
15.5	108	14		39	84	12		55	70	8	
15.5	110	14		39	85	13		55	73	10	
15.5	111	17		40	53	4		55	77	15	
20	59	5		40	62	6		55	82	11	
20	65	6		40	70	8		55	87	11	
20	66	5		40	73	7		55	94		
20	70	6		40	73	7		55	95		
20	70	6		40	75	7		57	74	10	
20	71	6		40	80			57	80	8	
20	71	6		40	87			57	81	11	
20	72	6		40	88	9		57	82	10	
20	77	8		40	89			57	83	13	
20	81	10		40	93			57	85	12	
20	85	10		40	94			57	90	10	
20	92	10		40	104			57	91	10	
20	98	10		40	104	14		57	92	13	
35.3	39	4		40	119	16		57	94	12	
35.3	66	8		43	71	8		57	95	13	
35.3	80	11		43	78	8		57	98	5	
35.3	97			43	78	9		57	103	15	
36	75	8		43	83	9		57	103	16	
36	85	5		43	95			57	113		
36	85	10		43	96			57	124	15	
36	95	11		43	105			60			
37	35	4		45.8	83	10		62	100		
37	38	4		45.8	85	9		65.5	75	11	
37	71	9		45.8	97			65.5	85	12	
37	75	10		45.8	102	12		65.5	96	10	
37	75	11		48.5	90			65.5	96	15	
37	77	11		48.5	102			65.5	106	12	
37	86	12		48.5	114			65.5	108	15	
38	43	4		51	64	5		80	20	2	
38	65	6		51	65	8		80	21	2	

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Amblema plicata											
80	42	5		80	73	8		82	81	10	
80	51	5		80	81	11		82	82	9	
80	61	6		80	82	9		82	85	11	
80	62	6		80	85	9		82	90	11	
80	65	6		82	40	4		82	91		
80	65	7		82	62	6		82	92	11	
80	65	8		82	62	7		82	95		
80	68	7		82	63	6		82	95	11	
80	68	7		82	66	8		82	97	12	
80	71	7		82	72	7		82	105	13	
80	72	8		82	72	8		82	115		
80	72	9		82	73	8		82	130		
Anodonta suborbiculata											
8	35	1		8	109	5		57	87	4	
8	42	2		13	102	5		57	88	4	
8	45	2		13	143	11		57	88	4	
8	108	5		55	63	4		57	89	5	
8	108	5		55	120	9		57	103	6	
8	109	5		57	87	4					
Arcidens confragosus											
10.5	93	8		13	100	8		13	113	12	
13	85	6		13	101	10		13	133	14	
13	90	9		13	102	10		15.5	107	10	
13	92	9		13	112	11		33.7			
13	93	8									
Cyclonaias tuberculata											
33.7	39	5		35.3	80			37	54	8	
33.7	47	6		35.3	84			37	55	9	
33.7	57	7		36	35	5		38	43	5	
33.7	58	8		36	45	7		38	43	5	
33.7	63	8		36	46	7		38	59	7	
33.7	64			36	51	10		38	59	7	
33.7	65	9		36	54	8		38	60	9	
33.7	66	9		36	55	8		38	60	9	
33.7	76			36	62	10		38	62	9	
35.3	48	7		36	62	11		38	62	10	
35.3	49	7		36	62	12		38	65		
35.3	50	8		36	64	12		38	65		
35.3	53	7		36	68			38	65	10	
35.3	61	10		36	68	10		38	66	11	
35.3	64			36	71	12		38	68	10	
35.3	66			36	75	13		38	70	9	
35.3	69			37	40	4		38	79	12	
35.3	72			37	51	7		39	55	10	
35.3	79			37	52	8		39	57	10	
35.3	80			37	52	8		39	66	10	
								39	67	12	

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Cyclonaias tuberculata cont.											
39	68	12		40	83	11		62	57	9	
39	69			43	61	7		62	65		
39	74			43	62	7		62	66		
39	75			43	68	9		62	69		
39	75	15		45.8	74			62	69		
39	76	15		45.8	77	11		62	71		
39	77			45.8	78	9		62	71		
39	79	21		45.8	90	15		62	71		
39	80	20		48.5	59	6		62	71	13	
40	55	6		48.5	72	9		62	72		
40	64	9		48.5	80	10		62	72	14	
40	66	10		55	29	3		62	74		
40	67			55	41	4		62	75		
40	69			55	51	6		62	81		
40	71	10		57	53			62	82		
40	74	10		57	74			62	82		
40	75			57	75	9		62	84		
40	77			60	78			62	84		
40	79	14		62	46	8		62	85		
Cyprogenia aberti											
33.7	32	4		35.3	52	10		37	39	5	
33.7	37	4		35.3	60	11	f	37	40	5	
33.7	37	5		35.3	61	12	f	37	40	5	
33.7	39	5		35.3	71			37	46	9	
33.7	42	7		36	27	4		37	48	8	
33.7	45	10		36	30	4		37	49	5	f
33.7	46	10		36	35	4		37	49	8	
33.7	48	7	f	36	35	4		37	49	11	
33.7	48	10		36	42	8		37	50	10	f
33.7	49	10		36	42	9		37	51	9	
33.7	51	7		36	42	9		37	51	10	
33.7	51	10		36	43	9		37	53	10	f
33.7	51	10		36	44	8		37	54	10	
33.7	53	12		36	44	10		37	55	11	f
33.7	54	11		36	45	9		37	55	12	f
33.7	55	10		36	45	10		37	58	8	
33.7	56	11		36	47	9		37	60	12	
33.7	57	14	f	36	47	10		38	24	3	
33.7	58	13	f	36	49	11		38	24	3	
33.7	61	12	f	36	52	10		38	43	5	
35.3	45	9		36	52	11		38	43	6	
35.3	45	10		36	53	12		38	47	9	
35.3	47	8	f	36	55	11		38	47	9	
35.3	47	9		37	20	2		38	49	10	
35.3	47	13		37	33	3		38	50	11	
35.3	49	9		37	38	4		38	52	9	

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Cyprogenia aberti cont.											
38	52	10		40	58	12		48.5	43	5	
38	55	8		40	60	10	f	48.5	44	7	
38	55	11		40	61	9	f	48.5	45	8	
38	55	13		40	61	12	f	48.5	47	10	
38	56	10		40	72	13	f	48.5	49	10	
38	57	9		43	42	9		48.5	50	8	
38	57	10		43	42	11		48.5	50	13	
38	58	11		43	45	9		48.5	51	8	
38	60	13		43	46			48.5	52	7	
38	68	15		43	48	11		48.5	54		
39	36	4	f	43	50	10		48.5	55	7	
39	40	8		43	51	11		48.5	56	11	
39	41	5		43	51	11		48.5	57	9	
39	41	5	f	43	51	12		48.5	58		
39	42	10	f	43	51	13		48.5	60		
39	44	8	f	43	52	10		48.5	64	14	
39	49	10		43	52	11		48.5	65		
39	50	11	f	43	52	12		48.5	67		
39	51	12		43	52	12		51	35	4	
39	53	10		43	53			51	39	4	
39	53	13	f	43	54	11		51	40	8	
39	55	10		43	55	12		51	44	9	
39	55	11		43	57	8		51	46	9	
39	57	13		43	60			55	31	5	
39	58	12	f	43	60			55	43	9	
39	60	13		45.8	40	7		55	43	9	
39	60	14	f	45.8	42	9		55	47	10	
39	61	11	f	45.8	42	9		55	48	10	
39	61	14		45.8	45	9		55	48	10	
39	67	15	f	45.8	45	9		55	48	10	
40	34	5	f	45.8	45	10		55	48	10	
40	40	5		45.8	46	9		57	37	8	
40	41	6		45.8	48	12		57	40	8	
40	42	8		45.8	49	10		57	44	8	
40	46	10		45.8	49	10		57	44	8	
40	48	10		45.8	50			57	44	8	
40	48	10		45.8	50	12		57	45	7	
40	51	9		45.8	52	12		57	45	8	
40	51	10		45.8	53	13		57	47	8	
40	53			45.8	54	11		57	48	10	
40	53	9		45.8	55	17		57	49	9	
40	53	13		45.8	57	11		57	51	11	
40	54	13		45.8	57	14		57	52	9	
40	56	12		45.8	65	17		57	52	10	
40	57	12		45.8	68	13		57	54		
40	57	14		48.5	42	6		57	55	11	
40	57	14		48.5	42	6		57	58		

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Cyprogenia aberti cont.											
57	59			62	55			69.4	44		
57	59			62	55			69.4	58	8	
57	60			62	56			74.6	61		
57	63			62	56	11		80	47	6	
60.5	54			62	57			80	48	8	
62	46	14		62	58			82	50	5	
62	50			62	58			82	52	8	
62	51			62	58	14		82	65	10	
62	52	13		62	59			82	69	10	
62	53			62	61			82	72	11	
62	54			62	63			82	81	15	
62	54										
Ellipsaria lineolata											
38	75	9		39	72	9	m	43	83	12	m
38	77	8		39	77	8	f	45.8	75	11	m
39	55	7		39	96	12	m	45.8	102	12	m
Elliptio dilatata											
15.5	112	11		36	90	9		40	91	7	
20	98	9		36	91	8		40	95	7	
33.7	82	6		36	100	11		40	95	7	
33.7	93	7		37	87	7		40	106	10	
33.7	94	7		37	105	9		40	112	12	
33.7	105	8		37	112	10		43	89	7	
35.3	42	3		38	22	1		43	96	8	
35.3	43	3		38	51	4		43	97	8	
35.3	47	3		38	55	4		43	99	13	
35.3	85	9		38	55	4		43	102	7	
35.3	88	9		38	80	6		45.8	82	7	
35.3	93	9		38	81	6		45.8	88	8	
36	43	4		38	82	8		45.8	92	9	f
36	53	5		38	85	7		45.8	94	9	
36	55	5		38	85	8		45.8	103	11	
36	56	5		38	90	10		48.5	84	6	
36	60	5		38	94	10		48.5	95	10	
36	62	5		38	95	9		51	35	2	
36	63	6		38	97	10		51	60	4	
36	65	5		38	98	11		51	65	4	
36	65	5		38	109	13		51	82	8	
36	65	7		39	64	4		51	84		
36	66	6		39	81	7		51	85	8	
36	68	5		39	95	10		51	90	8	
36	80	6		39	96	10		51	95		
36	84	7		40	25	0		51	95	8	
36	85	10		40	36	1		51	97	9	
36	86	8		40	86	5		55	99	8	
36	90	7		40	88	7		55	111	11	

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Elliptio dilatata											
62	72	8		74.6	84	7		77	81	6	
62	85	9		74.6	102	13		77	102	9	
Epioblasma triquetra											
65.5	39	4	m								
Fusconaia flava											
8	34	4		20	33	3		35.3	55	9	f
8	59	7		20	37	5		35.3	55	11	
8	62	8	f	20	38	4		35.3	60		
8	66	9		20	41	5		35.3	64	11	
8	66	11		20	42	5		35.3	64	13	
8	78	10		20	43	5		35.3	66	15	
8	82	10		20	51	5		35.3	70	15	
8	85	10		20	52	8		35.3	71		
8	89	10		20	54	5		35.3	73	14	
8	92	10		20	60	9	f	35.3	75	14	
10.5	37	4	f	20	61	9		36	24	4	
10.5	53	7	f	20	64	8		36	33	4	
10.5	62	10	f	20	65	8		36	35	6	
10.5	68	11		20	66	10		36	38	7	
10.5	72	10	f	20	72	10		36	42	6	
10.5	74	12		20	75	11		36	42	7	
10.5	80	11		33.7	23	3		36	45	8	
10.5	83	12		33.7	25	3		36	45	8	
10.5	85			33.7	33	4		36	48	9	
10.5	85	13		33.7	45	8		36	52	10	
10.5	91	13		33.7	51	8		36	55	11	
10.5	92	13		33.7	52	8		36	63	10	
10.5	97	12	f	33.7	53	8		36	67	12	
10.5	99	16		33.7	55	8		36	67	13	
13	57	10		33.7	55	11	f	36	68	10	
15.5	43	5		33.7	58	11		36	70		
15.5	51	6	f	33.7	59	11		36	71	9	
15.5	55	7		33.7	62	9		36	75	10	
15.5	64	10		33.7	62	10		36	75	10	
15.5	65	8	f	33.7	63	9		36	75	10	
15.5	66	8		33.7	71	12		37	17	1	
15.5	70	8		35.3	27	3		37	25	2	
15.5	72	11	f	35.3	42	7		37	28	3	
15.5	72	15		35.3	43	6		37	30	3	
15.5	74	10		35.3	50	8	f	37	31	3	
15.5	79	12		35.3	52	10		37	35	4	
15.5	83	15		35.3	52	10		37	36	4	
15.5	85	15		35.3	53	8		37	47	11	
20	26	2		35.3	53	9		37	55	10	
20	26	2		35.3	55	7		37	56	10	
20	31	3		35.3	55	9		37	59	8	

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Fusconaia flava cont.											
37	59	11		39	71			45.8	64	10	
37	61	13		39	72			45.8	65	10	
37	62	12		39	76	15		45.8	65	10	
37	65	12		40	42	7		45.8	65	12	
37	67	14		40	44	8		45.8	66	11	f
37	70	13		40	53	7		45.8	69	10	
37	71	15		40	53	10		45.8	70		f
37	72	14		40	54	11		45.8	70	14	
37	85	10		40	60	9		45.8	71		
38	23	4		40	61	14		45.8	72		
38	24	2		40	63	10		45.8	73	12	f
38	24	2		40	63	11		45.8	73	13	
38	26	3		40	64	9		45.8	75		
38	42	5		40	64	11		45.8	77		
38	55	11		40	65	10		45.8	81		
38	57	10		40	65	10		45.8	84		f
38	58	9		40	68	10	f	45.8	88	12	
38	58	11		40	68	13		48.5	25	4	
38	59	11		40	69		f	48.5	65		
38	61	10		40	72	13		48.5	65	9	f
38	61	11		40	73			48.5	70	10	
38	62	9		40	77	12		48.5	72		
38	62	11		40	78			48.5	72	12	
38	63	12		43	55	9		48.5	73		
38	64	11		43	57	9		48.5	74		
38	64	13		43	58	8	f	48.5	75		
38	67	12		43	59	12		48.5	77	11	f
38	70	11		43	61	10		48.5	78	10	
38	73	12		43	62			48.5	79	10	
39	21	2		43	62	10		48.5	82	11	f
39	22	2		43	63	10		48.5	94	12	f
39	31	3		43	63	10		51	21	2	
39	48	8		43	63	10		51	21	2	
39	49	10		43	67	11	f	51	30	3	
39	50	9		43	68	12		51	33	3	
39	50	10		43	70	12	f	51	33	3	
39	51	10		43	71			51	45	7	
39	55	7		43	72			51	47	8	
39	55	10		43	77			51	60	9	
39	57	11		43	79			51	60	11	
39	57	13		43	81			51	60	11	
39	59	10		43	82	11		51	60	11	
39	61	12		43	84	14		51	62	10	
39	61	13		45.8	51	10		51	62	12	
39	64	11		45.8	57	11		51	63	12	
39	65			45.8	60	9		51	65	11	

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Fusconaia flava cont.											
51	68	10		57	58	10		62	75		
51	70	12		57	60	10		62	75		
51	72	10		57	60	10		62	76		
51	72	15		57	61	10		62	81		
51	74	12		57	61	13		62	85	14	
51	75	12		57	62	10		62	92	13	
51	75	12		57	64	14		62	96	13	
51	79	14		57	65	11		62	99		
51	80	13		57	66	13		62	103	15	
55	34	4		57	67	12		62	104		
55	45	11		57	68	11		62	104	16	
55	49	10		57	68	14		62	106		
55	50	9		57	72	12		65.5	46	7	
55	62	13		57	75	10		65.5	82	14	f
55	71	12		57	75	12		69.4	88	10	
55	74	11		57	84			69.4	94	10	
55	74	14		57	87			69.4	105	13	
55	75	13		60	97			69.4	106	13	
55	75	14		60	102			69.4	111	12	
55	79	12		60	105	15		74.6	99	12	
55	92	15		60	116	15		77	97	12	
57	45	6		60.5				80	63	7	
57	54	11		62	72			82	40	4	
57	55	11		62	73			82	89	12	
Lampsilis abrupta											
10.5	122	20	f	39	85	8	m	48.5	85	13	f
36	61	6									
Lampsilis cardium											
33.7	86	5	m	35.3	120		m	38	119	7	m
33.7	87	5	f	35.3	122		m	38	122	6	m
33.7	91	7	f	35.3	125	12	m	39	104	6	f
33.7	98	5	f	35.3	138	12	m	39	107	9	f
33.7	101	7	m	36	82	5		39	110	1	f
33.7	101	9	f	36	97	6		39	111		f
33.7	104	8	f	36	104			39	112	7	f
33.7	105	7	m	36	115	10		39	125	11	m
33.7	117	10	m	36	115	11		40	98	5	m
33.7	128	10	m	36	118			40	103	6	m
35.3	31	2	m	36	125			40	105	6	m
35.3	37	3	m	37	30	1	m	40	109	7	m
35.3	91	5	m	37	127	8	m	40	112		m
35.3	108	12	f	37	129		m	40	122	8	m
35.3	111	10	f	38	39	2	m	40	127	9	m
35.3	112	7	m	38	99	8	f	45.8	116		m
35.3	116	11	f	38	111	5	m	45.8	120	10	m
35.3	117	9	m	38	115	9	f	45.8	121	10	m

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Lampsilis cardium cont.											
48.5	112	8	m	55	122	9	m	65.5	110	6	m
48.5	114	12	f	57	98	6	f	65.5	118	8	m
48.5	115	9	m	57	104	6	m	69.4	101	6	m
48.5	117	8	m	57	104	8	f	69.4	109	7	m
48.5	131	13	m	57	105	7	f	69.4	119		m
51	97	7	f	57	112	7	f	69.4	120		m
51	108	10	f	60	85		f	69.4	121		m
51	109	10	m	60	94		f	74.6	112		
51	111	9	f	60	111		m	77	93	8	f
51	112	5	m	60.5				80	71	4	f
51	112	8	m	62	87	7	f	80	85	5	f
51	115	8	m	62	91	7	m	80	102	6	m
51	116	7	m	62	103	8	f	80	105	7	f
51	118	6	m	62	110	8	m	80	112		f
55	85	5	f	62	111	8	m	80	127	12	m
55	94	6	f	62	116	9	f	80	129		f
55	95	6	f	62	117	8	m	80	139	15	m
55	101	7	f	65.5	70	4	f	82	112		f
55	102	7	m	65.5	101	7	m	82	116		m
55	103	7	f	65.5	103	7	m	82	119	10	m
55	116	9	f	65.5	109	8	m	82	132	9	m
Lampsilis reeveiana											
80	129	12									
Lampsilis siliquoidea											
39	114		f	48.5	116		m	77	103	11	f
43	112		m	60	93		f	80	110	8	m
48.5	85	5	m	62	112		m	82	112	10	m
48.5	110		m								
Lampsilis teres											
8	103	6	m	10.5	129	8	m	13	125	10	m
8	119	8	m	10.5	129	8	m	13	126	8	m
8	120	12	m	13	40	2		13	129	11	m
10.5	79	4	f	13	45	2		13	137	13	m
10.5	85	6	f	13	46	2		13	138	11	m
10.5	98	5	m	13	74	4	m	15.5	120	8	
10.5	105	7	f	13	84	5	f	20	95	5	f
10.5	108	7	m	13	99	6	f	20	110	8	m
10.5	110	8	f	13	104	6	f	36	87	7	
10.5	112	8	m	13	105	6	m	39	75	4	m
10.5	114	6	m	13	105	7	m	39	84	5	m
10.5	114	7	m	13	108	6	m	39	86	5	f
10.5	116		m	13	112	7	f	51	35	2	m
10.5	118	8	m	13	112	7	m	51	82	5	f
10.5	125	7	m	13	118	8	f	51	96	6	m
10.5	125	7	m	13	122	8	m	62	85	6	f
10.5	125	8	m	13	124	10	m	65.5	112	7	f

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Ligumia subrostrata											
20	45	4	f	57	85	6	m	65.5	88	7	m
20	55	4	m	57	85	7	m	65.5	90	8	m
35.3	38	3	f	57	87	7	f	65.5	95	8	m
36				57	90	7	m	65.5	95	8	m
39	51	4	f	57	90	9	m	65.5	95	11	f
57	64	6	f	57	97	9	f	65.5	97	8	m
57	65	7	f	57	99	8	m	65.5	97	11	f
57	65	7	f	57	104	10	m	65.5	98	8	m
57	68	7	f	65.5	58	4	m	65.5	99	8	m
57	68	7	f	65.5	72	6	f	65.5	101	9	m
57	81	7	m	65.5	78	6	f	65.5	105	9	m
57	82	7	f	65.5	85	8	f	65.5	110	11	m
57	83	7	f	65.5	86	7	m				
Obliquaria reflexa											
8	57	8	f	33.7	52	6		38	62	7	
10.5	58	7		33.7	53	6		38	63	10	
10.5	62	8		33.7	63	7		38	65	7	
10.5	73	10		35.3	40	4		40	60	7	
13	52	6		35.3	51	5		40	61	8	
13	54	7		35.3	53	6		40	62		
13	55	6		37	22	2		48.5	35	4	
13	59	6		37	35	3		51	37	5	
13	61	7		37	54	4		51	54	6	
15.5	58	6		37	55	6		55	45	6	
20	38	4		37	55	6		57	30	3	
20	40	4		37	57	8		80	37	4	
20	58	8		37	59	7		82	51	5	
20	59	7		38	51	7		82	52	7	f
20	60	7		38	55	7		82	55	6	
20	62	8		38	55	8		82	58	7	
20	70	9		38	56	7		82	60	7	
24.9	39	4		38	57	7		82	61	8	
33.7	42	5		38	60	6		82	62	8	f
33.7	50	5									
Plectomerus dombeyanus											
8	105	10		8	125	14		10.5	112	13	
8	106	10		8	126	14		10.5	113	12	
8	108	10		8	128	15		10.5	114	14	
8	109	10		8	132	15		10.5	115	15	
8	112	10		8	133	15		10.5	118		
8	114	15		8	134	15		10.5	120	15	
8	115	11		8	135	15		10.5	120	15	
8	115	12		8	139	15		10.5	121	12	
8	116	10		10.5	93	7		10.5	121	13	
8	120	14		10.5	109	12		10.5	122	15	
8	121	12		10.5	111			10.5	122	15	
8	125	13		10.5	112	10		10.5	124	15	

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Plectomerus dombeyanus cont.											
10.5	125	15		13	102	10		15.5	108	10	f
10.5	126	15		13	104	10		20	123	13	
10.5	128	15		13	118	12		33.7	96	9	
10.5	129	15		13	118	12		36	102	15	
13	58	4		15.5	87	6		36	115		
13	74	6		15.5	88	6		39	94	9	
13	78	7		15.5	90	7		40	95	9	m
13	80	7		15.5	97	8		48.5	126	13	
Pleurobema sintoxia											
15.5	45	7		36	25	4		37	85	14	
24.9				36	27	4		37	86	15	
33.7	38	5		36	42	6		37	86	15	
33.7	51	8		36	45	8		38	19	2	
33.7	52	9		36	48	7		38	25	2	
33.7	53	11		36	48	8		38	33	3	
33.7	55	9		36	59	13		38	35	3	
33.7	57	10		36	61	11		38	41	4	
33.7	59	10		36	65	9		38	44	4	
33.7	59	11		36	72	10		38	61	10	
33.7	59	11		36	79	15		38	63	11	
33.7	60	10		36	80	12		38	66	8	
33.7	61	9		36	81	13		38	67	11	
33.7	63	10		36	85			38	77	12	
33.7	65	10		36	85			38	78	14	
33.7	65	11		36	91	15		38	79	13	
33.7	65	12		36	92			38	81	12	
33.7	68	11		36	95	14		38	85	13	
33.7	69	13		36	95	17		38	87	17	
33.7	90	18		36	99			38	88	12	
35.3	30	4		37	17	2		38	89	17	
35.3	39	6		37	29	4		38	99	16	
35.3	47	7		37	31	3		38	107		
35.3	58	9		37	33	4		39	22	2	
35.3	63	15		37	43	8		39	48	9	
35.3	71	18		37	45	7		39	50	10	
35.3	78	12		37	45	7		39	75	15	
35.3	79	17		37	61	7		39	77	10	
35.3	84	17		37	71	13		39	80	12	
35.3	85	15		37	71	13		39	80	13	
35.3	85	16		37	72	12		39	80	14	
35.3	86	14		37	75	13		39	81	13	
35.3	90	19		37	81	11		39	85	14	
35.3	90	27		37	81	12		39	85	15	
35.3	98	23		37	81	15		39	87	16	
35.3	100	24		37	84	12		39	91		
35.3	101	21		37	84	15		39	93	15	

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Pleurobema sintoxia cont.											
39	101	20		45.8	69	9		51	75	9	
39	102	20		45.8	73	8		51	75	11	
39	104	20		45.8	79	12		51	77	10	
39	110			45.8	79	12		51	77	13	
39	111	20		45.8	81	12		51	79	13	
39	114	22		45.8	82	15		51	81	12	
40	37	4		45.8	83	13		51	82		
40	45	9		45.8	85	12		51	82	12	
40	65	8		45.8	85	15		51	84	10	
40	69	11		45.8	88	9		51	85	12	
40	72	11		45.8	88	14		51	85	14	
40	73	9		45.8	89			51	89		
40	74	12		45.8	90	11		51	89	11	
40	74	13		45.8	93			55	25	4	
40	75	13		45.8	97	14		55	48	9	
40	78	11		45.8	97	15		55	52	9	
40	78	13		45.8	104			55	55	8	
40	79	14		45.8	107	16		55	64	8	
40	80	12		45.8	112	16		55	65	9	
40	82	13		45.8	116	20		55	70	13	
40	85	15		48.5	65	9		55	71	14	
40	92			48.5	70	11		55	72	10	
40	93	15		48.5	71			55	78	11	
40	98	20		48.5	75	9		55	79	13	
40	99			48.5	75	9		55	80	12	
40	104	20		48.5	75	10		55	80	13	
43	69	12		48.5	79	11		55	84	14	
43	71	12		48.5	81	11		55	88		
43	73	18		48.5	85			55	95	11	
43	75	10		48.5	85	11		57	69	10	
43	78	13		48.5	88	17		57	75	10	
43	79	19		48.5	90	13		57	78	14	
43	80	13		48.5	92	12		57	79	14	
43	82	13		48.5	93	10		57	80	12	
43	82	14		48.5	95	12		57	81	11	
43	84	12		48.5	96	12		57	84	15	
43	87	13		48.5	102			57	85	13	
43	91	12		48.5	102	18		57	87		
43	91	15		48.5	110			57	87	14	
43	93			48.5	117	20		57	88	12	
43	96	18		51	58	7		57	88	14	
43	100	20		51	62	9		57	90	17	
43	104			51	68	10		57	94	15	
43	106			51	71	10		57	94	15	
43	109	17		51	72			57	97	13	
43	113			51	72	10		57	99	13	

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Pleurobema sintoxia cont.											
57	104	16		62	81	13		62	112	14	
57	108			62	85	11		62	113	20	
57	112	17		62	85	15		65.5	68	10	
59.5				62	90	9		65.5	107	15	
60	90	10		62	90	15		65.5	114	17	
60	93	11		62	91	10		65.5	117	19	
60	96	11		62	92	15		69.4	94	12	
60	98	10		62	94	10		69.4	96	15	
60	99	11		62	95	11		69.4	105	15	
60	102	15		62	97	10		69.4	106	15	
60	105			62	97	13		74.6	65	5	
60	108			62	97	15		74.6	98	13	
60	109	15		62	102	18		80	78	9	
60.5				62	105	15		82	92	8	
62	58	8		62	108			82	104	15	
62	71	13		62	110	13					
Potamilus ohiensis											
8	109	5		10.5	141	9		13	124	6	
10.5	11	11		10.5	142	9		13	127	7	
10.5	139	9		13	76	4		13	136	7	
10.5	140	9		13	84	4		13	149	9	
10.5	140	9		13	115	6		13	153	10	
10.5	140	9									
Potamilus purpuratus											
8	64	4	f	10.5	147	10	m	13	152	15	m
8	131	12	f	10.5	150	11	m	13	154	15	m
8	147	10	m	10.5	158	15	m	15.5	106	8	m
8	158	15	m	13	94	6	f	15.5	108	8	f
10.5	89	6	f	13	96	7	f	15.5	117	11	
10.5	91	6	f	13	102	8	f	15.5	124	9	m
10.5	96	6	f	13	102	9	f	15.5	139	13	f
10.5	104	9	f	13	109	10	f	20	87	5	f
10.5	105	10	f	13	112	9	f	20	102	6	f
10.5	106	8	m	13	113	8	m	20	104	6	f
10.5	106	9	f	13	114	9	f	20	117	7	f
10.5	107	8	f	13	115	12	f	20	121	9	m
10.5	109	8	f	13	116	7	m	20	128	10	m
10.5	125	11	f	13	117	12	f	20	129	10	m
10.5	127	9	m	13	120	10	f	20	133	10	m
10.5	130	12	f	13	129	11	m	20	134	10	m
10.5	131	9	f	13	131	8	m	20	138	10	m
10.5	134	10	m	13	133	12	m	20	141	12	m
10.5	141	10	m	13	135	16	f	20	142	11	m
10.5	142	11	m	13	139	16	f	24.9	85	7	f
10.5	142	13	m	13	142	15	m	24.9	92	5	m

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Potamilus purpuratus cont.											
24.9	100	10	f	38	88	6	f	51	95	10	f
24.9	106	6	m	38	148	12	m	51	97	10	f
33.7	112	9	m	39	107	9	m	51	101	10	f
33.7	118	10	m	39	114	12	f	51	116	11	m
35.3	79		f	40	99	8	f	51	117	13	m
35.3	95	9	f	40	103	9	m	51	119	11	m
35.3	109	9	m	45.8	88	8	f	51	123	12	m
35.3	115	10	m	45.8	125	11	m	51	125	12	m
35.3	116		f	45.8	128	12	m	55	109	11	f
35.3	118		m	48.5	74	7		55	117	11	m
35.3	120	10	m	48.5	77	5		55	118	10	m
35.3	122	12	m	48.5	81	6		57	103	7	m
35.3	125	12	m	48.5	82	6		62	95	7	f
36	91	7		48.5	101	8		65.5	68	6	f
37	119	8	m	48.5	103	9		80	106	10	m
37	124	9	m	48.5	117	9		80	130	11	m
37	130	9	m	48.5	119	10		80	135		m
38	67	5	f	51	67	6	f				
Ptychobranchus occidentalis											
35.3	78	5		36	91	9		65.5	80	9	
36	71			62	83			74.6	95	10	
36	77	7		65.5	70	6					
Pyganodon grandis											
8	44	1		8	125	6		13	140	9	
8	55	2		8	126	6		13	144	10	
8	100	4		8	127	6		13	145	10	
8	106	5		8	128	6		13	147	10	
8	107	5		8	130	6		13	148	10	
8	111	5		13	62	3		13	148	10	
8	112	5		13	71	4		13	156	11	
8	112	5		13	102	4		36	50	10	
8	114	5		13	116	8		36	71	5	
8	116	5		13	119	5		57	90	5	
8	117	6		13	121	5		57	128	9	
8	122	5		13	135	9		65.5	110	8	
8	122	6		13	135	9		65.5	111	8	
8	124	6		13	136	8		65.5	120	10	
8	125	6		13	139	9					
Quadrula metanevra											
20	23	1		33.7	64	7		33.7	70	10	
24.9	40	3		33.7	64	8		33.7	72	8	
24.9	56	5		33.7	66	7		33.7	72	10	
33.7	42	4		33.7	67	6		33.7	74	9	
33.7	55	7		33.7	67	9		33.7	77	10	
33.7	60	6		33.7	68	8		35.3	27	2	
33.7	62	8		33.7	69	10		35.3	44	6	

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Quadrula metanevra cont.											
35.3	45	5		37	71	8		40	51	6	
35.3	49	5		37	73			40	66	8	
35.3	53	8		38	21	1		40	72	8	
35.3	55	7		38	32	2		40	73	9	
35.3	57	7		38	35	3		40	74	8	
35.3	67	9		38	38	3		40	75	9	
35.3	71	10		38	49	4		40	77	10	
35.3	84			38	54	5		40	79	9	
35.3	88			38	57	6		40	80	10	
35.3	95			38	59	6		40	82	10	
35.3	105	21		38	64	7		40	84		
36	41	4		38	67			40	87		
36	50	6		38	68	7		40	94	12	
36	53	7		38	72	4		40	95		
36	55	6		38	72	7		40	96		
36	55	7		38	80	10		40	98		
36	62	10		38	84	10		40	102		
36	67	8		38	88	10		43	61	7	
36	69	10		38	89	10		43	64		
36	71			38	94	9		43	65	9	
36	73			38	95	11		43	66	10	
36	75			38	95	11		43	70	10	
36	78	9		38	103			43	71	10	
36	80			39	45	5		43	82	10	
36	81	10		39	46	5		43	85		
36	82	10		39	62	8		43	85	11	
36	84			39	65	8		43	85	12	
36	85			39	67			43	86	11	
36	88	9		39	67	9		43	88	9	
36	92	15		39	71			43	96	11	
36	100			39	73	10		43	97	15	
37	40	4		39	76	9		43	104		
37	41	4		39	80			45.8	60	7	
37	41	4		39	81	9		45.8	63	8	
37	42	4		39	82			45.8	74		
37	42	5		39	83	11		45.8	74	9	
37	44	5		39	85			45.8	80	10	
37	50	5		39	87			45.8	81		
37	51	6		39	89	123		45.8	82	11	
37	56			39	90	10		45.8	85		
37	56	7		39	93			45.8	88		
37	60	6		39	94			48.5	62	6	
37	61	6		39	94			48.5	64	6	
37	61	8		40	39	4		48.5	65	8	
37	64	9		40	42	5		48.5	70	7	
37	70	10		40	47	5		48.5	75		

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Quadrula metanevra cont.											
48.5	80	10		55	72	10		62	59	8	
48.5	81			55	74			62	82	12	
48.5	82			55	75	8		62	82	13	
48.5	83			55	76	11		62	86		
48.5	85			55	78	11		62	88	13	
48.5	85			55	86			62	91		
48.5	85	10		55	87			62	92	15	
48.5	85	11		55	87	9		62	93		
48.5	85	12		57	65			62	93		
48.5	86	10		57	65	7		62	98	15	
48.5	88			57	66	9		65.5	78	11	
48.5	98			57	68	8		69.4	69	9	
48.5	100			57	68	10		69.4	85		
48.5	100	8		57	69	8		69.4	87		
48.5	102			57	77	7		69.4	90		
51	31	4		57	77	10		69.4	90	11	
51	55	7		57	81	11		69.4	92	13	
51	55	7		57	82			69.4	94	13	
51	63	7		57	83	10		69.4	95	11	
51	65	8		57	84			69.4	97		
51	70	10		57	85			74.6			
55	38	5		57	86			77	89		
55	43	5		57	86	10		80	25	3	
55	55	6		57	89			80	34	3	
55	55	7		57	89	15		80	53	5	
55	55	8		57	90			80	55	5	
55	58	7		57	94			80	58	5	
55	58	8		57	95	13		80	65	5	
55	61	10		60	82			80	82	15	
55	63	8		60	98			80	85	8	
55	65	8		60.5	82			80	89	12	
55	68	7		60.5	86			80	98	10	
55	68	9									
Quadrula nodulata											
10.5	65	12									
Quadrula pustulosa											
8	27	3		8	75	11		10.5	44	5	
8	50	7		8	77	13		10.5	45	5	
8	63	9		8	78	12		10.5	50	6	
8	64	10		8	80			10.5	52	7	
8	71	10		8	80			10.5	53	6	
8	72			8	80	12		10.5	56	7	
8	73	12		8	82	13		10.5	60	10	
8	73	12		8	83			10.5	61	9	
8	74			8	92	20		10.5	67	9	
8	75			10.5	37	4		10.5	67	10	

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Quadrula pustulosa cont.											
10.5	68	10		24.9	28	3		37	24	2	
10.5	71	10		24.9	28	3		37	33	4	
10.5	71	10		24.9	46	8		37	37	5	
10.5	76	12		24.9	48	8		37	39	5	
10.5	81	12		24.9	50	8		37	41	7	
10.5	87	15		24.9	52	11		37	45	7	
10.5	88	15		24.9	56	11		37	51	9	
13	54	9		33.7	34	5		37	52	9	
13	62	10		33.7	41	5		37	57	11	
15.5	30	4		33.7	45	8		37	60		
15.5	35	4		33.7	46	9		37	60		
15.5	42	5		33.7	46	10		37	63	12	
15.5	50	7		33.7	47	9		37	64		
15.5	51	8		33.7	48	9		37	65		
15.5	53	10		33.7	49	9		38	18	2	
15.5	55	9		33.7	50	10		38	30	4	
15.5	59	9		33.7	55	10		38	34	6	
15.5	62	9		33.7	55	11		38	35	5	
15.5	63	13		33.7	58	10		38	39	6	
15.5	64	14		33.7	65	12		38	40	5	
15.5	72	15		33.7	68			38	41	5	
15.5	72	20		35.3	27	4		38	42	7	
15.5	74	20		35.3	42	6		38	49	8	
15.5	74	21		35.3	45	8		38	50	7	
15.5	79	25		35.3	46	9		38	51	8	
20	29	3		35.3	49	9		38	51	10	
20	32	4		35.3	59	10		38	53	10	
20	44	5		35.3	63	11		38	54	7	
20	47	4		35.3	65	12		38	54	9	
20	48	12		35.3	72			38	55	9	
20	49	8		35.3	76			38	55	9	
20	49	8		35.3	82	18		38	55	10	
20	49	8		35.3	84			38	60	10	
20	50	9		36	16	2		38	73		
20	51	8		36	24	4		39	32	7	
20	52	9		36	28	5		39	47	12	
20	53	8		36	41	4		39	50	11	
20	54	9		36	41	6		39	51	10	
20	54	11		36	50	12		39	51	11	
20	55	10		36	51	12		39	52	10	
20	56	9		36	52	11		39	52	10	
20	58	10		36	55	14		39	55	12	
20	59	13		36	56	13		39	56		
20	71	8		36	58	9		39	58	16	
20	79	15		36	64	15		39	59	11	
24.9	28	3		36	69			39	60	12	

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Quadrula pustulosa cont.											
39	61	13		43	67	11		51	29	3	
39	63	11		43	67	11		51	33	3	
39	64	11		43	69			51	36	4	
39	65	15		43	72			51	42	6	
39	65	15		43	72			51	43	5	
39	66			45.8	51	8		51	44	5	
39	66	13		45.8	53	9		51	51	9	
39	72	12		45.8	57	10		51	52	9	
40	16	1		45.8	59			51	55	10	
40	25	4		45.8	59	11		51	55	11	
40	29	5		45.8	63			51	57	10	
40	31	5		45.8	63	10		51	57	12	
40	35	5		45.8	63	10		51	60	10	
40	36	6		45.8	64			51	60	11	
40	39	7		45.8	64	12		51	65	12	
40	40	6		45.8	65	10		51	66	13	
40	42	7		45.8	66			51	70	11	
40	43	8		45.8	67			51	72		
40	49	8		45.8	67			51	78		
40	49	10		45.8	69	12		55	31	5	
40	50	8		45.8	71	13		55	37	6	
40	61	12		45.8	71	14		55	42		
40	64	13		45.8	72	11		55	44	10	
40	67			45.8	74	14		55	45	7	
40	69	12		45.8	83	15		55	46	11	
40	70			48.5	35	5		55	46	11	
40	70	12		48.5	42	8		55	47	11	
40	73	16		48.5	50	7		55	48	9	
43	32	5		48.5	55	10		55	48	10	
43	44	6		48.5	56			55	49	11	
43	50	7		48.5	63			55	51	12	
43	53	8		48.5	65			55	52	11	
43	53	10		48.5	65	12		55	52	12	
43	53	10		48.5	68			55	55	11	
43	55	8		48.5	68	9		57	45	7	
43	55	9		48.5	69	11		57	57	9	
43	58	9		48.5	70			57	58	11	
43	59			48.5	70	12		57	64	19	
43	61	10		48.5	72			57	65	12	
43	61	10		48.5	73			57	66		
43	62			48.5	74			57	68		
43	62	10		48.5	75			57	68	14	
43	62	10		48.5	80			57	70		
43	65			48.5	82			57	74		
43	66			48.5	89	15		57	75	15	
43	67			51	15	1		57	77	13	

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Quadrula pustulosa cont.											
57	83	15		80	92			82	76		
65.5	90	15		82	60	7		82	77		
74.6	42	6		82	61	7		82	79		
80	42	5		82	65	10		82	80	11	
80	56	7		82	68	8		82	90	15	
80	57			82	70	8					
Quadrula quadrula											
8	112	16	f	13	61	5		13	88	10	
10.5	127	30		13	76	9		13	97	12	
10.5	131	30		13	78	7		13	106	13	
13	57	5		13	82	7		15.5	84	9	
13	58	6		13	82	8					
Strophitus undulatus											
20	84	9		37	87	6		40	83	6	
20	90	7		37	87	7		40	85	6	
33.7	85	7		37	88	8		40	86		
33.7	121	9		37	90	7		43	83		
35.3	62	4		37	94	8		48.5	75	6	
35.3	78	5		37	95	7		51	40	3	
36	58	4		38	71	5		55	89	9	f
36	70			39	74	5		55	109		
37	77	5		39	76	5		57	81	7	
37	84			39	93	7		62	74	7	
37	85	7		39	98	7		80	97	10	
37	85	7		40	81	6					
Toxolasma parvus											
13	42	4		55	28	5	m	57	36	5	m
55	19	3	m	57	36	4	m	57	39	5	m
55	25	4	f	57	36	4	m	57	40	5	m
Tritogonia verrucosa											
10.5	120	12		20	122	10	m	35.3	90	8	m
13	95	5	m	20	123	9	f	35.3	110	13	m
13	107	10	m	20	125	11	f	35.3	113	10	m
20	90	10	m	20	128		m	36	46	4	
20	96	11	f	20	130	15	m	36	53	5	
20	97	7	m	20	132	9	f	36	69	5	
20	98	8	m	20	133	9	f	36	71	11	
20	101	10	m	33.7	52	3	m	36	74	11	
20	105	9	m	33.7	62	4	m	36	88	13	
20	110	10	m	33.7	63	4	m	36	92	10	
20	112	12	m	33.7	85	7	m	36	105	12	
20	113	8	m	33.7	90	7	m	37	80	7	m
20	119	7	f	33.7	98	8	m	37	102	11	f
20	120	9	f	35.3	47	3	m	38	77	10	m
20	122	10	f	35.3	84	10	m	38	78	8	m

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Tritogonia verrucosa											
38	87	10	m	40	103	10	f	48.5	106	8	f
38	88	9	m	40	103	10	m	48.5	112	8	f
38	90	10	m	40	108	9	f	48.5	112	11	f
38	95	11	m	40	109	9	f	48.5	114	9	f
38	97	12	m	40	115	12	f	48.5	115		f
38	101	11	m	40	117	11	f	51	45	3	m
38	104	8	f	40	124		f	51	67	8	m
38	104	10	f	40	128	11	f	51	78	8	m
38	105	11	f	43	82	7	m	51	86	8	m
38	125	13	f	43	84	7	m	51	91	9	m
39	53	4	m	43	88	8	m	51	92	10	m
39	86		m	43	92	7	f	51	97	9	m
39	91	10	m	43	93		m	51	105	12	m
39	96	10	f	43	101	10	m	51	110		f
39	101	10	f	43	106	11	m	51	111	12	f
39	104	9	f	43	116	12	f	62	63	6	m
39	104	13	m	43	122	12	f	69.4	128	12	f
39	110	12	f	43	139	17	f	80	76	6	m
39	113	12	f	45.8	77	7	m	80	85	8	m
39	115		f	45.8	88	9	m	80	111	15	f
40	49	4	m	45.8	91	10	m	80	117	15	f
40	51	4	m	45.8	92	9	m	80	119		m
40	58	5	m	45.8	98	10	m	80	120		m
40	60	4	m	45.8	100	10	f	80	131	17	f
40	72	6	m	45.8	100	13	m	82	78	5	m
40	77	9	m	45.8	102		m	82	100	9	m
40	85	8	m	45.8	102	11	f	82	116	12	m
40	87	7	m	45.8	106	11	f	82	129		f
40	88	8	m	45.8	113		m	43			
40	95	8	m	48.5	82	10	m	80	42	6	
40	98	8	f	48.5	84	5	m	82	33	4	
40	98	9	m								
Truncilla truncata											
10.5				36	32	6		38	38	5	
13	37	6		36	34	5		38	39	7	
24.9	41	9		36	39	7		38	40	7	
33.7	41	6		36	40	7		38	41	9	
33.7	41	6		36	44	7		38	45	7	
33.7	43	5		37	33	4		38	47	9	
33.7	44	5		37	40	6		38	48		
33.7	45	5		37	45	8		38	48		
33.7	46	6		38	23	2		38	48	7	
33.7	46	7		38	23	2		38	48	9	
35.3	40			38	24	2		38	49		
35.3	46	9		38	25	2		38	49	7	
36	25	3		38	33	4		38	50	8	

Appendix J, Table 1. Lengths, age estimates, and gender of unionids collected from the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Truncilla truncata cont.											
39	32	4		40	56	8		55	37	7	
39	44	7		40	59	10		55	42	7	
39	56	12		43	34	4		62	33	5	
40	34	5		45.8	47	9		80	41	7	
40	35	5		51	30	3		80	48	6	
40	45	9		51	39	6		80	48	9	
40	46	7		51	54	9		80	52	7	
40	50	10		55	35	6		82	57	8	
40	53	11		55	36	6		82	62	9	
Utterbackia imbecillis											
57	54	3		57	80	5		65.5	62	6	f
57	55	3		57	86	5		82	39	3	
57	65	4		65.5	55	5	f	82	42	3	
57	77	5		65.5	60	5					
Villosa iris											
62	65	5	m								
Villosa lienosa											
36	68	9		39	71	8	m	57	71	8	m
39	56	5	m	39	79	11	f	57	75	10	m
39	69	8	m	40	65	8	m	57	95	11	
39	70	8	m	51	49	5					

Appendix J, Table 2. Lengths, age estimates, and gender of unionids collected from the Cane Creek, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Lampsilis cardium											
29	48	3	m								
Lampsilis reeveiana											
29	69		f								
Lampsilis teres											
0.7	86	7	m								
Quadrula pustulosa											
0.7	43	5									
Toxolasma parvus											
37.8	30	4	f	37.8	32	4	f	37.8	32	4	m

Appendix J, Table 2. Lengths, age estimates, and gender of unionids collected from the Cane Creek Ditch, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Lampsilis teres											
3	59		f	3	93		f	3	97		f
3	91		m								
Potamilus purpuratus											
3	102		f								

Appendix J, Table 2. Lengths, age estimates, and gender of unionids collected from the Craven Ditch, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Lampsilis teres											
3.5	65										
Ligumia subrostrata											
3.5	57			3.5	62			3.5	70		
3.5	59			3.5	65			3.5	75		
3.5	62			3.5	68						
Pyganodon grandis											
3.5	69			3.5	71			3.5	72		
Toxolasma parvus											
3.5	35			3.5	39			3.5	40		
3.5	36										
Uniomerus tetralasmus											
3.5	38										

Appendix J, Table 2. Lengths, age estimates, and gender of unionids collected from the East Fork of the Black River, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Lampsilis reeveiana											
4.8	67	6	f	4.8	84	13	f	4.8	90	10	m
4.8	75		f	4.8	85		m	4.8	90	11	m
4.8	79	8	m	4.8	87	10	m	4.8	90	12	m
4.8	79	9	m	4.8	88	11	m	4.8	91	12	m
4.8	79	11	f	4.8	89	10	m	4.8	92	10	m
4.8	80	10	f	4.8	89	12	m	4.8	95	10	m
4.8	82	10	f	4.8	89	13	f	4.8	95	12	m

Appendix J, Table 2. Lengths, age estimates, and gender of unionids collected from Lake Slough, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Lampsilis teres											
3.0	80	4	m								
Leptodea fragilis											
3.0	105	6	m								
Potamilus purpuratus											
3.0	130	8	m								
Quadrula quadrula											
3.0	72	10		3.0	75	12					
Toxolasma parvus											
3.0	18	2									
Utterbackia imbecillis											
3.0	45	4		3.0	51	4					

Appendix J, Table 2. Lengths, age estimates, and gender of unionids collected from Main Ditch, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Lampsilis teres											
7.8	81	5	f	7.8	105	7	m				
Leptodea fragilis											
7.8	57	4	f	7.8	60	4	m				
Potamilus purpuratus											
7.8	88	7	f	7.8	97	8	f	7.8	102	9	f
Quadrula quadrula											
7.8	91	10		7.8	106	10					
Toxolasma parvus											
7.8	29	3	f	13.5	42	4	f	13.5	47	5	f
7.8	36	4	f	13.5	45	4	f	13.5	48	4	m
7.8	41	4	m	13.5	45	4	m	13.5	49	5	f
13.5	29	3	f	13.5	45	4	m	13.5	50	5	m
13.5	40	4	f	13.5	47	4	m	13.5	52	5	m

Appendix J, Table 2. Lengths, age estimates, and gender of unionids collected from Ten Mile Creek, Missouri, 2003.

River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender	River Mile	Length (mm)	Age (Years)	Gender
Lampsilis cardium											
2.5	88	9	f	2.5	91	7	f				
Lampsilis reeveiana											
2.5	19	2	m	2.5	61	5	f	2.5	65	5	m
2.5	53	5	f								
Lampsilis siliquoidea											
2.5	55	5	m								

Appendix K. Re-survey data for 16 localities in the Black River system.

Collector	Hutson	MDC	Hutson	MDC	MDC	Oesch
Collection Date	2003	1981	2003	1981	1982	1969
Water Body	Black	Black	Black	Black	Black	Black
River Mile	36	36	55	55	55	55
Actinonaias ligamentina	84	436	13	159		1
Alasmidonta marginata			2			
Anodonta suborbiculata			2			
Amblema plicata	3	3	16	2		
Arcidens confragosus						
Cyclonaias tuberculata	14	12	3	10		
Cyprogenia aberti	72	10	8	9		1
Elliptio dilatata	21	5	2	5		1
Ellipsaria lineolata						
Epioblasma florentina curtisi						1
Fusconaia ebena	fd					
Fusconaia flava	20	41	9	7		1
Lampsilis abrupta	1			WD	1	
Lampsilis cardium	7	5	9	21		1
Lampsilis reeveiana						
Lampsilis siliquoidea	wd	12		2		1
Lampsilis teres	1					1
Lasmigona complanata	wd					
Lasmigona costata	2					1
Leptodea fragilis	4	2				
Ligumia recta	1	SF		WD		1
Ligumia subrostrata	wd					
Obliquaria reflexa		SF	1	SF		
Plectomerus dombeyanus	2					
Pleurobema sintoxia	49	80	16	101		1
Potamilus purpuratus	1	6	3			
Potamilus ohiensis						
Ptychobranchus occidentalis	3					
Pyganodon grandis			wd			
Quadrula metanevra	23	16	32	72		1
Quadrula nodulata						
Quadrula pustulosa	13	10	15	4		1
Quadrula quadrula						
Strophitus undulatus	2		2			
Toxolasma lividis						1
Tritogonia verrucosa	7	3		1		1
Truncilla donaciformis						
Truncilla truncata	6		4	1		
Uniomeros tetralasmus						
Utterbackia imbecillis						
Villosa iris						
Villosa lienosa	1					1
No. of living individuals	337	641	137	394	1	16
No. of live species	22	14	16	13	1	16
Live and dead species	26	16	18	16	1	16
Effort (person-hrs.)	5	5.5	4	5.5		
CPUE	67.4	116.54545	34.25	71.636364		

Appendix K. Re-survey data for 16 localities in the Black River system.

Collector	Hutson	MDC	Hutson	MDC	MDC
Collection Date	2003	1982	2003	1981	2000
Water Body	Black	Black	Black	Black	Black
River Mile	60	60	62	62	62
Actinonaias ligamentina	4	35	72	77	25
Alasmidonta marginata			2		
Anodonta suborbiculata					
Amblema plicata	wd	1	1	3	
Arcidens confragosus					
Cyclonaias tuberculata	1	2	58	44	1
Cyprogenia aberti		7	18	16	2
Elliptio dilatata			2	4	
Ellipsaria lineolata					
Epioblasma curtisi				4	
Fusconaia ebena					
Fusconaia flava	4	1	14	6	1
Lampsilis abrupta				wd	sf
Lampsilis cardium	1	6	7	13	4
Lampsilis reeveiana				1	
Lampsilis siliquoidea	1		1	1	1
Lampsilis teres			1	3	
Lasmigona complanata					
Lasmigona costata	wd		13		5
Leptodea fragilis					
Ligumia recta	wd	sf	sf		sf
Ligumia subrostrata					
Obliquaria reflexa					
Plectomerus dombeyanus					
Pleurobema sintoxia	9	35	41	70	24
Potamilus purpuratus	wd		1	wd	
Potamilus ohiensis					
Ptychobranchus occidentalis			1		
Pyganodon grandis					
Quadrula metanevra	2	13	10	7	2
Quadrula nodulata					
Quadrula pustulosa		3		2	
Quadrula quadrula					
Strophitus undulatus			1		
Toxolasma lividis					
Tritogonia verrucosa	wd		1	sf	
Truncilla donaciformis					
Truncilla truncata			1		
Uniomeros tetralasmus					
Utterbackia imbecillis					
Villosa iris			1	1	wd
Villosa lienosa					
No. of living individuals	22	103	246	252	65
No. of live species	7	9	19	15	9
Live and dead species	12	10	20	18	11
Effort (person-hrs.)	2	2.5	2	5.5	2.66
CPUE	11	41.2	123	45.818182	24.4360902

Appendix K. Re-survey data for 16 localities in the Black River system.

Collector	Hutson	MDC	MDC	Hutson	MDC	MDC
Collection Date	2003	1978	1981	2003	1981	2000
Water Body	Black	Black	Black	Black	Black	Black
River Mile	65.5	65.5	65.5	69.4	69.4	69.4
Actinonaias ligamentina		sf	21	42	192	9
Alasmidonta marginata				1		
Anodonta suborbiculata						
Amblema plicata	6		8	wd	9	
Arcidens confragosus						
Cyclonaias tuberculata			1			
Cyprogenia aberti		sf	sf	2	28	
Elliptio dilatata		sf	1		14	
Ellipsaria lineolata						
Epioblasma curtisi	1					
Fusconaia ebena						
Fusconaia flava	1	sf		5	6	wd
Lampsilis abrupta					1	
Lampsilis cardium	6	sf	14	5	29	
Lampsilis reeveiana					2	
Lampsilis siliquoidea			4		4	
Lampsilis teres	1					
Lasmigona complanata						
Lasmigona costata			sf	2	wd	1
Leptodea fragilis	2					1
Ligumia recta			2	wd	sf	
Ligumia subrostrata	18					
Obliquaria reflexa						
Plectomerus dombeyanus						
Pleurobema sintoxia	4		1	4	65	9
Potamilus purpuratus	1		5		2	2
Potamilus ohiensis						
Ptychobranchus occidentalis	2			wd		
Pyganodon grandis	3		1			
Quadrula metanevra	1		1	9	25	
Quadrula nodulata						
Quadrula pustulosa	1		sf		6	
Quadrula quadrula						
Strophitus undulatus						
Toxolasma lividis						
Tritogonia verrucosa				1	1	
Truncilla donaciformis						
Truncilla truncata					2	
Uniomeros tetralasmus						
Utterbackia imbecillis	3					
Villosa iris						
Villosa lienosa	wd		wd		1	
No. of living individuals	50	0	59	71	387	22
No. of live species	14	0	11	9	16	5
Live and dead species	15	5	15	12	18	6
Effort (person-hrs.)	4	0.75	5	2	5.5	0.66
CPUE	12.5	0	11.8	35.5	70.3636364	33.333333

Appendix K. Re-survey data for 16 localities in the Black River system.

Collector	Hutson	MDC	MDC	Oesch		Hutson	MDC	MDC	Oesch
Collection Date	2003	1981	1981	1971		2003	1981	1981	1976
Water Body	Black	Black	Black	Black		Black	Black	Black	Black
River Mile	74.6	74.6	74.6	74.6		77	77	77	77
Actinonaias ligamentina	12	35	36	1		1	54	40	
Alasmidonta marginata									
Anodonta suborbiculata									
Amblema plicata		9	2			wd	6	5	1
Arcidens confragosus									
Cyclonaias tuberculata				1					
Cyprogenia aberti	2			1		wd		2	
Elliptio dilatata	2	5	8	1		2	18	3	1
Ellipsaria lineolata									
Epioblasma curtisi				1					
Fusconaia ebena									
Fusconaia flava	1	1		1		1	2		1
Lampsilis abrupta				1					1
Lampsilis cardium	1	29	22	1		1	32	21	1
Lampsilis reeveiana			sf	1					1
Lampsilis siliquoidea		14	2	1		1	21	8	1
Lampsilis teres									
Lasmigona complanata									
Lasmigona costata	1	1	5	1			19	4	1
Leptodea fragilis						1			
Ligumia recta	wd			1		1	wd	1	1
Ligumia subrostrata									
Obliquaria reflexa									
Plectomerus dombeyanus									
Pleurobema sintoxia	2	10	6	1			28	3	
Potamilus purpuratus						wd			1
Potamilus ohiensis									
Ptychobranchus occidentalis	1								
Pyganodon grandis							1		
Quadrula metanevra	wd	1	3	1		1	2	3	1
Quadrula nodulata									
Quadrula pustulosa	1	1		1			2		1
Quadrula quadrula									
Strophitus undulatus							3		
Toxolasma lividis									
Tritogonia verrucosa		5		1					1
Truncilla donaciformis									
Truncilla truncata									1
Uniomeros tetralasmus									
Utterbackia imbecillis									
Villosa iris									
Villosa lienosa		wd	wd				2		1
No. of living individuals	23	111	84	16		9	190	90	15
No. of live species	9	11	8	16		8	13	10	15
Live and dead species	11	12	10	16		11	14	10	14
Effort (person-hrs.)	2	3.5	2			2	4	2	
CPUE	11.5	31.714286	42			4.5	47.5	45	

Appendix K. Re-survey data for 16 localities in the Black River system.

Collector	Hutson	MDC	Hutson	MDC	Hutson	MDC
Collection Date	2003	1981	2003	1981	2003	1981
Water Body	Black	Black	Black	Black	Black	Black
River Mile	80	80	93.3	93.3	107	107
Actinonaias ligamentina	16	70				
Alasmidonta marginata		5				
Anodonta suborbiculata						
Amblema plicata	31	5				
Arcidens confragosus		4				
Cyclonaias tuberculata						
Cyprogenia aberti	2					
Elliptio dilatata						
Ellipsaria lineolata						
Epioblasma curtisi						
Fusconaia ebena						
Fusconaia flava	1					
Lampsilis abrupta		2				
Lampsilis cardium	8	92				
Lampsilis reeveiana	wd					
Lampsilis siliquoidea	1					
Lampsilis teres						
Lasmigona complanata						
Lasmigona costata	1	3				
Leptodea fragilis	1	3				
Ligumia recta	5	8				
Ligumia subrostrata						
Obliquaria reflexa	1	sf				
Plectomerus dombeyanus	1					
Pleurobema sintoxia	1	2				
Potamilus purpuratus	3					
Potamilus ohiensis						
Ptychobranchus occidentalis						
Pyganodon grandis						
Quadrula metanevra	9	4				
Quadrula nodulata						
Quadrula pustulosa	4					
Quadrula quadrula						
Strophitus undulatus	1					
Toxolasma lividis						
Tritogonia verrucosa	7	4				
Truncilla donaciformis						
Truncilla truncata	4	1				
Uniomeros tetralasmus						
Utterbackia imbecillis						
Villosa iris						
Villosa lienosa						
No. of living individuals	97	203	0	0	0	0
No. of live species	18	13	0	0	0	0
Live and dead species	19	14	0	0	0	0
Effort (person-hrs.)	4	6	2	2	2	2
CPUE	24.25	33.8333	0	0	0	0

Appendix K. Re-survey data for 16 localities in the Black River system.

Collector	Hutson	MDC	MDC		Hutson	MDC
Collection Date	2003	1980	2001		2003	1980
Water Body	Cane Creek	Cane Creek	Cane Creek		E. Fork, Black	E. Fork, Black
River Mile	29	29	29		0.9	0.9
Actinonaias ligamentina		23				
Alasmidonta marginata						
Anodonta suborbiculata						
Amblema plicata	sf		1			
Arcidens confragosus						
Cyclonaias tuberculata						
Cyprogenia aberti		wd				
Elliptio dilatata		wd	1			
Ellipsaria lineolata						
Epioblasma curtisi						
Fusconaia ebena						
Fusconaia flava		10				
Lampsilis abrupta						
Lampsilis cardium	1	2				
Lampsilis reeveiana	1	wd	1			5
Lampsilis siliquoidea		2				
Lampsilis teres						
Lasmigona complanata						
Lasmigona costata						
Leptodea fragilis						
Ligumia recta						
Ligumia subrostrata		wd				
Obliquaria reflexa						
Plectomerus dombeyanus						
Pleurobema sintoxia	sf	6	sf			
Potamilus purpuratus						
Potamilus ohiensis						
Ptychobranchus occidentalis						
Pyganodon grandis		wd				
Quadrula metanevra						
Quadrula nodulata						
Quadrula pustulosa						
Quadrula quadrula						
Strophitus undulatus		2				
Toxolasma lividis						
Tritogonia verrucosa		3				
Truncilla donaciformis						
Truncilla truncata						
Uniomeros tetralasmus						
Utterbackia imbecillis						
Villosa iris						
Villosa lienosa		2				
No. of living individuals	2	50	3		0	5
No. of live species	2	8	3		0	1
Live and dead species	0	13	4		0	1
Effort (person-hrs.)	2	4	1.75		2	1.25
CPUE	1	12.5	1.7142857		0	4

Appendix K. Re-survey data for 16 localities in the Black River system.

Collector	Hutson	MDC	Hutson	MDC
Collection Date	2003	1980	2003	1980
Water Body	E. Fork, Black	E. Fork, Black	Logan Creek	Logan Creek
River Mile	4.8	4.8	4.3	4.3
Actinonaias ligamentina				
Alasmidonta marginata				
Anodonta suborbiculata				
Amblema plicata				
Arcidens confragosus				
Cyclonaias tuberculata				
Cyprogenia aberti				
Elliptio dilatata				
Ellipsaria lineolata				
Epioblasma curtisi				
Fusconaia ebena				
Fusconaia flava				
Lampsilis abrupta				
Lampsilis cardium				
Lampsilis reeveiana	26	1		
Lampsilis siliquoidea				
Lampsilis teres				
Lasmigona complanata				
Lasmigona costata				
Leptodea fragilis				
Ligumia recta				
Ligumia subrostrata				
Obliquaria reflexa				
Plectomerus dombeyanus				
Pleurobema sintoxia				
Potamilus purpuratus				
Potamilus ohiensis				
Ptychobranchus occidentalis				
Pyganodon grandis		60		1
Quadrula metanevra				
Quadrula nodulata				
Quadrula pustulosa				
Quadrula quadrula				
Strophitus undulatus				
Toxolasma lividis				
Tritogonia verrucosa				
Truncilla donaciformis				
Truncilla truncata				
Uniomeros tetralasmus				
Utterbackia imbecillis				
Villosa iris				
Villosa lienosa				
No. of living individuals	26	61	0	1
No. of live species	1	2	0	1
Live and dead species	1	2	4	1
Effort (person-hrs.)	3	1.5	2	1.5
CPUE	8.666666667	40.66666667	0	0.6666667

Appendix K. Re-survey data for 16 localities in the Black River system.

Collector	Hutson	MDC
Collection Date	2003	1980
Water Body	Ten Mile Creek	Ten Mile Creek
River Mile	2.5	2.5
Actinonaias ligamentina		
Alasmidonta marginata		
Anodonta suborbiculata		
Amblema plicata		
Arcidens confragosus		
Cyclonaias tuberculata		
Cyprogenia aberti		
Elliptio dilatata		
Ellipsaria lineolata		
Epioblasma curtisi		
Fusconaia ebena		
Fusconaia flava		
Lampsilis abrupta		
Lampsilis cardium	2	
Lampsilis reeveiana	4	3
Lampsilis siliquoidea	1	
Lampsilis teres		
Lasmigona complanata		
Lasmigona costata		
Leptodea fragilis		
Ligumia recta		
Ligumia subrostrata		
Obliquaria reflexa		
Plectomerus dombeyanus		
Pleurobema sintoxia		
Potamilus purpuratus		
Potamilus ohiensis		
Ptychobranchus occidentalis		
Pyganodon grandis	wd	
Quadrula metanevra		
Quadrula nodulata		
Quadrula pustulosa		
Quadrula quadrula		
Strophitus undulatus		
Toxolasma lividis		
Tritogonia verrucosa		
Truncilla donaciformis		
Truncilla truncata		
Uniomeros tetralasmus		
Utterbackia imbecillis		
Villosa iris		
Villosa lienosa		
No. of living individuals	7	3
No. of live species	3	1
Live and dead species	4	1
Effort (person-hrs.)	2	1.25
CPUE	3.5	2.4

The End