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RESULTS OF A SURVEY OF THE MUSSEL FAUNA AT SELECTED STATIONS IN THE BLACK WARRIOR RIVER SYSTEM, ALABAMA, 2009-2012

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In cooperation with the Alabama Department of Conservation and Natural Resources
Division of Wildlife and Freshwater Fisheries

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CONTENTS

FIGURES

TABLES

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ABSTRACT

During 2009-12 mussel sampling in the Black Warrior River system yielded 28 species from 16 main channel and 119 tributary stations. Mussels were encountered more frequently and often in greater abundance in Coastal Plain tributaries downstream of Tuscaloosa and in the Sipsey Fork system. Among federally listed species encountered only *Potamilus inflatus* was collected in the main channel; *Hamiota perovalis* was found live or fresh dead in tributaries on the Coastal Plain and in the Sipsey Fork; and *Medionidus acutissimus, Pleurobema rubellum* (= *P. furvum*), and *Ptychobranchus greenii* were found live or fresh dead in the Sipsey Fork. A weathered dead shell of a possible *P. rubellum* was collected from Davis Creek, a direct Black Warrior tributary near Tuscaloosa. Most tributary stations upstream of the Fall Line at Tuscaloosa that were direct tributaries to the Black Warrior River yielded no mussels or only shells of common species. Some Locust Fork and Blackburn Fork stations yielded a few animals, and six species were collected live there. No listed species were found there, but weathered dead valves of *Elliptio arctata*, a State of Alabama Conservation Priority 1 (P1) species, were found in Locust Fork as well as Sipsey Fork. Live *Elliptio arctata* were found in a North River tributary a few years earlier. Mulberry Fork and its tributaries yielded no live animals or shells at any station. The Sipsey Fork, sampled mostly in or near Bankhead National Forest, still harbors what is likely the only intact fauna in the Mobile River Basin. All federally listed species documented from that watershed in the past two decades were collected, but in lower numbers and with less frequency than 20 years ago.

INTRODUCTION

The mussel and fish faunas of the Mobile River Basin are noteworthy for their high degrees of endemism and diversity. These phenomena can be attributed to the large size of the basin, numerous habitat types available due to the diverse physiography of the basin, geographic barriers such as the Fall Line, and the proximity of the basin to adjacent drainages with diverse faunas (Williams, 1982) (fig. 1). Hinkley (1906) reported 40 mussel species from the Tombigbee

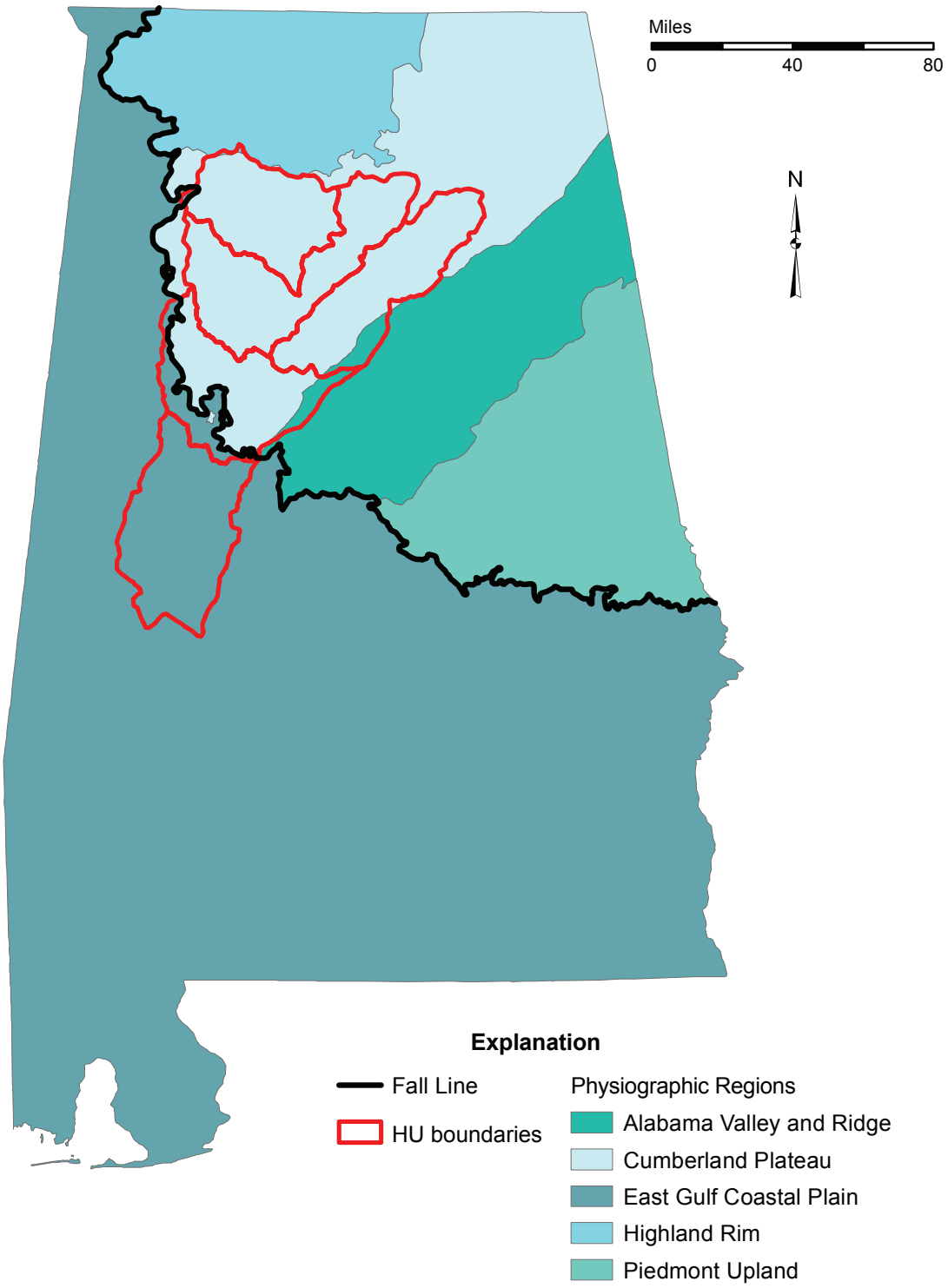

Figure 1. Map showing the 8-digit hydrologic unit (HU) boundaries in the Black Warrior Basin and their relation to the major physiographic regions in Alabama.

River system alone, while Williams and others (1992) reported that 50 species were known to have occurred in the upper Tombigbee River system (upstream of the confluence of the Tombigbee and Black Warrior Rivers) and 48 in the Black Warrior system, adjusted to taxonomic revisions in recent decades. Williams and others (2008), in a comprehensive review of the mussels of Alabama, tallied 51 species known from the Black Warrior system. Hartfield (1990) summarized mussel sampling at 73 stations in the upper Black Warrior system (Locust and Mulberry Forks), some with historic collection data and some without, and documented a sharp decline in diversity and abundance compared to previous faunal surveys, which he attributed to various anthropogenic factors.

The Sipsey Fork likely contains the only intact fauna remaining in the Black Warrior River system. A qualitative mussel survey at 38 stations in Sipsey Fork streams draining Bankhead National Forest in 1992 (McGregor, 1992) yielded 14 species of freshwater mussels (adjusted from 15 subsequent to revision of the ranges of two species). Subsequent to that study, Haag and Warren (2003) summarized results of the comparison of quantitative sampling at five stations within the forest in 1993 and 2001-02 and documented a marked decline in abundance, and added a single individual of one species not reported by McGregor (1992). They attributed the decline to the effects of a severe drought in 2000. They found that all species declined at a similar rate, with a similar relative abundance for each year, and with all species found live in 1993 also found live in at least one stream in 2001-02.

While the mussel population in Alabama remains among the most diverse on Earth, significant declines in many areas of the state have been documented (see Williams and others, 2008, for a review). Some of the causes of declines in abundance and diversity can be attributed to the effects of anthropogenic factors such as impoundment, eutrophication, sedimentation, pollution, and channel modifications and resultant population fragmentation of mussels and their obligate fish hosts suppressing gene flow and causing a steep and possibly fatal decline in the fauna (Hartfield, 1994; Mott and Hartfield, 1994). With the rapid increase in urbanization and associated pollution and uncontrolled runoff from mining, farming, and silvicultural activities leading to sharply elevated sediment loads and nutrification, many areas of the state face further declines if measures to protect the habitat of mussels and their host fishes are not established and enforced. To that end, the U.S. Fish and Wildlife Service (USFWS), Alabama Department of Conservation and Natural Resources (ADCNR), and Geological Survey of Alabama (GSA)

collaborated to identify watershed and river segments deemed most important for conservation activities for managing, recovering, and restoring populations of rare mussels in the Mobile River Basin (O'Neil and others, 2008). That effort was later expanded to include the entire state and to include fishes, snails, and crayfishes (Wynn and others, 2012). The intent of those publications was to facilitate and coordinate watershed management and restoration efforts and to focus funding in areas with habitat and water quality issues.

The purpose of the present study is twofold: first, to document current populations of federally listed and State of Alabama Conservation Priority mussel species (Mirarchi, 2004) at selected stations in the Black Warrior River system; and second, to document other species in the system. It is hoped that information gathered during this study will serve as a guide for regulatory agencies to target streams worthy of some level of protection or enhancement, to provide stakeholders with information to guide them in appropriate activities to protect the existing fauna and foster recovery of the fauna as a whole, and to help find sources of animals for propagation and streams appropriate for reintroductions.

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STUDY AREA

The Mobile River Basin is the largest Gulf of Mexico river basin east of the Mississippi River, draining about 43,683 square miles (mi^2) in Alabama, Mississippi, Georgia, and

Tennessee, including 32,207 mi^2, or 62 percent, of the land area of Alabama (Mettee and others, 1996). The Tombigbee River system is the westernmost tributary of the Mobile Basin and drains an area of 19,984 mi^2 in Alabama and Mississippi, and the Black Warrior River drains 6,228 mi^2 in north-central Alabama (fig. 1). Sampling in the main channel Black Warrior River extended from the tailwater of Oliver Lock and Dam at Black Warrior River mile (BWM) 113.6 upstream in the Oliver and Holt Pools to the Bankhead Lock and Dam tailwater at BWM 146.6. Tributary stations were selected based on accessibility and presence of suitable habitat for target species. Sampling locations were determined with the aid of Black Warrior River charts, DeLorme's Atlas and Gazetteer, and hand-held Global Positioning System (GPS) units.

METHODS

Mussel sampling was performed at stations within the Black Warrior River system where mussels were known historically and in streams with no historic data available. Stations were accessed at bridge crossings, foot trails, or by boat. Mussel collections were made by hand, often with the aid of mask and snorkel in tributary stations and with a surface air source at main channel stations. Main channel stations were randomly selected on presumed presence of suitable habitat for mussels from the tailwater of Oliver Lock and Dam near Tuscaloosa upstream to the tailwater of Bankhead Lock and Dam in the Holt Pool.

Due to the nature of the project and limited sampling time and resources, a generally qualitative sampling protocol (timed search) was employed, with emphasis on sampling habitats favored by target species (Strayer and Smith, 2003). Sampling time was dictated by the habitat or fauna encountered at each station. If a meager fauna or poor quality habitat was encountered, we terminated our efforts at that station and moved to another sampling station. Stations where the potential for finding target species was highest (generally stable substrate with mixed sand, gravel, cobble, or boulders) received more attention; therefore, species that prefer other habitats may be underrepresented. Some collections were made incidental to sampling for unrelated projects and did not involve a concerted effort to find live animals. Live animals were identified and returned to the stream where they were found. A few problematic specimens were retained for verification and possible genetic work and were deposited in the North Carolina Museum of Natural Sciences. Representative specimens of shell material collected were retained and will be deposited in the North Carolina State Museum of Natural Sciences or the University of Alabama Malacological Collection.

Nomenclature follows Williams and others (2008) and notes on species distributions were gleaned from Williams and others (2008) and Mirarchi (2004). *Pleurobema rubellum* (Warrior Pigtoe), a species known only from the Black Warrior River and Cahaba River systems, was considered extinct by the U.S. Fish and Wildlife Service because it had not been reported in any collections in nearly 100 years (Hartfield, 1990). However, Williams and others (2008) sunk *Pleurobema furvum* (Dark Pigtoe), a federally listed endangered species, and *Pleurobema hagleri*, both of which were restricted to the Black Warrior River system upstream of the Fall Line, into synonymy of *P. rubellum*.

Hydrological Units (HU) enclose the areal extent of surface water drainage to a point, accounting for all land and surface areas. HU boundaries are defined by hydrographic and topographic criteria that delineate an area of land upstream from a specific point on a river, stream, or similar surface waters. An HU is a drainage area delineated to nest in a multi-level, hierarchical drainage system. Hydrologic units are given a Hydrologic Unit Code (HUC) describing where the unit is in the country and the level of the unit. The HUC classification system is useful for water use planning activities on many scales, ranging from the national to local levels (USGS, http://nhd.usgs.gov/wbd.html). Distribution maps in this report are based on the 8-digit HUCs within the Black Warrior River system.

RESULTS AND DISCUSSION

During this project 16 stations were sampled in the main channel Black Warrior River and 119 in tributaries (table 1, fig. 2). Approximately 8.0 hours of bottom time were spent sampling in the main channel (average 0.5 hour per station) and 175 hours in tributaries (average about 1.5 hours per station). An aggregate total of 33 species were collected, with 16 found in the main channel and 28 in tributaries, with 11 species common to both habitats (tables 2, 3). During a recent, unrelated project mussels were surveyed at selected stations in the North River system, another major Black Warrior subbasin (McGregor and Wynn, 2008; O'Neil and others, 2011). Since the North River contains one of the most critical faunas in the Black Warrior system and the survey was done recently, data from that project is included herein. As conditions and faunas encountered among Black Warrior River subbasins differed, each major subunit will be addressed separately in the following sections. Individual species accounts are presented thereafter.

Table 1.—Summary information for stations sampled in the Black Warrior River system, Alabama, 2009-12.

Locality[1]	County	Map coordinates
Main channel stations[1]		
BWM 113.6 opposite Snow's Drift in Clement Bend, Oliver tailwater	Tuscaloosa	N 33.1954° W 87.6794°
BWM 116.5 Oliver tailwater near mouth of Big Creek	Tuscaloosa	N 33.2028° W 87.6605°
BWM 118.5 downstream of Black Warrior Parkway, Oliver tailwater	Tuscaloosa	N 33.1972° W 87.6286°
BWM 121.3 near old Oliver Lock and Dam, Oliver Pool	Tuscaloosa	N 33.2113° W 87.5821°
BWM 122.0 at Bama Belle mooring facility, Oliver Pool	Tuscaloosa	N 33.2141° W 87.5723°
BWM 123.4 downstream of old lock wall near Tuscaloosa, Oliver Pool	Tuscaloosa	N 33.2304° W 87.5500°
BWM 123.6 upstream of old lock wall near Tuscaloosa, Oliver Pool	Tuscaloosa	N 33.2221° W 87.5459°
BWM 124.8 Oliver Pool upstream of U.S. Highway 82 bridge	Tuscaloosa	N 33.2241° W 87.5246°
BWM 126.3 downstream of Black Warrior Parkway bridge, Oliver Pool	Tuscaloosa	N 33.2395° W 87.5083°
BWM 128.0 Oliver Pool near Waterfalls Branch	Tuscaloosa	N 33.2524° W 87.4808°
BWM 129.1 upstream of Hurricane Creek mouth, Oliver Pool	Tuscaloosa	N 33.2529° W 87.4648°
BWM 133.3 upstream of Rocky Branch boat ramp, Holt Pool	Tuscaloosa	N 33.2811° W 87.4214°
BWM 137.5 upstream of Bluff Creek at Laurel Branch, Holt Pool	Tuscaloosa	N 33.3184° W 87.4140°
BWM 141.4 downstream of Harold's Lake, Holt Pool	Tuscaloosa	N 33.3715° W 87.4095°
BWM 144.4 opposite mouth of Davis Creek, Holt Pool	Tuscaloosa	N 33.4090° W 87.3945°
BWM 146.6 at mouth of Blue Creek, Holt Pool/Bankhead tailwater	Tuscaloosa	N 33.4365° W 87.3796°
Lower Black Warrior HU[2]		
Big Prairie Creek at Alabama Highway 25 near Prairie Eden	Hale	N 32.5360° W 87.5994°
Whitsitt Creek near confluence with Big Prairie Creek at CR 10	Hale	N 32.5644° W 87.5602°
Little Prairie Creek at County Road 9 near Prairie Eden	Hale	N 32.5929° W 87.6464°
Big German Creek at County Road 16 near Cedarville	Hale	N 32.6124° W 87.6835°
Limestone Creek at County Road 24 and County Road 17 intersection	Hale	N 32.6787° W 87.7224°
Hines Creek at County Road 17 S of Sawyerville	Hale	N 32.7082° W 87.7364°
Stephens Creek at U.S. Highway 43 S of Eutaw	Greene	N 32.7993° W 87.8972°
Big Brush Creek at Alabama Highway 60 near Wedgeworth	Hale	N 32.8198° W 87.7537°
Dry Creek at County Road 30 near Wedgeworth	Hale	N 32.8034° W 87.7604°
Big Brush Creek at County Road 19 NW of Greensboro	Hale	N 32.7688° W 87.6158°
Fivemile Creek at County Road 42 near Akron	Hale	N 32.8901° W 87.7302°
Fivemile Creek at Alabama Highway 69 near Harper Hill	Hale	N 32.8296° W 87.6041°
Fivemile Creek at Alabama Highway 25 near Water Oak	Hale	N 32.8601° W 87.4607°
Spencers Creek downstream of U.S. Highway 43 near Knoxville and Eutaw	Greene	N 32.9310° W 87.7883°
Buck Creek at County Road 86 SE of I-59/20 near Ralph and Knoxville	Greene	N 33.0036° W 87.7535°
Grant Creek (Arthur Creek) at Abernathy Road and Wesley Chapel Rd.	Tuscaloosa	N 33.0930° W 87.7084°
Elliotts Creek at County Road 50 E of Moundville	Hale	N 32.9833° W 87.5725°
Big Creek at Commerce Road W of Malisham Parkway	Tuscaloosa	N 33.2066° W 87.6668°

Table 1.—Summary information for stations sampled in the Black Warrior River system, Alabama, 2009-12—continued.

Locality[1]	County	Map coordinates
Upper Black Warrior HU		
Hurricane Creek at Alabama Highway 216	Tuscaloosa	N 33.2123° W 87.4485°
Bee Branch at Bee Branch Road near U.S. Highway and I-59/20	Tuscaloosa	N 33.1838° W 87.4115°
Little Hurricane Creek at U.S. Highway 11 near Coaling	Tuscaloosa	N 33.1774° W 87.3084°
Hurricane Creek at George Newell Rd. near Brookwood Middle School	Tuscaloosa	N 33.2100° W 87.2940°
Davis Creek at County Road 59 near Kellerman	Tuscaloosa	N 33.3882° W 87.2969°
Davis Creek at Hannah Road	Tuscaloosa	N 33.3319° W 87.2375°
Davis Creek downstream of County Road 99 near Pattersontown	Tuscaloosa	N 33.3104° W 87.2221°
Blue Creek at Alabama Highway 69	Tuscaloosa	N 33.5218° W 87.4849°
Big Yellow Creek at Alabama Highway 69	Tuscaloosa	N 33.5684° W 87.4080°
Valley Creek near Oak Grove at Lock 17 Road (Co. Road 54)	Jefferson	N 33.4469° W 87.1225°
Locust Fork HU		
Village Creek at Elbow Porter Road near West Jefferson Power Plant	Jefferson	N 33.6274° W 87.0531°
Village Creek at Mulga Mine near Maytown	Jefferson	N 33.5666° W 87.0025°
Locust Fork at shoal 1 mile downstream of railroad bridge	Jefferson	N 33.6792° W 87.0026°
Fivemile Creek at U.S. Highway 78 near Graysville	Jefferson	N 33.6636° W 86.9709°
Fivemile Creek at Brookside Road near Brookside	Jefferson	N 33.6398° W 86.9161°
Fivemile Creek at Upper Coalburg on Coalburg Road	Jefferson	N 33.6060° W 86.8541°
Ward Creek at County Road 140 (Warrior-Jasper Road)	Jefferson	N 33.7641° W 86.9249°
Turkey Creek at Morris-Majestic Road 0.5 mile W of Crosston	Jefferson	N 33.7292° W 86.7391°
Turkey Creek at Turkey Creek Road in Turkey Creek Nature Preserve	Jefferson	N 33.7046° W 86.6948°
Gurley Creek at County Road 133 near Trafford	Jefferson	N 33.8023° W 86.7532°
Sand Valley Creek at Narrows Road (unnumbered county road)	Blount	N 33.7853° W 86.6483°
Red Valley Branch at Red Valley Road and Sand Valley Road	Blount	N 33.7776° W 86.6375°
Longs Branch at County Road 22 near County Line community	Blount	N 33.8388° W 86.7272°
Locust Fork at Dean's Ferry Bridge on County Road 22	Blount	N 33.8463° W 86.7274°
Locust Fork at County Road 43, Vaughn's Bridge, on Wallston Road	Blount	N 33.8893° W 86.6955°
Locust Fork at County Road 13	Blount	N 33.9459° W 86.6691°
Locust Fork at shoal 0.5 mi downstream of Blackburn Fork confluence	Blount	N 33.9354° W 86.6442°
Blackburn Fork at low water bridge on Jerry Marsh Road	Blount	N 33.9351° W 86.6159°
Calvert Prong at Moss Bridge on Deavers Town Road	Blount	N 33.3508° W 86.5825°
Calvert Prong at County Road 33	Blount	N 33.9773° W 86.5272°
Blackburn Fork at Hendrick Mill on House Road off County Road 15	Blount	N 33.8798° W 86.5805°
Hendrick Mill Branch at County Road 15 near Limestone Springs	Blount	N 33.8771° W 86.5677°
Blackburn Fork at Alabama Highway 75 near Remlap	Blount	N 33.8566° W 86.5632°
Blackburn Fork at Blount County Road 27	Blount	N 33.8654° W 86.4435°
Blackburn Fork at Blount County Road 20	Blount	N 33.9059° W 86.3934°

Table 1.—Summary information for stations sampled in the Black Warrior River system, Alabama, 2009-12—continued.

Locality[1]	County	Map coordinates
Locust Fork at Alabama Highway 160 near Nectar	Blount	N 33.9803° W 86.6159°
Locust Fork at Swann Bridge W of Cleveland	Blount	N 33.9978° W 86.6015°
Locust Fork at U.S. Highway 231 N of Cleveland	Blount	N 34.0236° W 86.5733°
Graves Creek at Hamilton Mountain Road off Alabama Highway 79	Blount	N 34.0567° W 86.5644°
Locust Fork at Royal (Riverside) on County Road 26	Blount	N 34.0674° W 86.4934°
Locust Fork at Ward's Mill Bridge near Susan Moore	Blount	N 34.0979° W 86.4571°
Locust Fork at County Road 30 near Susan Moore	Blount	N 34.0996° W 86.4353°
Whippoorwill Creek unnumbered county road S of County Road 14	Blount	N 34.1057° W 86.4123°
Locust Fork at County Road 14 (Stracener Bridge)	Blount	N 34.1143° W 86.4387°
Locust Fork at U.S. Highway 278 near Snead	Blount	N 34.1313° W 86.4140°
Slab Creek at County Road 39	Marshall	N 34.1948° W 86.3619°
Locust Fork at Alabama Highway 75 near Snead and Highmound	Blount	N 34.1347° W 86.3850°
Big Mud Creek at County Road 21	Blount	N 34.1354° W 86.3720°
Locust Fork at County Road 36 just N of U.S. Highway 278	Blount	N 34.1111° W 86.3622°
Locust Fork at unnumbered county road 1 mile NE of Walnut Grove	Etowah	N 34.0844° W 86.2892°
Bristow Creek at Bud Umphrey Road near Pine Grove	Etowah	N 34.0881° W 86.2573°
Locust Fork at Dee Nix Road near Altoona	Etowah	N 33.9956° W 86.3103°
Mulberry Fork HU		
Wolf Creek at Alabama Highway 18 W of Oakman	Walker	N 33.7088° W 87.4777°
Wolf Creek alongside County Road 173	Walker	N 33.7300° W 87.4724°
Wolf Creek at Wolf Creek Road upstream of Alabama Highway 102	Fayette	N 33.7994° W 87.5334°
Lost Creek at County Road 20 W of Parrish and E of Oakman	Walker	N 33.7250° W 87.3111°
Lost Creek at Pleasant Grove Road SW of New Jagger	Walker	N 33.8025° W 87.3679°
Lost Creek at Alabama Highway 118 near Carbon Hill	Walker	N 33.8816° W 87.5098°
Mill Creek at Radiant City Road near Spring Hill, 2 mi SW of Nauvoo	Walker	N 33.9705° W 87.5378°
Lost Creek at Haley Bottoms Road near Kansas community	Walker	N 33.9019° W 87.5710°
Broglen River at County Road 703 near Welti	Cullman	N 34.1446° W 86.7690°
Eightmile Creek at County Road 1492	Cullman	N 34.2890° W 86.7539°
Blue Springs Creek at Co. Rd. 47 at Blountsville, nr. U.S. Hwy. 231	Blount	N 34.0847° W 86.5951°
Duck River at U.S. Highway 278 near Oak Level	Cullman	N 34.1714° W 86.6963°
Duck River at County Road 1651 on Cullman Water Authority land	Cullman	N 34.1952° W 86.6878°
Duck River at County Road 1669 downstream of Birdsong	Cullman	N 34.2181° W 86.6609°
Mulberry Fork at County Road 747, upstream of Duck River mouth	Cullman	N 34.0863° W 86.6964°
Mulberry Fork at County Road 55, north of Blountsville	Cullman	N 34.1358° W 86.5948°
Mulberry Fork at U.S. Highway 278, east of Holly Pond	Cullman	N 34.1724° W 86.5605°
Mulberry Fork at Alabama Highway 67, near Roswell	Cullman	N 34.2153° W 86.5414°
Mulberry Fork at County Road 1807, near Harmony	Cullman	N 34.2441° W 86.5242°
Mulberry Fork at County Road 1830 near U.S. Highway 231	Cullman	N 34.2534° W 86.5052°

Table 1.—Summary information for stations sampled in the Black Warrior River system, Alabama, 2009-12—continued.

Locality[1]	County	Map coordinates
Sipsey Fork HU		
Crooked Creek at Clarkson Covered Bridge, 1 mi N U.S. Hwy. 278	Cullman	N 34.2082° W 86.9909°
Rock Creek at County Road 80 near New Georgia	Winston	N 34.2409° W 87.1355°
Rock Creek at County Road 50 near Upshaw	Winston	N 34.2818° W 87.1330°
Clear Creek at Spain Ford just E of Alabama Highway 195	Winston	N 34.0365° W 87.3779°
Coon Creek on County Road 8 near Black Pond	Winston	N 34.0617° W 87.3139°
Mile Creek near Forest Service Road 121	Winston	N 34.1911° W 87.2669°
Brushy Creek at ford upstream of U.S. Highway 278 near Inman Creek	Winston	N 34.1976° W 87.2600°
Inman Creek at Forest Service Road 124, 2.0 mi NW of Addison	Winston	N 34.2155° W 87.2246°
Capsey Creek at mouth, near Forest Service Road 255	Winston	N 34.2515° W 87.2451°
Capsey Creek at Forest Service Road 266, 1.5 mi NW of Inmanfield	Winston	N 34.2693° W 87.2110°
Capsey Creek headwaters, AL Hwy. 41 at Cave Spring Cave Cemetery	Winston	N 34.3253° W 87.1161°
Brushy Creek at Forest Service Road 255 nr mouth of Capsey Creek	Winston	N 34.2526° W 87.2473°
Rush Creek at Forest Service Road 245, 3 mi NE of Moreland	Winston	N 34.2736° W 87.2517°
Brown Creek at old Horse Trail 222, 1.5 mi NW of Hickory Grove	Lawrence	N 34.3050° W 87.2367°
Rush Creek at Forest Service Road 263 at Hickory Grove Church	Winston	N 34.2969° W 87.2231°
Collier Creek from Forest Service Road 253 to mouth	Winston	N 34.2608° W 87.2811°
Beech Creek at Forest Service Road 244/245 intersection	Winston	N 34.2972° W 87.3056°
Brushy Creek in Brushy Creek Lake tailwater	Winston	N 34.2925° W 87.2739°
Brushy Creek at Forest Service Road 254 NE Pine Torch Church	Lawrence	N 34.3306° W 87.2858°
Rockhouse Creek off Forest Service Road 108A, near Avery Cemetery	Winston	N 34.1135° W 87.3606°
Mill Creek at ford NW of Barnett Chapel, 2 mi W of Natural Bridge	Winston	N 34.1825° W 87.3153°
Sipsey Fork at low water bridge just upstream of AL Highway 33	Winston	N 34.2255° W 87.3768°
South Fork Caney Creek from Caney Falls downstream past lower falls	Winston	N 34.2441° W 87.4481°
Sipsey Fork at Sipsey Fork Picnic Area on County Road 60	Winston	N 34.2854° W 87.3990°
Borden Creek at wilderness boundary on Forest Service Road 224	Lawrence	N 34.3097° W 87.3944°
Flannagin Creek at Forest Service Road 208 at wilderness boundary	Lawrence	N 34.3389° W 87.3881°
Borden Creek at Forest Service Road 208 at wilderness boundary	Lawrence	N 34.3296° W 87.3778°
Hubbard Creek at Kinlock Falls at Forest Service Road 210	Lawrence	N 34.3089° W 87.5017°
Thompson Creek at Forest Service Road 208, 2.5 mi E Macedonia	Lawrence	N 34.3408° W 87.4711°

[1] BWM = Black Warrior River mile

[2] HU= Hydrologic Unit

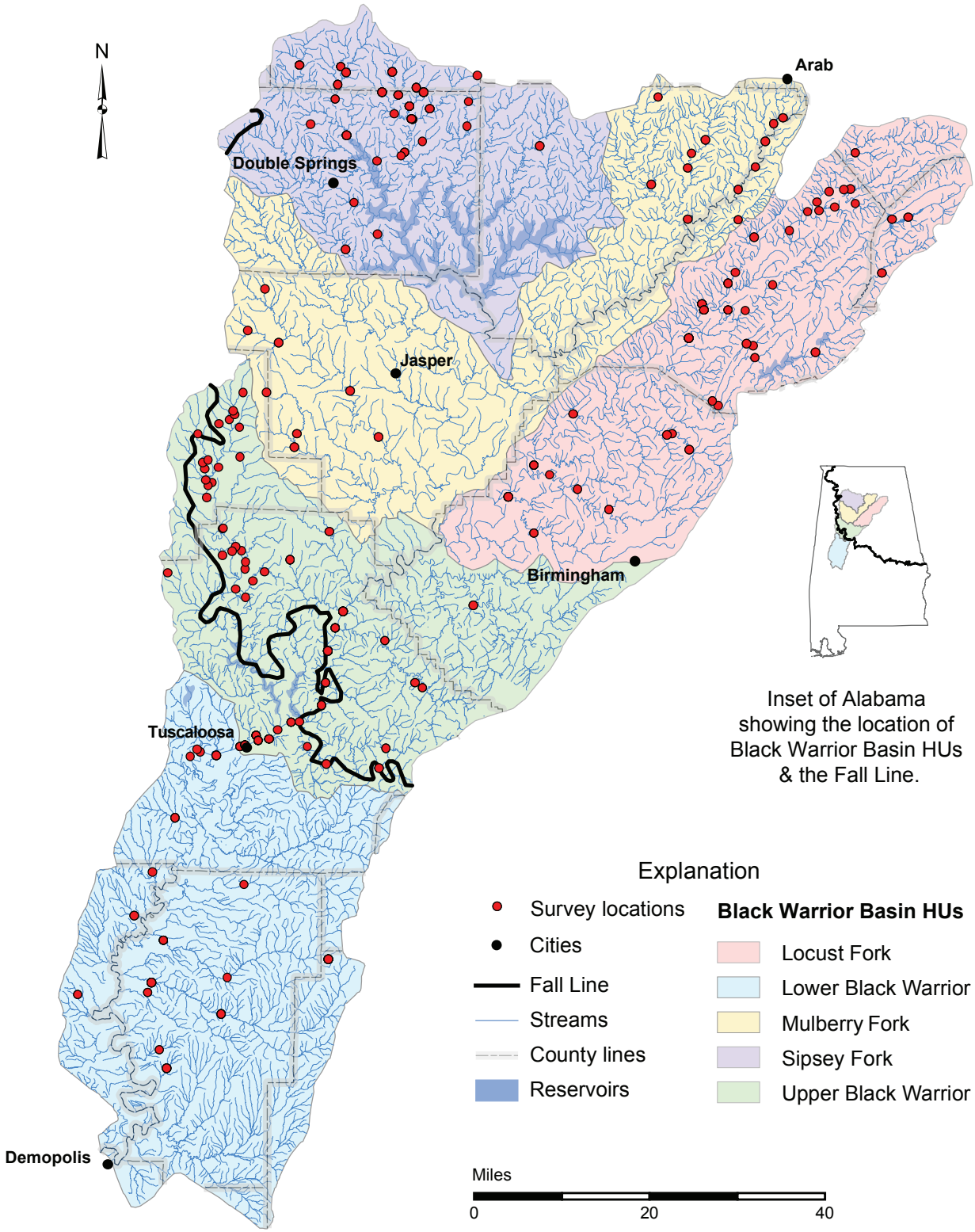

Figure 2. Map of the study area showing mussel survey locations in the Black Warrior Basin.

Table 2.—Overview of freshwater mussels collected in the Black Warrior River, Alabama, 2009.

Species	Status[1]	Results of sampling, summer 2009
Anodonta suborbiculata, Flat Floater	P4	Two live individuals were found in the upper reach of Holt Pool; these are the first main channel Black Warrior records of this adventitious species.
Arcidens confragosus, Rock Pocketbook	P3	Two live individuals were found in the Oliver Pool near Tuscaloosa.
Lampsilis teres, Yellow Sandshell	P5	Live individuals were frequently encountered throughout the study area.
Lasmigona alabamensis, Alabama Heelsplitter	P3	Live individuals were frequently encountered throughout the study area.
Leptodea fragilis, Fragile Papershell	P5	Live individuals were frequently encountered throughout the study area.
Megalonaias nervosa, Washboard	P5	A few live individuals were found at two stations in the upper reach of Holt Pool.
Obliquaria reflexa, Threehorn Wartyback	P5	The third most frequently encountered and numerically abundant species encountered, it was common throughout the study area.
Plectomerus dombeyanus, Bankclimber	P5	The most frequently encountered and numerically abundant species encountered, it was common throughout the study area.
Potamilus inflatus, Inflated Heelsplitter	P2, T	Four live individuals were encountered at two stations, one downstream of Oliver Dam and one in the Oliver Pool near Tuscaloosa.
Potamilus purpuratus, Bleufer	P5	Live individuals were frequently encountered throughout the study area.
Pyganodon grandis, Giant Floater	P5	A few live individuals were found at several scattered stations in the study area.
Quadrula apiculata, Southern Mapleleaf	P5	The second most frequently encountered and numerically abundant species encountered, it was common throughout the study area.
Quadrula asperata, Alabama Orb	P5	Only one live individual of this otherwise common and widespread Mobile Basin endemic was encountered in the Oliver Pool near Tuscaloosa.
Quadrula rumphiana, Ridged Mapleleaf	P4	A fairly commonly encountered species, especially in the Holt Pool; it can be difficult to distinguish from *Quadrula apiculata*, with some evidence of intergradation.
Toxolasma parvum, Lilliput	P3	A single live individual of this diminutive species was found in the Holt Pool.
Utterbackia imbecillis, Paper Pondshell	P5	A few live individuals and fresh dead shells of this common and widespread species were found.

[1] T=federally listed threatened; Alabama priority conservation ranks follow Mirarchi (2004): P2=High Conservation Concern, P3=Moderate Conservation Concern, P4=Low Conservation Concern, P5=Lowest Conservation Concern.

Table 3.—Overview of freshwater mussels collected in tributaries of the Black Warrior River, Alabama, 2009-2012.

Species	Status[1]	Results of sampling
Amblema plicata, Threeridge	P5	Weathered dead valves were found in Locust Fork.
Anodontoides radiatus, Rayed Creekshell	P2	Live animals were found in Fivemile Creek and Bucks Creek downstream of Tuscaloosa.
Ellipsaria lineolata, Butterfly	P4	Fresh dead shells were found in Locust Fork.
Elliptio arctata, Delicate Spike	P1	Weathered dead valves were found in Locust Fork, Sipsey Fork, and its tributary Capsey Creek.
Fusconaia cerina, Gulf Pigtoe	P5	Live animals and fresh dead shells were found in Big Brush and Fivemile Creeks and weathered dead valves in Limestone Creek downstream of Tuscaloosa.
Hamiota perovalis, Orangenacre Mucket	P2, T	Live animals were found in Fivemile Creek downstream of Tuscaloosa and live, fresh dead, and relict shells were found in numerous stations in the Sipsey Fork, including live in the Sipsey Fork itself and Brown, Brushy, Capsey, and Rush Creeks, fresh dead in Beech and Flannagin Creeks, and relict in Borden Creek.
Lampsilis ornata, Southern Pocketbook	P4	Live animals and weathered dead shells were found in Blackburn and Locust Forks; live animals were found in Big Brush Creek downstream of Tuscaloosa.
Lampsilis straminea, Southern Fatmucket	P4	A relict shell was found in Turkey Creek in the Locust Fork system; it was frequently found live in tributaries downstream of Tuscaloosa, and in the Sipsey Fork was found live in Brushy and Rush Creeks, fresh dead in Beech and Capsey Creeks, and weathered dead in Thompson Creek.
Lampsilis teres, Yellow Sandshell	P5	Live animals were found in Locust Fork and a weathered dead shell in Village Creek; live animals were found in Big Brush Creek downstream of Tuscaloosa.
Lasmigona alabamensis, Alabama Heelsplitter	P3	Fresh dead shells were found in Locust Fork and Village Creek.
Leptodea fragilis, Fragile Papershell	P5	Weathered dead shells were found in Village Creek and fresh and weathered dead shells at several stations in Locust Fork.
Medionidus acutissimus, Alabama Moccasinshell	P2, T	A live animal was found in Rush Creek and fresh dead shells in Brown and Brushy Creeks in the Sipsey Fork.
Megalonaias nervosa, Washboard	P5	Weathered dead shells were found in Little Prairie Creek downstream of Tuscaloosa.
Obliquaria reflexa, Threehorn Wartyback	P5	Live animals and weathered dead shells were found in Locust Fork.
Pleurobema rubellum (=*Pleurobema furvum*), Warrior Pigtoe	P1, E	One valve of a relict shell tentatively identified as this species was collected from Davis Creek; live animals were found in Sipsey Fork and its tributaries Brushy and Rush Creeks.
Potamilus purpuratus, Bleufer	P5	Live animals and fresh and weathered dead shells were found in Blackburn and Locust Forks; fresh and weathered dead shells were found in Village Creek; a weathered dead shell was found in Big Prairie Creek downstream of Tuscaloosa.
Ptychobranchus greenii, *Triangular Kidneyshell*	P1, E	Live animals were found occasionally in Sipsey Fork and its tributaries Brushy, Capsey, and Rush Creeks.

Table 3.—Overview of freshwater mussels collected in tributaries of the Black Warrior River, Alabama, 2009-2012.

Species	Status[1]	Results of sampling
Pyganodon grandis, Giant Floater	P5	Weathered dead shells were found in Village Creek; live individuals were found in Sipsey Fork.
Quadrula apiculata, Southern Mapleleaf	P5	One weathered dead shell was found in Little Prairie Creek downstream of Tuscaloosa.
Quadrula asperata, Alabama Orb	P5	Weathered dead shells were found in Davis Creek; live animals were found in Locust Fork and in Big Brush and Fivemile Creeks, downstream of Tuscaloosa.
Quadrula verrucosa, Pistolgrip	P4	Live animals and fresh dead shells were found in Blackburn and Locust Forks; weathered dead shells were found in Brushy Creek in the Sipsey Fork.
Strophitus subvexus, Southern Creekmussel	P3	A relict shell was found in Blue Creek, live animals were found in Big Brush Creek downstream of Tuscaloosa, and live animals were found in Sipsey Fork and its tributaries Beech, Brushy, Capsey, and Rush Creeks; a weathered dead shell was found in Crooked Creek, another Sipsey Fork tributary outside Bankhead National Forest.
Toxolasma parvum, Lilliput	P3	A live animal was found in Big Brush Creek and weathered dead shells in Big German and Whitsitt Creeks, downstream of Tuscaloosa.
Uniomerus tetralasmus, Pondhorn	P4	Live animals were found in Fivemile and Grant's Creeks and fresh and weathered dead shells in Little Prairie, Big German, Limestone, and Stephens Creeks, downstream of Tuscaloosa.
Utterbackia imbecillis, Paper Pondshell	P5	Weathered dead shells were found in Big German and Whitsitt Creeks, downstream of Tuscaloosa; live animals were found in Sipsey Fork.
Villosa lienosa, Little Spectaclecase	P5	Fresh and weathered dead shells were found in Blue Creek, upstream of Tuscaloosa; a weathered dead shell was found in Sand Valley Creek in the lower Locust Fork system; numerous live animals and fresh and weathered dead shells were found in tributaries downstream of Tuscaloosa; live and fresh dead shells were frequently found in Sipsey Fork and its tributaries Beech, Brown, Brushy, Rush, and Thompson Creeks, and weathered dead in Borden and Flannagin Creeks.
Villosa nebulosa, Alabama Rainbow	P3	Fresh dead shells were found in Blue Creek, upstream of Tuscaloosa, and weathered dead shells in Blackburn Fork; live animals were found in the Sipsey Fork tributaries Capsey and Rush Creeks and weathered dead shells in Borden and Flannagin Creeks.
Villosa vibex, Southern Rainbow	P5	Weathered dead shells were found in Blackburn Fork; fresh dead shells were found in Fivemile and Grant's Creeks downstream of Tuscaloosa; live animals were found in the Sipsey Fork tributaries Brown, Brushy, Capsey, and Rush Creeks, and fresh dead shells in Beech Creek.

[1] Alabama priority conservation ranks follow Mirarchi (2004): P1=Highest Conservation Concern, P2=High Conservation Concern, P3=Moderate Conservation Concern, P4=Low Conservation Concern, P5=Lowest Conservation Concern, X=not assigned; E=federally listed Endangered; T=federally listed Threatened.

MAIN CHANNEL

A cumulative total of 675 mussels either live or represented by fresh dead shells were collected in main channel Black Warrior River stations, for a catch per unit effort (CPUE) of 84.4 mussels/hour. The most numerically dominant and frequently encountered species there were *Plectomerus dombeyanus* (Bankclimber) (9 stations, CPUE 28.4), *Quadrula apiculata* (Southern Mapleleaf) (11 stations, CPUE 23.8), and *Obliquaria reflexa* (Threehorn Wartyback) (11 stations, CPUE 22.0). Four individuals of the federally threatened *Potamilus inflatus* (Inflated Heelsplitter), were collected, with three live individuals collected in the Oliver Lock and Dam tailwater at BWM 118.5 near the Black Warrior Parkway Bridge, and one live individual near the city of Tuscaloosa at BWM 122.0. A breakdown of species encountered among the main channel stations is presented in table 2.

Mussels in the main channel Black Warrior were usually found in areas of stable gravel and sand sometimes mixed with cobble and boulders and generally having varying levels of silt deposition. The two most downstream main channel collections (BWM 113.6 and 116.5) (table 1, fig. 2), located in the Oliver Lock and Dam tailwater just downstream of the Fall Line on the Coastal Plain, had relatively poor habitat and little effort was spent sampling there. Habitat generally improved with upstream progression in the main channel. Habitat in the Oliver and Holt pools was comprised primarily of fairly stable gravel and sand substrates with occasional cobble, boulders, woody debris, and bedrock with some areas of mud, often with a layer of fine silt in eddies and areas protected from the current. Visibility was often 3 to 4 feet with a light source.

LOWER BLACK WARRIOR HYDROLOGIC UNIT

Among the Lower Black Warrior HU tributaries downstream of Tuscaloosa, 16 species were recorded, with 12 represented by live animals or fresh dead shells (table 3). While some smaller streams yielded no mussels, some yielded species typical of small Mobile River Basin streams or the headwaters of larger streams, such as *Fusconaia cerina* (Gulf Pigtoe), *Lampsilis straminea* (Southern Fatmucket), and *Villosa lienosa* (Little Spectaclecase). However, a few tributary systems, such as Big German, Big Brush, Fivemile, and Big Prairie Creeks in Hale County, yielded more diverse and abundant faunas and warrant some discussion.

A cumulative total of eight species was recorded from two stations in Fivemile Creek while one station yielded no mussels, likely due to locally heavy sedimentation (tables 1, 3; fig.

3). All eight species collected were represented by live animals, including the only federally listed species encountered in Coastal Plain tributaries downstream of Tuscaloosa, *Hamiota perovalis* (Orangenacre Mucket), a Conservation Priority 2 species. The most downstream station sampled, at Hale County Road 42 near Akron, yielded six species and was characterized by moderate flow over stable gravel substrate (stained black) in runs and riffles, relatively stable sand with scattered woody debris in some reaches, and areas of coarse particulate organic matter and detritus in pools. Rip rap along an adjacent active railroad bed provided further stability for a long stretch of the reach sampled. Aside from the rip rap border along the railroad grade, the riparian border is protected by extensive forest cover providing stable banks and canopy. The most upstream station sampled in Fivemile Creek, at Alabama Highway 25, yielded a single live *H. perovalis* among six species, including two, *Anodontoides radiatus* (Rayed Creekshell), a Conservation Priority 2 species, and *Uniomerus tetralasmus* (Pondhorn), often found in headwaters and softer substrates such as encountered at this station. The site was characterized by extensive sand, mud, and silt introduced from upstream logging activities and the effects of recent tornados that had blown down streamside timber just upstream of the highway. All of the mussels found at this station were among rip rap beneath the bridge, the only evident stable substrate. A station sampled between these two, at Alabama Highway 69, yielded no mussels and was characterized by an extremely heavy sediment burden, likely due at least in part to poor land use practices in the vicinity and some recent tornado damage. Interestingly, neither upstream station yielded *Corbicula* sp.

Three stations sampled in the Big Brush Creek system yielded a total of nine species, all represented by live animals or fresh dead shells (tables 1, 3; fig. 2). While no federally listed species were encountered, the abundance and diversity of mussels found at two stations suggests that with more time and a greater number of stations sampled, even more species could be encountered. Both stations sampled in Big Brush Creek proper had heavy sediment loads, with extensive areas of sand and scattered patches of gravel, and with woody debris providing refugia. The upper station had the addition of an old collapsed bridge frame in the creek bed providing a very stable area where most of the mussels were found. All three stations had extensive wooded

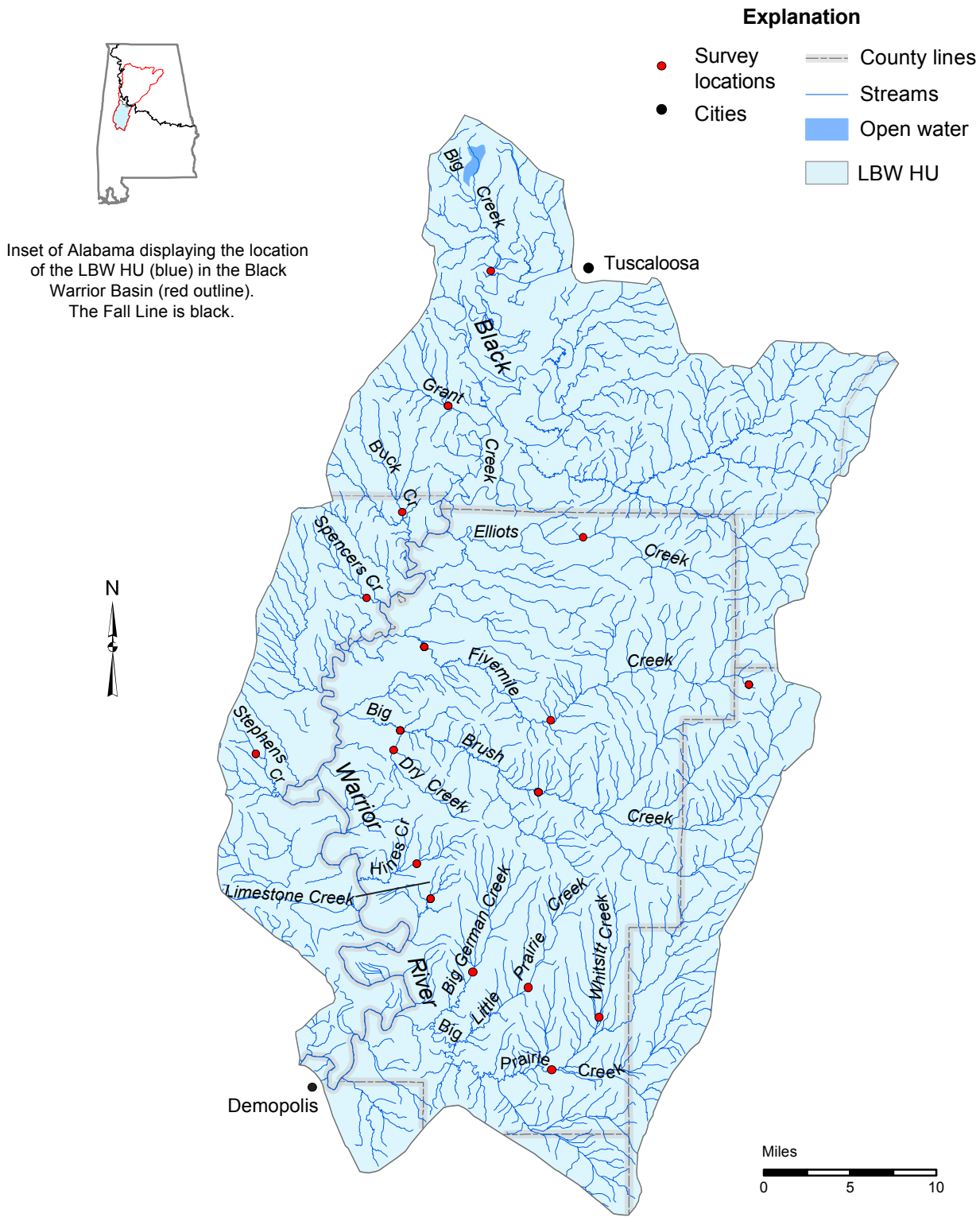

Figure 3. Map of mussel survey locations in the Lower Black Warrior (LBW) HU.

riparian borders. *Toxolasma parvum* (Lilliput) and *Strophitus subvexus* (Southern Creekmussel), both Conservation Priority 3 species, were found live at the upper station.

Six fairly common species were found in Big German Creek, but only one, *Villosa lienosa*, was found live (tables 1, 3; fig. 2). The Lilliput was found weathered dead here. The stream was characterized by a very heavy sand load from an unknown source with scattered patches of gravel and extensive woody debris. Flow was moderate to slow and somewhat turbid from recent rain. The sand load was not present two years prior when crayfish were sampled at the same location. The riparian border was a narrow strip of trees with pasture beyond.

Three stations sampled in the Big Prairie Creek system yielded a total of nine species, but none live and only three fresh dead (tables 1, 3; fig. 2). Again, additional sampling could reveal additional species and/or increased abundances. Interesting finds there were *Quadrula apiculata* and *Megalonaias nervosa* (Washboard) found weathered dead in Little Prairie Creek. These species are generally inhabitants of larger streams and rivers but were previously known from this system (Williams and others, 2008). Streams in this system were typically Black Belt in nature with extensive, soft 'bedrock' reaches interspersed with gravel and sand patches with lots of silt, mud, and detritus and scattered vegetation.

UPPER BLACK WARRIOR HYDROLOGIC UNIT

A few collections were made in streams that flow directly into the Black Warrior River just upstream of the Fall Line near Tuscaloosa, in the same HU region as the North River (table 1, fig. 4). Streams in that area are often highly affected by urban development, runoff from coal mining, pasture, and row crop production, and have resultant water quality problems and diminished biological integrity. A few species found in Blue Creek are common in smaller Mobile Basin streams and were represented by fresh dead shells (*Villosa lienosa* and *Villosa nebulosa* (Alabama Rainbow)), and three others were represented by weathered dead shells (*Pleurobema furvum* (=*rubellum*) and *Quadrula asperata* (Alabama Orb) in Davis Creek and *Strophitus subvexus* in Blue Creek.

During a recent, unrelated project (McGregor and Wynn, 2008) 29 stations were sampled in the North River system, including 14 main channel and 15 tributary stations (tables 4, 5; figs. 4, 5). A cumulative total of 15 species was collected, with 13 represented by live animals or fresh dead shells and two represented by weathered dead shells only (table 5). Approximately 62 hours were expended sampling, with 34 hours in main channel North River stations and 28 hours in

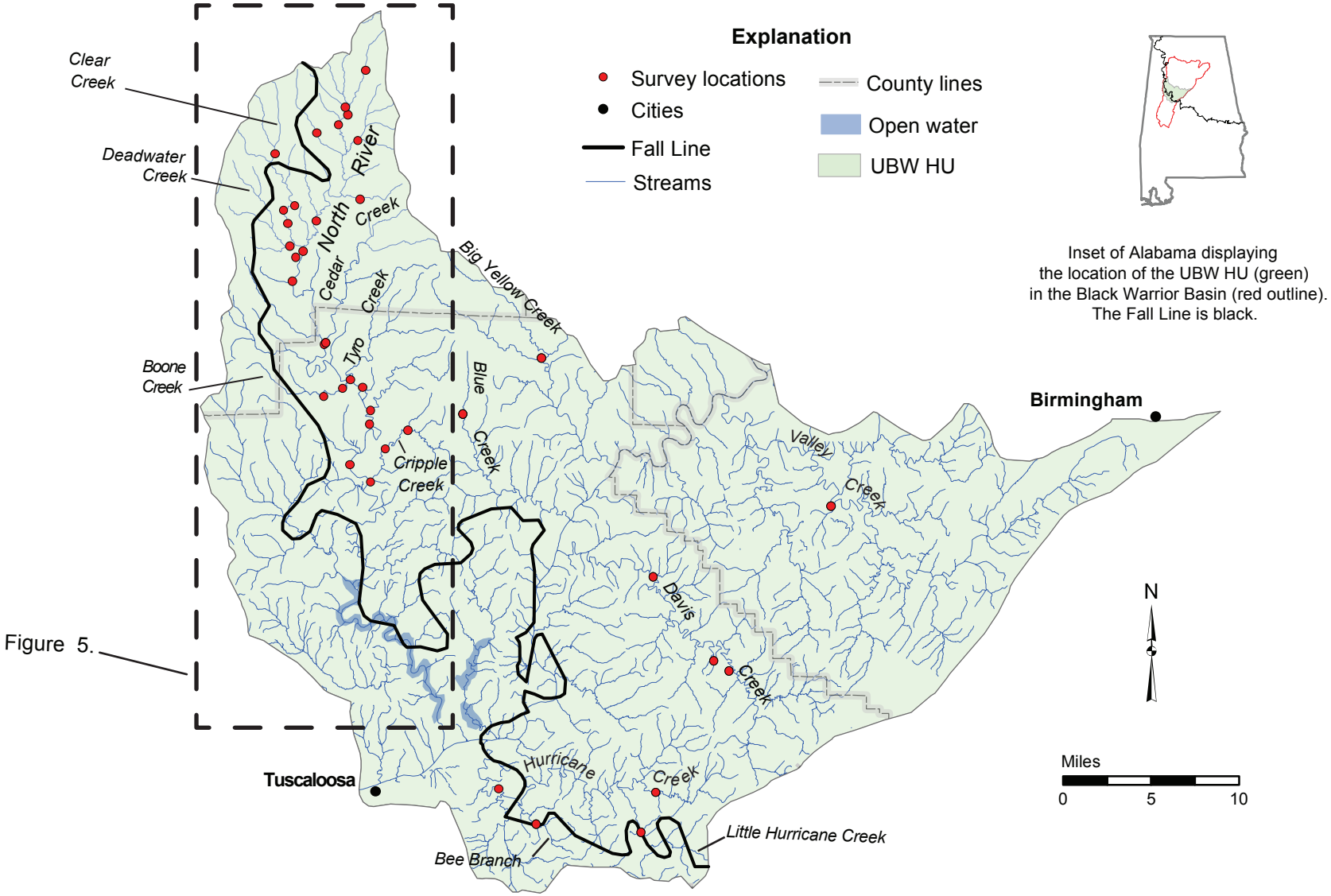

Figure 4. Map of mussel survey locations in the Upper Black Warrior (UBW) HU, including the North River and direct tributaries to the Black Warrior River. The dashed box indicates the area represented in Figure 5.

Table 4.—Summary information for stations sampled in the North River system, Alabama, 2005 and 2008.

Locality	County	Map coordinates
Main Channel North River stations		
North River at mouth of Cripple Creek	Tuscaloosa	N 33° 27.950' W 87° 34.593'
North River at County Road 38	Tuscaloosa	N 33° 28.786' W 87° 35.830'
North River downstream of Wittson Bridge	Tuscaloosa	N 33° 30.359' W 87° 43.877'
North River at tributary on right bank	Tuscaloosa	N 33° 30.809' W 87° 34.676'
North River downstream of Wittson Bridge	Tuscaloosa	N 33° 31.488' W 87° 34.606'
North River downstream of Wittson Bridge	Tuscaloosa	N 33° 32.612' W 87° 35.090'
North River at Wittson Bridge	Tuscaloosa	N 33° 32.992' W 87° 35.830'
North River at confluence of Cedar Creek	Tuscaloosa	N 33° 34.753' W 87° 37.383'
North River at Alabama Highway 18	Fayette	N 33° 37.858' W 87° 39.311'
North River at mouth of Clear Creek	Fayette	N 33° 39.363' W 87° 38.677'
North River at County Road 30	Fayette	N 33° 40.847' W 87° 37.914'
North River at mouth of Lowery Branch	Fayette	N 33° 45.612' W 87° 36.624'
North River at County Road 63	Fayette	N 33° 46.118' W 87° 36.066'
North River at Alabama Highway 102	Fayette	N 33° 48.320' W 87° 35.025'
Tributary stations		
Boone Creek downstream of County Road 55	Tuscaloosa	N 33° 32.575' W 87° 36.265'
Boone Creek at County Road 63	Tuscaloosa	N 33° 32.164' W 87° 37.375'
Beaver Creek near Alabama Highway 13	Fayette	N 33° 45.204' W 87° 37.896'
Clear Creek at Alabama Highway 13	Fayette	N 33° 39.042' W 87° 39.106'
Clear Creek at County Road 93	Fayette	N 33° 40.711' W 87° 39.580'
Clear Creek at Lowery Road	Fayette	N 33° 41.372' W 87° 39.822'
Clear Creek downstream of Bays Lake	Fayette	N 33° 41.599' W 87° 39.173'
Clear Creek at Clear Creek Road	Fayette	N 33° 44.175' W 87° 40.376'
Cane Creek at County Road 63	Fayette	N 33° 41.944' W 87° 35.331'
Cripple Creek at County Road 38	Tuscaloosa	N 33° 29.572' W 87° 33.739'
Cripple Creek at mouth of Johnson Creek	Tuscaloosa	N 33° 30.516' W 87° 32.406'
Cedar Creek near North River confluence	Tuscaloosa	N 33° 34.833' W 87° 37.285'
Deadwater Creek near U.S. Highway 43	Fayette	N 33° 39.599' W 87° 39.448'
George Creek at County Road 63	Fayette	N 33° 44.835' W 87° 35.446'
Hendon Creek at County Road 63	Fayette	N 33° 46.507' W 87° 36.219'

Table 5.—Overview of freshwater mussels collected in the North River system, Alabama, 1991-1993, 1996, and 2008.

Species	Conservation Status[1]	North River status[2]	
		1991-1993, 1996	2005, 2008
Amblema plicata	P4	A single fresh dead shell was collected at the most downstream North River station	A single weathered dead shell was collected at the same station
Anodontoides radiatus	P2	Not reported	Found live at two main channel and one tributary stations
Elliptio arca	P1	Fresh and weathered dead shells were collected from one North River station and from Cedar Creek near its confluence with North River	Not collected
Elliptio arctata	P1	Fresh and weathered dead shells were collected from three North River stations	Live individuals were collected at two Clear Creek stations
Hamiota perovalis	T, P2	Live individuals were found at two North River stations and fresh or weathered dead at three additional stations	Live individuals were found at two Clear Creek stations and fresh dead at one North River station
Lampsilis ornata	P4	Fresh and weathered dead shells were collected from three North River stations and one each in Cedar and Clear Creeks	Single fresh dead shells were found at one station each in North River and Clear Creek
Lampsilis straminea	P3	This species was collected from nine main channel and four tributary stations	Live individuals were found at several stations in Clear Creek and its tributary Deadwood Creek
Lampsilis teres	P5	One weathered shell was collected from Cedar Creek near its confluence with North River	A live individual was found in Clear Creek
Pleurobema furvum	E, P1	Live individuals were collected at two North River stations and fresh dead at one station	A live individual and a fresh dead shell were found in Clear Creek
Pyganodon grandis	P5	One fresh dead specimen was collected in the upper North River	A weathered dead shell was found in Boone Creek in 2005
Quadrula asperata	P5	Live animals and fresh and weathered dead shells were collected from nine North River stations	Live and fresh dead shells were found at three North River and two Clear Creek stations
Quadrula verrucosa	P4	Live animals were collected at one main channel station and fresh dead shells from six North River stations	Fresh dead shells were found at one North River station and weathered dead at two additional stations
Strophitus subvexus	P3	Live animals were collected at 17 North River and three tributary stations	Live individuals were found at several stations in Clear Creek and two North River stations
Uniomerus tetralasmus	P4	Not reported	One live individual was collected at one upper North River station
Villosa lienosa	P5	Live animals were collected at one North River station and fresh dead or relic at three additional North River and four tributary stations	Live individuals were found at several stations in Clear Creek and at two North River stations
Villosa vibex	P5	Live and fresh dead shells were found at ten North River and three tributary stations	Live individuals were found at several stations in Clear Creek and one North River station

[1] E=federally listed endangered, T=federally listed threatened; Alabama priority conservation ranks follow Mirarchi (2004): P1=Highest Conservation Concern, P2=High Conservation Concern, P3=Moderate Conservation Concern, P4=Low Conservation Concern, P5=Lowest Conservation Concern.

[2] From McGregor and Pierson (1999) and McGregor and Wynn (2008).

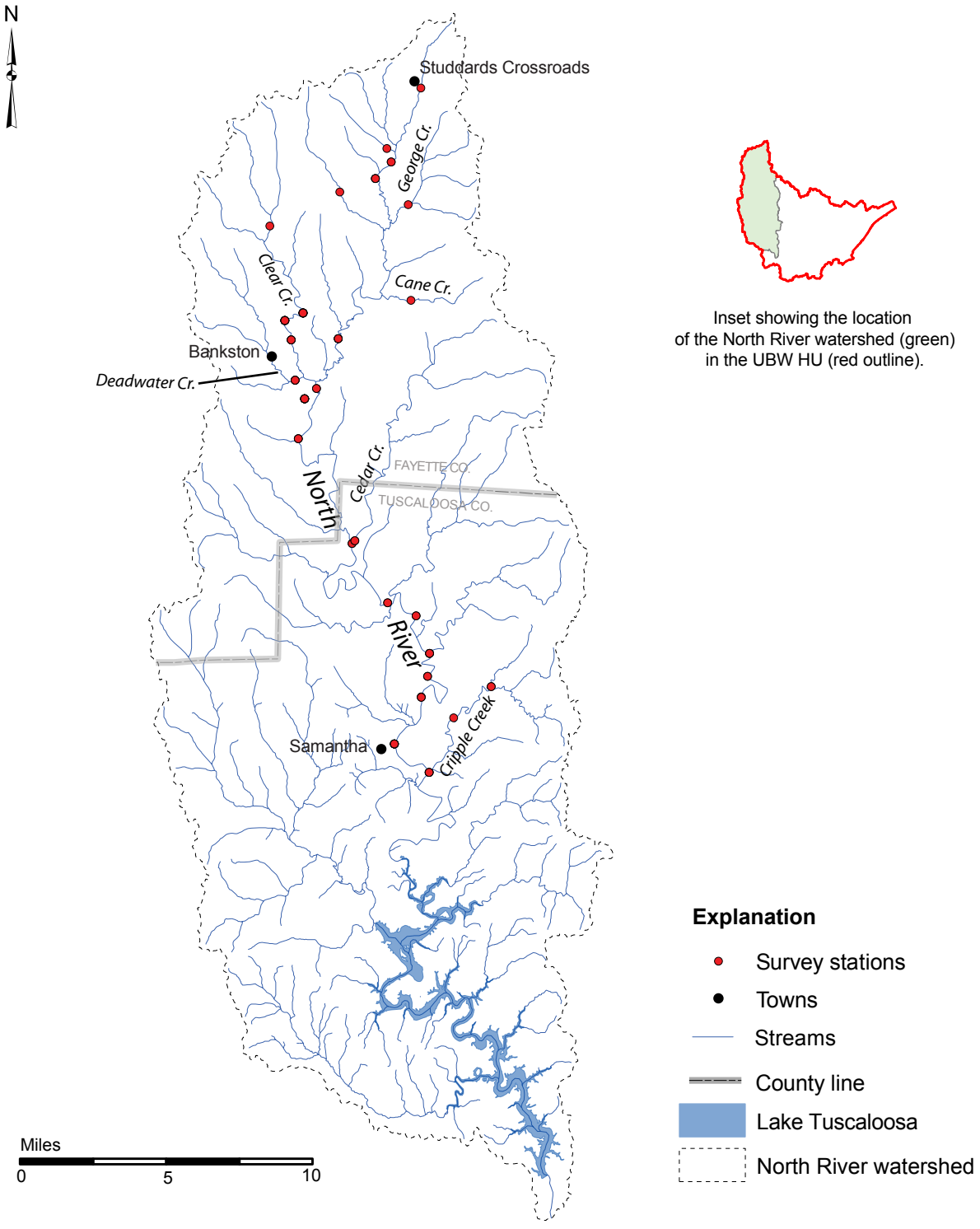

Figure 5. Map of mussel survey locations in the North River watershed of the UBW HU.

tributary stations. A cumulative total of 155 mussels either live, fresh dead, weathered dead, or relict, was collected, including 139 (90%) either live or fresh dead. A CPUE of 2.2 mussels per hour was determined for species collected either live or fresh dead. That project documented a significant decline in sensitive species in the North River system.

During a previous survey of the North River system mussels (McGregor and Pierson, 1999), 14 species were collected with 13 represented by live animals or fresh dead shells. A cumulative total of 224 mussels was found at 30 stations, with 196 (88%) either live or fresh dead. However, sampling effort was not reported for that study and no meaningful CPUE values for comparison can be calculated.

During the recent study (McGregor and Wynn, 2008) the most abundant species collected either live or fresh dead were *Elliptio arctata* (Delicate Spike) (34 individuals), *Strophitus subvexus* (22 individuals), *Lampsilis straminea* (20 individuals), and *Villosa lienosa* (14 individuals). The most widespread were *S. subvexus* (9 stations), *V. lienosa* (7 stations), and *L. straminea* and *Quadrula asperata* (5 stations each). During the previous study (McGregor and Pierson, 1999) dominant mussels collected were *S. subvexus* (60 individuals), *Quadrula asperata* (37 individuals), *L. straminea* (27 individuals), *Pleurobema furvum* (=*rubellum*) (26 individuals), and the Southern Rainbow, *Villosa vibex* (Southern Rainbow) (21 individuals). The most widespread were *S. subvexus* (23 stations), *V. vibex* (14 stations), and *L. straminea* (13 stations).

One federally listed endangered and one threatened species, *Pleurobema furvum* (=*rubellum*) and *Hamiota perovalis*, respectively, were collected live during sampling in the North River system from 1991 to 1996, and *P. furvum* was the fourth most abundant species among 14 species reported (table 5). However, only one live and one fresh dead specimen of *P. furvum* were found during the latter study (at one station in Clear Creek), suggesting a sharp decline in abundance. Similarly, *H. perovalis* was found at five stations in the earlier study (13 live or fresh dead) but at only three stations (two in Clear Creek and one in the main channel North River) during the latter study (3 live or fresh dead). *Ptychobranchus greenii* (Triangular Kidneyshell) was reported by van der Schalie (1981) to occur in the drainage prior to 1920 but was not collected in either recent survey, nor was *Pleurobema hagleri*, another species known from the drainage prior to 1920 which has not been reported in the scientific literature, technical reports, or museum collections in over 30 years and is considered extinct by the USFWS (Hartfield, 1994). As with *P. furvum*, Williams and others (2008) placed *P. hagleri* in the

synonymy of *Pleurobema rubellum*.

The reasons for the change in dominance and frequency between the studies cannot be determined with certainty, but several explanations are possible. These include changes in habitat quality and availability and in sample bias. During the earlier study (McGregor and Pierson, 1999) the most diverse and abundant locations were in the North River at the mouth of Cedar Creek, where 39 individuals among 8 species were collected, while during the latter study (McGregor and Wynn, 2008) only one weathered dead shell was found there. A nearby station in the North River just upstream of the Cedar Creek confluence and another in the lower reach of Cedar Creek were the next most diverse locations during the earlier study, each with 7 species, but no mussels were found in Cedar Creek during the latter study. The additional North River reach was not sampled. Sample bias could also account for the discrepancy in abundance and distribution. During the latter study numerous *Elliptio arctata* were found in Clear Creek in a unique niche preferred by that species, under large slab rocks, many of which were flipped over (19 were found under one rock). Since no discussion of sampling methodology was offered by McGregor and Pierson (1999), it is unknown if that sampling technique was employed, and it is possible that *E. arctata* may have been underrepresented. Another explanation for the decline is an extreme drought in the region in 2000, which was purported to be a primary cause of local decline of mussel diversity and abundance in streams in the Sipsey Fork (Haag and Warren, 2003; see following discussion of Sipsey Fork subwatershed for more details).

Two species collected during 2008 were not reported by McGregor and Pierson (1999)—*Anodontoides radiatus* and *Uniomerus tetralasmus*—and one species reported during the previous study, *Elliptio arca* (Alabama Spike), was not collected during the latter study. *Anodontoides radiatus* rather strongly resembles *Strophitus subvexus*, and distinguishing the two can be problematic. In the Mobile Basin, *A. radiatus* is widespread downstream of the Fall Line with some populations upstream of the Fall Line, while *S. subvexus* is now generally considered to be restricted to the Black Warrior and Tombigbee River drainages, usually downstream of the Fall Line, but with some populations upstream (Williams and others, 2008). It is possible that some individuals reported as *S. subvexus* in the previous study were misidentified. In the Mobile Basin *U. tetralasmus* is generally restricted to streams downstream of the Fall Line, with some records from the upper Coosa River system. It is found in headwater streams, ponds, and floodplain lakes, may be locally abundant, and can withstand extended periods of dewatering

(Williams and others, 2008). It may have been merely overlooked during the previous study. That collection represented a new tributary record for the species. *Elliptio arca* strongly resembles *Elliptio arctata,* and only one fresh dead and two weathered dead shells of *E. arca* were reported by McGregor and Pierson (1999) and these may have been misidentified. However, *E. arca* has been documented from the North River system (Williams and others, 2008) and their limited presence in the previous study and absence during the latter study may document a decline within the system, reflecting their rangewide decline.

A variety of human activities in the North River drainage have contributed to siltation of the main channel and tributaries. The substrate in pools and in some riffle areas was often dominated by a dense layer of coarse sand covered with a fine layer of silt. Live mussels were usually found in areas of slow to moderate current in relatively silt-free sand or gravel substrate.

LOCUST FORK HYDROLOGIC UNIT

During this study 43 stations were sampled in the Locust Fork HU, with 17 in the main channel and 26 in selected tributaries (table 1, fig. 6). A cumulative total of 16 species was collected with 9 represented by live animals or fresh dead shells, compared to 17 reported by Hartfield (1990) (total 24 between the two studies) (table 6). Nine species were common to both studies.

The lower reaches of the main channel of Locust Fork and the lower reach of its major tributary, Blackburn Fork, yielded the most diverse and abundant populations during this study, and most tributaries yielded few or no mussels. Hartfield (1990) reported 2 species live, 3 fresh dead, and 12 as weathered dead or relict shells from main channel Locust Fork stations, a single weathered dead shell of *Quadrula verrucosa* (Pistolgrip), in Gurley Creek, and a relict shell of *Lampsilis teres* (Yellow Sandshell) in Blackburn Fork. No mussels were found in the Locust Fork main channel upstream of the confluence of Blackburn Fork in either study. Extensive areas of bedrock and loose, unconsolidated substrate along with the effects of past mining and ongoing silvicultural, row crop, and poultry production activities likely restrict mussel abundance in the upper reaches of Locust Fork and tributaries. Species reported by Hartfield (1990) not found during the current study include *Elliptio arca*, *Elliptio crassidens* (Elephantear), *Fusconaia cerina, Ligumia recta* (Black Sandshell), *Megalonaias nervosa, Obovaria* sp., *Pleurobema furvum* (=*rubellum*), and *Quadrula rumphiana* (Ridged Mapleleaf). Six species reported during this study not reported by Hartfield (1990) include *Amblema plicata* (Threeridge), *Lampsilis*

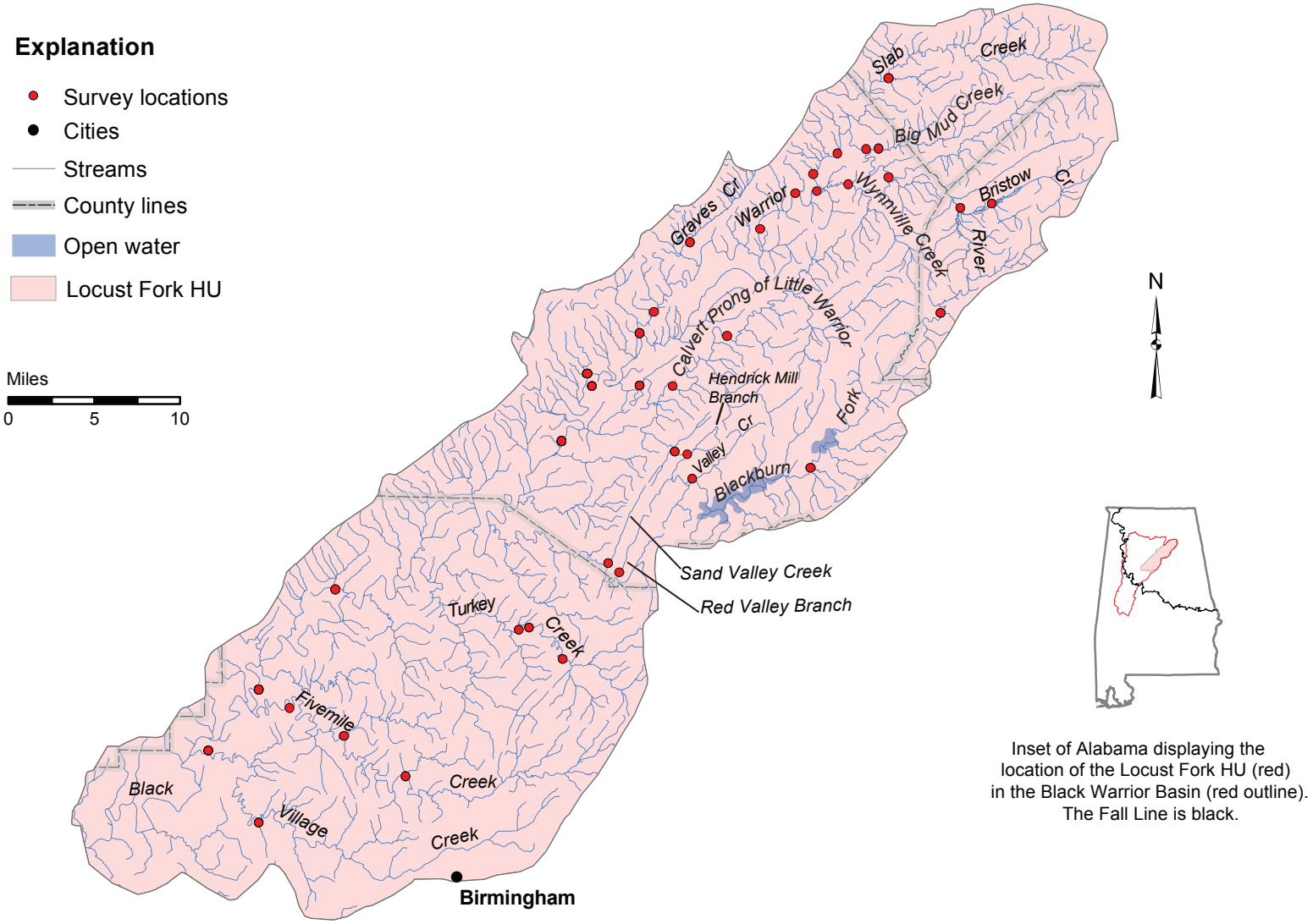

Figure 6. Map of mussel survey locations in the Locust Fork HU.

Table 6.—Comparison of freshwater mussel species in Locust Fork and tributaries reported by Hartfield (1990) and the current study.

Species	Status[1]	Conditions of species reported[2]	
		Hartfield (1990)	Current study
Amblema plicata, Threeridge	P5	--	W
Ellipsaria lineolata, Butterfly	P4	W	F
Elliptio arca, Alabama Spike	P5	W	--
Elliptio arctata, Delicate Spike	P1	W	W
Elliptio crassidens, Elephantear	P1	W	--
Fusconaia cerina, Gulf Pigtoe	P5	W	--
Lampsilis ornata, Southern Pocketbook	P4	L	L
Lampsilis straminea, Southern Fatmucket	P4	--	W
Lampsilis teres, Yellow Sandshell	P5	W	L
Lasmigona alabamensis, Alabama Heelsplitter	P3	W	F
Leptodea fragilis, Fragile Papershell	P5	L	F
Ligumia recta, Black Sandshell	P4	W	--
Megalonaias nervosa, Washboard	P5	W	--
Obliquaria reflexa, Threehorn Wartyback	P5	--	L
Obovaria sp.	--	W	--
Pleurobema furvum, Dark Pigtoe	P5	W	--
Potamilus purpuratus, Bleufer	P5	F	L
Pyganodon grandis, Giant Floater	P5	--	W
Quadrula asperata, Alabama Orb	P5	W	L
Quadrula rumphiana, Ridged Mapleleaf	P4	F	--
Quadrula verrucosa, Pistolgrip	P4	F	L
Villosa lienosa, Little Spectaclecase	P5	--	W
Villosa nebulosa, Alabama Rainbow	P3	--	W
Villosa vibex, Southern Rainbow	P5	--	W

[1] Alabama priority conservation ranks follow Mirarchi (2004):P1=Highest Conservation Concern, P3=Moderate Conservation Concern, P4=Low Conservation Concern, P5=Lowest Conservation Concern.

[2]F=fresh dead shells, L=live animals, W=weathered dead or relict shells, --=not collected.

straminea; *Obliquaria reflexa*; *Pyganodon grandis* (Giant Floater); *Villosa lienosa*; *Villosa nebulosa*; and *Villosa vibex*, all of which are common and widespread species with Low to Lowest Conservation Priority in Alabama. Additionally, a single fresh dead specimen of *Ptychobranchus greenii* was collected in the main channel Locust Fork by GSA personnel in the mid-90s during an unrelated project.

MULBERRY FORK HYDROLOGIC UNIT

A total of 20 stations were sampled in the Mulberry Fork HU during this survey, with 6 in the flowing portion of the main channel and the remainder in tributaries (tables 1, 3; fig. 7). Neither live animals nor dead shells were collected at any station. Hartfield (1990) sampled 11 stations on the Mulberry Fork proper and 15 stations among 6 tributaries. He reported one live *Obliquaria reflexa* and a few fresh and weathered dead shells of several common species using SCUBA gear at the lowermost sampling station on Mulberry Fork, in the upper reach of Bankhead Reservoir. None were found anywhere else in the Mulberry Fork proper. Among tributary stations he reported one fresh dead *Leptodea fragilis* (Fragile Papershell) and fresh dead *Elliptio arctata* and *Villosa vibex* among a few tributaries. He reported that streams in the Mulberry Fork system often appeared stable, with riffle/shallow pool sequences, moderate to swift currents, boulder/cobble/gravel substrates with sand and silt more common downstream, and with algal growth prominent. The same conditions were commonly encountered during the present study, suggesting that water quality may be the limiting factor in mussel distribution and abundance there.

SIPSEY FORK HYDROLOGIC UNIT

The upper reach of the Sipsey Fork has long been isolated from the rest of the Black Warrior River system by Lewis Smith Reservoir, and the major tributaries within the upper Sipsey Fork are also isolated from one another by the reservoir. Historically the upper Sipsey Fork HU has a much more diverse and abundant mussel fauna than other tributary systems likely due, at least in part, to the presence of Bankhead National Forest (Forest), which, along with its state forest predecessors, has protected a significant portion of the watershed to varying degrees since 1918.

During this study 29 stations were qualitatively sampled in the Sipsey Fork system, including 28 of the 38 stations sampled within and near the Forest in 1992 (McGregor, 1992), all in wadeable streams (table 1, fig. 8). Many of the more remote stations sampled in 1992, those

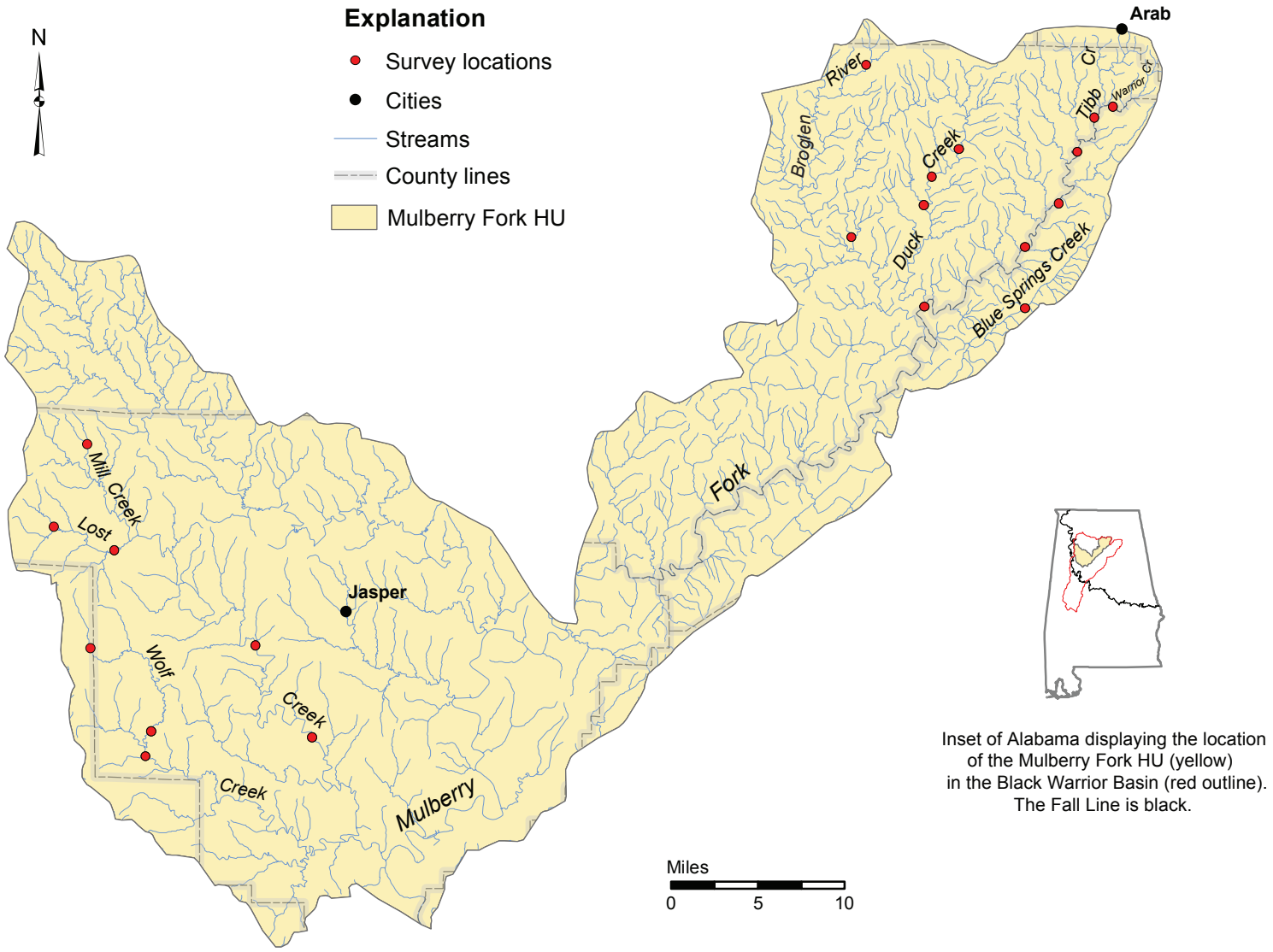

Figure 7. Map of mussel survey locations in the Mulberry Fork HU.

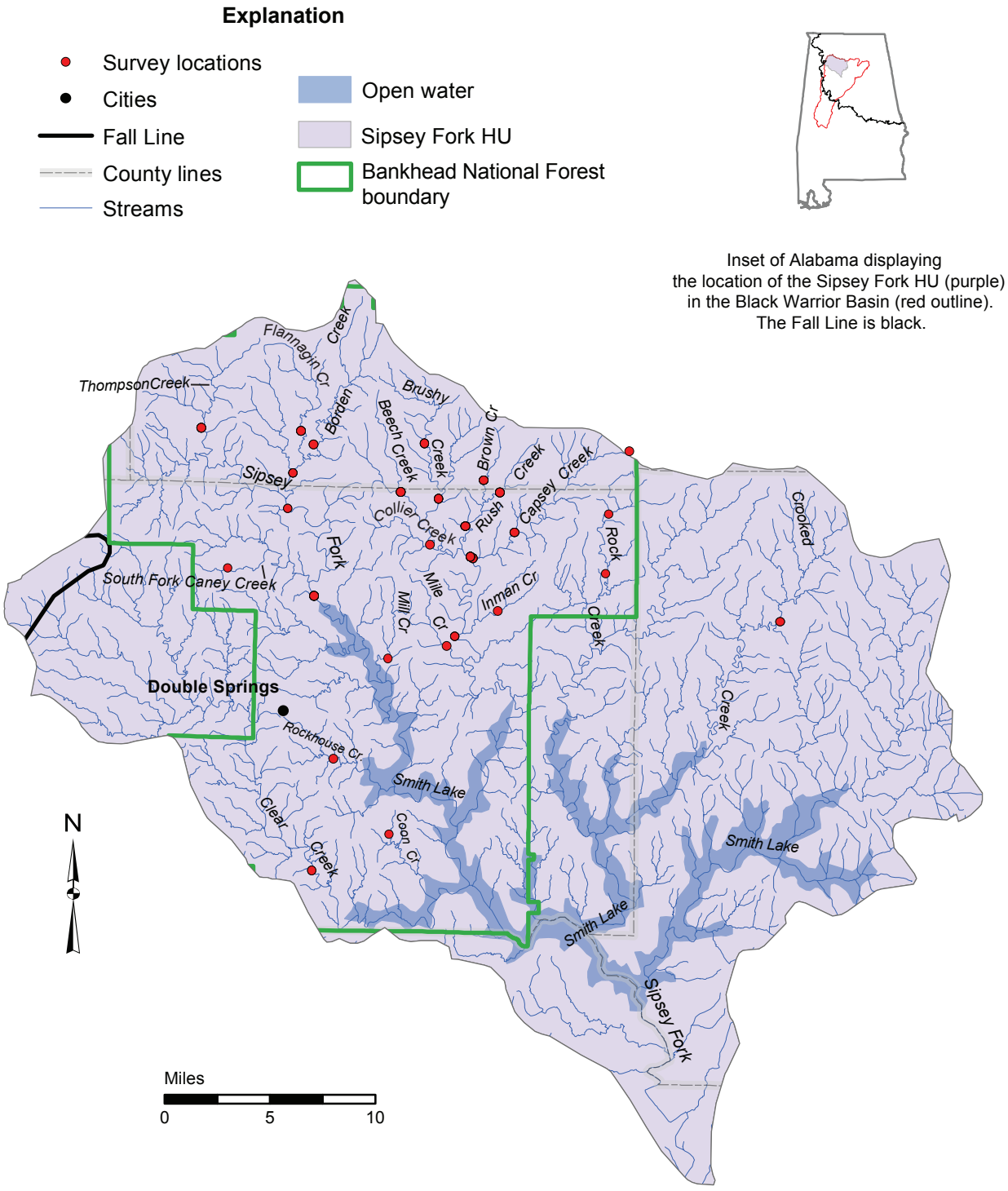

Figure 8. Map of mussel survey locations in the Sipsey Fork HU.

accessed by foot via horse trails or via forest roads behind locked gates maintained by the U.S. Forest Service, are no longer easily accessible due to shifts in forestry management practices (no longer maintaining roads or by abandoning horse trails) and as a result of downed timber from recent tornados. Access to those streams is now problematic and time consuming, and time and resource constraints led us to bypass them.

During the previous study (McGregor, 1992) a cumulative total of 14 species were recorded during qualitative sampling, all represented by at least one live animal (table 7). Among those species a total of 892 live animals or fresh dead shells were recorded and a total of about 130 person hours were expended at 38 stations, for an average of about 3.4 person hours/station. The most frequently encountered and relatively abundant species recorded as live animals and/or fresh dead shells were *Hamiota perovalis* (20 stations, 48%), *Strophitus subvexus* (13 stations, 20%), *Villosa vibex* (18 stations, 16%) and *Villosa lienosa* (14 stations, 13%). Haag and Warren (2003) reported *H. perovalis* and *V. nebulosa* to be the most abundant species from quantitative sampling at five stations within the Forest in 2002.

Qualitative sampling in the Sipsey Fork system during this study yielded 11 species, with 9 represented by live animals or fresh dead shells (tables 3, 7). A total of 249 mussels were found live and/or fresh dead. About 75 person hours were spent sampling among 29 stations, for an average of about 2.5 person hours/station. The most commonly encountered and relatively abundant species encountered were the same as during the previous study, but with some modest shifts. The most common was, again, *Hamiota perovalis* (11 stations, 40%), followed by *Villosa vibex* (7 stations, 20%), *Villosa lienosa* (9 stations, 16%), and *Strophitus subvexus* (8 stations, 35%). A comparison of the results between those studies indicate that, while the fauna in the Sipsey Fork still contains almost all species found in 1992, those that remain are often absent from streams where they were previously found, and, when present, their numbers are diminished and some are represented only by dead shells.

A prime example of the documented decline in abundance and diversity in the Forest mussel fauna includes a comparison of qualitative sampling results in the Sipsey Fork at the low water bridge just upstream of Alabama Highway 33. In 1992, 23 live individuals among 10 species were collected there, with each species represented by at least one live animal. During this study, only nine live individuals among six species were found there, and only five species were represented by live animals. Another significant example is Flannagin Creek at Forest

Table 7.—Summary of mussel species known from streams draining Bankhead National Forest, including a comparison of the results of surveys in 1992 and 2012[1].

SPECIES	1992[2]	2012
Elliptio arca	X	--
Elliptio arctata	X	WD
Hamiota perovalis	X	X
Lampsilis ornata	X	--
Lampsilis straminea	X	X
Medionidus acutissimus	X	X
Pleurobema rubellum	X	X
Ptychobranchus greenii	X	X
Pyganodon grandis	I	I
Quadrula asperata	X	--
Quadrula verrucosa	X	WD
Strophitus subvexus	X	X
Toxolasma corvunculus	I	I
Utterbackia imbecillis	I	I
Villosa lienosa	X	X
V. nebulosa	X	X
V. vibex	X	X

1-based on McGregor (1992) and the current study (2012), plus independent collections.
2-X= live animals and fresh dead shells recorded; WD= weathered dead or relict shells only; --= not reported; I=independently verified during unrelated studies.

Service Road 208. During qualitative sampling in 1992 (McGregor, 1992), 164 live mussels among eight species were collected, and all were represented by at least one live individual. Subsequent quantitative sampling at that station in 1993 and 2002 by Haag and Warren (2003) reported a sharp decline in species richness, from seven species live in 1993 to four species live in 2002, and in relative abundance, with only one species found live in 2002 more abundant than in 1993, and then only slightly. No mussels, not even dead shells, were found at this station during the current study.

The wholesale reduction in diversity and relative abundance of mussels documented across all streams in the Forest over the past two decades can be attributed, at least in part, to a series of severe droughts, including an exceptionally severe drought in 2000. During that drought the longest period of sustained low flows in 37 years of record was documented. Streams that normally flow year round were dewatered for extended periods of time, leading to stress and death of mussels and perhaps shifts in the abundance and distribution of the potential host fish population (Haag and Warren, 2003). Especially hard hit was Flannagin Creek, which is underlain by porous and soluble limestone of the Bangor Formation, versus other streams underlain by shales and sandstones of the Parkwood Formation, which apparently has better water retention qualities and allowed streams to maintain at least some water in pools and interstitially in runs and riffles (Haag and Warren, 2003). Borden Creek, of which Flannagin Creek is a tributary, likely occupies the same geologic setting and suffered the same reduction in water level as Flannagin Creek, having lost from 10 species (8 live) in 1992 to 0 species during the current study.

Species reported during the previous study (McGregor, 1992) not found during this study were *Quadrula asperata* (five live animals among three stations), *Elliptio arca* (one live animal and one fresh dead shell from two stations in the main channel Sipsey Fork), and *Lampsilis ornata* (Southern Pocketbook) (one live animal from the lower end of Brushy Creek, not far upstream of the influence of Lewis Smith Reservoir). *Elliptio arca* is generally known from larger streams, is rapidly declining rangewide, and now is likely restricted to the Sipsey River in the Tombigbee River drainage (Mirarchi and others, 2004). *Quadrula asperata* and *L. ornata* are generally found in larger streams also and were restricted to the main channel Sipsey Fork and the lower reaches of a few larger tributaries. They may persist further downstream in appropriate habitat and could repopulate the project area if conditions were to improve. During a

contemporaneous but unrelated study in the Forest, two additional species, *Pyganodon grandis* and *Utterbackia imbecillis* (Paper Pondhshell), were commonly collected live in the lower reach of Sipsey Fork and in some impounded tributaries where the streams commingle with Lewis Smith Reservoir (Wendell Haag and John Moran, U.S. Forest Service, pers. comm., 9/25/12). Both species are typical of impounded waters with soft substrates. Haag and Warren (2003) also reported a single live *Toxolasma corvunculus* (Southern Purple Lilliput), collected in 2002 from Sipsey Fork that was collected neither before nor since, bringing the cumulative total of mussel species known historically from the Sipsey Fork to 17, with probably 13 extant.

SPECIES ACCOUNTS

Amblema plicata, Threeridge, P4, is a widespread and common species in the Tennessee River system, the western and lower Mobile River Basin, and some coastal river systems, and can be found in riverine or impounded areas. It is declining in the Mobile River Basin. It was found as weathered dead material at two main channel Locust Fork stations and the lowermost North River station.

Anodonta suborbiculata, Flat Floater, P4, is widespread in the Tennessee River system with localized populations in Mobile River Basin impoundments and is usually found in soft sediments in sluggish water. It may be a relatively recent invader of the Mobile River Basin. Two live animals were found in the upper reach of Holt Reservoir, representing the first main channel Black Warrior River record for this species.

Anodontoides radiatus, Rayed Creekshell, P2, occurs mostly on the Coastal Plain from Louisiana and Mississippi to Florida and Georgia and is usually found in small to medium-sized streams in sand or silt substrate and moderate flow. Live animals were found in typical habitat in Fivemile and Bucks Creeks on the Coastal Plain downstream of Tuscaloosa and at three stations in the North River system.

Arcidens confragosus, Rock Pocketbook, P3, is fairly common in some areas of the Tennessee River system but is declining in the Mobile River Basin and can be found in either riverine or impounded areas. Two live individuals were found in the Oliver Pool.

Ellipsaria lineolata, Butterfly, P4, is common and widespread in the Tennessee River system and Mobile River Basin, usually in riverine habitats. Fresh dead shells were found in Locust Fork.

Elliptio arca, Alabama Spike, P1, was historically widespread in the Mobile River Basin but is now restricted to a few disjunct populations, more significantly the Sipsey River and Yellow Creek in the Tombigbee River system. It was found in the Sipsey Fork and North River in the past 20 years, but not during recent surveys.

Elliptio arctata, Delicate Spike, P1, is widespread but never common in the Mobile River Basin, is declining, and is almost always found in riverine habitats, often under large rocks. Weathered dead valves were found in the Locust Fork main channel, Sipsey Fork main channel, and its tributary Capsey Creek. Numerous live individuals were found in a short reach of stable habitat in Clear Creek in the North River system.

Fusconaia cerina, Gulf Pigtoe, P5, is endemic to the Mobile River Basin and is common throughout, usually found in streams with at least moderate current. It was found live and fresh dead in Big Brush and Fivemile Creeks and weathered dead in Limestone Creek, all on the Coastal Plain downstream of Tuscaloosa.

Hamiota perovalis, Orangenacre Mucket, P2, is a federally listed threatened species endemic to the western Mobile River Basin, usually in stable gravel/sand substrates in streams with at least moderate current. It was found live at two stations in Fivemile Creek on the Coastal Plain downstream of Tuscaloosa, live at two stations in Clear Creek and fresh dead at one station in the North River system, and live or fresh dead in several Sipsey Fork main channel stations and Brown, Brushy, Capsey, and Rush Creeks, fresh dead in Beech and Flannagin Creeks, and relict in Borden Creek. In 1992 it was found at 20 stations in the Sipsey Fork system (McGregor, 1992).

Lampsilis ornata, Southern Pocketbook, P4, is widespread and common in the Mobile River Basin and sporadically in the Conecuh River drainage and can occupy a variety of habitats. Live animals were found in Big Brush Creek on the Coastal Plain downstream of Tuscaloosa, fresh dead in North River and its tributary Clear Creek, live in Locust Fork and its tributary Blackburn Fork, and live in Brushy and Rush Creeks, fresh dead in Beech and Capsey Creeks, and relict in Thompson Creek in the Sipsey Fork.

Lampsilis straminea, Southern Fatmucket, P4, is fairly common and widespread in Alabama south of the Tennessee River system and is often found in slow to moderate current, but generally not in impoundments. A relict shell was found in Turkey Creek in the Locust Fork system and it was commonly found live in tributaries on the Coastal Plain downstream of

Tuscaloosa, live in Clear and Deadwater Creeks in the North River system, and live in Brushy and Rush Creeks, fresh dead in Beech and Capsey Creeks, and relict in Thompson Creek in the Sipsey Fork.

Lampsilis teres, Yellow Sandshell, P5, is common throughout Alabama and may be found in gravel, sand, or mud substrates in riverine or impounded habitats. It was frequently encountered in the Black Warrior main channel and Locust Fork and its tributary Village Creek, and single live animals were found in Big Brush Creek on the Coastal Plain downstream of Tuscaloosa and in Clear Creek in the North River system.

Lasmigona alabamensis, Alabama Heelsplitter, P3, is restricted to the Mobile River Basin and is uncommon and may be found in riverine or pooled habitats. It was found live at numerous stations in the main channel Black Warrior River and fresh dead at several stations in Locust Fork and one station in Village Creek. Hartfield (1990) reported weathered dead or relict shells from Locust Fork.

Leptodea fragilis, Fragile Papershell, P5, is a common and widespread species in the Tennessee River system and Mobile River Basin and can be found in riverine habitats and impoundments. It was frequently encountered live in the main channel Black Warrior and as weathered dead valves in Locust Fork and Village Creek. Hartfield (1990) reported a live individual from Locust Fork.

Medionidus acutissimus, Alabama Moccasinshell, P2, a federally listed threatened species, was found live in Rush Creek and fresh dead in Brown and Brushy Creeks in the Sipsey Fork system. The Brushy Creek locality was a new record for the station. It was collected live at six stations and fresh dead at two additional stations in the Sipsey Fork in 1992 (McGregor, 1992).

Megalonaias nervosa, Washboard, P5, is common and widespread throughout Alabama except the Choctawhatchee and Yellow River systems, and can be found in riverine habitats and impoundments. It was found live at a few stations in the upper reach of Holt Pool and weathered dead in Little Prairie Creek on the Coastal Plain downstream of Tuscaloosa. Hartfield (1990) reported weathered dead or relict shells from Locust Fork.

Obliquaria reflexa, Threehorn Wartyback, P5, is common throughout the Tennessee River system and Mobile River Basin, and can be found in riverine habitats and impoundments.

It was frequently encountered at main channel Black Warrior River stations and was the third most frequently collected species there. A few live animals were found in Locust Fork.

Plectomerus dombeyanus, Bankclimber, P5, is common in the Alabama and lower Tombigbee River drainages and lower reaches of Coosa and Cahaba Rivers, and occurs in both sluggish and flowing water, often on channel slopes. It was the most commonly encountered and numerically abundant species found in the main channel Black Warrior River.

Pleurobema rubellum, Warrior Pigtoe, has not been found outside of the Sipsey Fork and North River systems in the past 20 years (McGregor, 1992; McGregor and Pierson, 1999; McGregor and Wynn, 2008; O'Neil and others, 2011). During this project it was found live in Sipsey Fork, Brushy, and Rush Creeks, and one very old shell resembling this species was found in Davis Creek near Tuscaloosa. McGregor and Wynn (2008) recently reported a single live animal and a few fresh dead shells in Clear Creek in the North River system.

Potamilus inflatus, Inflated Heelsplitter, P2, a federally listed threatened species, is uncommon, restricted to the Mobile River Basin, and is usually found in soft substrates in slow to moderate current. Four live individuals were collected in the Black Warrior River: three in the tailwater of Oliver Dam and one in the Oliver Pool near Tuscaloosa.

Potamilus purpuratus, Bleufer, P5, is widespread and common in the Mobile River Basin and is found in both pools and shoals, often under large rocks in shoals. It was frequently found live in main channel Black Warrior River stations and occasionally among several Locust Fork stations (including 25 live animals at the most downstream station in Blackburn Fork) as well as weathered dead in Big Prairie Creek on the Coastal Plain downstream of Tuscaloosa.

Ptychobranchus greenii, Triangular Kidneyshell, P1, a federally listed endangered species, was found live in the Sipsey Fork, Brushy, Capsey, and Rush Creeks. In 1992 it was found live or fresh dead at nine stations and was the dominant species in Borden Creek near Bunyan Hill Cemetery (one of nine species, it represented 43% of the total). Only weathered dead and relict shells of three species were found at that station during this project.

Pyganodon grandis, Giant Floater, P5, is common throughout Alabama and occurs in practically any habitat including farm ponds. Live animals were found at several stations in the main channel Black Warrior River and in the lower Sipsey Fork in the transition zone to Lewis Smith Reservoir, and weathered dead shells were found in the Locust Fork tributary Village Creek and in Boone Creek in the North River system.

Quadrula apiculata, Southern Mapleleaf, P5, is common and was formerly restricted to the Mobile River Basin but has been introduced into the Tennessee River, likely by mussel divers, and can be found in riverine and impounded reaches. It was the second most commonly encountered and numerically abundant species found among main channel Black Warrior River stations, and a weathered dead shell was found in Little Prairie Creek on the Coastal Plain downstream of Tuscaloosa.

Quadrula asperata, Alabama Orb, P5, is common and endemic to the Mobile River Basin, usually in habitats with at least some current. Oddly, only one live individual of this common and widespread Mobile River Basin endemic was found in the Oliver Pool of the Black Warrior River. Live animals were found at two stations in Locust Fork, in Big Brush and Fivemile Creeks on the Coastal Plain downstream of Tuscaloosa, and in Clear Creek and North River, and weathered dead valves were found in Davis Creek near Tuscaloosa.

Quadrula rumphiana, Ridged Mapleleaf, P4, is endemic to the Mobile River Basin and fairly common, usually in habitats with at least some current. It was commonly encountered in main channel Black Warrior River stations, especially in the Holt Pool, but not in tributaries. Hartfield (1990) reported fresh dead shells from Locust Fork.

Quadrula verrucosa, Pistolgrip, P4, is fairly common and widespread in the Tennessee River system and Mobile River Basin, usually in streams with at least some current but occasionally in impoundments. Live animals were found in lower Blackburn Fork and at several stations in Locust Fork downstream of the mouth of Blackburn Fork. Fresh dead shells were found at one station in North River, and weathered dead shells were found in Brushy Creek in the Sipsey Fork system.

Strophitus subvexus, Southern Creekmussel, P3, is found throughout Alabama south of the Tennessee River system but is uncommon and is often found in sluggish streams. Live animals were found in Big Brush Creek on the Coastal Plain downstream of Tuscaloosa, at several stations in Clear Creek and North River, and a relict valve was found in Blue Creek just upstream of Tuscaloosa. Live animals were found in Sipsey Fork, Beech, Brushy, Capsey, and Rush Creeks, and an intact weathered dead shell in Crooked Creek, another Sipsey Fork tributary outside Bankhead National Forest.

Toxolasma parvum, Lilliput, P3, is known from the Tennessee River system, Mobile River Basin, and Gulf Coast drainages, and often occupies soft sediments in sluggish water. It is

poorly known and further taxonomic work may lead to generic revision and further restrict its distribution. A single live individual was found in the Holt Pool of the Black Warrior River upstream of Tuscaloosa; a live animal was also found in Big Brush Creek and weathered dead shells were found in Whitsitt and Big German Creeks, all on the Coastal Plain downstream of Tuscaloosa.

Uniomerus tetralasmus, Pondhorn, P4, is common across the Gulf Coast and Mobile River Basin, often in areas with little or no current, including intermittent ponds and streams. It was found live in North River and in Fivemile Creek on the Coastal Plain downstream of Tuscaloosa. It was also found as fresh or weathered dead shells in Little Prairie, Big German, Limestone, and Stephens Creeks on the Coastal Plain downstream of Tuscaloosa.

Utterbackia imbecillis, Paper Pondshell, P5, is common throughout Alabama and occurs in practically any habitat including farm ponds. A few live and fresh dead individuals were found in the main channel Black Warrior River and in the lower Sipsey Fork in the transition zone to Lewis Smith Reservoir, and weathered dead shells were found in Big German and Whitsitt Creeks on the Coastal Plain downstream of Tuscaloosa.

Villosa lienosa, Little Spectaclecase, P5, is common throughout Alabama south of the Tennessee River system and can occur in a variety of habitats. One fresh dead and a few weathered dead shells were found in Blue Creek upstream of Tuscaloosa, a weathered dead shell was found in Sand Valley Creek in the Locust Fork system, and numerous live animals and fresh and weathered dead shells were found in tributaries on the Coastal Plain downstream of Tuscaloosa and at several stations in the North River system. Live and fresh dead shells were also found with some frequency in the Sipsey Fork, Beech, Brown, Brushy, Rush, and Thompson Creeks, and weathered dead in Borden and Flannagin Creeks.

Villosa nebulosa, Alabama Rainbow, P3, is occasionally found in the Mobile River Basin upstream of the Fall Line, usually in small stream environments. Two fresh dead shells were found in Blue Creek and two weathered dead shells in Blackburn Fork, and live animals were found in Capsey and Rush Creeks and weathered dead shells in Borden and Flannagin Creeks in the Sipsey Fork system.

Villosa vibex, Southern Rainbow, P5, is common throughout Alabama south of the Tennessee River system in a variety of habitats. Live animals were found at several stations in Clear Creek and North River, and fresh dead shells were found in Fivemile Creek on the Coastal

Plain downstream of Tuscaloosa. Relict shells were found in Blackburn Fork. Live animals were found in Brown, Brushy, Capsey, and Rush Creeks and fresh dead shells in Beech Creek in the Sipsey Fork system.

SUMMARY AND RECOMMENDATIONS

Qualitative sampling for mussels in the main channel Black Warrior River and in selected tributaries over the past four years, using appropriate sampling techniques for conditions encountered, yielded records of 38 of 51 species known from the system, with 36 represented by live animals and/or fresh dead shells. In the main channel 16 species were documented, all represented by live animals, including a few individuals of the federally listed threatened Inflated Heelsplitter, *Potamilus inflatus,* and the first main channel Black Warrior River record of the Flat Floater, *Anodonta suborbiculata*, which was found in the Holt Pool. Habitat quality in the river deteriorates with downstream progression onto the Coastal Plain from Oliver Lock and Dam, but areas of stable gravel and sand do yield mussels, especially in the Oliver and Holt Pools at and upstream of Tuscaloosa.

Among tributaries, collections were made at selected stations and comparisons made to recent historic collection records when possible. Among those tributary stations a cumulative total of 28 species was documented, with 26 represented by live animals and/or fresh dead shells. Some relatively diverse and robust populations were found in some Coastal Plain tributaries downstream of Tuscaloosa, especially in Hale County, probably due to the rural setting and correspondingly minor stressors present there. The upper Sipsey Fork (upstream of Lewis Smith Reservoir) continues to harbor the most significant mussel fauna among Black Warrior River tributaries, but its relative abundance has been severely affected, at least partly, by the effects of a severe drought in 2000. The North River, near Tuscaloosa, has the next most valuable fauna within the system but has seen a decline in abundance commensurate with that in the Sipsey Fork. These two systems harbor the final populations of several sensitive species, and special care needs to be taken to protect those elements. Mulberry Fork, Locust Fork, and direct tributaries to the Black Warrior upstream of Tuscaloosa generally yielded few to no mussels, and none considered rare.

While no effort to document or quantify potential stressors to the mussel fauna were attempted as part of this project, some outside efforts have been made recently to document

sources of impairment in the Black Warrior River system using a variety of analytical tools. O'Neil and Shepard (2000), using the Index of Biotic Integrity (IBI) determined that 55 percent of the stations sampled in the Black Warrior River system ranked Poor to Fair, and the remaining 45 percent ranked Fair or better. O'Neil and Shepard (2003) analyzed 64 water quality parameters at 27 stations in the Locust Fork system during the severe drought of 2000, including physical characteristics, nutrients, inorganic substances, trace metals, selected pesticides, and selected biological characteristics. They found that eutrophication was active, with four stations ranked as eutrophic and one hypereutrophic. Thick mats of algae and elevated turbidity from phytoplankton blooms were common and elevated levels of dissolved solids were found in some tributaries and attributed to mine drainage and the discharge of permitted waste waters. Shepard and others (2004) performed fish IBIs and habitat evaluations at 55 stations in the Locust Fork system and found that overall 25 ranked Poor and Very Poor, 27 ranked Fair, and only 3 ranked Good. O'Neil and others (2011) summarized historical and recent biological, chemical, and physical conditions in the North River watershed and reported that conditions in many parts of the watershed are of diminished quality. Fish IBIs were performed at 21 stations and 15 ranked Poor to Fair, 5 Good, and only 1 Excellent. They also reported that levels of *E. coli* are elevated in many parts of the watershed due to cattle access to streams and poor handling of poultry waste; Lake Tuscaloosa, once an oligotrophic lake, is rapidly seeing algal blooms; water quality impairment in some reaches of the system attributable to coal surface mining is in evidence; and bed sediment loads in many reaches are elevated.

Based on the results of this study suggesting a recent decline in mussel distribution and abundance among the last remaining high quality subwatersheds left in the Black Warrior River system, and on outside documentation of declining habitat quality in the Black Warrior River system, we make the following recommendations:

- Quantitative sampling of the mussel fauna at selected stations should be executed to establish empirical baseline conditions for the mussel fauna in the system. This should include not only streams with currently healthy mussel populations, but also some with documented diminished populations in order to accurately assess recovery.

- Factors that influence mussel distribution and abundance should be evaluated by such means as land cover/land use determinations, water and sediment quality measurements, and evaluation of rates of sediment loading.
- Upon determination of the factors limiting the fauna, steps should be taken to ameliorate those factors (for example, implementation of Best Management Practices such as restoration of streamside cover, upgrading waste and stormwater effluents, upgrading of unpaved roads etc.).
- Periodic monitoring of selected stations should be executed to document temporal and spatial recovery.

REFERENCES CITED

Haag, W. R., and Warren, M. L, 2003, Changes in freshwater mussel populations in Bankhead National Forest from 1993-2002: Oxford, Mississippi, U.S.D.A. Forest Service, Center for Aquatic Technology Transfer, unpublished report, 24 p.

Hartfield, Paul, 1990, Status survey for mussels in the tributaries of the Black Warrior River, Alabama, 1990: Unpublished report from U.S. Fish and Wildlife Service, Jackson, Mississippi, 8 p.

Hartfield, Paul, 1994, Status review of select mussel species in the Mobile River basin: U.S. Fish and Wildlife Service, Jackson, Mississippi, 3 p.

Hinkley, A. A., 1906, Some shells from Mississippi and Alabama: The Nautilus, v. 20, nos. 3, 4, and 5, p. 34-36, 40-44, and 52-55.

McGregor, S. W., 1992, A mussel survey of the streams draining Bankhead National Forest and the Oakmulgee Division of Talladega National Forest, Alabama: U.S. Department of Agriculture Forest Service, Montgomery, Alabama, unpublished report, 93 p.

McGregor, S.W., and Pierson, J.M., 1999, Recent freshwater mussel records from the North River System, Fayette and Tuscaloosa Counties, Alabama: Journal of the Alabama Academy of Science v. 70, no. 4, p. 215-237.

McGregor, S. W., and Wynn, E. A., 2008, An evaluation of the mussel fauna in the North River system, 2008: Geological Survey of Alabama Open-file Report 0814, 21 p.

Mettee, M. F., O'Neil, P. E., and Pierson, J. M., 1996, Fishes of Alabama and the Mobile basin including Mobile basin tributaries in adjacent states: Oxmoor House, Birmingham, Alabama, 820 p.

Mirarchi, R. E., Garner, J. T., Mettee, M. F., and O'Neil, P. E., eds., 2004, Alabama wildlife, Volume 2, Imperiled aquatic mollusks and fishes: Tuscaloosa, the University of Alabama Press, 255 p.

Mott, Seth, and Hartfield, Paul, 1994, Status review summary of the Alabama pearlshell, *Margaritifera marrianae*: U.S. Fish and Wildlife Service, Jackson, Mississippi, 6 p.

O'Neil, P.E., McGregor, S. W., and Wynn, E. A., 2008, Critical habitat units for threatened and endangered mussels in the Mobile River Basin: Geological Survey of Alabama Special Map 247.

O'Neil, P.E., McGregor, S. W., and Wynn, E. A., 2011, Watershed assessment of the North River System for recovery and restoration of rare mussel species: Geological Survey of Alabama Bulletin 183, 65 p.

O'Neil, P. E., and Shepard. T. E., 2000, Application of the index of biotic integrity for assessing biological condition of wadeable streams in the Black Warrior River system, Alabama: Alabama Geological Survey Bulletin 169, 71 p.

O'Neil, P. E., and Shepard, T. E., 2003, Water-quality assessment of the Locust Fork watershed, Alabama: Alabama Geological Survey Bulletin 172, 60 p.

Shepard, T. E., O'Neil, P. E., McGregor, S. W., and Mettee, M. F., 2004, Biomonitoring in the Locust Fork watershed, Alabama, 1997-98: Alabama Geological Survey Bulletin 175, 61 p.

Strayer, D. L., and Smith, D. R., 2003, A guide to sampling freshwater mussel populations: Bethesda, Maryland, American Fisheries Society, Monograph 8, 103 p.

USGS, http://nhd.usgs.gov/wbd.html, accessed 12/3/12.

Williams, J. D., 1982, Distribution and habitat observations of selected Mobile basin unionid mollusks, *in* Miller, A. C., ed., Report of freshwater mollusks workshop: Vicksburg, Mississippi, U.S. Army Corps of Engineers, Waterways Experiment Station, p. 61-85.

Williams, J.D., Bogan, A.E., and Garner, J.T., 2008, Freshwater mussels of Alabama and the Mobile basin in Georgia, Mississippi, and Tennessee: The University of Alabama Press, Tuscaloosa, 908 p.

Williams, J. D., Fuller, S. L., and Grace, Randall, 1992, Effects of impoundments on freshwater mussels (Mollusca: Bivalvia: Unionidae) in the main channel of the Black Warrior and Tombigbee Rivers in western Alabama: Bulletin of the Alabama Museum of Natural History, v. 13, p. 1-10.

Wynn, E. A., O'Neil, P. E., McGregor, S. W., Powell, J. R., Pritchett, J. M., Ford, A. D., and Johnson, P. D., 2012, Strategic habitat and river reach units for aquatic species of conservation concern in Alabama: Geological Survey of Alabama Special Map 248.

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