GEOLOGICAL SURVEY OF ALABAMA

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AN ASSESSMENT OF FRESHWATER MOLLUSKS AND CRAYFISH FROM SELECTED WATERBODIES ON AND NEAR REDSTONE ARSENAL, MADISON COUNTY, ALABAMA, 2008-09

OPEN-FILE REPORT 0922

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Prepared in cooperation with
U. S. Army, Redstone Arsenal
Environmental and Cultural Resources Directorate
Under Contract No. W9124P-08-P-0094

Tuscaloosa, Alabama
2009

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ABSTRACT

Sampling for freshwater mollusks and crayfish was conducted in springs, streams, swamps, and roadside ditches on and near Redstone Arsenal by the Geological Survey of Alabama in 2008 and 2009. Efforts yielded weathered dead valves of the Tennessee Clubshell, a species of highest conservation priority in Alabama, along with at least nine snail species, including species of highest and high conservation priority in Alabama, at least two taxa of fingernail clams, the Asian Clam, and eight crayfish species.

INTRODUCTION

The diversity of freshwater aquatic life in North America is centered in Alabama, owing to the geological antiquity of the state, the lack of glaciation, the abundance of large, discrete river basins, and a mild, stable climate, collectively providing ample time, separation, and ambient conditions for speciation (Boschung and Mayden, 2004; Williams and others, 2008). Freshwater mussels are considered one of the most imperiled faunal groups in North America based on the rapid extinction rate and preponderance of imperiled species (Master, 1993; Williams and others, 1993; Lydeard and Mayden, 1995) and drastic reductions in diversity and abundance of mussel populations are documented in many systems (Williams and others, 2008). The southeastern U.S., and Alabama in particular, once harbored a mussel fauna unequaled in diversity anywhere else in the world. Historic records of 91 percent of the recognized North American fauna exist from the southeastern U.S. and 60 percent from Alabama (Neves and others, 1997; Williams and others, 2008).

Of particular importance in mussel distribution is the Tennessee River system, considered to be the most diverse in the world due to the overlap of the Ohioan fauna of the interior basin of North America and the Cumberlandian fauna of the interior highlands of the South, along with some species whose origins are unknown (Ortmann, 1918, 1924, 1925; van der Schalie, 1939; Remington and Clench, 1925; Dennis, 1984; Garner and McGregor, 2001). Cumberlandian species are restricted to the Cumberland

River system upstream of Clarksville, Tennessee, and the Tennessee River system from Muscle Shoals, Alabama, upstream, and occupy streams with generally high gradient and high quality, abundant water with clean gravel substrata, while Ohioan species are more tolerant of streams with sluggish flow and less consolidated substrata (Ortmann, 1924, 1925; van der Schalie, 1939; Stansbery, 1964). Many Cumberlandian species have proven to be highly intolerant of modern habitat degradation and are now imperiled or extinct.

Freshwater mussels are benthic filter-feeding organisms, and as such are exposed to metals and other pollutants that are dissolved in water, associated with suspended sediments, or deposited in bottom sediments (Naimo, 1995). Because they are relatively long-lived, generally sedentary in nature, easily collected, large enough to provide sufficient tissue mass for analysis, tolerant of a wide assortment of pollutants, and known to bioconcentrate or bioaccumulate contaminants, their value as indicator organisms for evaluation of long-term ecosystem function and health is paramount. While relatively little is known about the lethal limits of various pollutants to freshwater mussels, ongoing research documents the different tolerances of various species and life history stages of mussels. It is widely understood that despite improvements in modern effluent treatment facilities, freshwater mollusks are still affected by such contaminants as ammonia, chlorine, elevated temperature, organic waste, suspended solids, and nutrients.

Threats to mussel communities including introduction of competitive exotics, fragmentation of populations with consequential decline of genetic viability, and loss of habitat for host species, lead to loss of populations through attrition. While many of these effects can be lethal in the short term, the long-lived nature of most mussel species makes it difficult to detect declines in mussel populations. They may succumb to the cumulative effects of these factors over a period of time and may be functionally extirpated, with cessation of reproduction and/or recruitment, for some time before their actual demise (Bogan, 1993). Powell (2003) found that although many water-quality and habitat variables were covariant with the density of cropland in streams in the Eastern Highland Rim Ecoregion of the lower Tennessee River basin, fish communities (and therefore mussel communities) primarily responded to the cumulative effects of sedimentation. Roy and others (2003) found that riffle habitats exhibited the strongest relationships with

environmental variables among riffle, pool, and bank habitats studied, and were negatively affected by both physical (bed mobility) and chemical (specific conductance, nutrient concentrations) variables. Poole and Downing (2004) reported that the greatest declines to mussel species richness and abundance in Iowa occurred where conditions had changed the most, that is, where streamside cover was removed and siltation ensued.

The Tennessee River system in North Alabama is home to 60 percent of the known freshwater mussel (Unionidae) taxa and 45 percent of the known crayfish (Cambaridae) taxa in the state (Williams and others, 2008; Schuster and Taylor, 2004). In the mid-1960s, Isom (1968) surveyed Indian Creek for freshwater mussels and found 11 species, mostly restricted to a short reach of the creek from stream mile 7.75 to 9.0, due to pollution downstream and poor substrate conditions upstream. He reported siltation of the habitat from highway construction and surmised that the mussel population may have been terminal.

Schuster and Taylor (2004) summarized the known information on crayfish in Alabama up to that time and discussed the reasons for Alabama's considerable aquatic diversity. They discussed the aforementioned reasons, but also reported, as had earlier researchers, that regarding crayfish evolution in Alabama one of the most important centers of dispersal for *Cambarus* sp. and *Orconectes* sp., which comprise greater than 50 percent of the state's fauna, is the Cumberland Plateau. Outliers of the Cumberland Plateau commingle with the Highland Rim section in the study area (Rheams and others, 1994). Crayfishes, another major component of aquatic ecosystems known to be rather diverse in the Tennessee Valley, are relatively unknown statewide and no inventory of the Redstone Arsenal (RSA) fauna exists.

The streams and wetlands on RSA have been degraded by chemicals and materials from nonpoint sources on and off the installation for a number of years. Because mussels are among the more sensitive components of aquatic systems, they are often the first to respond to habitat degradation. With recent efforts to remediate and restore degraded areas of RSA, knowledge of the current status of mussels on RSA is a necessary benchmark in evaluating their possible recovery. In 2008 the Geological Survey of Alabama (GSA) was contracted by the U.S. Army to perform surveys for freshwater mussels (Bivalvia: Unionidae) in streams and other waterbodies on and near

RSA. Furthermore, as GSA is involved in sampling crayfish statewide in an effort to increase our knowledge of that fauna, they were targeted as well. While sampling for these groups, other macroinvertebrates were frequently encountered, such as snails, fingernail clams, and the Asian Clam, and they were documented as well. This report is a brief summary of those activities.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the staff of RSA for their invaluable assistance. Danny Dunn and personnel at Test Area 3 provided information on sampling localities and facilitated access to some areas of the base, Shannon Allen and Christine Easterwood assisted with some field sampling, and Ben Hoksbergen provided information on some sampling stations. Guenter Schuster retired professor emeritus from Eastern Kentucky University, a noted crayfish biologist, graciously identified that fauna for us.

METHODS

Freshwater mussels and snails were collected by hand, sometimes with the aid of mask and snorkel where depth and clarity of water allowed. Collections were made at 27 stations on and near RSA (fig. 1, table 1). While sampling effort at some stations emphasized one targeted group (for example, snorkeling for mussels or trapping crayfish), effort was made at each station to collect all of the targeted taxa. Most mussel sampling was done during the spring and summer of 2009. Crayfish were collected with kick nets and seines in wadeable springs, streams, swamps, and roadside ditches throughout the study period or by deploying baited minnow traps and leaving them for several nights, often up to a week. Sampling efforts were conducted in winter and spring months when oxygen levels in the water were higher to ensure survival of captured specimens. Anticipated collecting of crayfish with baited minnow traps in the impounded lower reaches of streams tributary to the Tennessee River was prevented by high water. Some snails, fingernail clams, and Asian Clams were collected incidental to sampling for other taxa. Comments on status of each species collected during this study (uncommon, common, etc.) were subjective based on the best professional judgment of collectors and are not meant to express or imply a correlation to normal conditions or for comparison to results elsewhere.

Mussel nomenclature follows Williams and others (2008). Snails were identified by Jeff Garner of the Alabama Department of Conservation and Natural Resources, and nomenclature follows Burch (1989). Dr. Guenter Schuster of Richmond, Kentucky, identified the crayfish, and nomenclature follows Schuster and others (2008). Fingernail clams were identified only to genus based on shell morphology. Much more intensive analysis of soft parts would be necessary to assign species. Status of State of Alabama conservation priority (P) for mussels and snails follows Mirarchi (2004) with the following designated rankings: P1-Highest Conservation Concern, P2-High Conservation Concern, P3-Moderate Conservation Concern, P4-Low Conservation Concern, and P5-Lowest Conservation Concern. The same designated rankings for crayfish used herein are provisional and are based on recommendations found in Schuster and Taylor (2004), which were in turn based on Taylor and others (1996). No designation of conservation priority for fingernail clams or Asian Clams is recognized in Alabama.

Due to time and resource constraints many collections were made at predetermined locations where target species might be encountered based on prior knowledge of habitat conditions and accessibility. However, a fair amount of time was spent visiting locations identified from topographic maps and DeLorme's Atlas and Gazetteer to ascertain their respective values as sampling locations, and many were rejected if habitat was judged insufficient for targeted taxa. Therefore, this report is not to be construed as a definitive inventory of the respective RSA resources. Each collection was documented on a field sheet and the data stored in an electronic database at GSA. Specimens retained are temporarily housed at GSA and will ultimately be deposited in an appropriate museum collection. Locations were determined with the aid of a Garmin GPS (Global Positioning System) unit.

RESULTS

Indian Creek and McDonald Creek both have what appear to be the most suitable habitats for freshwater mussels remaining on RSA (relatively stable substrates with mixed sand, gravel, and cobble and sufficient flow to minimize sediment overburden, along with good canopy cover) and so were more intensively searched for mussels than were other waterbodies. Some common species of mussels are tolerant of unconsolidated bottom sediments or require less flow, such as found in swamps, embayments, and

ditches, but those habitats are often more difficult to sample and less likely to yield important taxa and were bypassed during this study. About 7.0 hours were spent snorkeling in Indian Creek at Martin Road (IC1), 0.5 hour in Indian Creek at Old Madison Pike (IC4), and about 2.5 hours in McDonald Creek at Hansen Road (MC).

Only one weathered dead valve of the Tennessee Clubshell, *Pleurobema oviforme*, was collected during this study, in Indian Creek at Martin Road (IC1) (table 2). During a past unrelated study a weathered dead Tennessee Clubshell was also collected at this location (2000). No other stations yielded mussels. The Tennessee Clubshell, a Cumberlandian species, was reported from Indian Creek by Isom (1968) and is considered a P1 species due to its limited distribution, rarity, and declining population trend, and was recently listed as a Species of Concern by the U.S. Fish and Wildlife Service. It is known to persist in Alabama only in the Paint Rock River system in Jackson County (Mirarchi and others, 2004), though weathered dead valves were also reported in the Bear Creek system in Franklin County in the past decade (McGregor and Garner, 2004).

Fingernail clams, also called pea clams due to their diminutive size, (Sphaeriidae: *Pisidium* sp. and *Musculium* sp.), were collected at several stations. Fingernail clams are often encountered when sampling for other taxa when the substrate is disturbed, are common in organically rich soft substrates of lakes, reservoirs, ponds, and quiet areas in lotic systems, and often persist during temporary periods of dewatering. Fingernail clams were super-abundant at one Indian Creek tributary (IC3) where the stream was impounded by a large beaver dam and conditions mimicked a swampy area with a very soft and organically rich substrate conducive to their life history needs. During an unrelated study on December 12, 1996, three live fingernail clams were collected in a spring-fed margin of Lady Ann Lake on RSA north of Bobcat Cave. They were deposited in the Ohio State University Museum of Biological Diversity (OSUM) and identified by Kathy G. Borror of OSUM (now retired) as *Musculium partumeium*, the Swamp Fingernail Clam, (two live and five fresh dead) and *Musculium securis*, the Pond Fingernail Clam, (one live). The Asian Clam, *Corbicula fluminea*, is a widespread exotic species commonly found in practically any aquatic freshwater habitat in North America and was frequently encountered and very abundant.

A conservative total of nine species (based on best possible identifications of problematic taxa) of snails were collected during this study and were found at most stations sampled in appropriate habitat. Brief accounts of those taxa follow.

Campeloma decisum, the Pointed Campeloma, a P4 species, was uncommon in Williams Spring (WS) and Indian Creek at Martin Road (IC1). These specimens resemble *Campeloma decampi*, the Slender Campeloma, a federally listed endangered species and State of Alabama P1 species, but under microscopic examination that is not supported, as they lack the fairly well-developed carinae and perpendicular lines on the upper whorls present on the Slender Campeloma. They were small (young?) individuals. In Alabama this species is widespread and common in the Tennessee River system, usually found in soft sediments in slow to moderate current (Mirarchi, 2004).

Elimia perstriata, the Engraved Elimia, was collected in McDonald Creek (MC), Williams Spring (WS), and two stations in Indian Creek (IC1, 4). The species was common to abundant at most stations, but uncommon at IC4 (Old Madison Pike), which was characterized by loose gravel and cobble with swift flow and little sand and silt. The identification of *E. perstriata* here is tentative and it appears there may be multiple species present, with the additional taxa being *Elimia nassula*, the Round-rib Elimia (known from springs), and possibly *Elimia laqueata*, the Panel Elimia, which tends to have closer affinities with the Elk River system and regions to the north in Tennessee and Kentucky. Larger specimens collected appear to match the type of *E. perstriata*, but the smaller individuals do not appear to be very young. If that is the case, they are likely *E. nassula*, which retains a diminutive size throughout life. Some also resembled specimens from nearby Knox Creek, which resemble *Elimia acuta*, the Acute Elimia, or *Pleurocera striatum*. *Elimia perstriata* and *E. nassula* are P1 species due to limited distribution, specific habitat requirements (sand, gravel, and cobble substrates in springs and small streams; intolerant of silt), and declining population trends. In Alabama they are known only from a few streams in Colbert, Lawrence, and Madison Counties (Mirarchi and others, 2004). *Elimia laqueata* is a P3 species due to limited distribution and habitat vulnerability. Burch (1989) reported *P. striatum* as *Pleurocera canaliculatum alabamense*, and it is not recognized in subsequent literature and has no designated State of Alabama conservation priority rank.

Fossaria obrussa, the Golden Fossaria, a P5 species, was found in the headwaters of Betts Spring Branch (BSB) and was rather common there. It is found throughout Alabama in lakes, rivers, and streams (Mirarchi, 2004).

Gyraulus parvus, the Ash Gyro, a P5 species, was uncommon in McDonald Creek and was found in Milfoil. It is presumably found throughout Alabama, usually on woody debris and submerged clumps of bryophytes and tree roots (Mirarchi, 2004).

Mircomenutus dilatatus, the Bugle Sprite, a P5 species, was uncommon in McDonald Creek (MC) and was found in Milfoil. It is presumably found throughout Alabama, usually on woody debris and submerged clumps of bryophytes and tree roots (Mirarchi, 2004).

Physella gyrina, the Tadpole Physa, a P5 species, was found in McDonald Creek (MC) and in a roadside ditch tributary to Indian Creek at Anderson Road (IT1) and was uncommon. It is presumably found throughout Alabama in streams, rivers, and ponds (Mirarchi, 2004). Several *Physella* sp. were found in an unnamed channelized tributary of Huntsville Spring Branch (HST) and was fairly common.

A single *Pleurocera canaliculatum*, the Silty Hornsnail, a P5 species, was found in Williams Spring (WS). It is commonly found in a variety of habitats throughout the Tennessee River system in Alabama, displays high variability in shell morphology, and may represent a species complex (Mirarchi, 2004).

Pleurocera pyrenella, the Skirted Hornsnail, a P2 species, was found in Indian Creek at Martin Road (IC1) and was common. It is a P2 species due to its limited distribution and vulnerability to habitat degradation. This species is known occupies pools, runs, and sometimes riffles (though it usually avoids areas with swift current), as well as swampy streams and impounded springs, and is tolerant of silt. Historically this species is known from Limestone, Madison, and Morgan Counties in Alabama but was not recently collected in Morgan County (Mirarchi and others, 2004).

Pseudosuccinea columella, the Mimic Lymnaea, a P5 species, was found in a roadside ditch tributary to Indian Creek at Anderson Road (IT1) and was represented by a single individual. It is common (although often marginally so) apparently throughout Alabama in streams and rivers (Mirarchi, 2004).

A cumulative total of eight species of crayfish were collected during this study, from springs, streams, swamps, and roadside ditches. No crayfish were collected from burrows or from the lower impounded reaches of streams tributary to the Tennessee River. Such efforts would likely expand the species list. Brief species accounts follow.

Cambarus striatus, the Ambiguous Crayfish, a provisional P5 species, was found throughout the study area. It was common, especially in swampy or stagnant habitats. It is usually found in streams under rocks and can burrow (Schuster and Taylor, 2004).

Fallicambarus fodiens, the Digger Crayfish, a provisional P5 species, was found in a roadside ditch tributary to Indian Creek at Anderson Road (IT1) and was rather common. This species is found in the Tennessee, Tombigbee, and Alabama River systems in Alabama and is a burrower, occasionally found in streams (Schuster and Taylor, 2004).

Orconectes erichsonianus, the Reticulate Crayfish, a provisional P5 species, was found in Indian Creek at Martin Road (IC1) and was fairly common. It is widespread in Alabama from all but the smaller coastal river systems and occurs in streams under rocks (Schuster and Taylor, 2004).

Orconectes forceps, the Surgeon Crayfish, a provisional P4 species, was found in Bradford Creek (BC) just west of RSA and in McDonald Creek at Hansen Road (MC) and was common. In Bradford Creek it was collected incidental to sampling fishes with a seine and backpack shocker for an unrelated study. It is known in Alabama from the Tennessee River system and lives in streams under rocks (Schuster and Taylor, 2004).

Orconectes mirus, the Wonderful Crayfish, a provisional P4 species, was found at several stations with gravel and cobble substrates and fairly swift flow, including Indian Creek (IC1, 2, 3, 4, and 5) and McDonald Creek (MC), and was common. It is a Tennessee River system endemic, known from tributaries in western Tennessee and northern Alabama. It lives in streams under rocks (Schuster and Taylor, 2004).

Orconectes validus, the Powerful Crayfish, a provisional P5 species, was found at several stations with gravel and cobble substrates and fairly swift flow, including Williams Spring (WS), the Indian Creek system (IC1, 2, 3, 5, and IT2, 3), Bradford Creek (BC), and McDonald Creek (MC). It is known from larger river basins in Alabama and is a stream dwelling species (Schuster and Taylor, 2004).

Procambarus acutus, the White River Crawfish, a provisional P5 species, was found in Indian Creek tributaries (IT1, 3) and Williams Spring (WS). In Alabama it is known from all major river systems except the Cahaba, Tallapoosa, Perdido, and Chattahoochee, and inhabits slow streams and lentic environments (Schuster and Taylor, 2004).

Procambarus clarkii, the Red Swamp Crayfish, a provisional P5 species, was frequently encountered in low numbers in sluggish habitats, mostly in traps, including most of the Byrd Spring collections (BS2, 3, 4, 5, 6), the Path to Nature natural area in a lowland along the Tennessee River (P2), the swampy upper reach of an Indian Creek tributary (IT3), the swamp north of Martin Road (MRS), near a swampy area along Eagle Road (ER), and McDonald Creek (MC). In Alabama it occurs from all but the smallest coastal river systems. It occurs in lentic and lotic environments and is a tertiary burrower (Schuster and Taylor, 2004).

SUMMARY

While no federally listed endangered or threatened species were encountered during this study, and only a few State of Alabama P1 and P2 species, several noteworthy finds were made. Weathered dead valves of the Tennessee Clubshell, *Pleurobema oviforme*, a P1 species and a former Species of Concern to the U.S. Fish and Wildlife Service, were collected during this study and, at the same location in Indian Creek, in 2000. More rigorous sampling could produce a remnant live population of that and other species. However, because as Isom (1968) reported 11 species of mussels restricted to a short reach of Indian Creek and postulated that the fauna might be terminal at that time, and only one species represented by weathered dead shells was collected during this study 40-plus years later, and the fact that the upper reaches of Indian Creek are undergoing rapid urbanization, it is unlikely.

Six of eight species of crayfish documented during this study were collected from the Indian Creek system, a rather respectable number for such a restricted drainage (Guenter Schuster, pers. comm. 2009). This suggests that there remains quality, undisturbed habitat for those taxa in that system. Four species were also collected from McDonald Creek. As noted earlier, no effort to capture burrowing crayfish or sampling in the impounded lower reaches of tributaries was made during this study. The total of

crayfish taxa on RSA could be elevated pending such efforts along with additional sampling in appropriate habitats.

At least nine species of snails were documented during this study, including State of Alabama P1 and P2 species, both of which were commonly encountered. Additional sampling in other habitats and more rigorous sampling in stations already sampled could further refine their distributions on RSA.

Fingernail clams and Asian Clams were often encountered without being targeted and were very abundant at numerous stations. Due to the location of RSA on the floor of the Tennessee Valley, many of the streams have soft substrates and are organically rich. With more concerted effort targeting those taxa and with skilled examination of collected specimens by a competent researcher, it is likely that a very diverse population of fingernail clams would be documented.

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Table 1-Summary information for stations sampled on and near Redstone Arsenal, Madison County, Alabama, 2008-2009.

Locality	Station number[1]	Map Coordinates
Bradford Creek at James Record Road west of RSA Gate 7	BC	N 34.6509° W 86.7516°
Lady Ann Lake, impoundment of Betts Spring Branch, on east bank	LAL	N 34.6733° W 86.7140°
Headwater of Betts Spring Branch at Zierdt Road	BSB	N 34.6837° W 86.7160°
Indian Creek at Martin Road west of Rideout Rd. intersection	IC1	N 34.6440° W 86.6861°
Williams Spring, tributary of Indian Creek just north of Martin Road	WS	N 34.6467° W 86.6863°
Unnamed tributary of Indian Creek on Anderson Road near Bobcat Cave	IT1	N 34.6654° W 86.7079°
Indian Creek oxbow off Hackberry Road	IT2	N 34.6577° W 86.6903°
Indian Creek headwater/swamp at south end of RSA airport	IT3	N 34.6651° W 86.6822°
Indian Creek on Laser Range at Hale Road Bridge	IC2	N 34.6694° W 86.6979°
Indian Creek at cul-de-sac on north end of laser range	IC3	N 34.6911° W 86.6998°
Indian Creek at Old Madison Pike just west of Slaughter Road	IC4	N 34.7090° W 86.7017°
Indian Creek at U.S. Highway 72 near Madison	IC5	N 34.7499° W 86.6972°
Unnamed tributary of Huntsville Spring Branch at Mills Road near Patton Road intersection	HST	N 34.6381° W 86.6327°
Swamp north of Martin Road near Gate 1	MRS	N 34.6532° W 86.6128°
McDonald Creek at Hansen Road near Gate 5	MC	N 34.6783° W 86.6193°
Unnamed spring box on Weeden Mountain near old home site	WM1	N 34.6800° W 86.6532°
Unnamed spring run on Weeden Mountain	WM2	N 34.6805° W 86.6512°
Unnamed direct tributary to Tennessee River north of Redstone Road at Eagle Road and Eastline Road intersection	ER	N 34.6226° W 86.594°
Byrd Spring at Byrd Spring Hunting Club at lower dam	BS1	N 34.6460° W 86.6011°
Byrd Spring at Byrd Spring Hunting Club at Three Pipes	BS2	N 34.6428° W 86.5866°
Byrd Spring at Byrd Spring Hunting Club at Hayes Branch	BS3	N 34.6491° W 86.5836°
Byrd Spring at Byrd Spring Hunting Club at large spring	BS4	N 34.6526° W 86.5839°
Byrd Spring at Byrd Spring Hunting Club at Piers	BS5	N 34.6527° W 86.5841°
Byrd Spring at Byrd Spring Hunting Club at little spring	BS6	N 34.6628° W 86.5830°
Path to Nature trail along Tennessee River, east of Lehmann's Bluff	PN1	N 34.5821° W 86.6188°
Path to Nature trail alongside backwater of Tennessee River	PN2	N 34.5816° W 86.6169°
Drainage ditch in pasture near SE boundary of Redstone Arsenal near Tennessee River	DD	N 34.5866° W 86.5873°

[1]Corresponds to stations on Figure 1.

Table 2- Summary information for taxa collected on and near Redstone Arsenal, Madison County, Alabama, 2008-2009.

Taxa	Status[1,2]	Occurrence[3]	Status
Unionidae			
Pleurobema oviforme, Tennessee Clubshell	P1	Indian Creek at Martin Road (IC1) (also here in 2000)	Paired weathered dead valves each time
Corbiculidae			
Corbicula fluminea, Asian Clam	NA	Found commonly throughout the study area	Live, common
Sphaeriidae			
Musculium sp., fingernail clam	NA	Unnamed channelized tributary of Huntsville Spring Branch at Mills Road (HST) and an Indian Creek tributary (IT3)	Live, fairly common in the tributary and super-abundant at IT3
Pisidium sp., fingernail clam	NA	Unnamed channelized tributary of Huntsville Spring Branch at Mills Road (HST) and an Indian Creek tributary (IT3)	Live, fairly common in the tributary and super-abundant at IT3
Musculium partumeium, Swamp Fingernail Clam	NA	Margin of Lady Ann Lake (known as 'Cow Sump')	Two live animals and five fresh dead shells collected during an unrelated study, December 1996
Musculium securis, Pond Fingernail Clam	NA	Margin of Lady Ann Lake (known as 'Cow Sump')	One live animal collected during an unrelated study, December 1996
Gastropoda			
Campeloma decisum, Pointed Campeloma	P4	Williams Spring (WS) and Indian Creek at Martin Road (IC1)	Live, uncommon
Elimia perstriata, Engraved Elimia	P1	McDonald Creek at Hansen Road (MC), Williams Spring (WS), and Indian Creek at Martin Road (IC1) and Old Madison Pike (IC4)	Live, common at most stations, but uncommon in Indian Creek at Old Madison Pike
Fossaria obrussa, Golden Fossaria	P5	Headwaters of Betts Spring Branch at Zierdt Road (BSB)	Live, fairly common
Gyraulus parvus, Ash Gyro	P5	McDonald Creek at Hansen Road (MC)	Live, uncommon
Mircomenetus dilatatus, Bugle Sprite	P5	McDonald Creek at Hansen Road (MC)	Live, uncommon
Physella gyrina, Tadpole Physa	P5	McDonald Creek at Hansen Road (MC) and in a roadside ditch tributary to Indian Creek at Anderson Road (IT1)	Live, uncommon

Physella sp.	NA	Unnamed channelized tributary of Huntsville Spring Branch at Mills Road (HST)	Live, fairly common
Pleurocera canaliculatum, Silty Hornsnail	P5	One was found in Williams Spring (WS)	Live, uncommon
Pleurocera pyrenella, Skirted Hornsnail	P2	Indian Creek at Martin Road (IC1)	Live, common
Pseudosuccinea columella, Mimic Lymnaea	P5	One individual was found in a roadside ditch tributary to Indian Creek at Anderson Road (IT1)	Live, uncommon
Cambaridae			
Cambarus striatus, Ambiguous Crayfish	P5	Found throughout the study area, except Bradford Creek at James Record Road (BC)	Common
Fallicambarus fodiens, Digger Crayfish	P5	Roadside ditch tributary to Indian Creek at Anderson Road (IT1)	Eight specimens collected with a hand net
Orconectes erichsonianus, Reticulate Crayfish	P5	Indian Creek at Martin Road (IC1)	11 specimens collected
Orconectes forceps, Surgeon Crayfish	P4	Bradford Creek at James Record Road (BC) and McDonald Creek (MC)	Common in Bradford Creek; less so in McDonald Creek
Orconectes mirus, Wonderful Crayfish	P4	Indian Creek (IC1, 2, 3, 4, 5)	Common
Orconectes validus, Powerful Crayfish	P5	Williams Spring (WS), Indian Creek system (IC1, 2, 3, 5, IT2, 3), Bradford Creek (BC), and McDonald Creek (MC)	Usually in low numbers but fairly common in McDonald Creek
Procambarus acutus, White River Crawfish	P5	Indian Creek tributaries (IT1, 3), Williams Spring (WS)	Most numerous in trap sets; a few collected in hand nets and seine hauls
Procambarus clarkii, Red Swamp Crayfish	P5	Byrd Spring (BS2, 3, 4, 5, 6), Path to Nature (P2), Indian Creek system (IT3), swamp north of Martin Road (MRS), Eagle Road (ER), and McDonald Creek (MC)	Frequently encountered, but in low numbers, in traps in swampy habitats

[1]Conservation priority from Mirarchi and others (2004)–P1 Highest, P2 High, P4 Low, P5 Lowest; NA=not available;

[2]Crayfish conservation priority provisional per Schuster and Taylor (2004).

[3]Map and table designations in parentheses.

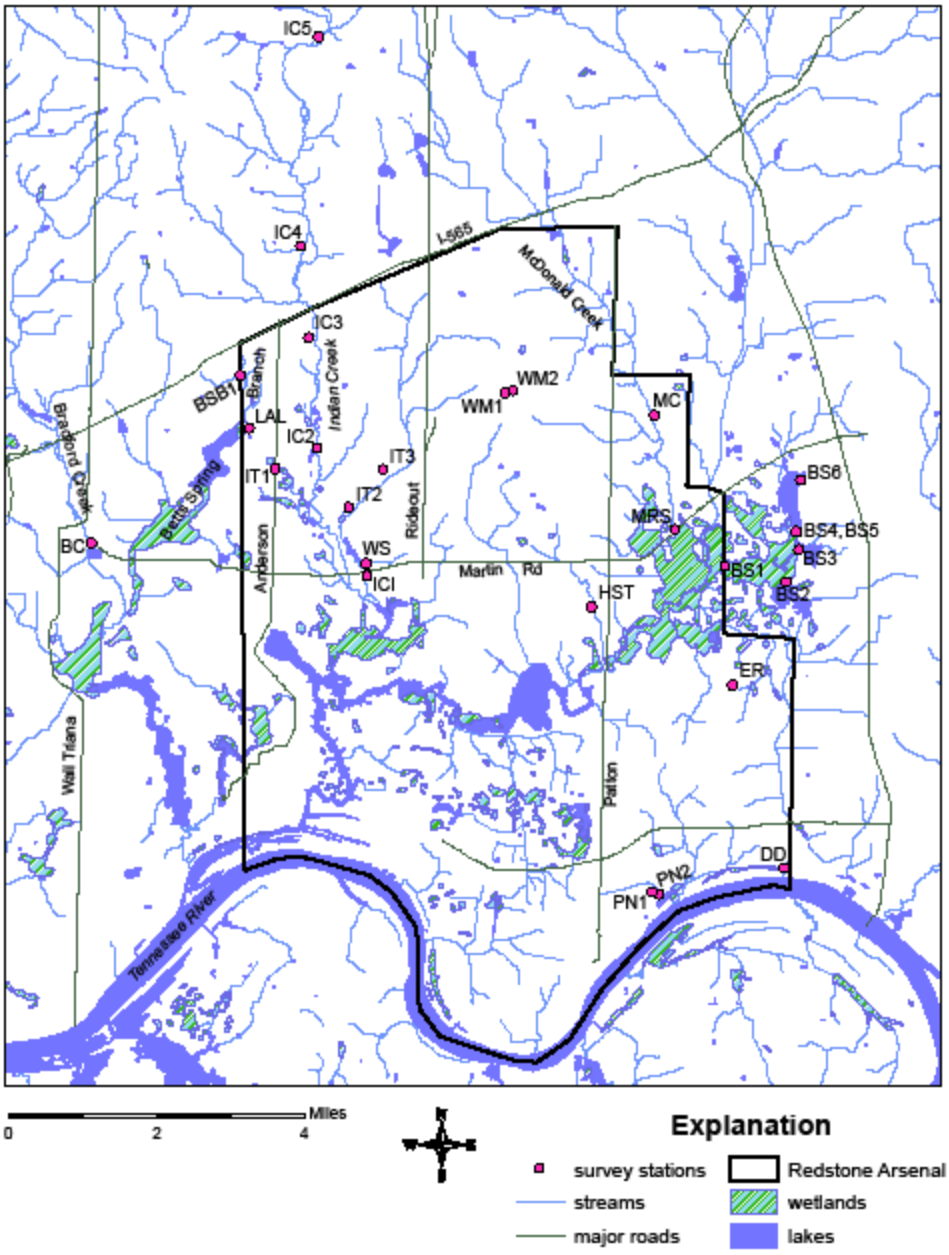

Figure 1. Sampling stations on and near Redstone Arsenal, Madison County, Alabama, 2008 - 2009.

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