

## **A Survey of Terrestrial Gastropods of the Sipsey Wilderness (Bankhead National Forest), Alabama**

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**Abstract** - A survey of the terrestrial mollusks of the Sipsey Wilderness Area, Bankhead National Forest, in northwestern Alabama was conducted from August 2003 to May 2004. A total of 15 sites were sampled across a number of different habitat and vegetation types found within the area. A total of 50 species were found, representing 14 families and 30 genera, including 58 new county and 2 new state records. This represents a significant increase in the known diversity of the area based on a preliminary survey conducted in the 1960s, which yielded only six species. The current survey highlights the need for more detailed survey work across Alabama and the southeastern United States.

### **Introduction**

Terrestrial gastropods are a ubiquitous component of terrestrial ecosystems of the eastern United States. Distribution maps of the 523 native species and subspecies of terrestrial snails of the eastern United States were presented by Hubricht (1985). The distribution maps are based primarily upon the data presented in the taxonomic monographs published by Henry A. Pilsbry (1939, 1940, 1946, 1948) and the extensive material collected by Leslie Hubricht (deposited and available on-line at the Field Museum of Natural History, Chicago, IL). Alabama is considered one of the states in the eastern United States in which collecting effort has been most intensive (Archer 1939, Hubricht 1965). From 1903 to 1919, Herbert H. Smith, the first curator of the Alabama Museum of Natural History, collected land and freshwater mollusks throughout the state (Clapp 1920). Smith's land-snail collection provided the basis for a monograph on the terrestrial shell-bearing mollusks of Alabama by Bryant Walker (1928). During the 1960s, Leslie Hubricht conducted numerous terrestrial gastropod surveys throughout the state. These collections provide a strong foundation and historical benchmark for our knowledge of the malacofauna of Alabama. Despite the pioneering efforts of these early naturalists, there is still a considerable amount to be learned about the distribution of the malacofauna of the state. For example, many early collection efforts were opportunistic or even superficial, and without extensive field notes, it is difficult to judge whether the absence of a species at a locale is due to it not being found at that locale or due to insufficient collecting methods. Historical museum records are critically important for evaluating and monitoring changes in species composition through time (Mikkelsen and

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Bieler 2001, Ponder et al. 2001); therefore it is essential that the baseline data fully represents the malacofauna of the region.

In order to extend our knowledge of the malacofauna of Alabama, we conducted a survey of the terrestrial mollusks of the northern half of the Bankhead National Forest, concentrating on the Sipsey Wilderness Area. This area was chosen as it is relatively undisturbed compared to the southern half of the Bankhead National Forest and because L. Hubricht had collected in the area previously (= Site 1). We hoped a comparison with this earlier collection would give us an indication of the historical terrestrial gastropod diversity.

### Study Area

The study area is located in the north western section of the William B. Bankhead National Forest (NF) and encompasses the Sipsey Wilderness Area of northern Alabama (Fig. 1). The Bankhead NF is approximately 182,000 acres and the Sipsey Wilderness Area is approximately 25,000 acres in area. The bulk of the NF lies in the Southwestern Appalachian Ecoregion with its northern borders crossing into the Interior Plateau Ecoregion (US Environmental Protection Agency 2005, Omernik 1987). The Southwestern Appalachian Ecoregion is comprised of temperate broadleaf and mixed forests that cover the plateaus and rolling hills west of the Appalachian

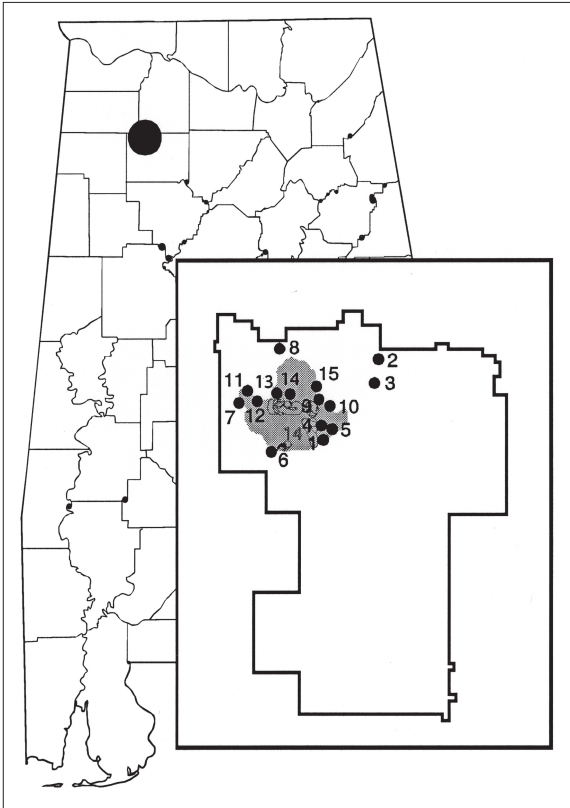


Figure 1. Map showing the location of the William B. Bankhead National Forest in northern Alabama. The insert shows the location of the 15 sample sites within the Bankhead National Forest and the shaded area is the Sipsey Wilderness Area.

Mountains and is considered a “globally outstanding” terrestrial ecoregion by the World Wildlife Fund based on it harbouring some of the richest and most endemic land-snail, amphibian, and herbaceous plant biotas in the United States and Canada (Ricketts et al. 1999). We chose sites within the NF because, other than impacts from silvicultural practices and road building, it is largely a protected area.

### Materials and Methods

A total of 15 randomly chosen sites were surveyed for terrestrial gastropods (Table 1; Fig. 1) between October 2003 and March 2004. At least one

Table 1. Sampling sites located in the northern half of the Bankhead National Forest, including the Sipsey Wilderness Area.

Site	Location	Latitude	Longitude	Date
1	E. side of Sipsey River; along walking track N. of CR 60, Bankhead NF, Winston Co.	34°17'12"N	87°23'56"W	11-Oct-03
2	Along an old track, about 0.5 miles N. of Tennessee Valley Divide Rd, 0.6 miles E. of Cheatham Rd, Bankhead NF, Lawrence Co.	34°23'32"N	87°18'27"W	12-Oct-03
3	Along banks of small trib. of Brushy Creek, ≈ 0.4 mi. E. of Bushy Creek Rd, opposite Pine Torch Church, Bankhead NF, Lawrence Co.	34°19'31"N	87°18'40"W	12-Oct-03
4	About 2.5 miles W. of CR 6, on CR 5, road to bow-hunting camp, Bankhead NF, Lawrence Co.	34°18'39"N	87°23'38"W	19-Oct-03
5	About 1 mile W. of CR 6 on CR 5, Bankhead NF., Lawrence Co.	34°18'51"N	87°22'21"W	19-Oct-03
6	Parker Branch at CR 60, 0.2 miles E. of junction with FR210 (= CR 60), Bankhead NF, Winston Co.	34°16'51"N	87°29'30"W	19-Oct-03
7	Off FR 210, 0.6 miles S. of junction with FR 203, Bankhead NF, Winston Co.	34°20'33"N	87°31'09"W	19-Oct-03
8	Northern side of FR 213, E. of FR 203, Bankhead NF, Winston Co.	34°23'29"N	87°28'16"W	19-Oct-03
9	Off western side of FR 208, W. of Flannagin Creek, Bankhead NF, Lawrence Co.	34°20'27"N	87°23'33"W	19-Oct-03
10	Bluff, above Borden Creek at FR 208, Bankhead NF, Lawrence Co.	34°19'48"N	87°22'39"W	19-Oct-03
11	About 0.2 miles along track S. of FR 203, about 1 mile W. of Tedford Creek, Bankhead NF, Lawrence Co.	34°20'05"N	87°29'01"W	21-Mar-04
12	Off FR 203, 0.8 miles W. of Tedford Creek, Bankhead NF, Lawrence Co.	34°20'23"N	87°29'05"W	21-Mar-04
13	Off FR 203, 0.5 miles W. of Tedford Creek, Bankhead NF, Lawrence Co.	34°20'21"N	87°28'44"W	21-Mar-04
14	Trailhead of Thompson Creek at end of FR 203, Bankhead NF, Lawrence Co.	34°20'28"N	87°28'14"W	21-Mar-04
15	Flannagin Creek at FR 208E, Bankhead NF, Lawrence Co.	34°20'20"N	87°23'17"W	21-Mar-04

Table 2. Rank order and frequency of summed specimens.

Taxon	Rank	Samples	Number of specimens	Percent of specimens	New county records		New state records
					Lawrence	Winston	
<i>Mesomphix globosus</i> (MacMillan, 1940)	1	12	109	7.42		X	
<i>Gastrodonia interna</i> (Say, 1822)	2	12	94	6.40			
<i>Haplotrema concavum</i> (Say, 1821)	3	11	123	8.37	X		
<i>Mesodon normalis</i> (Pilsbry, 1900)	4	11	75	5.11	X		
<i>Triodopsis tridentata</i> (Say, 1816)	5	10	43	2.93	X	X	
<i>Glyphyalinia cryptophthalma</i> (Clapp, 1915)	6	10	33	2.25	X		
<i>Patera perigrapta</i> (Pilsbry, 1894)	7	9	64	4.36	X	X	
<i>Zonitoides arboreus</i> (Say, 1816)	8	9	61	4.15		X	
<i>Stenotrema barbigerrum</i> (Redfield, 1856)	9	9	43	2.93			
<i>Mesodon thyroideus</i> (Say, 1816)	10	9	35	2.38			
<i>Ventridens pilsbryi</i> Hubricht, 1964	11	9	30	2.04			
<i>Glyphyalinia indentata</i> (Say, 1823)	12	9	23	1.57			
<i>Stenotrema stenotrema</i> (Pfeiffer, 1842)	13	7	33	2.25	X	X	
<i>Carychium exile</i> Lea, 1842	14	6	180	12.25	X	X	
<i>Glyphyalinia wheatleyi</i> (Bland, 1883)	15	6	48	3.27			
<i>Striatura meridionalis</i> (Pilsbry & Ferriss, 1906)	16	6	31	2.11	X	X	
<i>Mesomphix latior</i> (Pilsbry, 1900)	17	6	23	1.57	X	X	
<i>Euconulus dentatus</i> (Sterki, 1893)	18	6	20	1.36	X	X	
<i>Mesomphix capnoides</i> (Binney, 1857)	19	6	14	0.95	X	X	
<i>Gastrocopta contracta</i> (Say, 1822)	20	5	38	2.59	X	X	
<i>Xolotrema obstrictum</i> (Say, 1821)	21	5	32	2.18	X	X	
<i>Strobellops aeneus</i> Pilsbry, 1926	22	5	18	1.23		X	
<i>Philomycus carolinianus</i> (Bosc, 1802)	23	5	11	0.75		X	
<i>Inflectarius inflectus</i> (Say, 1821)	24	4	43	2.93			
<i>Oligyra orbiculata</i> Say, 1818	25	4	8	0.54		X	

Table 2, continued.

Taxon	Rank	Samples	Number of specimens	Percent of specimens	New county records		New state records
					Lawrence	Winston	
<i>Punctum minutissimum</i> (Lea, 1841)	26	4	7	0.48	X	X	
<i>Glyphyalinia wetherbyi</i> (Cockerell, 1900)	27	4	4	0.27			
<i>Millerelix plicata</i> (Say, 1821)	28	3	45	3.06		X	
<i>Triodopsis vulgata</i> Pilsbry, 1940	29	3	20	1.36	X	X	
<i>Punctum vitreum</i> (Baker, 1930)	30	3	11	0.75	X	X	
<i>Lobosculum pustuloides</i> (Bland, 1858)	31	3	4	0.27	X		
<i>Strobilops labyrinthica</i> (Say, 1817)	32	3	3	0.20	X		
<i>Carychium nannodes</i> Clapp, 1905	33	2	75	5.11	X		
<i>Cochlicopa morscana</i> (Doherty, 1878)	34	2	22	1.50	X	X	
<i>Anguispira alternata</i> (Say, 1816)	35	2	6	0.41	X		
<i>Gastrocopta pentadon</i> (Say, 1821)	36	2	5	0.34		X	
<i>Glyphyalinia carolinensis</i> (Cockerell, 1890)	37	2	4	0.27	X		X
<i>Glyphyalinia praecox</i> (Baker, 1930)	38	2	4	0.27	X		
<i>Hawaiiia minuscula</i> (Binney, 1841)	39	2	3	0.20	X	X	
<i>Helicodiscus parallelus</i> (Say, 1817)	40	2	3	0.20	X	X	
<i>Ventridens intertextus</i> (Binney, 1841)	41	2	3	0.20	X	X	
<i>Paravitrea multidentata</i> (Binney, 1840)	42	2	2	0.14	X		
<i>Discus patulus</i> (Deshayes, 1830)	43	1	5	0.34	X		
<i>Ventridens demissus</i> (Binney, 1843)	44	1	4	0.27	X		
<i>Euchemotrema fasciatum</i> (Pilsbry, 1940)	45	1	2	0.14			
<i>Vertigo gouldii</i> (Binney, 1843)	46	1	1	0.07	X		X
<i>Punctum smithi</i> Morrison, 1935	47	1	1	0.07	X		
<i>Mesomphix pilsbryi</i> (Clapp, 1904)	48	1	1	0.07			
<i>Paravitrea capsella</i> (Gould, 1805)	49	1	1	0.07	X		
<i>Mesodon zaletus</i> (Binney, 1837)	50	1	1	0.07		X	
Total			1469	100.00%	32	26	2

sample per major habitat type was collected from sites accessible from forestry roads and along walking trails. Sampling included hand searching for specimens on site on the ground, in the leaf litter, under bark, under logs, and under stones, and taking a 5-litre bag of leaf litter to be sorted in the lab. An average of about an hour was spent at each site.

All shells were identified to species using the keys provided in: Burch 1962; Emberton 1988, 1991; Hubricht 1961, 1962a, 1962b, 1964, 1976, 1978; and Pilsbry 1939, 1940, 1946, 1948. All specimens have been deposited in the University of Alabama Scientific Collections Facility. The taxonomic nomenclature used follows Emberton (1988, 1991), Schileyko (2002, 2003), and Turgeon et al. (1998).

### Results and Discussion

The 15 samples yielded a total of 1469 identifiable shells, representing 50 taxa (Appendix 1). A total of 58 new county records were recorded, with 26 for Winston and 32 for Lawrence counties, and 2 new state records were established (Table 2). While no species of the families Succineidae or Pomatiopsidae were found during the current survey, it is very likely that they are present as suitable habitat does occur within the study area. Therefore, as more extensive surveys of the area are completed, the total number of species inhabiting the area will likely be increased.

The rank order was also calculated for each species for the entire study (Table 2). *Mesomphix globosus*, *Gastrodonta interna*, and *Haplotrema concavum* were ranked 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup>, respectively. The following five taxa are each represented by a single specimen and received the lowest rank: *Vertigo gouldii*, *Punctum smithi*, *Mesomphix pilsbryi*, *Paravitrea capsella*, and *Mesodon zaletus*.

The molluscan assemblage of taxa found is typically associated with upland woodland areas, with deep layers of leaf litter and fallen timber on the ground (Burch, 1955, Hubricht 1985). Three species found during this survey are considered by Hubricht (1985) to be mainly associated with limestone outcrops or soils (calciphiles): *Oligyra orbiculata*, *Lobosculum pustuloides*, and *Gastrocopta pentadon*. As our specimens were found in woodland habitats, it suggests that the soils may have some limestone influences.

A search of the on-line database of the Chicago Field Museum of Natural History (<http://www.fmnh.org>) showed that L. Hubricht collected in the study area in 1961. His collection effort yielded only 6 species: *Glyphyalinia cryptomphala*, *Glyphyalinia indentata*, *Haplotrema concavum*, *Stenotrema barbiggerum*, *Mesodon thyroideus*, and *Mesodon normalis*. Our examination of the same general area yielded 24 species. As little information is available about the collection effort employed or the condition of the site at the time of Hubricht's visit, the difference in the number of species found nonetheless is significant. Therefore, investigators should exercise care in interpreting historical data (e.g., absence of a species may not necessarily equal true absence).

Our survey clearly indicates that there is a tremendous amount of information to be gleaned from thorough biotic surveys and inventories of terrestrial gastropods in the region. Due to their limited dispersal capabilities, terrestrial gastropod species can make excellent study organisms for evolutionary (e.g., Hugall et al. 2003) and ecological studies (Coney et al. 1982, Cook 2001, Heller 2001, Neck 1990, Nekola and Smith 1999), as well as inferring paleoclimates and habitats (Theler et al. 2004). In addition, most species of terrestrial mollusks are restricted to particular vegetation and soil types (Burch 1955, Clark 2004, Hotopp 2002, Riggle 1976), and changes in species composition can be used to gauge impacts of both human and non-human factors effecting the environment.

From a conservation stand-point, better informed assessments of environmental impacts of various human-related activities or affects of climate change can be assessed when sufficient baseline data exists. Although terrestrial gastropod species are typically not considered keystone species for most ecosystems, the decline in their abundance has been linked to decline in song birds (Graveland et al. 1994). In addition to biotic surveys and inventories, most terrestrial gastropod taxa have not been thoroughly treated taxonomically and systematically. Since Pilsbry's classic work (1939, 1940, 1946, 1948), there has been no thorough systematic treatment of the United States land snail fauna; however, there have been smaller revisions, a few state field guides, and checklists (e.g., Bequaert and Miller 1973; Emberton, 1988, 1991; Metcalf and Smartt 1997; Roth and Sadeghian 2003).

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### Literature Cited

- Archer, A.F. 1939. The distribution of land mollusks of Alabama from their probable centers of origin. *The Nautilus* 52(4):112–115.
- Bequaert, J.C., and W.B. Miller. 1973. The mollusks of the arid southwest, with an Arizona checklist. The University of Arizona Press, Tucson, AZ.
- Burch, J.B. 1955. Some ecological factors of the soil affecting the distribution and abundance of land snails in eastern Virginia. *The Nautilus* 69(2):62–69.
- Burch, J.B. 1962. How to Know the Eastern Land Snails. Wm. C. Brown, Dubuque, IA. 214 pp.

- Clapp, G.H. 1920. Herbert Huntington Smith. *The Nautilus* 33(4):136–141.
- Clark, S.A. 2004. Native snails in an urban environment: Conservation from the ground up. Pp. 78–81, *In* D. Lunney and S. Burgin (Eds.). *Urban Wildlife: More Than Meets the Eye*. Royal Zoological Society of New South Wales, Mosman, Australia.
- Coney, C.C., W.A. Tarpey, J.C. Warden, and J.W. Nagel. 1982. Ecological studies of land snails in the Hiwassee River basin of Tennessee, USA. *Malacological Review* 15:69–106.
- Cook, A. 2001. Behavioural Ecology: On doing the right thing, in the right place, at the right time. Pp. 447–488, *In* G.M. Barker (Ed.). *The Biology of Terrestrial Mollusks*. CAB International, Oxon, UK.
- Emberton, K.C. 1988. The genitalic, allozymic, and conchological evolution of the eastern North American Triodiopsinae (Gastropoda: Pulmonata: Polygyridae). *Malacologia* 28(1–2):159–273.
- Emberton, K.C. 1991. The genitalic, allozymic, and conchological evolution of the Tribe Mesodontini (Pulmonata: Stylommatophora: Polygyridae). *Malacologia* 33(1–2):71–178.
- Graveland, J., R. van der Wal, J.H. van Balen, and A.J. van Noordwijk. 1994. Poor reproduction in forest passerines from decline of snail abundance on acidified soils. *Nature* 368:446–448.
- Heller, J. 2001. Life history strategies. Pp. 413–446, *In* G.M. Barker (Ed.). *The Biology of Terrestrial Mollusks*. CAB International, Oxon, UK.
- Hotopp, K.P. 2002. Land snails and soil calcium in Central Appalachian mountain forest. *Southeastern Naturalist* 1:27–44.
- Hubricht, L. 1961. Eight new species of land snails from the southern United States. *Nautilus* 75(1):26–33, plate 4.
- Hubricht, L. 1962a. New species of *Helicodiscus* from the eastern United States. *The Nautilus* 75(3):102–107, plates 7–9.
- Hubricht, L. 1962b. *Mesomphix vulgatus* and its allies. *The Nautilus* 76(1):1–7, plate 1.
- Hubricht, L. 1964. The bidentate species of *Ventridens* (Stylommatophora: Zonitidae). *Malacologia* 1(3):417–426.
- Hubricht, L. 1965. The land snails of Alabama. *Sterkiana* 17:1–5.
- Hubricht, L. 1976. Five new species of land snails from the eastern United States. *Malacological Review* 9:126–130.
- Hubricht, L. 1978. Thirteen new species of land snails from the southeastern United States with notes on other species. *Malacological Review* 10:37–52.
- Hubricht, L. 1985. The distributions of the native land mollusks of the eastern United States. *Fieldiana, Zoology* 24:1–191.
- Hugall, A., J. Stanisic, and C. Moritz. 2003. Phylogeography of terrestrial gastropods: The case of the Sphaerospira lineage and history of Queensland Rainforests. Pp. 270–301, *In* C. Lydeard and D.R. Lindberg (Eds.). *Molecular Systematics and Phylogeography of Mollusks*. Smithsonian Books, Washington, DC.
- Metcalf, A.L., and R.A. Smartt. 1997. Land snails of New Mexico: A systematic review. *Bulletin of the New Mexico Museum of Natural History and Science* 10:1–69.
- Mikkelsen, P.M., and R. Bieler. 2001. Marine bivalves of the Florida Keys: Discovered biodiversity. Geological Society of London, Special Publication 177:247–257.
- Neck, R.W. 1990. Ecological analysis of the living mollusks of the Texas panhandle. *American Malacological Bulletin* 8:9–18.



- Nekola, J.C., and T.M. Smith. 1999. Terrestrial gastropod richness patterns in Wisconsin carbonate cliff communities. *Malacologia* 41(1):253–269.
- Omernik, J.M. 1987. Ecoregions of the conterminous United States. Map (scale 1:7,500,000). *Annals of the Association of American Geographers* 77(1):118–125.
- Pilsbry, H.A. 1939. Land Mollusca of North America (North of Mexico). Academy of Natural Sciences of Philadelphia, Monographs 3(1 part 1):1–574.
- Pilsbry, H.A. 1940. Land Mollusca of North America (North of Mexico). Academy of Natural Sciences of Philadelphia, Monographs 3(1 part 2):575–994.
- Pilsbry, H.A. 1946. Land Mollusca of North America (North of Mexico). Academy of Natural Sciences of Philadelphia, Monographs 3(2 part 1):1–520.
- Pilsbry, H.A. 1948. Land Mollusca of North America (North of Mexico). Academy of Natural Sciences of Philadelphia, Monographs 3(2 part 2):521–1113.
- Ponder, W.F., G.A. Carter, P. Flemons, and R.R. Chapman. 2001. Evaluation of museum collection data for use in biodiversity assessment. *Conservation Biology* 15(3):648–657.
- Ricketts, T.H., E. Dinerstein, D.M. Olson, C.J. Loucks, W. Eichbaum, D. Dellasala, K. Kavanagh, P. Hedao, P.T. Hurley, K.M. Carney, R. Abell, and S. Walters. 1999. *Terrestrial Ecoregions of North America: A Conservation Assessment*. Island Press, Washington, DC.
- Riggle, R.S. 1976. Quantitative examination of gastropod and soil relationships in oak-hickory forest in the lower Illinois Valley region. *Sterkiana* 62:1–17.
- Roth, B., and P.S. Sadeghian. 2003. Checklist of the land snails and slugs of California. Santa Barbara Museum of Natural History, Santa Barbara, CA. Contributions in Science Number 3. 81 pp.
- Schileyko, A.A. 2002. Treatise on recent terrestrial pulmonate molluscs. Part 8. Punctidae, Helicodiscidae, Discidae, Cystopeltidae, Euconulidae, Trochomorphidae. *Ruthenica*, Supplement 2:1035–1166.
- Schileyko, A.A. 2003. Treatise on recent terrestrial pulmonate molluscs. Part 10. Ariophantidae, Ostracolethidae, Ryssotidae, Milacidae, Dyakiidae, Staffordiidae, Gastrodontidae, Zonitidae, Daudebardiidae, Parmacellidae. *Ruthenica*, Supplement 2:1309–1466.
- Theler, J. L. D.G. Wyckoff, and B.J. Carter. 2004. The Southern Plains Gastropod Survey: The distribution of land snail populations in an American grassland environment. *American Malacological Bulletin* 18:1–21.
- Turgeon, D.D., J.F. Quinn, A.E. Bogan, E.V. Coan, F.G. Hochberg, W.G. Lyons, P.M. Mikkelsen, R.J. Neves, C.F.E. Roper, G. Rosenberg, B. Roth, A. Scheltema, F.G. Thompson, M. Vecchione, and J.D. Williams. 1988. Common and Scientific Names of Aquatic Invertebrates from the United States and Canada: Mollusks. American Fisheries Society Special Publication 16:1–536.
- US Environmental Protection Agency. 2005. Level III Ecoregions. (Based on Omernik 1987). Available at: [http://www.epa.gov/wed/pages/ecoregions/level\\_iii.htm](http://www.epa.gov/wed/pages/ecoregions/level_iii.htm).
- Walker, B. 1928. The terrestrial shell-bearing Mollusca of Alabama. *Miscellaneous Publications of the Museum of Zoology, University of Michigan* 18:1–180.

Appendix 1. List of species and their locations.

Species	Sites														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Helicinidae															
<i>Oligyra orbiculata</i> Say, 1818	X			X					X					X	
Ellobiidae															
<i>Carychium exile</i> Lea, 1842		X			X		X							X	X
<i>Carychium nannodes</i> Clapp, 1905												X		X	
Cochlicopidae															
<i>Cochlicopa morseana</i> (Doherty, 1878)	X													X	
Pupillidae															
<i>Gastrocopta contracta</i> (Say, 1822)	X			X		X						X	X		
<i>Gastrocopta pentodon</i> (Say, 1821)	X					X									
<i>Vertigo gouldii</i> (Binney, 1843)														X	
Strobilopsidae															
<i>Strobilops aeneus</i> Pilsbry, 1926	X			X		X							X	X	
<i>Strobilops labyrinthica</i> (Say, 1817)					X	X						X			
Philomycidae															
<i>Philomycus carolinianus</i> (Bosc, 1802)	X	X				X		X					X		
Patulidae															
<i>Anguispira alternata</i> (Say, 1816)													X	X	
<i>Discus patulus</i> (Deshayes, 1830)													X	X	
Helicodiscidae															
<i>Helicodiscus parallelus</i> (Say, 1817)						X			X						
Punctidae															
<i>Punctum minutissimum</i> (Lea, 1841)				X		X					X	X			
<i>Punctum smithi</i> Morrison, 1935				X											
<i>Punctum vitreum</i> (Baker, 1930)						X			X					X	
Gastrodontidae															
<i>Gastrodonta interna</i> (Say, 1822)	X			X	X	X	X	X	X		X	X	X	X	X
<i>Siriatura meridionalis</i> (Pilsbry & Ferriss, 1906)	X			X	X	X						X	X		

Species	Sites														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
<b>Gastrodontidae</b>															
<i>Ventridens intertextus</i> (Binney, 1841)	X	X													X
<i>Ventridens demissus</i> (Binney, 1843)	X	X				X	X	X		X		X		X	X
<i>Ventridens pilsbryi</i> Hubricht, 1964	X		X	X		X			X	X	X	X	X	X	
<i>Zonitoides arboreus</i> (Say, 1816)															
<b>Euconulidae</b>															
<i>Euconulus dentatus</i> (Sterki, 1893)	X			X		X						X	X	X	
<b>Haplotrematidae</b>															
<i>Haplotrema concavum</i> (Say, 1821)	X	X		X	X	X	X			X		X	X	X	X
<b>Zonitidae</b>															
<i>Glyphyalinia carolinensis</i> (Cockerell, 1890)				X								X			
<i>Glyphyalinia cryptomphala</i> (Clapp, 1915)		X		X	X	X				X	X	X	X	X	X
<i>Glyphyalinia indentata</i> (Say, 1823)	X	X		X	X	X						X	X	X	X
<i>Glyphyalinia praecox</i> (Baker, 1930)											X				
<i>Glyphyalinia wetherbyi</i> (Cockerell, 1900)	X	X										X	X	X	
<i>Glyphyalinia wheateleyi</i> (Bland, 1883)				X	X	X						X	X	X	
<i>Hawaia minuscula</i> (Binney, 1841)	X			X											
<i>Mesomphix capnodes</i> (Binney, 1857)		X			X		X	X						X	X
<i>Mesomphix globosus</i> (MacMillan, 1940)	X	X		X	X	X	X	X			X	X	X	X	X
<i>Mesomphix latior</i> (Pilsbry, 1900)	X			X			X		X			X	X	X	X
<i>Mesomphix pilsbryi</i> (Clapp, 1904)															
<i>Paravitrea capsella</i> (Gould, 1805)													X		
<i>Paravitrea multidentata</i> (A. Binney, 1840)													X	X	
<b>Polygyridae</b>															
<i>Euchemotrema fasciatum</i> (Pilsbry, 1940)	X					X	X	X					X		
<i>Inflectarius inflectus</i> (Say, 1821)											X				
<i>Lobosculum pustuloides</i> (Bland, 1858)					X							X	X	X	X
<i>Mesodon normalis</i> (Pilsbry, 1900)	X	X		X		X		X	X	X					
<i>Mesodon thyroidus</i> (Say, 1816)	X	X	X	X	X	X	X			X				X	X
<i>Mesodon zaletus</i> (A. Binney, 1837)	X						X								

Species	Sites														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Polygyridae															
<i>Millerelix plicata</i> (Say, 1821)						X	X	X							
<i>Paterra perigrapta</i> (Pilsbry, 1894)	X			X		X		X			X	X	X	X	X
<i>Stenotrema barbigerrum</i> (Redfield, 1856)	X			X		X	X	X				X	X	X	X
<i>Stenotrema stenotrema</i> (Pfeiffer, 1842)				X			X	X				X	X	X	X
<i>Triodopsis tridentata</i> (Say, 1816)			X	X	X	X	X				X	X	X	X	X
<i>Triodopsis vulgata</i> Pilsbry, 1940						X		X						X	
<i>Xolotrema obstrictum</i> (Say, 1821)						X	X			X			X	X	X