

THE FAUNA OF CAVES AND OTHER SUBTERRANEAN HABITATS OF NORTH CAROLINA, USA

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Abstract

Over 1,500 caves have been documented in North Carolina, however, cave fauna in the Blue Ridge Mountains and Piedmont regions of North Carolina have been overlooked historically compared to the cave-rich karst terrains in the Appalachian Valley and Ridge and Interior Low Plateau to the west. Here, we provide the first comprehensive faunal list of caves and other subterranean habitats in the state based on over 40 years of periodic surveys and compilation of literature, biodiversity databases, and museum records. We report 475 occurrences from 127 caves, springs, and wells in 29 counties, representing 5 phyla, 17 classes, 43 orders, 90 families, 124 genera, and at least 164 species. Vertebrate fauna comprised 32 species, including 4 fishes, 9 salamanders, 1 lizard, 4 snakes, 2 birds, and 12 mammals (8 bats). Diverse invertebrate groups included spiders (11 families and 18 genera), springtails (7 families and 9 genera), segmented worms (3 families and 8 genera), and snails (6 families and 9 genera). At least 25 taxa are troglobites/stygobites (cave obligates), including 5 species of cave flatworms, 5 cave springtails, and 5 cave amphipods. Most troglotic/stygotitic fauna documented in this study are endemic to North Carolina. Counties with the greatest cave biodiversity include Rutherford, McDowell, Swain, Henderson, Polk, and Avery counties. Over 20 species documented are of conservation concern, including 14 troglobites and 3 federally-listed bats. Although not as diverse as adjacent states, caves and other subterranean habitats in North Carolina support a diverse community of invertebrates and vertebrates. Our review serves as a base line for future cave biological surveys in the state and highlights the importance of subterranean habitats for North Carolina biodiversity.

Introduction

Caves and associated subterranean habitats are home to a unique and taxonomically diverse assemblage of invertebrate and vertebrate organisms in North America. In addition to the more than 1,350 species that are obligate inhabitants of terrestrial and aquatic subterranean habitats in the United States (i.e., troglobites and stygobites) (Niemiller et al., 2019), hundreds of other species use caves on an occasional to semi-permanent basis. Most of this subterranean diversity is known from the ten major karst biogeographic regions defined in the United States that are associated with carbonate exposures (Culver et al., 2003; Hobbs, 2012). Several additional smaller karst regions exist, but these regions have received comparatively little attention from biospeleologists.

The fauna of caves and associated subterranean habitats in the Blue Ridge Mountains and Piedmont physiographic provinces of North Carolina has been grossly understudied compared to subterranean fauna of the cave-rich Appalachian and Interior Low Plateau karst to the west of the Appalachian Mountains in Tennessee, Alabama, Georgia, and Virginia. In contrast to most cave systems in the Appalachians and Interior Low Plateau karst regions, cave systems in North Carolina are predominately non-solutional (i.e., pseudo-karst) and granite-gneiss talus and fissure caves, in particular. A few troglobites and stygobites are known from North Carolina, including some that are endemic to the state, such as the Carolina Groundwater Amphipod (*Stygobromus carolinensis*) and Blowing Springs Cave Springtail (*Pseudosinella flatua*). The bat fauna from several caves and mines has been characterized (Boynton et al., 1992), particularly in association to winter hibernation surveys in recent years (e.g., North Carolina Wildlife Resources Commission, 2017b). However, a comprehensive, annotated list of the subterranean fauna of North Carolina has never been published.

In early 1972, after the Flittermouse Grotto of the National Speleological Society was chartered, its members initiated the North Carolina Cave Survey (NCCS) to track and catalog caves in the state. In conjunction with this statewide cave inventory, and with the suggestion and encouragement of the late Dr. John Cooper, former Director of Research and Collections at the North Carolina State Museum of Natural Sciences, a survey of North Carolina's little-known cave fauna also began. Here we report new distributional records of subterranean fauna documented during periodic surveys of caves between 1970 and 2018 conducted by the lead author and maintained by the NCCS. We also compiled occurrence records from caves and other subterranean habitats (e.g., wells, springs, and seeps) for invertebrate and vertebrate fauna of North Carolina from several sources, including published and unpublished literature, databases, and museum collections. We include these data to generate the first comprehensive faunal list from caves in the state.

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Materials and Methods

STUDY REGION AND GEOLOGICAL SETTING

North Carolina lies in the southeastern United States bordered on the east by the Atlantic Ocean, on the south by South Carolina and Georgia, on the west by Tennessee, and on the north by Virginia. The state is divided into three physiographic regions: i) the Blue Ridge Mountains, composed of assorted igneous, metamorphic, volcanic, and sedimentary rocks of widely ranging ages; ii) the Piedmont Plateau consisting primarily of metamorphic and igneous rocks, and iii) the extensive Coastal Plain with its sands, clays, phosphates, and limestone, making up 45% of the state.

As of October 2018, the North Carolina Cave Survey (NCCS) has 1,582 caves on record (Figure 1). Some states limit the term “cave” to a specific length measure; for example, several state cave surveys require that a passage be at least 50 feet (15.2m) in length to be considered a cave. Karst regions and solution caves are not common in North Carolina, thus the NCCS recognizes the term as any naturally occurring opening within the earth capable of being entered by a human. True karst (solution) caves are limited to a few areas of the state. Madison County has three cave-bearing geological formations: Shady Dolomite, the Honaker Limestone, and a dolomite member of the Rome formation. Several significant caves have been dissolved out of the Murphy Marble in Swain County. The Cambrian age Shady Dolomite also occurs in McDowell County where numerous caves have resulted, including Linville Caverns, a well-known commercial cave. Finally, on the Coastal Plain, Eocene age limestones harbor several small solutional caves.

What the state is lacking in karst is more than made up for in its pseudokarst. Most caves in North Carolina are, in fact, pseudokarstic in origin, created not by solution but by physical processes, such as gravity-sliding producing talus and fissure caves, often in igneous and metamorphic rocks (Holler, 2019). Several of these are surprisingly extensive. Bat Cave, for example, has over 2 km of surveyed passages and represents the longest known pseudokarst cave of its type (augen-gneiss) in the world (Holler, 1981; Holler and Holler, 2009).

BIOLOGICAL INVENTORIES

The lead author (CH) conducted periodic biological inventories of caves and fissures in North Carolina from 1970 to 2018. Most of the cave surveys were in the western North Carolina counties of Avery, Burke, McDowell, Rutherford, and Swain. Bioinventories involved visual-encounter surveys for cave life in terrestrial, riparian, and aquatic habitats, such

as entrance areas, cave walls and ceilings, mud banks, rimstone pools, and cave streams. These surveys systematically traversed the cave from the entrance to the farthest extent of the cave explorable by the research team. Search effort included lifting rocks and other cover, as well as searching through cobbles, detritus, and organic matter. Depending on the extent of the cave system, each survey typically involved 2 to 4 surveyors (maximum 4), with a search effort of 2 to 36 person-hours per cave visit. For vertebrates (other than mammals), an effort was made to capture each individual observed either by hand or with dip nets to confirm identification and obtain voucher photographs. A concerted effort was made to capture representatives of each invertebrate species observed as voucher specimens. Specimens were collected by hand with the aid of brushes, aspirator, or fine-meshed dip nets for aquatic taxa, and placed into 70–100% ethanol. In some instances, Berlese funnels were used to collect tiny specimens within leaves and detritus. Specimens were sorted in the laboratory and identified to the lowest taxonomic level possible using published taxonomic keys and species descriptions. Specimens of several taxonomic groups were sent to experts for identification. In some cases, identification to the species level was not possible due to collection of immature specimens or lack of taxonomic expertise for some groups.

We searched for additional distributional records of invertebrates and vertebrates in North Carolina caves in the scientific literature, unpublished reports, biodiversity databases, and museum accession records. Literature sources included peer-reviewed journals, books, proceedings, theses and dissertations, government reports, and caving organization newsletters. Searches of literature sources included keyword queries of ISI Web of Science, Google Scholar, and Zoological Record. We also queried the VertNet database (<http://www.vertnet.org>), a web portal to search accessions of over 170 vertebrate museum collections from 12 countries. The U.S. Geological Survey Bat Population Database (Ellison et al., 2003) was queried for bat observations from caves in North Carolina. We also queried the

Figure 1. Distribution of the 1,582 caves by county in North Carolina. Data from the North Carolina Cave Survey (NCCS) as of October 2018.



Symbiota Collections of Arthropods Network (SCAN) database (<https://scan-bugs.org/portal/>), a web portal to search over 21 million arthropod records in over 215 museum collections, and InvertEBase (<http://www.invertebase.org/portal/index.php>), a web portal to search 18 arthropod and mollusk collections in the United States. Institutions for which accessions included specimens collected from North Carolina include Carnegie Museum of Natural History (CMNH), Denver Museum of Nature & Science (DMNS), Field Museum of Natural History (FMNH), North Carolina Museum of Natural Sciences (NCSM), University of Florida Museum of Natural History (UF), Museum of Comparative Zoology at Harvard University, Museum of Vertebrate Zoology at University of California-Berkeley (MVZ), Royal Ontario Museum (ROM), San Diego State University Museum of Biodiversity (SDSU), Smithsonian National Museum of Natural History (USNM), and University of Michigan Museum of Zoology (UMMZ). We also searched the North Carolina Natural Heritage Program database for occurrences (<https://www.ncnhp.org/data/species-community-search>).

The annotated list of invertebrate and vertebrate fauna includes the scientific name, authority, ecological classification, common name, and conservation status for each species. Taxonomic nomenclature primarily followed the Encyclopedia of Life (<http://www.eol.org>). We used common names from published sources when available (e.g. NatureServe). We note the type locality for species described from caves or other subterranean habitats in North Carolina. Classifications of cave-associated organisms (cavernicoles) have been proposed by several authors (e.g., Barr, 1968; Sket, 2008; Culver and Pipan, 2009). We used terminology from Barr (1968) with clarification from Sket (2008) and Culver and Pipan (2009), depending on the taxa, to indicate species found in terrestrial (trogl-) versus aquatic (stygo-) habitats. The four primary ecological categories, with the abbreviations used in the fauna list below and Table 2, were troglobite or stygobite (TB or SB, respectively), troglophile or stygophile (TP or SP) (synonym: eutroglophile), troglaxene or stygaxene (TX or SX) (synonym: subtroglophile), and accidental (AC) (synonym: troglaxene, sensu Sket, 2008). Troglobites and stygobites are obligate cavernicoles with morphological, physiological, and behavioral adaptations for living in subterranean habitats and that have few to no records from surface habitats. Troglophiles and stygophiles frequent subterranean habitats and can complete their life cycles within caves but also may occur in surface habitats. Troglaxenes and stygaxenes use subterranean habitats seasonally, or for only a portion of their life cycles, but also rely significantly on surface habitats. Accidentals are species found in caves only by accident, such as by falling into a pit or being washed into a cave during a flood. We also include species that are intentionally introduced into caves by humans and would not otherwise occur there naturally in this category (e.g., trout). We also denote edaphobites (ED), species thought to be deep-soil inhabitants that may occasionally occur in caves.

The conservation status of each species, based on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (<http://www.iucnredlist.org/>; accessed 1 December 2019) and NatureServe (<http://www.natureserve.org/>; accessed 1 December 2019), is included to provide a better understanding of the distribution and biogeography of subterranean organisms in North Carolina, and to aid in the future conservation and management of this unique fauna. The status of a species according to the U.S. list of threatened and endangered species under the Endangered Species Act is included (<http://www.fws.gov/endangered>), as well as if a species is included on the list of rare animal species in North Carolina (LeGrand et al., 2014). In addition, we also note species designated "Species of Greatest Conservation Need" in the 2015 North Carolina Wildlife Action Plan (North Carolina Wildlife Resources Commission, 2015).

Seven IUCN Red List categories are recognized on a continuum of increasing extinction risk (International Union for the Conservation of Nature, 2012): Least Concern, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild, and Extinct. Two additional categories are also recognized: Data Deficient, in which a species has been evaluated, but insufficient data are available to determine a conservation rank; and Not Evaluated, in which a species has yet to be evaluated. Critically Endangered, Endangered, and Vulnerable are considered Threatened categories. Species are classified as Threatened provided they meet one of five criteria (International Union for the Conservation of Nature, 2012): (A) past, present, or projected reduction in population size over three generations; (B) small geographic range in combination with fragmentation, population decline or fluctuations; (C) small population size in combination with decline or fluctuations; (D) very small population or very restricted distribution; or (E) a quantitative analysis of extinction risk. The IUCN Red List classification and associated criteria and subcriteria are presented, if applicable. Subcriteria are detailed in International Union for the Conservation of Nature (2012). NatureServe conservation status ranks are based on a one to five scale, from most to least at risk of extinction (Faber-Langendoen et al., 2012): G1 (Critically Imperiled), G2 (Imperiled), G3 (Vulnerable), G4 (Apparently Secure), and G5 (Secure). Two additional ranks associated with extinction exist: GH (Possibly Extinct) and GX (Presumed Extinct). Finally, species that have not been assessed are assigned GNR (Unranked). A Questionable rank qualifier (?) can be used to denote uncertainty in the conservation status rank (e.g., G2?). Status ranks are assessed at three geographic scales: global (G1–5), national (N1–5), and state (S1–5). Ranks at the global and state scales are given in the text and Table 2.

ANNOTATED LIST OF INVERTEBRATE AND VERTEBRATE SUBTERRANEAN FAUNA OF NORTH CAROLINA

Phylum Platyhelminthes
Class Turbellaria
Order Tricladida
Family Planariidae
Genus *Phagocata*

***Phagocata carolinensis* Kenk, 1979 (SB) Carolina Cave Planarian**

LOCALITIES: Burke Co.: One Bat Cave (type locality)¹; McDowell Co.: Wind Cave².

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G1G2 (S1S2 in North Carolina).

COMMENTS: This cave flatworm is known only from these two caves.

REFERENCES: ¹ Kenk (1979b); ² Kenk (1987).

***Phagocata holleri* Kenk, 1979 (SB) Holler's Cave Planarian**

LOCALITIES: Ashe Co.: Mount Jefferson Cave (type locality)¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G1G2 (S1S2 in North Carolina).

COMMENTS: This cave flatworm is known only from the type locality. Specimens have been collected from a seep within the cave. This species was named in honor of the lead author who first discovered this stygobite.

REFERENCES: ¹ Kenk (1979a).

***Phagocata morgani* (Stevens & Boring, 1906) (SP) Morgan's Planarian**

LOCALITIES: Avery Co.: Frying Pan Cave*; McDowell Co.: Staircase Cave*; Rutherford Co.: Bat Cave complex¹; Wilkes Co.: Devils Den Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G4G5 (SNR in North Carolina).

COMMENTS: This species is known from spring-runs, springs, and caves in eastern North America.

REFERENCES: ¹ Hertl (1981); * this study.

***Phagocata procera* Kenk, 1984 (SB) A Cave Planarian**

LOCALITIES: Burke Co.: Fifty-Fifty Fissure², Flatworm Fissure²; Jackson Co.: Cat Den Cave (type locality)^{1,2}; McDowell Co.: Lake Tahoma Cave²; Mitchell Co.: Buckshot Cave²; Yancey Co.: seep on State Road 128², Mount Mitchell².

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G1G2 (S1S2 in North Carolina).

COMMENTS: This stygobite was described from Cat Den Cave in Jackson County but has been found in several caves and springs in western North Carolina.

REFERENCES: ¹ Kenk (1984); ² Kenk (1987).

***Phagocata pygmaea* Kenk, 1987 (SB) A Cave Planarian**

LOCALITIES: Stokes Co.: Turtle Shell Cave (type locality)¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

COMMENTS: This small cave flatworm is known only from the type locality.

REFERENCES: ¹ Kenk (1987).

***Phagocata spuria* Kenk, 1987 (SB) A Cave Planarian**

LOCALITIES: McDowell Co.: Bennett's Mill Cave (type locality)¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

COMMENTS: This species is similar in appearance to *P. morgani* but is known only from the type locality.

REFERENCES: ¹ Kenk (1987).

***Phagocata* sp. (SP) A Planarian**

LOCALITIES: Ashe Co.: Mount Jefferson Cave*; Burke Co.: Crystal Worm Cave*; Flaky Lips Fissure Cave*; Henderson Co.: Stillers Cave*.

COMMENTS: Flatworms collected from these caves were immature and could not be identified confidently to species.

REFERENCES: * this study.

***Phagocata* sp.? (SP) A Planarian**

LOCALITIES: Avery Co.: Charlie's Ridge Bat Cave*; Buncombe Co.: Cedar Cliff Cave*; Mitchell Co.: Buckshot Cave*; Surry Co.: Mitchell River Cave*.

COMMENTS: These immature flatworms resembled *Phagocata* but may be another related genus.

REFERENCES: * this study.

Phylum Annelida
Class Clitellata
Order Haplotaxida
Family Acanthodrilidae
Genus *Diplocardia*

***Diplocardia caroliniana* Eisen, 1899 (ED) An Earthworm**

LOCALITIES: Macon Co.: Marie Cave¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

COMMENTS: *Diplocardia* sp. have been reported from caves in Illinois and Missouri (Peck and Lewis, 1978).

REFERENCES: ¹ Reynolds (1994).

Family Lumbricidae
Genus *Aporrectodea*

***Aporrectodea trapezoides* (Duges, 1828) (ED) Southern Worm**

LOCALITIES: Macon Co.: Horse Cave¹, Marie Cave¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

COMMENTS: This species has also been reported from caves in Georgia, Illinois, and Missouri (Peck and Lewis, 1978; Reeves and Reynolds, 1999; Reeves et al., 2000).

REFERENCES: ¹ Reynolds (1994).

Genus *Dendrobaena*

***Dendrobaena octaedra* (Savigny, 1826) (ED) Octagonal-tail Worm**

LOCALITIES: Macon Co.: Horse Cave¹, Marie Cave¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

COMMENTS: This species has also been reported from a cave in Georgia (Reeves and Reynolds, 1999).

REFERENCES: ¹ Reynolds (1994).

Genus *Dendrodrilus*

***Dendrodrilus rubidus* (Savigny, 1826) (ED) European Earthworm**

LOCALITIES: Macon Co.: Horse Cave¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

COMMENTS: This species has also been reported from several caves in Georgia, Illinois, Missouri, Tennessee and New Brunswick, Canada (McAlpine and Reynolds, 1977; Peck and Lewis, 1978; Reeves and Reynolds, 1999; Reeves et al., 2000).

REFERENCES: ¹ Reynolds (1994).

Genus *Eisenoides*

***Eisenoides lonnbergi* (Michaelsen, 1894) (ED) American Grey Soil Worm**

LOCALITIES: Macon Co.: Horse Cave¹; Rockingham Co.: Pine Hill Cave¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

COMMENTS: The only reported cave records of this wide-ranging, common earthworm are from North Carolina to date.

REFERENCES: ¹ Reynolds (1994).

Genus *Lumbricus*

***Lumbricus rubellus* Hoffmeister, 1843 (ED) Red Marshworm**

LOCALITIES: Macon Co.: Horse Cave¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

COMMENTS: This species has also been reported from caves in Georgia and Illinois (Peck and Lewis 1978; Reeves et al. 2000).

REFERENCES: ¹ Reynolds (1994).

Genus *Octolasion*

***Octolasion tyrtaeum* (Savigny, 1826) (ED) Woodland White Worm**

LOCALITIES: Macon Co.: Horse Cave¹; Rockingham Co.: Pine Hill Cave¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

COMMENTS: This species has also been reported from caves in Georgia, Illinois, and Tennessee (Holsinger and Peck, 1971; Peck and Lewis, 1978; Lewis, 2005a), including Great Smoky Mountains National Park (Reeves, 2000b).

REFERENCES: ¹ Reynolds (1994).

**Family Sparganophilidae
Genus *Sparganophilus***

***Sparganophilus eiseni* (Smith, 1895) (ED) American Mudworm**

LOCALITIES: Macon Co.: Horse Cave¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

COMMENTS: This species is known from several records in the eastern United States and southeastern Canada, including North Carolina (Reynolds, 1980; McAlpine et al., 2001).

REFERENCES: ¹ Reynolds (1994).

**Phylum Mollusca
Class Gastropoda
Order Neotaenioglossa
Family Pleuroceridae
Genus *Elimia***

Elimia proxima* (Say, 1825) (SX) Sprite *Elimia

LOCALITIES: Rutherford Co.: McGrath Fissure*, Rumbling Bald Spring Cave*, Spring Fissure¹.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G5 (S5 in North Carolina).

COMMENTS: This freshwater snail also has been reported from Santee Cave in Orangeburg Co., South Carolina (Reeves, 2001).

REFERENCES: ¹ Christ (2003); * this study.

**Order Stylommatophora
Family Gastrododontidae
Genus *Zonitoides***

***Zonitoides elliotti* (Redfield, 1856) (TX) Green Gloss**

LOCALITIES: Macon Co.: Horse Cave¹; McDowell Co.: Staircase Cave².

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G4 (S4 in North Carolina).

REFERENCES: ¹ Invertebase: CMNH; ² Invertebase: UF.

**Family Haplotrematidae
Genus *Haplotrema***

***Haplotrema concavum* (Say, 1821) (TX/AC) Grayfoot Lancetooth Snail**

LOCALITIES: Davidson Co.: Boone's Cave¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G5 (S5 in North Carolina).

REFERENCES: ¹ Invertebase: FMNH.

***Haplotrema* sp. (TX/AC) A Lancetooth Snail**

LOCALITIES: Swain Co.: Blowing Springs Cave*.

COMMENTS: A carnivorous genus that feeds on other gastropod. Two species have been documented from western North Carolina, *H. concavum* and the rarer *H. kendeighi* (Dourson, 2013).

REFERENCES: * this study.

**Family Helicodiscidae
Genus *Helicodiscus***

***Helicodiscus saludensis* (Morrison, 1937) (TX/AC) Corncob Snail**

LOCALITIES: Rutherford Co.: Ice Cave¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G1 (S1? in North Carolina).

REFERENCES: ¹ Invertebase: UF.

Family Polygyridae
Genus *Inflectarius*

***Inflectarius inflectus* (Say, 1821) (TX) Shagreen**

LOCALITIES: Davidson Co.: Boone's Cave¹; Henderson Co.: Hog Rock Cave*, Middle Fork Shelter Cave no. 2*; Rutherford Co.: McGrath Fissure*, Rumbling Bald Spring Cave*, Spring Fissure².

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G5 (S5 in North Carolina).

REFERENCES: ¹ Invertebase: FMNH; ² Christ (2003), * this study.

Genus *Mesodon*

***Mesodon andrewsae* Binney, 1879 (AC) Balsam Globe**

LOCALITIES: Polk Co.: World's Edge Fissure*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G3 (S2S3 in North Carolina); Listed as a Species of Greatest Conservation Need in North Carolina (North Carolina Wildlife Resources Commission, 2015).

REFERENCES: * this study.

***Mesodon thyroidus* (Say, 1816) (AC) Whitelip Globe**

LOCALITIES: Rutherford Co.: Devil's Smokehouse Cave¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G5 (S5 in North Carolina).

REFERENCES: ¹ Invertebase: NCSM.

***Mesodon* sp. (AC) A Globe**

LOCALITIES: Madison Co.: Anthodite Cave¹.

COMMENTS: This occurrence may be *M. andrewsae*, *M. thyroidus*, or another species.

REFERENCES: ¹ Invertebase: UF.

Genus *Patera*

***Patera perigrapta* (Pilsbry, 1894) (TX) Engraved Bladetooth**

LOCALITIES: Henderson Co.: Hog Rock Cave*; Madison Co.: French Broad Cave¹; Shutin Creek Cave¹, Polk Co.: Beast Cave¹, Rutherford Co.: Bat Cave², Rumbling Bald Cave¹, White Root Shelter*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G5 (S5? in North Carolina).

REFERENCES: ¹ Invertebase: UF; ² Invertebase: NCSM; * this study.

Family Zonitidae
Genus *Glyphyalinia*

***Glyphyalinia carolinensis* (Cockerell, 1890) (TX/AC) Spiral Mountain Glyph**

LOCALITIES: McDowell Co.: Staircase Cave¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G4 (S4 in North Carolina).

REFERENCES: ¹ Invertebase: UF.

***Glyphyalinia* sp. (TX/AC) A Glyph**

LOCALITIES: Rutherford Co.: Western Talus Tunnel*.

REFERENCES: * this study.

Genus *Mesomphix*

***Mesomphix andrewsae* (Pilsbry, 1895) (TX/AC) Mountain Button**

LOCALITIES: Swain Co.: Lost Nantahala Cave¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G3G4 (S3S4 in North Carolina).

REFERENCES: ¹ Invertebase: UF.

***Mesomphix latior* (Pilsbry, 1900) (TX/AC) Broad Button**

LOCALITIES: Swain Co.: Lost Nantahala Cave¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G3G4 (S2S3 in North Carolina); Listed as a Species of Greatest Conservation Need in North Carolina (North Carolina Wildlife Resources Commission, 2015).

REFERENCES: ¹ Invertebase: UF.

***Mesomphix subplanus* (Binney, 1842) (TX/AC) Flat Button**

LOCALITIES: Rutherford Co.: Bat Cave¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G3G4 (S3S4 in North Carolina).

REFERENCES: ¹ Invertebase: NCSM.

Phylum Arthropoda
Subphylum Chelicerata
Class Arachnida
Order Araneae
Family Agelenidae
Genus *Agelenopsis*

***Agelenopsis* sp. (TX/AC) A Grass Spider**

LOCALITIES: Polk Co.: Little Warrior Mountain Cave¹; Rutherford Co.: Rumbling Bald Cave¹.

REFERENCES: ¹ Gaddy (1986b).

Genus *Coras*

***Coras* sp. (TX) A Funnel Weaver Spider**

LOCALITIES: Henderson Co.: Hog Rock Cave²; Polk Co.: Little Warrior Mountain Cave¹; Rutherford Co.: Bat Cave¹, Cane Creek Mountain Cave², Rumbling Bald Cave¹, Sliding Rock Cave*, Western Talus Tunnel²; Yancey Co.: Celo Cave*.

REFERENCES: ¹ Gaddy (1986b); ² Christ (2003); * this study.

Genus *Wadotes*

***Wadotes bimucronatus* (Simon, 1898) (TX/AC) Hackledmesh Weaver Spider**

LOCALITIES: Swain Co.: Blowing Springs Cave*

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

REFERENCES: * this study.

***Wadotes* sp. (TX/AC) A Weaver Spider**

LOCALITIES: Rutherford Co.: Bat Cave complex¹.

REFERENCES: ¹ Hertl (1981).

Undetermined Genus

Undetermined species (TX/AC) A Weaver Spider

LOCALITIES: Henderson Co.: Devils Kitchen Cave¹; Rutherford Co.: A-Frame Fissure¹, Moonshiners Cave*, Rumbling Bald Cave¹.

REFERENCES: ¹ Christ (2003); * this study.

**Family Antrodiaetidae
Genus *Antrodiaetus***

***Antrodiaetus unicolor* (Hentz, 1842) (TX) Collar Door Spider**

LOCALITIES: McDowell Co.: Wind Cave*; Rutherford Co.: Rumbling Bald Cave*, Western Talus Tunnel¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

COMMENTS: This is a burrowing species; most records were of wandering adult males.

REFERENCES: ¹ Christ (2003); * this study.

**Family Araneidae
Genus *Mangora***

***Mangora maculata* (Keyserling, 1865) (TX/AC) Green-legged Orbweaver**

LOCALITIES: Rutherford Co.: Western Talus Tunnel¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

REFERENCES: ¹ Christ (2003).

**Family Cybaeidae
Genus *Calymmaria***

***Calymmaria persica* (Hentz, 1847) (TX) A Dwarf Sheet Spider**

LOCALITIES: Caldwell Co.: Nats Cave*; Rutherford Co.: Bat Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).
 COMMENTS: This is one of over 30 known species of *Calymmaria*, all from North America.
 REFERENCES: * this study.

Family Hypochilidae
Genus Hypochilus

***Hypochilus coylei* Platnick, 1987 (TX) A Lampshade Weaver**

LOCALITIES: Polk Co.: Little Warrior Mountain Cave²; Rutherford Co.: Bat Cave², Breakdown Cave¹, Rumbling Bald Cave², Sliding Rock Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G3? (S3? in North Carolina).
 COMMENTS: This species lives an average of two years and feeds on other spiders and crickets.
 REFERENCES: ¹ SCAN: SDSU; ² Gaddy (1986b); * this study.

***Hypochilus pococki* Platnick, 1987 (TX) Pocock's Lampshade-web Spider**

LOCALITIES: Avery Co.: Elk River Cave²; McDowell Co.: Linville Caverns¹; Transylvania Co.: Snake Den no. 2 Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G4G5 (SNR in North Carolina).
 REFERENCES: ¹ SCAN: DMNS; ² SCAN: SDSU; * this study.

***Hypochilus* sp. (TX) A Lampshade Weaver**

LOCALITIES: Henderson Co.: Devils Kitchen Cave¹; Madison Co.: French Broad Cave*; Polk Co.: Garnet Shelter Cave¹, World's Edge Cave¹; Rutherford Co.: Breakdown Cave*, Cane Creek Mountain Cave¹, Moonshiners Cave*, Western Talus Tunnel¹.

COMMENTS: The records represent collections of immatures or visual observations only that could not be identified to species.
 REFERENCES: ¹ Christ (2003); * this study.

Family Linyphiidae
Genus Miconeta

***Miconeta viaria* (Blackwell, 1841) (TX/AC) Small Sheetweb Weaver**

LOCALITIES: Polk Co.: World's Edge Fissure¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.
 REFERENCES: ¹ Christ (2003).

Genus Origanates

***Origanates rostratus* (Emerton, 1882) (TX/AC) A Sheetweb Weaver**

LOCALITIES: Henderson Co.: Stillers Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).
 REFERENCES: * this study.

Genus Phanetta

***Phanetta subterranea* (Emerton, 1875) (TB) Subterranean Sheetweb Spider**

LOCALITIES: McDowell Co.: Lake Tahoma Cave*; Rutherford Co.: Breakdown Cave*, White Root Shelter¹; Yancey Co.: Cooper's Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G5 (SNR in North Carolina).
 COMMENTS: Like many linyphiids, this species is likely more common in North Carolina caves than records indicate but easily overlooked due to its small size.
 REFERENCES: ¹ Christ (2003); * this study.

Genus Porrhomma

***Porrhomma cavernicola* (Keyserling, 1886) (TB) Appalachian Cave Spider**

LOCALITIES: Swain Co.: Blowing Springs Cave*, Lost Nantahala Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G5 (SNR in North Carolina).
 COMMENTS: This wide-ranging troglobite is known from several caves in the Appalachian Valley and Ridge and Interior Low Plateau (Fong et al., 2012; Niemiller et al., 2013).
 REFERENCES: * this study.

Undetermined Genus

Undetermined species (TX/AC) A Sheetweb Spider

LOCALITIES: Swain Co.: Blowing Springs Cave*.

COMMENTS: The specimen was immature.

REFERENCES: * this study.

Family Nesticidae Genus *Nesticus*

Nesticus brimleyi Gertsch, 1984 (TB) A Cave Cobweb Spider

LOCALITIES: Polk Co.: Little Warrior Mountain Cave^{1,4,5,*}; Rutherford Co.: A-Frame Fissure⁷, Bat Cave complex^{2,3,5}, Breakdown Cave^{3,6}, Ice Cave³, Moonshiners Cave*, Rumbling Bald Cave (type locality)^{3,5}, Rumbling Bald Mountain Cave⁷, Rumbling Bald Spring Cave*, Sliding Rock Cave⁷.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G1G2 (S1? in North Carolina).

COMMENTS: This troglobite is endemic to North Carolina.

REFERENCES: ¹ NCNHP; ² Hertl (1981); ³ Gertsch (1984); ^{4,5} Gaddy (1986a,b); ⁶ Hedin (1997b); ⁷ Christ (2003); * this study.

Nesticus carolinensis Gertsch, 1984 (TP) Linville Caverns Spider

LOCALITIES: McDowell Co.: Lime Kiln Cave*, Linville Caverns (type locality)¹⁻⁴, Staircase Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G1? (S1 in North Carolina).

COMMENTS: Gertsch (1984) considered this species a troglophile despite being known only from caves in McDowell County.

REFERENCES: ¹ NCNHP; ² Gertsch (1984); ^{3,4} Hedin (1997a,b); * this study.

Nesticus cooperi Gertsch, 1984 (TP) Lost Nantahala Cave Spider

LOCALITIES: Swain Co.: Blowing Springs Cave¹⁻³, Lost Nantahala Cave (type locality)^{2,3}.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G1 (S1 in North Carolina).

COMMENTS: Although described from a cave, this species is also known from surface records.

REFERENCES: ¹ NCNHP; ² Gertsch (1984); ³ Hedin (1997b).

Nesticus mimus Gertsch, 1984 (TP) A Cobweb Spider

LOCALITIES: Caldwell Co.: Burnt Field Branch Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G2 (S2? in North Carolina).

COMMENTS: This species also is known from surface collections in southwestern Virginia and northwestern North Carolina (Gertsch, 1984).

REFERENCES: * this study.

Nesticus sp. (TP) A Cobweb Spider

LOCALITIES: Madison Co.: Mine Hollow Cave*; McDowell Co.: Wind Cave*; Yancey Co.: Celo Cave*.

COMMENTS: Immatures from these caves could not be identified to species.

REFERENCES: * this study.

Family Pisauridae Genus *Dolomedes*

Dolomedes sp. (TX) A Fishing Spider

LOCALITIES: Avery Co.: Charlie's Ridge Bat Cave*.

COMMENTS: Fishing spiders are observed not infrequently around the entrances and twilight zones of caves. This individual was observed crawling along the floor of a pool pursuing an undescribed species of *Stygobromus* amphipod.

REFERENCES: * this study.

Family Tetragnathidae Genus *Meta*

Meta ovalis (Gertsch, 1933) (TP) Cave Orbweaver

LOCALITIES: Avery Co.: Cranberry Mines*; Jackson Co.: Kitchen Cave*; McDowell Co.: Lime Kiln Cave*, Linville Caverns*, Linville Indian Cave*, Pseudo-Saltpetre Cave*, Staircase Cave*, Wind Cave*; Polk Co.: Little Warrior Mountain Cave¹⁻³; Rutherford Co.: Bat Cave complex^{1,3}, Breakdown Cave*, Ice Cave*, Moonshiners Cave*, Rumbling Bald Cave³, Rumbling Bald Spring Cave*, Sliding Rock Cave*; Swain Co.: Blowing Springs Cave*, Lost Nantahala Cave*; Transylvania Co.: Snake Den no. 2 Cave*; Yancey Co.: Celo Cave*, Cooper's Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

COMMENTS: This species is widely distributed in caves in North Carolina and throughout its range. It is also commonly reported from culverts, basements, and other dark recesses.

REFERENCES: ¹ Hertl (1981); ^{2,3} Gaddy (1986a,b); * this study.

Family Theridiidae
Genus *Cryptachaea*

***Cryptachaea rupicola* (Emerton, 1882) (TX) A Cobweb Spider**

LOCALITIES: Rutherford Co.: Breakdown Cave*, Rumbling Bald Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

REFERENCES: * this study.

Genus *Parasteatoda*

***Parasteatoda tepidariorum* (Koch, 1841) (TX) Common House Spider**

LOCALITIES: Madison Co.: Anthodite Cave*, French Broad Cave*, Shutin Creek Cave*; McDowell Co.: Linville Indian Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

REFERENCES: * this study.

Genus *Tidarren*

***Tidarren sisypoides* (Walckenaer, 1841) (TX/AC) Tent Cobweb Spider**

LOCALITIES: Polk Co.: Little Warrior Mountain Cave^{1,2}; Rutherford Co.: Bat Cave², Rumbling Bald Cave².

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

REFERENCES: ^{1,2} Gaddy (1986a,b).

Undetermined Genus

Undetermined species (TX/AC) A Cobweb Spider

LOCALITIES: Henderson Co.: Devils Kitchen Cave¹.

REFERENCES: ¹ Christ (2003).

Family Theridiosomatidae
Genus *Theridiosoma*

***Theridiosoma gemmosum* (Koch, 1877) (TX) A Ray Orbweaver**

LOCALITIES: Caldwell Co.: Nats Cave*; McDowell Co.: Staircase Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

REFERENCES: * this study.

Order Opiliones
Family Phalangidae
Genus *Leiobunum*

***Leiobunum bicolor* (Wood, 1870) (TX) A Harvestman**

LOCALITIES: McDowell Co.: Lime Kiln Cave*, Linville Caverns*, Staircase Cave*; Rutherford Co.: McGrath Fissure¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

COMMENTS: This genus is known to overwinter, often in large aggregations, in caves.

REFERENCES: ¹ Christ (2003); * this study.

***Leiobunum* sp. (TX) A Harvestman**

LOCALITIES: Avery Co.: Cranberry Mines*; Swain Co.: Lost Nantahala Cave*; Transylvania Co.: Snake Den no. 2 Cave*; Yancey Co.: Celo Cave*, Isom Mica Mine*.

COMMENTS: These records may be *L. bicolor*.

REFERENCES: * this study.

Family Phalangodidae
Genus *Bishopella*

***Bishopella laciniosa* (Crosby & Bishop, 1924) (TP) Bishop's Harvestman**

LOCALITIES: McDowell Co.: Linville Caverns¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

COMMENTS:

REFERENCES: ¹ SCAN: SDSU.

***Bishopella* sp. (TP) A Harvestman**

LOCALITIES: Swain Co.: Blowing Springs Cave*, Lost Nantahala Cave*.

COMMENTS: These records are probably *B. laciniosa*.

REFERENCES: * this study.

Family Travuniidae
Genus *Theromaster*

***Theromaster brunneus* (Banks, 1902) (TX) A Harvestman**

LOCALITIES: Henderson Co.: Devils Kitchen Cave³; McDowell Co.: Linville Caverns¹; Polk Co.: Garnet Shelter Cave³; Rutherford Co.: Bat Cave complex^{1,2}.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

COMMENTS: This armored harvestman is collected occasionally from caves.

REFERENCES: ¹ SCAN: SDSU; ² Hertl (1981); ³ Christ (2003).

Order Pseudoscorpiones
Family Chthoniidae
Genus *Kleptochthonius*

***Kleptochthonius* sp. (TP/TX) A Pseudoscorpion**

LOCALITIES: Henderson Co.: Devil's Kitchen Cave*.

REFERENCES: * this study.

Undetermined Genus

Undetermined species (TX/AC) A Pseudoscorpion

LOCALITIES: Swain Co.: Blowing Springs Cave*.

REFERENCES: * this study.

Family Neobisiidae
Genus *Microcreagris*

***Microcreagris* sp. (TP/TX) A Pseudoscorpion**

LOCALITIES: Polk Co.: Zig-Zag Fissure*.

REFERENCES: * this study.

Subclass Acari
Order Mesostigmata
Family Arctacaridae
Undetermined Genus

Undetermined species (TX/AC) A Mite

LOCALITIES: Rutherford Co.: Bat Cave complex¹.

REFERENCES: ¹ Hertl (1981).

Family Parasitidae
Undetermined Genus

Undetermined species (TX/AC) A Mite

LOCALITIES: Henderson Co.: Devils Kitchen Cave¹; Rutherford Co.: Block Creep Cave¹.

REFERENCES: ¹ Christ (2003).

Family Parholaspididae
Undetermined Genus

Undetermined species (TX/AC) A Mite

LOCALITIES: Henderson Co.: Devils Kitchen Cave¹.

REFERENCES: ¹ Christ (2003).

Order Sarcoptiformes
Family Lohmanniidae
Genus *Lohmannia*

***Lohmannia* sp. (TX) A Mite**

LOCALITIES: Rutherford Co.: Bat Cave complex¹.

REFERENCES: ¹ Hertl (1981).

Family Phthiracaridae
Genus *Steganacarus*

***Steganacarus* sp. (TX) A Mite**

LOCALITIES: Rutherford Co.: Bat Cave complex¹.

REFERENCES: ¹ Hertl (1981).

Order Trombidiformes
Family Bdellidae
Undetermined Genus

Undetermined species (TP/TX) A Mite

LOCALITIES: Rutherford Co.: Block Creep Cave¹.

REFERENCES: ¹ Christ (2003).

Family Rhagidiidae
Undetermined Genus

Undetermined species (TP) A Mite

LOCALITIES: Polk Co.: Garnet Shelter Cave¹, World's Edge Cave¹.

REFERENCES: ¹ Christ (2003).

Subphylum Hexapoda
Class Collembola
Order Entomobryomorpha
Family Entomobryidae
Genus *Entomobrya*

***Entomobrya quadrilineata* Bueker, 1939 (AC) A Springtail**

LOCALITIES: Rutherford Co.: Block Creep Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

COMMENTS: This well-pigmented and eyed springtail is occasionally collected in caves.

REFERENCES: * this study.

Genus *Pseudosinella*

***Pseudosinella collina* Wray, 1952 (TP) A Springtail**

LOCALITIES: Polk Co.: Garnet Shelter Cave¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

COMMENTS: This troglophilic springtail is known from several cave and surface records in the eastern United States.

REFERENCES: ¹ Christ (2003).

***Pseudosinella flatua* Christiansen & Bellinger, 1996 (TB) Blowing Springs Cave Springtail**

LOCALITIES: Swain Co.: Blowing Springs Cave (type locality)^{1,2}.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G1G2 (S1S2 in North Carolina).

COMMENTS: This troglobite is known only from the type locality.

REFERENCES: ¹ Christiansen and Bellinger (1996); ² SCAN: MCZ.

***Pseudosinella gisini carolina* Christiansen & Bellinger, 1996 (TB) Carolina Cave Springtail**

LOCALITIES: Rutherford Co.: McGrath Fissure (type locality)^{1,2}, Rumbling Bald Cave².

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G3G4T1T2 (S1S2 in North Carolina).

COMMENTS: This subspecies is known only from these two caves.

REFERENCES: ¹ Christ (2003); ² Christiansen and Bellinger (1996).

***Pseudosinella orba* Christiansen, 1961 (TB) A Cave Springtail**

LOCALITIES: Polk Co.: World's Edge Cave¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G3G4 (SU in North Carolina).

COMMENTS: This species also is known from caves in Kentucky, Tennessee, Virginia, and West Virginia.

REFERENCES: ¹ Christiansen Grinnell Database.

***Pseudosinella pecki* Christiansen & Bellinger, 1980 (TB) Peck's Cave Springtail**

LOCALITIES: Swain Co.: Hot Pit Cave¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G2G3 (SNR in North Carolina).

COMMENTS: This troglobite is known from caves in several states in the eastern United States (Christiansen and Bellinger, 1980; Reeves et al., 2000).

REFERENCES: ¹ Christiansen Grinnell Database.

***Pseudosinella vespera* Christiansen & Bellinger, 1996 (TB) Bat Cave Springtail**

LOCALITIES: Rutherford Co.: Bat Cave (type locality)¹⁻⁴; Swain Co.: Blowing Springs Cave³.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G2 (S1S2 in North Carolina).

COMMENTS: This troglobite is known from these two North Carolina caves as well as a cave in Bland Co., Virginia.

REFERENCES: ¹ Christiansen Grinnell Database; ² Hertl (1981); ³ Christiansen and Bellinger (1996), ⁴ SCAN: MCZ.

***Pseudosinella* sp. nov.? (TB) A Springtail**

LOCALITIES: Rutherford Co.: White Root Shelter¹.

COMMENTS: This record may represent a new species or one of the described troglobitic taxa.

REFERENCES: ¹ Christ (2003).

**Family Isotomidae
Genus *Folsomia***

***Folsomia candida* Willem, 1902 (TP) White Springtail**

LOCALITIES: Swain Co.: Blowing Springs Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

REFERENCES: * this study.

**Family Lepidocyrtidae
Genus *Lepidocyrtus***

***Lepidocyrtus* sp. (TX) A Springtail**

LOCALITIES: Henderson Co.: Devils Kitchen Cave¹, Hog Rock Cave¹; Polk Co.: World's Edge Cave¹; Rutherford Co.: Sliding Rock Cave¹, White Root Shelter¹.

REFERENCES: ¹ Christ (2003).

**Family Tomoceridae
Genus *Pogonognathellus***

***Pogonognathellus bidentatus* (Folsom, 1913) (TP) A Springtail**

LOCALITIES: Caldwell Co.: Burnt Field Branch Cave*; McDowell Co.: Lake Tahoma Cave*; Polk Co.: Little Warrior Mountain Cave*, World's Edge Cave²; Rutherford Co.: Bat Cave complex¹; Rimstone Skull Cave², Sliding Rock Cave²; Swain Co.: Blowing Springs Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

REFERENCES: ¹ Hertl (1981); ² Christ (2003); * this study.

***Pogonognathellus flavescens* (Tullberg, 1871) (TP) A Springtail**

LOCALITIES: Polk Co.: World's Edge Cave¹; Swain Co.: Blowing Springs Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

REFERENCES: ¹ Christ (2003); * this study.

***Pogonognathellus* sp. (TP) A Springtail**

LOCALITIES: Rutherford Co.: Middle Bat Cave (Bat Cave complex)*.

REFERENCES: * this study.

Order Poduromorpha

Family Onychiuridae

Genus *Onychiurus*

***Onychiurus similis* Folsom, 1917 (TP) A Springtail**

LOCALITIES: Swain Co.: Blowing Springs Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

REFERENCES: * this study.

***Onychiurus* sp. nov.? (TP) A Springtail**

LOCALITIES: Henderson Co.: Devils Kitchen Cave¹.

COMMENTS: This record may represent an undescribed species.

REFERENCES: ¹ Christ (2003).

***Onychiurus* sp. (TP) A Springtail**

LOCALITIES: Henderson Co.: Devils Kitchen Cave¹.

REFERENCES: ¹ Christ (2003).

Genus *Paronychiurus*

***Paronychiurus ramosus* (Folsom, 1917) (TP) A Springtail**

LOCALITIES: Polk Co.: Garnet Shelter Cave¹, Little Warrior Mountain Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

REFERENCES: ¹ Christ (2003); * this study.

Order Symphypleona

Family Arrhopalitidae

Genus *Arrhopalites*

***Arrhopalites* sp. (TP) A Springtail**

LOCALITIES: Swain Co.: Blowing Springs Cave*.

COMMENTS: This specimen was collected from the surface of a cave pool, but unfortunately was lost in the taxonomic lab before species could be determined.

REFERENCES: * this study.

Family Katiannidae

Genus *Sminthurinus*

***Sminthurinus* sp. nov.? (TP) A Springtail**

LOCALITIES: Polk Co.: World's Edge Shelter*.

COMMENTS: This record may represent an undescribed species (K. Christensen, pers. comm.).

REFERENCES: * this study.

Class Entognatha

Order Diplura

Family Campodeidae

Genus *Litocampa*

***Litocampa* sp. (TB) A Cave Bristletail**

LOCALITIES: Henderson Co.: Hog Rock Cave¹, Stillers Cave*; Madison Co.: Mine Hollow Cave*, Shut-In Creek Cave*; McDowell Co.: Lime Kiln Cave*, Staircase Cave*, Wind Cave*; Polk Co.: Little Warrior Mountain Cave*, Zig-Zag Fissure¹; Rutherford Co.: McGrath Fissure¹; Swain Co.: Blowing Springs Cave*, Flowstone Cave*, Lost Nantahala Cave*, Sand Cave*.

COMMENTS: *Litocampa* diplurans are common in caves in Interior Low Plateau and Appalachians karst regions. Cave records from North Carolina may include multiple undescribed species.

REFERENCES: ¹ Christ (2003); * this study.

Family Japygidae
Undetermined Genus

Undetermined species (TP/TX) A Two-pronged Bristletail

LOCALITIES: Polk Co.: Zig-Zag Fissure¹.

COMMENTS: This family is reported rarely from caves in the eastern United States.

REFERENCES: ¹ Christ (2003).

Class Insecta
Order Coleoptera
Family Carabidae
Genus *Scaphinotus*

***Scaphinotus andrewsi montanus* (Valentine, 1935) (TX/AC) A Ground Beetle**

LOCALITIES: Avery Co.: Davis Moonshine Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

COMMENTS: This large beetle was observed dragging its preferred food (a snail) across the cave floor.

REFERENCES: * this study.

Family Coccinellidae
Undetermined Genus

Undetermined species (AC) A Ladybug

LOCALITIES: Rutherford Co.: Rumbling Bald Cave*.

REFERENCES: * this study.

Family Staphylinidae
Genus *Lathrobium*

***Lathrobium* sp. (TX) A Rove Beetle**

LOCALITIES: Jackson Co.: Balsam Cave*.

REFERENCES: * this study.

Genus *Leptusa*

***Leptusa cribratula* (Casey, 1906) (TX) A Rove Beetle**

LOCALITIES: Henderson Co.: Stillers Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

REFERENCES: * this study.

Undetermined Genus

Undetermined species (TX/AC) A Rove Beetle

LOCALITIES: McDowell Co.: Linville Caverns*.

REFERENCES: * this study.

Order Diptera
Family Culicidae
Genus *Culex*

***Culex* sp. (TX) A Mosquito**

LOCALITIES: McDowell Co.: Linville Caverns*.

COMMENTS: Mosquitoes often overwinter in caves.

REFERENCES: * this study.

Family Heleomyzidae
Undetermined Genus

Undetermined species (TX) A Sunfly

LOCALITIES: Swain Co.: Blowing Springs Cave*.

COMMENTS: Heleomyzid flies are common in caves, particularly in winter. The two most common species in caves in the eastern United States are *Amoebaleria defessa* and *Oecothea specus*.

REFERENCES: * this study.

Family Limoniidae
Genus *Chionea*

***Chionea scita* Walker, 1848 (TX) A Crane Fly**

LOCALITIES: Rutherford Co.: Amazing Bat Cave¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

COMMENTS: Crane flies are observed on occasion in the twilight zones of caves.

REFERENCES: ¹ Gaddy (1986a).

***Chionea* sp. (TX) A Crane Fly**

LOCALITIES: Rutherford Co.: Bat Cave complex¹.

COMMENTS: Crane flies are observed on occasion in the twilight zones of caves.

REFERENCES: ¹ Hertl (1981).

Family Muscidae
Undetermined Genus

Undetermined species (TX/AC) A House Fly

LOCALITIES: Rutherford Co.: Bat Cave complex¹.

REFERENCES: ¹ Hertl (1981).

Family Mycetophilidae
Genus *Orfelia*

***Orfelia fultoni* (Fisher, 1940) (TX) Foxfire Fly**

LOCALITIES: Burke Co.: Conley Cove Rockhouse*, Glow Worm Grotto*; McDowell Co.: Lake Tahoma Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

COMMENTS: This bioluminescent fly was found near the entrances and twilight zones of these three caves.

REFERENCES: * this study.

Undetermined Genus

Undetermined species (TX) A Hump-backed Fly

LOCALITIES: Swain Co.: Blowing Springs Cave*.

COMMENTS: Mycetophilid flies are reported frequently from caves.

REFERENCES: * this study.

Family Psychodidae
Undetermined Genus

Undetermined species (TX/AC) A Moth Fly

LOCALITIES: Rutherford Co.: Bat Cave complex¹.

REFERENCES: ¹ Hertl (1981).

Family Sciaridae
Undetermined Genus

Undetermined species (TP/TX) A Dark-winged Fungus Gnat

LOCALITIES: Rutherford Co.: Bat Cave complex¹.

COMMENTS: Sciarid flies are reported frequently from caves.

REFERENCES: ¹ Hertl (1981).

Order Ephemeroptera
Family Heptageniidae
Genus *Stenonema*

***Stenonema* sp. (AC) A Mayfly**

LOCALITIES: Onslow Co.: Brinson's Rockhouse Cave*.

REFERENCES: * this study.

Order Hemiptera
Family Cicadellidae
Genus *Erythroneura*

***Erythroneura* sp. (AC) A Leafhopper**

LOCALITIES: Rutherford Co.: Block Creep Cave¹.

REFERENCES: ¹ Christ (2003).

Family Reduviidae
Genus *Empicoris*

***Empicoris* sp. (AC) A Thread-legged Bug**

LOCALITIES: Rutherford Co.: Block Creep Cave¹.

REFERENCES: ¹ Christ (2003).

Order Hymenoptera
Family Braconidae
Undetermined Genus

Undetermined species (AC) A Parasitoid Wasp

LOCALITIES: Rutherford Co.: Bat Cave complex¹.

REFERENCES: ¹ Hertl (1981).

Family Formicidae
Undetermined Genus

Undetermined species (AC) An Ant

LOCALITIES: Rutherford Co.: Dusty Bat Cave*.

REFERENCES: * this study.

Order Lepidoptera
Family Erebidae
Genus *Scoliopteryx*

***Scoliopteryx libatrix* (Linnaeus, 1758) (TX) Herald Moth**

LOCALITIES: Ashe Co.: Three Top Mountain Wildcat Den*; Avery Co.: Cranberry Mines*; Burke Co.: Cardboard Cave*; Henderson Co.: Cloven Cliffs Cave*, Devils Kitchen Cave*; McDowell Co.: Bennett's Mill Cave*; Rutherford Co.: Break-down Cave*; Stokes Co.: *Scoliopteryx* Column Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G5 (SNR in North Carolina).

COMMENTS: This species commonly overwinters in caves in eastern North America.

REFERENCES: * this study.

Order Neuroptera
Family Myrmeleontidae
Undetermined Genus

Undetermined species (AC) An Antlion

LOCALITIES: Henderson Co.: Indian Cave*.

REFERENCES: * this study.

Order Orthoptera
Family Rhabdophoridae
Genus *Ceuthophilus*

***Ceuthophilus* sp. (TX) A Camel Cricket**

LOCALITIES: McDowell Co.: Staircase Cave*, Limekiln Cave*.

COMMENTS: These records are likely *C. gracilipes*.

REFERENCES: * this study.

Genus *Euhadenoecus*

***Euhadenoecus adelphus* Hubbell & Norton, 1978 (TX) A Cave Cricket**

LOCALITIES: Macon Co.: Granite City Cave*; Rutherford Co.: Bat Cave complex^{1,2}; Swain Co.: Blowing Springs Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

COMMENTS: Cave crickets were commonly observed in many caves in North Carolina. However, only confirmed records are presented.

REFERENCES: ¹ Hubbell and Norton (1978), ² Hertl (1981), * this study.

***Euhadenoecus puteanus* (Scudder, 1877) (TX) Puteanus Camel Cricket**

LOCALITIES: Madison Co.: Campbells Vegetable Cave²; McDowell Co.: Linville Caverns^{1,2}; Swain Co.: cave in Indian Ridge near Judson².

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

COMMENTS: Cave crickets were commonly observed in many caves in North Carolina. However, only confirmed records are presented.

REFERENCES: ¹ Petrie (1942), ² Hubbell and Norton (1978).

***Euhadenoecus* sp. (TX) A Cave Cricket**

LOCALITIES: Madison Co.: Anthodite Cave*; McDowell Co.: Staircase Cave*; Rutherford Co.: Breakdown Cave*, Moonshiners Cave*; Transylvania Co.: Snake Den no. 2 Cave*; Yancey Co.: Celo Cave*.

COMMENTS: Cave crickets were commonly observed in many caves in North Carolina. However, only confirmed records are presented. These records are either *E. adelphus* or *E. puteanus*.

REFERENCES: * this study.

Order Zygentoma Family Lepismatidae Undetermined Genus

Undetermined species (TX/AC) A Silverfish

LOCALITIES: McDowell Co.: Wind Cave*; Rutherford Co.: Breakdown Cave*, Rumbling Bald Cave*; Swain Co.: Blowing Springs Cave*.

REFERENCES: * this study.

Subphylum Crustacea Class Malacostraca Order Amphipoda Family Crangonyctidae Genus *Stygobromus*

***Stygobromus araeus* (Holsinger, 1969) (SB) Tidewater Interstitial Amphipod**

LOCALITIES: Gates Co.: seepage spring near Merchants Mill Pond^{1,2}.

CONSERVATION STATUS: IUCN: Vulnerable D2 (Inland Water Crustacean Specialist Group 1996a); NatureServe: G3 (SU in North Carolina).

COMMENTS: This small groundwater amphipod also is known from several seepage springs and seep-fed streams in the Coastal Plain of Virginia (Culver et al., 2012).

REFERENCES: ¹ Terwilliger (1991); ² Culver et al. (2012).

***Stygobromus carolinensis* Holsinger, 1978 (SB) Carolina Groundwater Amphipod**

LOCALITIES: Yancey Co.: seeps on W side of State Rd 128, 2.4 km N of Blue Ridge Parkway (type locality)¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G1 (S1 in North Carolina).

COMMENTS: This small groundwater amphipod is known only from the type locality.

REFERENCES: ¹ Holsinger (1978).

***Stygobromus* cf. *carolinensis* (SB) A Cave Amphipod**

LOCALITIES: Wilkes Co.: Harrold Mountain Cave*.

COMMENTS: Specimens from Harrold Mountain Cave may be *S. carolinensis* or an undescribed species.

REFERENCES: * this study.

***Stygobromus indentatus* (Holsinger, 1967) (SB) Tidewater Amphipod**

LOCALITIES: Nash Co.: shallow well at Bailey^{1,2}.

CONSERVATION STATUS: IUCN: Vulnerable D2 (Inland Water Crustacean Specialist Group, 1996b); NatureServe: G3 (SU in North Carolina).

COMMENTS: This relatively large groundwater amphipod also is known from several seepage springs and wells in the Coastal Plain of Maryland and Virginia (Culver et al., 2012).

REFERENCES: ¹ Holsinger (1978); ² Culver et al. (2012).

***Stygobromus* nov. sp. A (SB) A Cave Amphipod**

LOCALITIES: Avery Co.: Black Rocks Mystery Cave*, Charlie's Ridge Bat Cave*, Frying Pan Cave*; Burke Co.: Odell Cave*; Henderson Co.: Stillers Cave*; McDowell Co.: Lake Tahoma Cave*, Linville Caverns*, Roadside Surprise Cave*, Staircase Cave*, Wind Cave*; Mitchell Co.: Buckshot Cave*.

COMMENTS: This undescribed species is the most wide-ranging groundwater amphipod in North Carolina.

REFERENCES: * this study.

***Stygobromus* nov. sp. B (SB) A Cave Amphipod**

LOCALITIES: Jackson Co.: seep below Jones Knob¹.

CONSERVATION STATUS: IUCN: not assessed; NatureServe: GNR (S1? in North Carolina).

COMMENTS: This undescribed groundwater amphipod is known only from a seep in Jackson County.

REFERENCES: ¹ NCNHP.

***Stygobromus* sp. (SB) A Cave Amphipod**

LOCALITIES: Buncombe Co.: Cedar Cliff Cave*; McDowell Co.: Roadside Surprise Cave*, Staircase Cave*; Polk Co.: Little Warrior Mountain Cave*.

COMMENTS: These records represent collections of immatures or females that could not be identified to species.

REFERENCES: * this study.

**Order Decapoda
Family Cambaridae
Genus *Cambarus***

***Cambarus asperimanus* Faxon, 1914 (SX) Mitten Crayfish**

LOCALITIES: McDowell Co.: Staircase Cave¹.

CONSERVATION STATUS: IUCN: Least concern; NatureServe: G4 (S4 in North Carolina).

REFERENCES: ¹ NCSM.

***Cambarus bartonii* (Fabricius, 1798) (SP) Common Crayfish**

LOCALITIES: McDowell Co.: Linville Caverns^{1,2}, Staircase Cave¹.

CONSERVATION STATUS: IUCN: Least concern; NatureServe: G5 (S5 in North Carolina).

COMMENTS: This species is common in caves in the Appalachian Valley and Ridge (Fong et al., 2012).

REFERENCES: ¹ NCSM; ² SCAN: USNM.

***Cambarus latimanus* (LeConte, 1856) (SX) Variable Crayfish**

LOCALITIES: Jones Co.: small limestone cave along NC 41 0.9 miles west of Comfort; Onslow Co.: small limestone cave off SR 1222 2 miles NNE of Catherine Lake¹.

CONSERVATION STATUS: IUCN: Least concern; NatureServe: G5 (S5 in North Carolina).

REFERENCES: ¹ NCSM.

Genus *Procambarus*

***Procambarus acutus* (Girard, 1852) (SX) White River Crayfish**

LOCALITIES: Onslow Co.: small limestone cave off SR 1222 2 miles NNE of Catherine Lake¹.

CONSERVATION STATUS: IUCN: Least concern; NatureServe: G5 (S5 in North Carolina).

REFERENCES: ¹ NCSM.

**Order Isopoda
Family Armadillidiidae
Genus *Armadillidium***

***Armadillidium vulgare* Latreille, 1804 (TP) Common Woodlouse**

LOCALITIES: Henderson Co.: Hog Rock Cave¹; Rutherford Co.: Tank Bug Cave*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

COMMENTS: This species is native to Europe but has been introduced throughout North America and is often observed in caves.

REFERENCES: ¹ Christ (2003), * this study.

Family Asellidae
Genus Caecidotea

***Caecidotea carolinensis* Lewis & Bowman, 1977 (SB) Bennett's Mill Cave Isopod**

LOCALITIES: McDowell Co.: Bennetts Mill Cave (type locality)¹⁻³.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G2G3 (SH in North Carolina; Listed as Endangered in North Carolina (NCWRC 2017).

COMMENTS: This stygobite also has been collected from Parlar Cave in Orangeburg Co., South Carolina (Reeves, 2000a) suggesting that this species may be more widespread than currently known.

REFERENCES: ¹ NCNHP; ² SCAN: USNM; ³ Lewis and Bowman (1977).

Family Trichoniscidae
Genus Miktoniscus

***Miktoniscus linearis* (Patience, 1908) (TP) A Terrestrial Isopod**

LOCALITIES: McDowell Co.: Linville Caverns^{1,2}.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

COMMENTS: This species was described in England; however, Schultz (1964) compared three specimens collected from Linville Caverns with specimens redescribed by Vandel (1950) and noted that they were identical.

REFERENCES: ¹ SCAN: USNM; ² Schultz (1964).

Class Maxillopoda
Order Cyclopoida
Family Cyclopidae
Genus Cyclops

***Cyclops* sp. (SP/SX) A Copepod**

LOCALITIES: McDowell Co.: Staircase Cave*.

REFERENCES: * this study.

Genus Diacyclops

***Diacyclops crassicaudis brachycercus* (Kiefer, 1929) (SP) A Copepod**

LOCALITIES: Chatham Co.: well 200 yards south of the Orange-Chatham county line¹; well 12 miles east of Pittsboro¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

COMMENTS: This wide-ranging species in North America is occasional sampled from groundwater habitats (Reid, 2004; Lewis and Reid, 2007).

REFERENCES: ¹ Yeatman (1943).

***Diacyclops jeanneli putei* (Yeatman, 1943) (SB) Carolina Well Copepod**

LOCALITIES: Orange Co.: well 2.7 miles from the Wilson Zoological Laboratory on US 501 (type locality)¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G3G4 (SH in North Carolina); Listed as Special Concern in North Carolina (NCWRC, 2017).

COMMENTS: This subspecies is only known from North Carolina.

REFERENCES: ¹ Yeatman (1943).

***Diacyclops navus* (Herrick, 1882) (SP) A Copepod**

LOCALITIES: Chatham Co.: well 12 miles east of Pittsboro¹; well 2 mi from US 501 between Pittsboro and Moncure¹; well 2.5 north of US 1 near New Elam Christian Church¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

COMMENTS: This species also has been collected from groundwater habitats in Indiana (Lewis and Reid, 2007).

REFERENCES: ¹ Yeatman (1943).

***Diacyclops nearcticus* (Kiefer, 1934) (SP) A Copepod**

LOCALITIES: Chatham Co.: well 1.5 miles north of Fearrington¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G3G4 (SNR in North Carolina).

COMMENTS: This species ranges throughout the eastern and central United States. It also has been collected from groundwater habitats in Florida, Indiana, Kentucky, and Tennessee (Strayer and Reid, 1999; Bruno et al., 2000; Reid, 2004; Lewis and Reid, 2007).

REFERENCES: ¹ Yeatman (1943).

Genus *Eucyclops*

***Eucyclops serrulatus* (Fischer, 1851) (SX) A Copepod**

LOCALITIES: Orange Co.: well 2.7 miles from the Wilson Zoological Laboratory on US 501¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

COMMENTS: This species also is known from Mammoth Cave in Kentucky (Kofoid, 1900).

REFERENCES: ¹ Yeatman (1943).

Genus *Microcyclops*

***Microcyclops rubellus* (Lilljeborg, 1901) (SP) A Copepod**

LOCALITIES: Chatham Co.: well 12 miles east of Pittsboro¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

COMMENTS: This species also is known from groundwater habitats in Illinois, Indiana, Kentucky, and Tennessee (Strayer and Reid, 1999; Lewis and Reid, 2007).

REFERENCES: ¹ Yeatman (1943).

Subphylum Myriapoda

Class Chilopoda

Order Lithobiomorpha

Family Lithobiidae

Genus *Watobius*

***Watobius anderisus* Chamberlin, 1911 (AC) A Centipede**

LOCALITIES: Henderson Co.: Hog Rock Cave¹; Rutherford Co.: McGrath Fissure¹, Western Talus Tunnel¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

REFERENCES: ¹ Christ (2003).

Order Scolopendromorpha

Family Scolopocryptopidae

Genus *Scolopocryptops*

***Scolopocryptops* sp. (AC) A Centipede**

LOCALITIES: Rutherford Co.: Western Talus Tunnel¹.

CONSERVATION STATUS: na.

REFERENCES: ¹ Christ (2003).

Class Diplopoda

Order Chordeumatida

Family Cleidogonidae

Genus *Pseudotremia*

***Pseudotremia fracta nantahala* Hoffman, 1981 (TX) A Millipede**

LOCALITIES: Swain Co.: Blowing Springs Cave (type locality)¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

COMMENTS: This pigmented species is known only from the type locality and from Cliff Ridge near Blowing Springs.

REFERENCES: ¹ Hoffman (1981).

***Pseudotremia shelleyi* Lewis, 2009 (TB) Shelley's Cave Millipede**

LOCALITIES: McDowell Co.: Lime Kiln Cave³; Rutherford Co.: Bat Cave complex^{1,3}; Rumbling Bald Cave (type locality)^{3,4}; Rumbling Bald Spring Cave^{3,4}.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: Not assessed.

COMMENTS: This is the only troglobitic *Pseudotremia* in North Carolina. Several troglobitic *Pseudotremia* are known from the Appalachians and Interior Low Plateau karst regions (Lewis, 2000, 2005b, 2009; Shear, 2008, 2011).

REFERENCES: ¹ Hertl (1981); ² Shelley (2000); ³ Lewis (2009), ⁴ NCSM.

***Pseudotremia* sp. (TP/TX) A Millipede**

LOCALITIES: Avery Co.: Cranberry Mines²; Rutherford Co.: A-Frame Fissure³, Bat Cave complex^{1,2}; Sliding Rock Cave³; Madison Co.: Anthodite Cave².

COMMENTS: Specimens from these caves could not be identified to species.

REFERENCES: ¹ Hertl (1981); ² Shelley (2000); ³ Christ (2003).

**Family Trichopetalidae
Genus *Nannopetalum***

***Nannopetalum vespertilio* Shear, 2003 (TB) Bat Cave Millipede**

LOCALITIES: Rutherford Co.: Bat Cave (type locality)¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: GNR (SNR in North Carolina).

COMMENTS: This troglobite is known only from the type locality and is the smallest known trichopetalid millipede measuring under 4 mm in total length.

REFERENCES: ¹ Shear (2003).

**Order Julida
Family Parajulidae
Genus *Ptyoiulus***

***Ptyoiulus* sp. (TX/AC) A Millipede**

LOCALITIES: Rutherford Co.: Western Talus Tunnel*.

COMMENTS: This genus is known from several surface records in North Carolina (Shelley, 2000).

REFERENCES: * this study.

**Order Polydesmida
Family Macrosterodesmidae
Genus *Chaetaspis***

***Chaetaspis* sp. (TX/AC) A Millipede**

LOCALITIES: Swain Co.: Lost Nantahala Cave¹.

COMMENTS: This genus is known primarily from surface records in North Carolina (Shelley, 2000).

REFERENCES: ¹ Shelley (2000).

**Family Polydesmidae
Genus *Pseudopolydesmus***

***Pseudopolydesmus* sp. (TX/AC) A Millipede**

LOCALITIES: Rutherford Co.: Western Talus Tunnel¹.

COMMENTS: This may be one of four species *Pseudopolydesmus* known primarily from surface records in North Carolina (Shelley, 2000).

REFERENCES: ¹ Christ (2003).

**Order Spirostreptida
Family Cambalidae
Genus *Cambala***

***Cambala annulata* (Say, 1821) (TX) A Millipede**

LOCALITIES: Henderson Co.: Hog Rock Cave¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G5 (SNR in North Carolina).

COMMENTS: This species is known primarily from surface records in several counties in North Carolina (Shelley, 2000).

REFERENCES: ¹ Christ (2003).

***Cambala hubrichti* Hoffman, 1958 (TX) A Millipede**

LOCALITIES: Rutherford Co.: Bat Cave complex¹.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G5 (SNR in North Carolina).

COMMENTS: This species is known primarily from surface records in several counties in North Carolina (Shelley, 2000).

REFERENCES: ¹ Hertl (1981).

***Cambala* sp. (TX) A Millipede**

LOCALITIES: McDowell Co.: Linville Caverns*; Rutherford Co.: McGrath Fissure¹; Swain Co.: Blowing Springs Cave*.

COMMENTS: These records may be either *C. annulata* or *C. hubrichti*.

REFERENCES: ¹ Christ (2003); * this study.

**Class Symphyla
Order Cephalostigmata
Family Scutigereidae
Genus *Scutigere***

***Scutigere* sp. (TP/TX) A Symphylan**

LOCALITIES: Henderson Co.: Devils Kitchen Cave¹; Rutherford Co.: Western Talus Tunnel¹.

COMMENTS: These soil-dwelling arthropods are not well represented in cave collections.

REFERENCES: ¹ Christ (2003).

**Phylum Chordata
Subphylum Vertebrata
Class Actinopterygii
Order Cypriniformes
Family Cyprinidae
Genus *Rhinichthys***

***Rhinichthys cataractae* (Valenciennes, 1842) (AC) Longnose Dace**

LOCALITIES: McDowell Co.: Linville Caverns*.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G5 (S5 in North Carolina).

COMMENTS: This species also has been reported from caves in Minnesota and West Virginia (Dearolf, 1956; Schmidt, 1994; Poly, 2001).

REFERENCES: * this study.

**Order Salmoniformes
Family Salmonidae
Genus *Oncorhynchus***

***Oncorhynchus mykiss* (Walbaum, 1792) (AC) Rainbow Trout**

LOCALITIES: McDowell Co.: Linville Caverns*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G5 (SNA in North Carolina).

COMMENTS: Trout were purposefully stocked at Linville Caverns by the owners.

REFERENCES: * this study.

Genus *Salmo*

***Salmo trutta* Linnaeus, 1758 (AC) Brown Trout**

LOCALITIES: McDowell Co.: Linville Caverns*.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G5 (SNA in North Carolina).

COMMENTS: Trout were purposefully stocked at Linville Caverns by the owners.

REFERENCES: * this study.

Genus *Salvelinus*

***Salvelinus fontinalis* (Mitchill, 1814) (AC) Brook Trout**

LOCALITIES: McDowell Co.: Linville Caverns*.

CONSERVATION STATUS: IUCN: Not assessed; NatureServe: G5 (S5 in North Carolina); Listed as a Species of Greatest Conservation Need in North Carolina (North Carolina Wildlife Resources Commission, 2015).

COMMENTS: Trout were purposefully stocked at Linville Caverns by the owners.

REFERENCES: * this study.

Class Amphibia
Order Caudata
Family Plethodontidae
Genus *Aneides*

***Aneides caryaensis* Patton et al., 2019 (TX) Green Salamander**

LOCALITIES: Henderson Co.: Green Salamander Shelter*.

CONSERVATION STATUS: IUCN: Near Threatened (Hammerson 2004); NatureServe: G3G4 (S2S3 in North Carolina); Listed as Threatened in North Carolina (North Carolina Wildlife Resources Commission, 2017a); Listed as a Species of Greatest Conservation Need in North Carolina (North Carolina Wildlife Resources Commission, 2015). Conservation statuses are for *A. aeneus*, as this species was described last year and has not yet been assessed officially.

COMMENTS: This species is a member of the Green Salamander (*A. aeneus*) species complex and was described recently (Patton et al. 2019). *Aneides aeneus* has been observed infrequently in the twilight zone and entrance area of caves throughout its range (Dearolf, 1956; Osbourn, 2005; M.L. Niemiller, unpublished data). We believe this occurrence to represent a new site for this newly described salamander endemic to Hickory Nut Gorge.

REFERENCES: * this study.

Genus *Desmognathus*

***Desmognathus monticola* Dunn, 1916 (TX/AC) Seal Salamander**

LOCALITIES: McDowell Co.: Linville Caverns*.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G5 (S5 in North Carolina).

COMMENTS: Like other *Desmognathus*, *D. monticola* has been infrequently reported from caves throughout its range (Garton et al., 1993; Pauley, 1993; Osbourn, 2005).

REFERENCES: * this study.

***Desmognathus* sp. (TX/AC) A Dusky Salamander**

LOCALITIES: Rutherford Co.: Rumbling Bald Spring Cave*, White Root Shelter*.

COMMENTS: *Desmognathus* salamanders are infrequently reported from caves in the Blue Ridge Mountains and adjacent Appalachian Valley and Ridge, with most records from the entrance or twilight zones (Wallace, 1984, 2003; Garton et al., 1993; Osbourn, 2005; Niemiller et al., 2016).

REFERENCES: * this study.

Genus *Eurycea*

***Eurycea wilderae* Dunn, 1920 (TX/AC) Blue Ridge Two-lined Salamander**

LOCALITIES: McDowell Co.: Linville Caverns*.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G5 (S5 in North Carolina).

COMMENTS: *Eurycea wilderae* has been reported from a few caves in eastern Tennessee, including Great Smoky Mountains National Park (Wallace, 1984, 2003; Dodd et al., 2001; Niemiller et al., 2016).

REFERENCES: * this study.

Genus *Gyrinophilus*

***Gyrinophilus porphyriticus* (Green, 1827) (TP) Spring Salamander**

LOCALITIES: Rutherford Co.: White Root Shelter*.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G5 (S5 in North Carolina).

COMMENTS: This species is common in caves in the Appalachian Valley and Ridge and Blue Ridge Mountains (Dearolf, 1956; Brandon, 1966; Cooper and Cooper, 1968; Wallace, 1984, 2003; Garton et al., 1993; Dodd et al., 2001; Osbourn, 2005; Miller and Niemiller, 2008; Miller et al., 2008; Niemiller and Miller, 2009; Niemiller et al., 2010).

REFERENCES: * this study.

Genus *Plethodon*

***Plethodon cinereus* (Green, 1818) (TX/AC) Eastern Red-backed Salamander**

LOCALITIES: McDowell Co.: Linville Caverns*.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G5 (S5 in North Carolina).

COMMENTS: This species also has been reported from caves in Indiana, Maryland, Virginia, and West Virginia (Dearolf, 1956; Garton et al., 1993; Osbourn, 2005).

REFERENCES: * this study.

***Plethodon cylindraceus* (Harlan, 1825) (TX) White-spotted Slimy Salamander**

LOCALITIES: McDowell Co.: Linville Caverns*; Rutherford Co.: Breakdown Cave*, Rimstone Skull Cave*.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G5 (S5 in North Carolina).

COMMENTS: *Plethodon cylindraceus* is a member of the Slimy Salamander (*P. glutinosus*) species complex. A few members of this complex, such as *P. glutinosus* and *P. albagula*, are common in caves throughout their respective ranges (Garton et al., 1993; Buhlmann, 2001; Trauth et al., 2004; Taylor and Mays, 2006; Taylor et al., 2015; Niemiller et al., 2016).

REFERENCES: * this study.

***Plethodon metcalfi* Brimley, 1912 (TX) Southern Gray-cheeked Salamander**

LOCALITIES: Polk Co.: Little Warrior Mountain Cave¹.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G4 (S5 in North Carolina).

COMMENTS: *Plethodon metcalfi* is a member of the *P. jordani* species complex. Gaddy (1986a) observed this species (reported as *P. jordani*) at the entrance to Little Warrior Mountain Cave. Highton and Peabody (2000) removed *P. metcalfi* from synonymy with *P. jordani*.

REFERENCES: ¹ Gaddy (1986a).

***Plethodon yonahlossee* Dunn, 1917 (TX) Yonahlossee Salamander**

LOCALITIES: McDowell Co.: Limekiln Cave*, Linville Caverns*, Wind Cave*; Rutherford Co.: Bat Cave complex^{2,3}, Breakdown Cave*, Rumbling Bald Cave*; Watauga Co.: cave along Howard's Creek¹.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G4 (S4 in North Carolina); Listed as a Species of Greatest Conservation Need in North Carolina (North Carolina Wildlife Resources Commission, 2015).

COMMENTS: *Plethodon yonahlossee* from the Bat Cave area in Rutherford County are a unique variant, commonly referred to as the Crevice Salamander. This species is often found in rock crevices (Beane et al., 2010; Niemiller and Reynolds, 2011).

REFERENCES: ¹ VertNet: UF; ² NCSM; ³ Holland (1981); * this study.

Genus *Pseudotriton*

***Pseudotriton ruber* (Latreille, 1801) (TP) Red Salamander**

LOCALITIES: McDowell Co.: Linville Caverns*.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G5 (S5 in North Carolina).

COMMENTS: This species has been reported from several caves in the Interior Low Plateau and Appalachian Valley and Ridge to the west of the study area where it is frequently found in the twilight zone (Buhlmann, 2001; Osbourn, 2005; Camp and Jensen, 2007; Godwin, 2008; Miller et al., 2008; Niemiller and Miller, 2009; Niemiller and Reeves, 2014; Niemiller et al., 2016). *Pseudotriton ruber* has been documented to breed in caves (Miller and Niemiller, 2005; Niemiller et al., 2006; Miller et al., 2008).

REFERENCES: * this study.

Class Reptilia

Order Squamata

Suborder Serpentes

Family Colubridae

Genus *Thamnophis*

***Thamnophis sirtalis* (Linnaeus, 1766) (AC) Common Gartersnake**

LOCALITIES: Wake Co.: Raleigh Mine¹.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G5 (S5 in North Carolina).

COMMENTS: This species also has been reported from caves in Pennsylvania and Tennessee (Dearolf, 1956; Niemiller et al., 2016).

REFERENCES: ¹ VertNet: USNM.

Family Dipsadidae

Genus *Diadophis*

***Diadophis punctatus* (Linnaeus, 1766) (AC) Ring-necked Snake**

LOCALITIES: Burke Co.: Holy Moley Cave*.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G5 (S5 in North Carolina).

COMMENTS: This species has been reported on occasion from caves (Brode, 1958; Cliburn and Middleton, 1983; Pauley, 1993; Niemiller et al., 2016).

REFERENCES: * this study.

Family Viperidae
Genus *Agkistrodon*

***Agkistrodon contortrix* (Linnaeus, 1766) (AC) Copperhead**

LOCALITIES: Burke Co.: Copperhead Cave*; Davidson Co.: New Boone's Cave*.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G5 (S5 in North Carolina).

COMMENTS: This species is observed on occasion around cave entrances (Dearolf, 1956; Pauley, 1993; Dodd et al., 2001; Niemiller et al., 2016).

REFERENCES: * this study.

Genus *Crotalus*

***Crotalus horridus* Linnaeus, 1758 (AC) Timber Rattlesnake**

LOCALITIES: McDowell Co.: Crotalus Shelter*; Polk Co.: Rattlesnake Fissure*.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G4 (S3 in North Carolina); Listed as Special Concern in North Carolina (North Carolina Wildlife Resources Commission, 2017a); Listed as a Species of Greatest Conservation Need in North Carolina (North Carolina Wildlife Resources Commission, 2015).

COMMENTS: This species is observed on occasion around cave entrances (Dearolf, 1956; Garton et al., 1993; Osbourn, 2005).

REFERENCES: * this study.

Suborder Lacertilia
Family Dactyloidae
Genus *Anolis*

***Anolis carolinensis* (Voigt, 1832) (AC) Green Anole**

LOCALITIES: Rutherford Co.: Rumbling Bald Cave*.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G5 (S5 in North Carolina).

COMMENTS: Lizards, including anoles, are not regularly encountered in caves, and all records are suspected to be accidental occurrences.

REFERENCES: * this study.

Class Aves
Order Passeriformes
Family Corvidae
Genus *Corvus*

***Corvus corax* Linnaeus, 1758 (TX/AC) Common Raven**

LOCALITIES: Yancey Co.: Cooper's Cave*.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G5 (S3 in North Carolina); Listed as a Species of Greatest Conservation Need in North Carolina (North Carolina Wildlife Resources Commission, 2015).

COMMENTS: We observed a pair of Common Ravens nesting at a skylight entrance to Cooper's Cave in March 2006.

REFERENCES: * this study.

Family Tyrannidae
Genus *Sayornis*

***Sayornis phoebe* (Latham, 1790) (TX) Eastern Phoebe**

LOCALITIES: Avery Co.: Shelter of the Hands*; McDowell Co.: Staircase Cave*; Yancey Co.: Cooper's Cave*; Watauga Co.: Boone Rockhouse*.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G5 (S5 in North Carolina).

COMMENTS: *Sayornis phoebe* is common throughout the eastern United States and is frequently encountered nesting on ledges in the entrances and twilight zone of caves (Dearolf, 1956; Garton et al., 1993; Fong et al., 2012; Niemiller et al., 2013, 2016; Slay et al., 2016).

REFERENCES: * this study.

Class Mammalia
Order Carnivora
Family Procyonidae
Genus *Procyon*

***Procyon lotor* (Linnaeus, 1758) (TX) Raccoon**

LOCALITIES: McDowell Co.: Wind Cave*.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G5 (S5 in North Carolina).

COMMENTS: Raccoons are known to enter caves throughout the range of the species (Dearolf, 1956; Garton et al., 1993; Niemiller et al. 2016). The authors recall observing raccoon scat in several North Carolina caves.

REFERENCES: * this study.

Order Chiroptera
Family Vespertilionidae
Genus *Corynorhinus*

***Corynorhinus rafinesquii* Handley, 1955 (TX) Rafinesque's Big-eared Bat**

LOCALITIES: Swain Co.: Eagle Creek Mine¹, Sugar Fork Mine¹; Yancey Co.: Cooper's Cave*.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G3G4 (S3 in North Carolina); Listed as Threatened in North Carolina (North Carolina Wildlife Resources Commission, 2017a); Listed as a Species of Greatest Conservation Need in North Carolina (North Carolina Wildlife Resources Commission, 2015).

COMMENTS: This species frequents caves throughout its range, primarily during winter. Populations in the western part of the state associated with mines and occasionally caves are considered *C. r. rafinesquii*.

REFERENCES: ¹ Bat Population Database; * this study.

***Corynorhinus townsendii virginianus* Handley, 1955 (TX) Virginia Big-eared Bat**

LOCALITIES: Avery Co.: Black Coral Cave¹, Black Rock Cliffs Cave¹⁻³, Black Rock Mystery Cave¹, Pilot Knob Cave no. 1¹, Thunder Hole¹, Tom Terrific Cave¹.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G3G4T2 (S1 in North Carolina); Listed as Endangered in North Carolina (North Carolina Wildlife Resources Commission, 2017a); Listed as Endangered under the U.S. Endangered Species Act; Listed as a Species of Greatest Conservation Need in North Carolina (North Carolina Wildlife Resources Commission, 2015).

COMMENTS: This federally endangered species is rare in North Carolina where it has been reported from caves and mines at high elevations in the western part of the state. The IUCN Red List status rank reflects the conservation status of the species and not this subspecies.

REFERENCES: ¹ Boynton et al. (1992); ² VertNet: MVZ; ³ Bat Population Database.

Genus *Eptesicus*

***Eptesicus fuscus* (Beauvois, 1796) (TX) Big Brown Bat**

LOCALITIES: Avery Co.: Cranberry Mines*; Jackson Co.: Kitchen Cave¹; Madison Co.: French Broad Cave*; McDowell Co.: Linville Caverns*; Rutherford Co.: Rumbling Bald Cave*, Sliding Rock Cave*; Transylvania Co.: Snake Den no. 2 Cave*; Yancey Co.: Cooper's Cave*, Isom Mica Mine*.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G5 (S5 in North Carolina).

COMMENTS: *Eptesicus fuscus* is encountered frequently in caves throughout its range, particularly in winter, where it often roosts alone or in small clusters on ledges or in crevices.

REFERENCES: ¹ VertNet: MVZ; * this study.

Genus *Myotis*

***Myotis leibii* (Audubon & Bachman, 1842) (TX) Eastern Small-footed Bat**

LOCALITIES: Avery Co.: Black Rock Cliffs Cave^{1,3}; Jackson Co.: Kitchen Cave²; McDowell Co.: Wind Cave¹; Rutherford Co.: Bat Cave^{1,3}, Breakdown Cave¹, Rumbling Bald Cave¹; Swain Co.: Blowing Springs Cave¹, Flowstone Cave*, Lost Nantahala Cave¹; Yancey Co.: Cooper's Cave¹; Isom Mica Mine*.

CONSERVATION STATUS: IUCN: Endangered A4bce (Solari, 2018a); NatureServe: G4 (S2 in North Carolina); Listed as Special Concern in North Carolina (North Carolina Wildlife Resources Commission, 2017a); Listed as a Species of Greatest Conservation Need in North Carolina (North Carolina Wildlife Resources Commission, 2015).

COMMENTS: This species is known primarily from mountainous areas in the western part of the state. The conservation status of *M. leibii* was elevated recently to Endangered due to impacts from White-nose Syndrome among other factors (Solari, 2018a).

REFERENCES: ¹ Boynton et al. (1992); ² VertNet: MVZ; ³ Bat Population Database, * this study.

***Myotis lucifugus* (LeConte, 1831) (TX) Little Brown Bat**

LOCALITIES: Avery Co.: Black Rock Cliffs Cave², Cranberry Mines*; Jackson Co.: Kitchen Cave¹; McDowell Co.: Linville Caverns*, Wind Cave*; Rutherford Co.: Bat Cave¹, Moonshiners Cave*, Sliding Rock Cave*; Swain Co.: Blowing Springs Cave*; Yancey Co.: Celo Cave*, Isom Mica Mine*.

CONSERVATION STATUS: IUCN: Endangered A3be (Solari, 2018b); NatureServe: G3 (S2 in North Carolina); Listed as a Species of Greatest Conservation Need in North Carolina (North Carolina Wildlife Resources Commission, 2015).

COMMENTS: This species is known from all physiographic regions in North Carolina but is known primarily from mountainous areas in the western part of the state. Due to population declines associated with White-nose Syndrome, *M. lucifugus* is now considered Endangered by IUCN. Population declines have been particularly severe in North Carolina (North Carolina Wildlife Resources Commission, 2017b; O'Keefe et al., 2019). Declines also have been noted for some eastern Tennessee populations (Flock, 2013, 2014). This species is under review by USFWS for potential listing.

REFERENCES: ¹ VertNet: MVZ; ² VertNet: NCSM; * this study.

***Myotis septentrionalis* (Trovessart, 1897) (TX) Northern Long-eared Bat**

LOCALITIES: Avery Co.: Black Rock Cliffs Cave^{1,3}, Cranberry Mines*; Rutherford Co.: Bat Cave¹, Rumbling Bald Cave³; Swain Co.: Blowing Springs Cave*; Transylvania Co.: Snake Den no. 2 Cave*; Yancey Co.: Celo Cave*, Isom Mica Mine*.

CONSERVATION STATUS: IUCN: Near Threatened (Solari, 2018c); NatureServe: G1G2 (S2 in North Carolina); Listed as Threatened in North Carolina (North Carolina Wildlife Resources Commission, 2017a); Listed as a Species of Greatest Conservation Need in North Carolina (North Carolina Wildlife Resources Commission, 2015); Listed as Threatened under the U.S. Endangered Species Act.

COMMENTS: *Myotis septentrionalis* is one of the bat species most impacted by White-nose Syndrome. The species was listed as Threatened under the Endangered Species Act, effective 4 May 2015 (USFWS, 2015). It is considered uncommon in the mountainous areas of western North Carolina where significant declines have been documented (North Carolina Wildlife Resources Commission, 2017b; O'Keefe et al., 2019).

REFERENCES: ¹ Boynton et al. (1992); ² VertNet: MVZ; ³ VertNet: NCSM; * this study.

***Myotis sodalis* Miller & Allen, 1928 (TX) Indiana Bat**

LOCALITIES: Jackson Co.: Kitchen Cave^{2,3}; Madison Co.: Anthodite Cave¹; McDowell Co.: Linville Caverns¹, Wind Cave¹; Rutherford Co.: Bat Cave¹⁻⁵; Swain Co.: Blowing Springs Cave¹, Hewitt Station Mine², Lost Nantahala Cave¹.

CONSERVATION STATUS: IUCN: Near Threatened (Arroyo-Cabrales and Ospina-Garces, 2016); NatureServe: G2 (S1S2 in North Carolina); Listed as Endangered in North Carolina (NCWRC, 2017); Listed as a Species of Greatest Conservation Need in North Carolina (North Carolina Wildlife Resources Commission, 2015); Listed as Endangered under the U.S. Endangered Species Act.

COMMENTS: Two caves and one mine in North Carolina are considered priority sites for this federally endangered bat (USFWS, 2007). Records from Madison, McDowell and Swain counties (other than Hewitt Station Mine) by Boynton et al. (1992) have not been confirmed and are based on questionable identifications. Like many other cave-hibernating bat species, populations of *M. sodalis* have suffered declines due to White-nose Syndrome. *Myotis sodalis* was never common in North Carolina hibernacula before the arrival of White-nose Syndrome but now are rarely encountered (Katherine Caldwell, North Carolina Wildlife Resources Commission, personal communication in O'Keefe et al., 2019).

REFERENCES: ¹ Boynton et al. (1992); ² USFWS (2007); ³ VertNet: MVZ; ⁴ VertNet: NCSM; ⁵ VertNet: UMMZ.

Genus *Perimyotis*

***Perimyotis subflavus* (Cuvier, 1832) (TX) Tri-colored Bat**

LOCALITIES: Avery Co.: Black Rock Cliffs Cave², Cranberry Mines*; Jackson Co.: Kitchen Cave*; Madison Co.: Anthodite Cave*; McDowell Co.: Lime Kiln Cave*, Linville Caverns^{3,4}, Pseudo-Saltpetre Cave*, Wind Cave*; Onslow Co.: Brinson's Rockhouse Cave²; Rutherford Co.: Bat Cave^{1,4,5}, Breakdown Cave*, Halloween Haven*, Moonshiners Cave*, Rumbling Bald Cave*, Sliding Rock Cave*; Swain Co.: Blowing Springs Cave²; Transylvania Co.: Snake Den no. 2 Cave*; Yancey Co.: Celo Cave*, Cooper's Cave*, Isom Mica Mine*.

CONSERVATION STATUS: IUCN: Vulnerable A3bce (Solari, 2018d); NatureServe: G2G3 (S3 in North Carolina); Listed as a Species of Greatest Conservation Need in North Carolina (North Carolina Wildlife Resources Commission, 2015).

COMMENTS: *Perimyotis subflavus* was quite common in caves of North Carolina before White-nose Syndrome spread into the region but have experienced significant declines in the Southern Appalachians (O'Keefe et al., 2019). Its conservation status was recently elevated to Vulnerable due to impacts from White-nose Syndrome. In addition, *P. subflavus* is under review by USFWS for potential listing.

REFERENCES: ¹ VertNet: MVZ; ² VertNet: NCSM; ³ VertNet: ROM; ⁴ VertNet: UMMZ; ⁵ Bat Population Database; * this study.

Order Didelphimorphia
Family Didelphidae
Genus *Didelphis*

***Didelphis virginiana* (Kerr, 1792) (AC) Virginia Opossum**

LOCALITIES: McDowell Co.: Holler's Potato Hole no. 2*; Rutherford Co.: Moonshiners Cave*, Rumbling Bald Cave*.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G5 (S5 in North Carolina).

COMMENTS: Opossums have been reported from caves in the eastern United States (Dearolf, 1956; Cliburn and Middleton, 1983; Niemiller, unpublished data), but caves are thought to be much less important to this species compared to *Procyon lotor*.

REFERENCES: * this study.

Order Rodentia
Family Cricetidae
Genus *Neotoma*

***Neotoma floridana haematoreia* Howell, 1934 (TX) Southern Appalachian Woodrat**

LOCALITIES: McDowell Co.: Lime Kiln Cave*, Wind Cave*; Rutherford Co.: Moonshiners Cave*, Rumbling Bald Cave¹; Yancey Co.: Celo Cave*.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G5T4Q (S3S4 in North Carolina); Listed as a Species of Greatest Conservation Need in North Carolina (North Carolina Wildlife Resources Commission, 2015).

COMMENTS: Nests and scat are common in North Carolina caves. The IUCN Red List status rank reflects the conservation status of the species and not this subspecies.

REFERENCES: ¹ VertNet: NCSM; * this study.

Family Dipodidae
Genus *Napaeozapus*

***Napaeozapus insignis* (Miller, 1891) (TX/AC) Woodland Jumping Mouse**

LOCALITIES: Henderson Co.: Middle Fork Shelter Cave no. 2*.

CONSERVATION STATUS: IUCN: Least Concern; NatureServe: G5 (S4 in North Carolina).

COMMENTS: Mice are not uncommon in caves, although few records for this particular species are known.

REFERENCES: * this study.

Summary of bioinventory and literature records

We compiled occurrence records from 127 caves and other subterranean habitats in 29 counties in North Carolina from the literature and biological surveys. In total, this dataset includes occurrences for at least 5 phyla, 17 classes, 43 orders, 90 families, 124 genera, and 164 species (Table 1; Figure 2). Twenty-nine taxa are aquatic, whereas 135 taxa are terrestrial. Diverse invertebrate groups included spiders (Order Araneae; 11 families, 18 genera, 22 species), springtails (Class Collembola; seven families, nine genera, 15 species), copepods (Class Maxillopoda; one family, four genera, seven species), clitellate worms (Class Clitellata; three families, eight genera, eight species), and snails (Class Gastropoda; six families, nine genera, 12 species). The most common invertebrate species included the Cave Orbweaver (*Meta ovalis*) (21 occurrences from eight counties), a cave-obligate dipluran (*Litocampa* sp.) (15 occurrences from six counties), a cave cobweb spider (*Nesticus brimleyi*) (11 occurrences from two counties), and an undescribed species of *Stygobromus* amphipod (11 occurrences from five counties). Thirty-two vertebrate taxa were documented, including four fishes, nine salamanders, one lizard, four snakes, two birds, and 12 mammals. Mammal diversity was dominated by bats (eight species), with Tri-colored bats (*Perimyotis subflavus*) documented most frequently (20 occurrences). Most of the vertebrates reported to date in North Carolina have been previously documented from caves in adjacent states (e.g., Buhlmann, 2001; Fong et al., 2012; Niemiller et al., 2016).

At least 25 taxa are considered cave obligates, i.e., troglobites and stygobites (Table 2), with the greatest troglobitic/stygotibic species richness observed in *Phagocata* flatworms (five species), *Pseudosinella* springtails (five species), and *Stygobromus* amphipods (three described species and at least two undescribed taxa). Three of the 25 cave-ob-

Table 1. Taxonomic diversity of invertebrates and vertebrates from caves and other subterranean habitats in North Carolina.

Taxon	No. of Orders	No. of Families	No. of Genera	No. of Taxa	No. of Troglobites
Phylum Platyhelminthes					
Class Turbellaria	1	1	1	6	5
Phylum Annelida					
Class Clitellata	1	3	8	8	0
Phylum Arthropoda					
Class Arachnida	6	23	30	34	3
Class Chilopoda	2	2	2	2	0
Class Collembola	3	7	9	17	5
Class Diplopoda	4	6	6	8	2
Class Entognatha	1	2	2	2	1
Class Insecta	9	19	21	22	0
Class Malacostraca	3	5	6	13	8
Class Maxillopoda	1	1	4	7	1
Class Symphyla	1	1	1	1	0
Phylum Mollusca					
Class Gastropoda	2	6	9	12	0
Phylum Chordata					
Class Actinopterygii	2	2	4	4	0
Class Amphibia	1	1	6	9	0
Class Aves	1	2	2	2	0
Class Mammalia	4	5	8	12	0
Class Reptilia	1	4	5	5	0
Total	43	90	124	164	25

ligate taxa (*Phanetta subterranea*, *Porrhomma cavernicola*, and *Pseudosinella pecki*) have broad distributions that include several karst regions in the eastern United States. The other cave-obligate taxa are predominately endemic to North Carolina. No cave-obligate vertebrates have been documented from North Carolina to date.

Of the taxa included in the checklist above, at least 25 taxa are considered troglaphiles/stygophiles, 50 taxa as troglaxenes/stygoxenes, and 22 as accidentals. All taxa classified as accidentals are considered common in surface habitats, except for *Mesodon andrewsae*. This terrestrial snail is considered Vulnerable (G3) globally and Imperiled-Vulnerable (S2S3) in North Carolina. All eight earthworms reported from North Carolina caves (Reynolds, 1994) are considered edaphic. The ecological classification of 44 taxa could not confidently be assigned to one specific category: seven taxa were classified as troglaphiles or troglaxenes (stygoaphiles or stygoxenes) and 27 taxa as troglaxenes or accidentals.

Counties with the greatest number of caves with biological occurrences include Rutherford, McDowell, Swain, Henderson, Polk, and Avery counties (Table 3). Unsurprisingly, these counties also have the greatest subterranean species richness in North Carolina. However, most occurrences for each of these counties are for just a few cave systems. Twenty or more taxa have been documented at four caves (Table 4): Bat Cave complex in Rutherford County (34 taxa), Blowing Springs Cave in Swain County (27 taxa), Linville Caverns in McDowell County (27 taxa), and Rumbling Bald Cave in Rutherford County (22 taxa).

Caves with the greatest troglobitic species richness include the Bat Cave complex in Rutherford County, Blowing Springs Cave in Swain County, and Wind Cave in McDowell County, each with four troglobites documented. A particularly rich vertebrate fauna is known from Linville Caverns with 14 taxa, including four fishes, six salamanders, and four bat species. A diverse vertebrate fauna (>5 taxa) also has been documented to date at Rumbling Bald Cave in

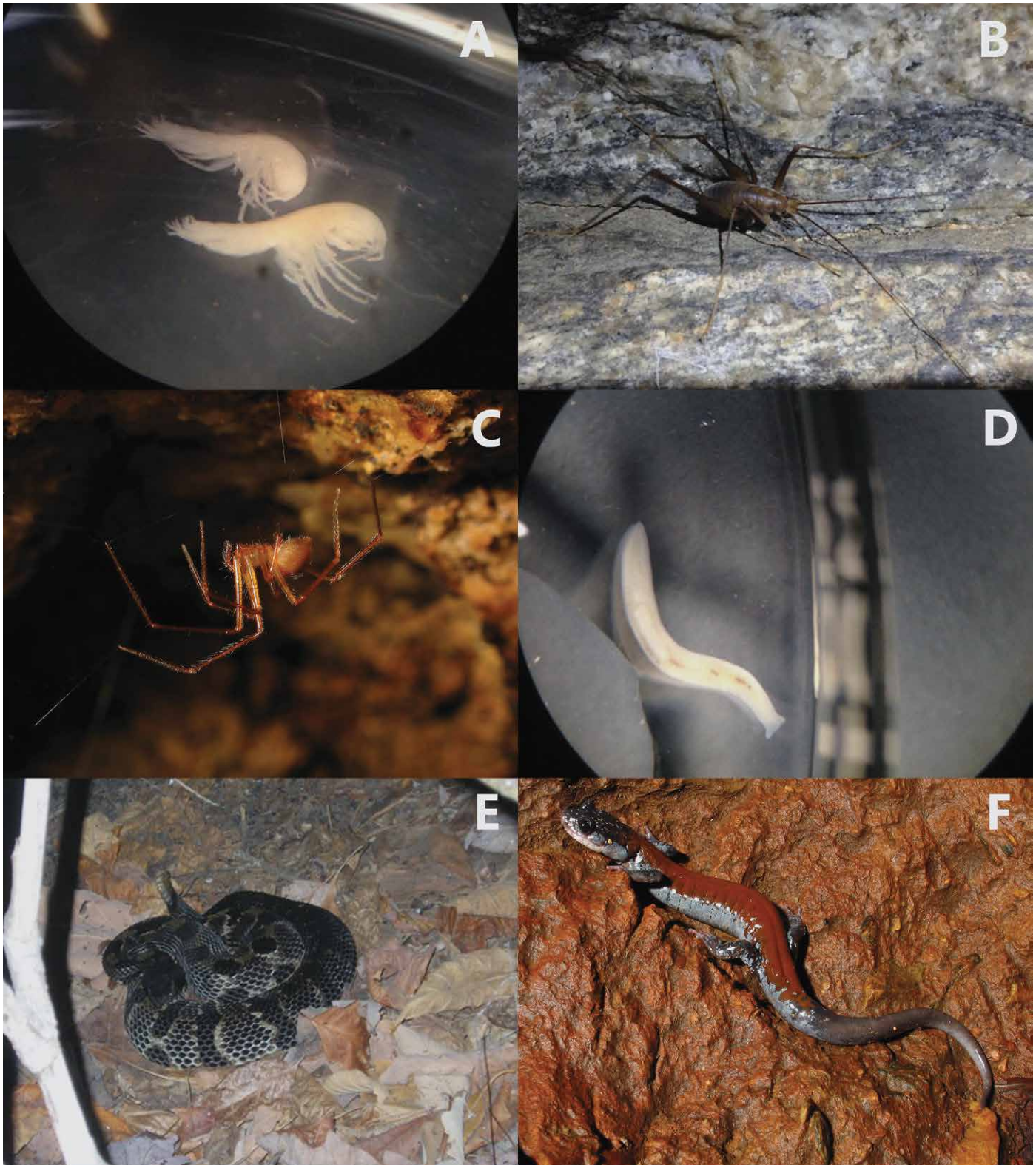


Figure 2. Representative cave life documented in North Carolina caves: A) *Stygobromus* sp. from Wind Cave, McDowell County (Photo by Cato Holler); B) *Euhadenoecus adelphus* from Bat Cave, Rutherford County (Photo by Cato Holler); C) *Nesticus* sp. from Wind Cave, McDowell County (Photo by Alan Cressler); D) *Phagocata* sp. from Wind Cave, McDowell County (Photo by Cato Holler); E) *Crotalus horridus* from Crotalus Shelter, McDowell County (Photo by Cato Holler); F) *Plethodon yonahlossee* from Wind Cave, McDowell County (Photo by Alan Cressler).

Table 2. Troglotic and stygotic taxa documented from caves and other subterranean habitats in North Carolina.

Species	Authority	No. of Occurrences	Counties
<i>Caecidotea carolinensis</i>	Lewis & Bowman, 1977	1	McDowell
<i>Diacyclops jeanneli putei</i>	(Yeatman, 1943)	1	Orange
<i>Litocampa</i> sp.		15	Henderson, Madison, McDowell, Polk, Rutherford, Swain
<i>Nannopetalum vespertilio</i>	Shear, 2003	1	Rutherford
<i>Nesticus brimleyi</i>	Gertsch, 1984	11	Polk, Rutherford
<i>Phagocata carolinensis</i>	Kenk, 1979	2	Burke, McDowell
<i>Phagocata holleri</i>	Kenk, 1979	1	Ashe
<i>Phagocata procera</i>	Kenk, 1984	7	Burke, Jackson, McDowell, Mitchell, Yancey
<i>Phagocata pygmaea</i>	Kenk, 1987	1	Stokes
<i>Phagocata spuria</i>	Kenk, 1987	2	McDowell
<i>Phanetta subterranea</i>	(Emerton, 1875)	4	McDowell, Rutherford, Yancey
<i>Porrhomma cavernicola</i>	(Keyserling, 1886)	2	Swain
<i>Pseudosinella flatua</i>	Christiansen & Bellinger, 1996	1	Swain
<i>Pseudosinella gisini carolina</i>	Christiansen & Bellinger, 1996	2	Rutherford
<i>Pseudosinella orba</i>	Christiansen, 1961	1	Polk
<i>Pseudosinella pecki</i>	Christiansen & Bellinger, 1980	1	Swain
<i>Pseudosinella vespera</i>	Christiansen & Bellinger, 1996	2	Rutherford, Swain
<i>Pseudotremia shelleyi</i>	Lewis, 2009	4	McDowell, Rutherford
<i>Stygobromus araeus</i>	(Holsinger, 1969)	1	Gates
<i>Stygobromus carolinensis</i>	Holsinger, 1978	2	Yancey
<i>Stygobromus</i> cf. <i>carolinensis</i>		1	Wilkes
<i>Stygobromus indentatus</i>	(Holsinger, 1967)	1	Nash
<i>Stygobromus</i> nov. sp. A		11	Avery, Burke, Henderson, McDowell, Mitchell
<i>Stygobromus</i> nov. sp. B		1	Jackson
<i>Stygobromus</i> sp.		4	Buncombe, McDowell, Polk

Rutherford County (8 taxa), Bat Cave complex in Rutherford County (6 taxa), Wind Cave in McDowell County (7 taxa), and Cooper's Cave in Yancey County (6 taxa) (Table 4).

Species of conservation concern

Several species documented from caves and other subterranean habitats in North Carolina are of conservation concern, including 14 species that are troglotes or stygobites (Table 5). Five species are on the IUCN Red List of Threatened Species. The bats *Myotis lucifugus* and *M. leibii* have been evaluated as Endangered and the Tri-colored Bat (*Perimyotis subflavus*) and groundwater amphipods *Stygobromus araeus* and *S. indentatus* have been evaluated as Vulnerable. Two additional bats, *M. septentrionalis* and *M. sodalis*, and the Hickory Nut Gorge Green Salamander (*Aneides caryaensis*) have been evaluated as Near Threatened. *Aneides caryaensis* likely will be placed on the IUCN Red List in the near future. The conservation status of four bat species on the IUCN Red List was recently increased in response to population declines associated with White-nose Syndrome (Solaris 2018a,b,c,d).

Based on NatureServe conservation rank criteria, 21 species are of conservation concern at the global level (G1–G3), many of which are troglotes or stygobites. *Nesticus cooperi*, *Stygobromus carolinensis*, *N. carolinensis*, and *Helicodiscus saludensis* are ranked as Critically Imperiled (G1). In addition, three species are ranked as Imperiled (G2), five species as Vulnerable (G3), six species as Critically Imperiled-Imperiled (G1G2), and three species as Imperiled-Vulnerable (G2G3). At the state level, 28 species of conservation concern, including two species ranked as Possibly Extinct (SH), seven species as Critically Imperiled (S1), four species as Imperiled (S2), five as Vulnerable (S3), seven species as Critically Imperiled-Imperiled (S1S2), and three species as Imperiled-Vulnerable (S2S3).

Nine species are listed as protected species in North Carolina by the North Carolina Wildlife Resources Commission (North Carolina Wildlife Resources Commission, 2017a; Table 5), including three species as Endangered, three species as Threatened, and three species as Special Concern. Three bats are also listed under the U.S. Endangered

Table 3. Subterranean occurrences and taxa by county and caves sampled in North Carolina. Percent is the number of caves with records divided by the total number of caves multiplied by 100 in a county. Some counties include sites that are not caves and are not included in this calculation.

County	No. of Records	No. of Taxa	No. of Sites with Records	Total No. of Caves	Percent (%)
Alexander	0	0	0	11	0.0
Alleghany	0	0	0	10	0.0
Anson	0	0	0	9	0.0
Ashe	3	2	2	32	6.3
Avery	27	14	12	136	8.1
Bladen	0	0	0	2	0.0
Buncombe	2	2	1	41	2.4
Burke	11	7	11	254	4.3
Caldwell	4	4	2	7	28.6
Chatham	7	4	6	1	0.0
Cherokee	0	0	0	8	0.0
Clay	0	0	0	17	0.0
Columbus	0	0	0	10	0.0
Craven	0	0	0	1	0.0
Dare	0	0	0	1	0.0
Davidson	3	3	2	8	25.0
Davie	0	0	0	1	0.0
Duplin	0	0	0	3	0.0
Forsyth	0	0	0	1	0.0
Gaston	0	0	0	20	0.0
Gates	1	1	1	0	...
Harnett	0	0	0	1	0.0
Haywood	0	0	0	38	0.0
Henderson	30	27	7	46	15.2
Hoke	0	0	0	4	0.0
Iredell	0	0	0	6	0.0
Jackson	9	9	4	23	13.0
Jones	1	1	1	4	0.0
Lincoln	0	0	0	1	0.0
Macon	12	10	3	24	12.5
Madison	15	12	5	28	17.9
Martin	0	0	0	2	0.0
Mecklenburg	0	0	0	2	0.0
McDowell	82	54	11	259	4.2
Mitchell	5	3	3	12	8.3
Montgomery	0	0	0	9	0.0
Nash	1	1	1	0	...
New Hanover	0	0	0	4	0.0
Northhampton	0	0	0	5	0.0
Onslow	4	4	2	5	20.0
Orange	2	2	1	11	0.0
Polk	30	25	8	17	47.1
Randolph	0	0	0	13	0.0
Rockingham	2	2	1	1	100.0
Rowan	0	0	0	2	0.0
Rutherford	137	76	20	186	10.8
Stokes	2	2	2	96	2.1
Surry	1	1	1	17	5.9
Swain	47	35	9	40	22.5
Transylvania	7	7	1	35	2.9
Union	0	0	0	2	0.0
Wake	1	1	1	12	8.3
Watauga	2	2	2	44	4.5
Wilkes	2	2	2	30	6.7
Yancey	25	17	5	31	9.7
Total	475	164	127	1,582	8.0

Table 4. List of the 14 most diverse cave systems in North Carolina.

Cave	County	No. of Taxa	No. of Trogllobites	No. of Vertebrates	No. of Species of Conservation Concern
Bat Cave complex	Rutherford	34	4	6	8
Blowing Springs Cave	Swain	27	4	5	8
Linville Caverns	McDowell	27	1	14	4
Rumbling Bald Cave	Rutherford	22	3	8	7
Staircase Cave	McDowell	16	3	1	1
Wind Cave	McDowell	15	4	7	6
Breakdown Cave	Rutherford	13	2	4	4
Devil's Kitchen Cave	Henderson	12	0	0	0
Little Warrior Mountain Cave	Polk	11	3	1	2
Lost Nantahala Cave	Swain	11	2	2	4
Western Talus Tunnel	Rutherford	10	0	0	0
Sliding Rock Cave	Rutherford	10	1	3	4
Moonshiners Cave	Rutherford	9	1	4	4
Celo Cave	Yancey	9	0	4	4

Table 5. List of species of conservation concern and their conservation status documented from caves and other subterranean habitats in North Carolina. Conservation status includes IUCN Red List ranking, NatureServe global conservation rank, NatureServe state conservation rank, state designation by NCWRC, and federal status under the U.S. Endangered Species Act. Species considered trogllobites or stygobites are in bold.

Scientific name	Common name	IUCN	NS Global	NS State	NC Status	US Status
<i>Phagocata carolinensis</i>	Carolina Cave Planarian		G1G2	S1S2		
<i>Phagocata holleri</i>	Holler's Cave Planarian		G1G2	S1S2		
<i>Phagocata procera</i>	A Cave Planarian		G1G2	S1S2		
<i>Hypochilus coylei</i>	A Lampshade Weaver		G3?	S3?		
<i>Nesticus brimleyi</i>	A Cave Cobweb Spider		G1G2	S1?		
<i>Nesticus carolinensis</i>	Linville Caverns Spider		G1?	S1		
<i>Nesticus cooperi</i>	Lost Nantahala Cave Spider		G1	S1		
<i>Nesticus mimus</i>	A Cobweb Spider		G2	S2?		
<i>Pseudosinella flatua</i>	Blowing Springs Cave Springtail		G1G2	S1S2		
<i>Pseudosinella gisini carolina</i>	Carolina Cave Springtail		G3G4T1T2	S1S2		
<i>Pseudosinella pecki</i>	Peck's Cave Springtail		G2G3	SNR		
<i>Pseudosinella vespera</i>	Bat Cave Springtail		G2	S1S2		
<i>Stygobromus araeus</i>	Tidewater Interstitial Amphipod	VU	G3	SU		
<i>Stygobromus carolinensis</i>	Carolina Groundwater Amphipod		G1	S1		
<i>Stygobromus indentatus</i>	Tidewater Amphipod	VU	G3	SU		
<i>Stygobromus nov. sp. B</i>	A Cave Amphipod		GNR	S1?		
<i>Caecidotea carolinensis</i>	Bennett's Mill Cave Isopod		G2G3	SH	LE	
<i>Diacyclops jeanneli putei</i>	Carolina Well Copepod		G3G4	SH	SC	
<i>Helicodiscus saludensis</i>	Corncob Snail		G1	S1?		
<i>Mesodon andrewsae</i>	Balsam Globe		G3	S2S3		
<i>Mesomphix latior</i>	Broad Button		G3G4	S2S3		
<i>Aneides caryaensis</i>	Hickory Nut Green Salamander	NT	G3G4	S2S3	LT	
<i>Corynorhinus rafinesquii</i>	Rafinesque's Big-eared Bat	LC	G3G4T2	S1	LE	LE
<i>Corynorhinus townsendii virginianus</i>	Virginia Big-eared Bat	LC	G3G4	S3	LT	
<i>Myotis leibii</i>	Eastern Small-footed Bat	EN	G4	S2	SC	
<i>Myotis lucifugus</i>	Little Brown Bat	EN	G3	S3		
<i>Myotis septentrionalis</i>	Northern Long-eared Bat	NT	G1G2	S2	LT	LT
<i>Myotis sodalis</i>	Indiana Bat	NT	G2	S1S2	LE	LE
<i>Perimyotis subflavus</i>	Tri-colored Bat	VU	G2G3	S3		
<i>Crotalus horridus</i>	Timber Rattlesnake	LC	G4	S3	SC	

Species Act, including *Myotis sodalis* and *Corynorhinus townsendii virginianus* as Endangered and *M. septentrionalis* as Threatened. Since White-nose Syndrome was first detected in North Carolina at a cave in Avery County in 2011, it has spread into 12 counties in western North Carolina (<https://www.whitenosesyndrome.org/static-page/where-is-wns-now>) resulting in significant population declines for several bat species. Most impacted have been populations of *M. septentrionalis*, *M. lucifugus*, *M. sodalis*, and *P. subflavus*, in which some populations have experienced over 90 percent declines (North Carolina Wildlife Resources Commission, 2017b). *Myotis septentrionalis* was recently listed as Threatened on the U.S. Endangered Species Act in 2015 due to population declines associated with White-nose Syndrome (USFWS, 2015). *Myotis lucifugus* and *P. subflavus* may be listed in the near future; their respective conservation statuses (both IUCN Red List and NatureServe) were elevated to higher risk of extinction ranks recently due to high mortality from White-nose Syndrome (e.g., Frick et al., 2010; Verant et al., 2012).

Conclusions and Future Directions

Although not nearly as extensive and common as in adjacent states, such as Georgia, Tennessee, and Virginia, caves and other subterranean habitats in North Carolina support a diverse community of invertebrates and vertebrates. Our review of the subterranean fauna of North Carolina includes at least 164 taxa representing five phyla and 90 families. While this review highlights the biodiversity found in subterranean habitats in the state, we aim for this assessment to serve as a base line for future biological surveys in caves and other subterranean habitats in the state. Moreover, we highlight the importance of caves and subterranean habitats for many species, not just bats and troglobites (obligate cave species).

A small percentage of caves in North Carolina have biological occurrence records (8.0%), and even a smaller fraction of sites has had comprehensive or repeated biological inventories conducted. Several counties, such as Buncombe, Burke, Haywood, Stokes, Transylvania, and Watauga counties, have >30 caves yet <4% of caves have even a single biological occurrence. This biodiversity knowledge shortfall is not limited to North Carolina, but even occurs in states with considerably greater karst and cave systems (e.g., Tennessee; Niemiller and Zigler, 2013). Thus, there is great potential to document new cave distributional records. With 20 described cave-obligate taxa, North Carolina is tied for 19th (with Pennsylvania) in cave-obligate species richness among U.S. states (Niemiller et al. 2019). Much of the cave-obligate diversity in North Carolina is endemic to the state. At least three undescribed taxa are noted in the literature and await formal taxonomic description. However, there is considerable potential to discover new taxa unknown to science in subterranean habitats of North Carolina, given the complex geological history, topography, and isolated nature of cave systems in much of the state.

Caves are important habitats for many species of vertebrates and invertebrates. Several caves and mines have been identified previously as important hibernacula for several threatened and endangered bat species in North Carolina (Boynton et al., 1992), and there is a growing body of literature that caves are critically important habitats for other vertebrates and invertebrates (e.g., Niemiller and Miller, 2009; Niemiller et al., 2016) for shelter, hibernation, food, and other aspects of life history.

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