Biological Inventory of the Cave and Karst Systems of The Nature Conservancy's Sharp-Bingham Mountain Preserve

James Godwin
Alabama Natural Heritage Program
Environmental Institute
Auburn University
Auburn, AL 36849

Introduction

Overview of Karst and Caves (adapted from Palmer 2007; White 2008)

Karst is a landform or landscape with the characteristics of caves, sinkholes, subterranean streams, and springs. These topographical features have formed from the dissolution, rather than mechanical, eroding of the underlying bedrock. This dissolutional process is based on the actions of a weak carbonic acid solution reacting with the basic limestone. Raindrops, as they pass through the atmosphere, pick up carbon dioxide and form a weak carbonic acid solution. Limestone, a type of calcium carbonate, is easily dissolved by this mildly acidic water. Over time rainwater percolates along horizontal and vertical fissures and joints of the limestone bedrock and these joints and fissures gradually become widened and deepened, eventually coalescing into an underground drainage system of conduits. Caves formed by this process are termed solution caves.

While the lifespan of a cave, from the initial phase of development to deterioration, may be on the order of tens of thousands to a few million years, geologically they are regarded as being transient. Cave "life history" can be divided into the following sequential phases: initiation, enlargement, stagnation, and destruction. Each phase in the life cycle of a cave presents new invasion and niche expansion opportunities for organisms associated with these subterranean features.

During the phase of initiation, as water moves through a multitude of fissures dissolving bedrock, the smallest fissures of 10 to 50 micrometers wide are enlarged to widths of 5 to 10 millimeters. Once a complete pathway from groundwater source to spring outlet has reached the 5 to 10 millimeter width the initiation phase is complete and the enlargement phase begins. Percolation is the primary method of water movement during the initiation phase, but once the enlargement phase is reached the flow pattern changes and higher flow velocities are in effect.

Enlargement of flow paths through the bedrock occurs rapidly as the increased size of the conduit allows unsaturated (with calcium carbonate) water to reach deeper depths, and the transport of insoluble sediments through the system. For most caves the enlargement phase involves only a few of the many small fissures, and flow rate differs widely among the fissures. Interaction of variables, such as fissure width, flow length, and hydraulic gradient, influence the growth of new passages. Flow paths which carry more water will enlarge more rapidly than those which carry less water. With an increase in water flow, sediment transport is increased which aids in passage enlargement by mechanical abrasion. Related to this process is sinkhole growth and with the increased transport of sediments the rate of sinkhole growth increases.

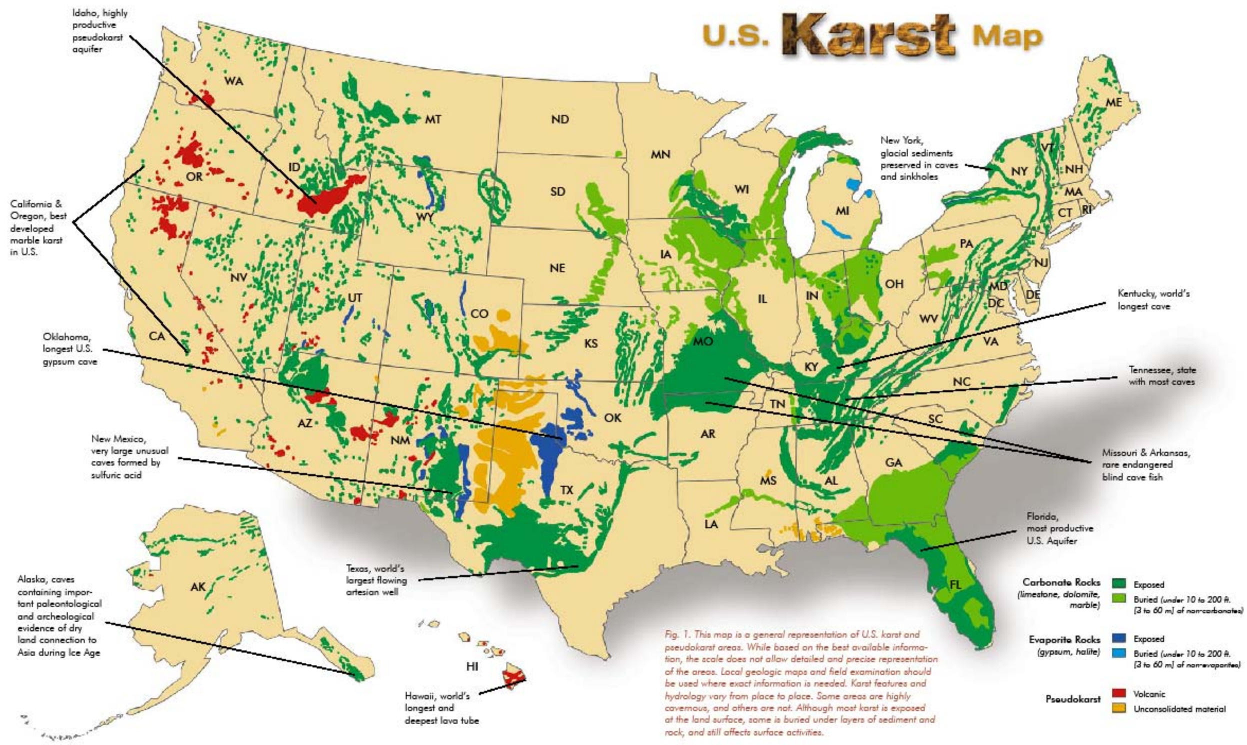
Passage diameter of a water-filled cave may enlarge at the rapid rate of one meter per 1000 years or to the leisurely pace of one meter per 10,000 years. Growing water-filled passages assume a circular or ellipsoid shape as dissolution operates on all surfaces. If the volume of water no longer fills the conduit and an air space develops, then dissolution of the ceiling and upper walls will cease. The shift of conduit from a pipe flow to an open-channel flow will alter the shape of the channel from that of an elliptical tube to one of a canyon.

Cave passage development does not take place independent of actions on the land surface. Sinkholes, sinking streams, caves, and springs are in a continual state of interplay. As cave passages have been enlarging, surface streams have been down-cutting, with an associated lowering of the water table. If the original water source continues to flow, the cave canyon will continue to grow; if not, the conduit passages are abandoned. With the down-cutting of surface streams, new passages may form at lower levels in response to the lowered water table. In this case, the original passages may become disconnected from the water table, and therefore air-filled, and dry.

Caves discovered and explored by humans are typically in the stagnation, or abandonment and decay, phase. These are passages which are no longer enlarging because stream down-cutting has shifted the water table below the passage. Valley down-cutting and surface erosion truncates passages and exposes entrances. With progression of surface erosion leading to lowering of hilltops and plateaus, the cave passages are reduced to smaller and smaller sections, such as short tunnels and natural bridges. Ultimately, erosion of the land surface will lead to the destruction of the cave. The time that is needed for a cave to progress through the stages of initiation, enlargement, stagnation, and destruction may be on the order of 2 million years.

Worldwide, 15% of the land surface is karst. In the United States the total is 20% (Figure 1). Most of the major cave regions of the world are associated with karst.

Figure 1. Map of the karst regions of the United States. Major karst regions east of the central US are associated with areas of limestone. The Appalachian Mountain chain of karst extends into northeastern Alabama. Map downloaded from http://www.agiweb.org/environment/karstmap.pdf.



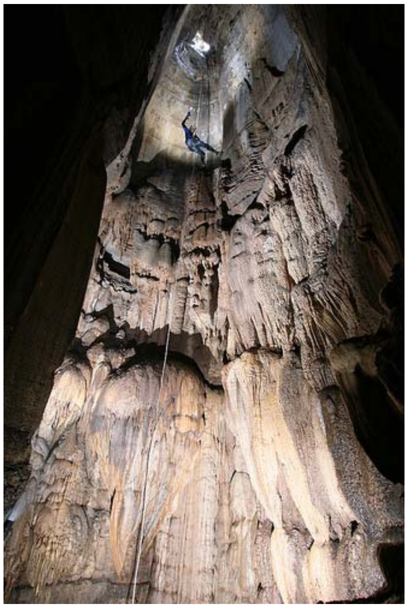
©Alan Cressler

Cumberland Plateau of Alabama – Geological Setting

In Alabama the Cumberland Plateau has extensive karst topography, with an extraordinary density of caves, sinkholes, and springs; Jackson County, with over 1500 known caves, has the highest density of caves per county within North America. Overlying the plateau top is a sandstone cap, while layers of limestone comprise the lower strata. Where the soils have been removed, limestone exposures are evident. At the lower elevations streams draining the escarpments via the valley bottoms flow over cobble, cherty gravel, and limestone blocks. Elevations across the plateau range from ca. 180 m (600 ft) to 520 m (1700 ft). Karst landscape to be found on the Cumberland Plateau falls under the subcategory of fluviokarst. Primary characteristics of fluviokarst are that much of the drainage is underground. Even though surface stream channels are present, streambeds carry water only during times of high flow or flood, and valley floors contain sinkholes.

On the Cumberland Plateau a non-soluble cap of sandstone overlies the limestone, but with erosion of the sandstone the limestone becomes exposed, allowing water to begin the process of dissolution and the formation of solution chimneys and vertical shafts. The thick limestone beds, the critical matrix for the presence of the numerous caves in northeastern Alabama, were laid down during the Mississippian Period of the Paleozoic Era. At this time, about 350 - 320 m.y.a, much of Alabama was covered by a broad sea. Depth of the limestone beds may be as thick as 400 or more feet thus providing one condition for the development of karst topography with its caves, sinkholes, and springs (Adams et al. 1926; Lacefield 2000). A moderate to heavy rainfall and good groundwater circulation are two additional conditions. Thus, on the Cumberland Plateau of northeastern Alabama optimum conditions for karst development have been met with thick beds of limestone and an annual total average of 155 cm of precipitation.

©Alan Cressler



©Alan Cressler

Caves & Ecology

Sinkholes and cave entrances are important to underground biota. Plant- and animal-derived organic material enters the subterranean system in the form of leaves, twigs, limbs, dead or living animals by falling or being washed into holes. Animals living underground depend upon this above-ground material that is channeled into cave systems, and sinkholes and cave entrances provide the important avenues for this food base to enter the caves.

Other means by which organic material is brought into caves is by the actions of animals which live near entrances. Woodrats build nests within the mouths of caves, and the twigs, leaves, nuts, and bark that they bring in for nest material and food is also fed upon by invertebrates. Bats using caves deposit their guano which is a rich source of energy. Cave crickets often live in caves in large numbers. At night they forage in the surrounding forest, returning to the cave by daybreak. Cricket droppings are one more energy-rich source of food for other cave life, as are their eggs.

Cave, or subterranean fauna, is often placed into one of several ecological categories depending upon the extent of the life cycle which is spent in the cave, the degree of dependence upon the cave habitat, and whether the species in question is aquatic or terrestrial. The terminology of these ecological associations is below, and aquatic and terrestrial distinctions are identified by either the prefix “stygo-“ or “troglo-“, respectively. Ecological degree of dependence is characterized by the following suffixes, “-bite”, “-xene”, or “-phile”.

Obligate cave dwellers, the troglobites and stygobites, are those species that must complete their entire life cycle underground and are incapable of surviving above ground. An example of a stygobite is the southern cave fish (*Typhlicththys subterraneus*). Troglobites are, without exception, invertebrates, with many being arthropods.

Trogoloxenes and stygoxenes are species which utilize the caves during a portion of their life cycle, and often this portion of the life cycle is critically dependent upon the conditions found in the cave. An example of this ecological characterization is the gray myotis (*Myotis grisescens*) which requires caves with specific environmental parameters for maternity sites.

Troglo- and styogophiles are species which are facultative cave dwellers, which is to say, the species is capable of completing its life cycle within the cave but may also live quite well outside of the cave. The cave salamander (*Eurycea lucifuga*) is considered to be a troglophile. The troglo- and stygo- labels are often quite useful and species seldom blur this distinction, but such is not the case with amphibians. The cave salamander mentioned above has an aquatic larval stage (stygo-) but as an adult is terrestrial (troglo-).

One final term needs to be defined – troglomorphy. This term applies best to the stygobites and troglobites. Stygobites and troglobites exhibit extreme morphological adaptation to cave life and their morphological features often express this adaptation of troglomorphy. Obvious troglomorphism includes the loss of eyesight, reduction or loss of pigmentation, hypertrophy of the lateral line system, and elongation of antennae and appendages, all adaptations to surviving the unusual conditions of the subterranean world.

©Alan Cressler

Karst and Biodiversity

The karst region of northeastern Alabama is regarded as having one of the most diverse subterranean fauna of the world. This area includes the three counties of Jackson, Madison, and Marshall, as pointed out in Culver et al. (1999). Factors to explain this diversity include avoidance of Pleistocene glaciations, low karst fragmentation, a high density of caves (which equates to increased available habitat), and long-term productivity as measured by high temperature and rainfall (Culver et al. 2006). To further emphasize the richness of the subterreanean fauna of northeastern Alabama, several additional facts pertaining to Jackson County will be pointed out. Jackson County leads North America in the number of caves (1500+) for an individual county, and the number of known stygobites and troglobites (66). The county is ranked number one with 52 obligate terrestrial cave-dwelling species, and finally, it has the greatest degree of single county endemism with 24 species. The Sharp-Bingham Mountain Preserve is within the core of this region of subterranean biodiversity.

©Alan Cressler

The Nature Conservancy's Sharp-Bingham Mountain Preserve

A comment on nomenclature: Calloway, Keel, and Cox sinks are surface feature depressions with a connection to the subterranean system. These are named topographical features on the USGS Hollytree quadrangle. Tony Sinks Cave is the extensive underground cave passage complex which runs, at a minimum, from Calloway Sinks down to Cox Sinks. Tony Sinks Cave has been recognized as the accepted name for this cave system; this name is not found on the USGS quadrangle.

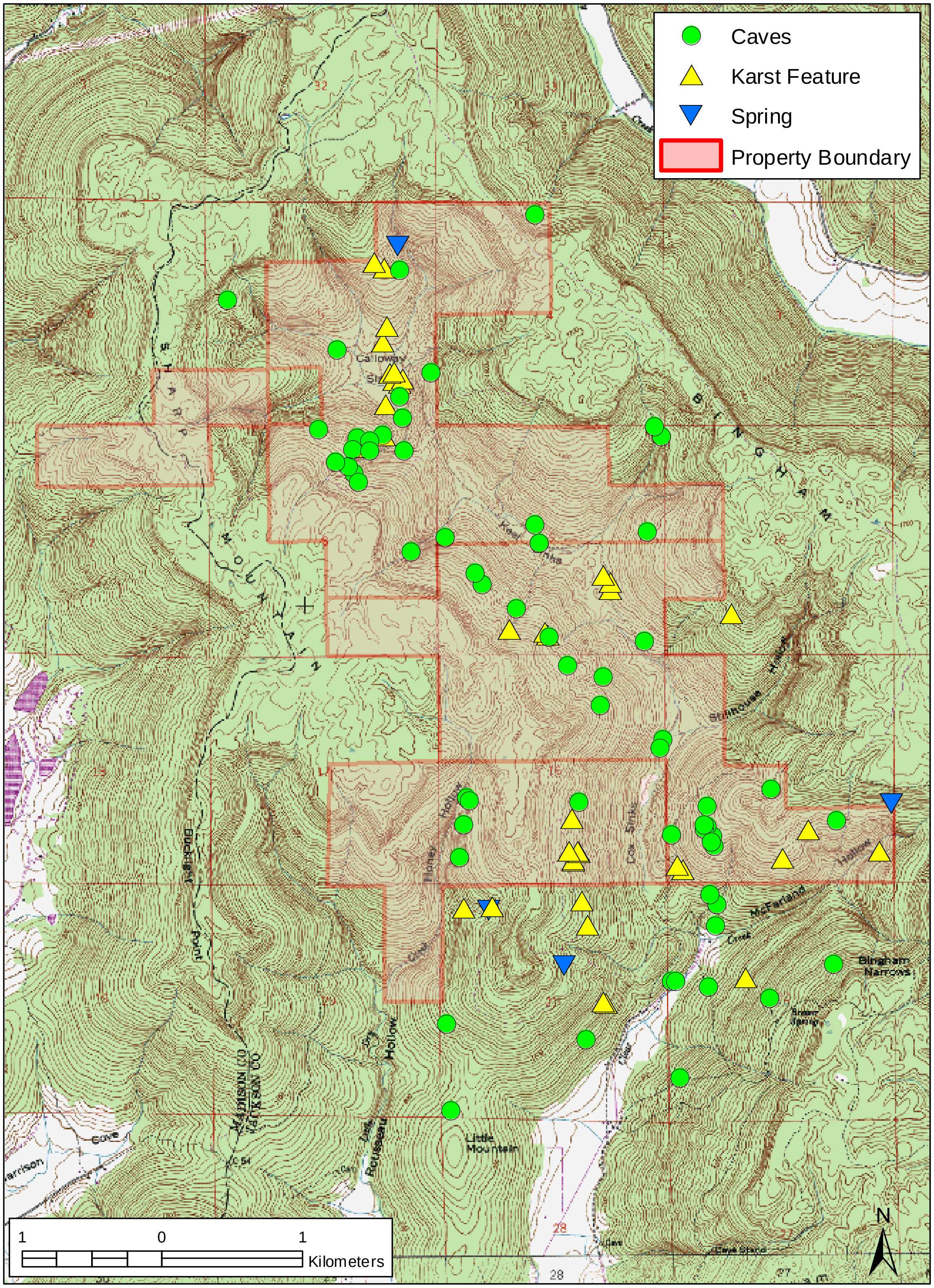
The Sharp-Bingham Mountain Preserve is located in western Jackson County near the Madison County line and, as the name implies, includes portions of Sharp and Bingham mountains. Sharp Mountain, along the Jackson-Madison county line, is the western boundary, while Bingham Mountain forms the eastern boundary. The two mountains meet at the north end of Calloway Sink. Within the boundaries of the preserve is an extensive sink system, which includes Calloway, Keel, and Cox sinks. The sinks complex runs generally north to south from Calloway to Keel to Cox Sink. The lowest elevations in Calloway Sink are approximately 980 feet, those in Keel Sink 900 feet, and in Cox Sink 780 feet. Plateau top elevations, along the northern end of the site, approach 1700 feet. The ephemeral surface hydrology, from rain or occasionally snow, flows off the plateau tops and sides and into the bowls of the three sinks. These waters aid in maintaining a permanently flowing stream in the largest cave system of the preserve, the Tony Sinks Cave system.

Approximately 60 caves, 30 karst features, and several springs are known from the Sharp-Bingham Mountain area (Figure 2). Following the criteria used by the Alabama Cave Survey, to qualify as a cave, a subterranean passage must be either a minimum of 50 feet of vertical depth, 50 feet of horizontal passage, or a combination of both to reach or exceed 50 feet. The term “karst features”, as used in this study, are sinkholes, small pits, or passages less than 50 total feet. Karst features are being mapped because of the functional linkage they have to active cave systems in that they may serve as inflow points for water and nutrient delivery into subterranean systems, and that often cave-associated biota may be found in them.

This area is an important one for karst and cave systems in Alabama because of the number of caves and the extensive connected systems. Contained within the boundaries are the Calloway, Keel, and Cox sinks, surface features of the Tony Sinks Cave system. This cave system is hydrologically dynamic; new sinkholes in the Calloway and Keel Sinks have opened in the past few years. The tract boundaries include most of Calloway and Keel watersheds; the Calloway watershed drains about 2 square miles, the Keel watershed drains about 1 ½ square miles, and the Cox watershed drains about 2 square miles, and underground are a total of about 12 miles of passage. Above ground is a relatively unbroken second-growth hardwood forest, and good forest cover is vital to protection of the underground waters, which is crucial to protection of the subterranean biota. All together this is one of the best intact cave and karst systems in Alabama, in large part due to the intact forest cover.

©Alan Cressler

Figure 2. Map of caves, springs, and karst features of The Nature Conservancy's Sharp-Bingham Mountain Preserve and immediate vicinity.



Results

Fifty-seven caves (Table 1) have been located within the boundaries of the Sharp-Bingham Mountain Preserve but some nearby caves have been included as they are within the immediate vicinity and may be connected to one of the large cave systems. A first step with the inventory was to locate the caves and confirm or correct the coordinates. During the course of locating caves, additional caves were found as were karst features. In addition to the caves 37 karst features and four springs were added to the database of landscape-significant geological features.

Table 1. Caves of the Sharp-Bingham TNC Preserve. This list also includes ones in the immediate vicinity because of the connectivity of the subterranean systems. Caves are listed by Alabama Cave Survey number (ACS #), recognized cave name, the total known length, and vertical depth. Caves with no ACS # have not been entered into the ACS database.

ACS #	CAVE NAME	LENGTH (ft)	DEPTH (ft)
882	Bear Bone Cave	2539	100
na	Beers Bore Hole	22	68
na	Beers Dig Dug	30	135
na	Bo’s Cave		
na	Brain Wave Cave	100	30
909	Brewer Spring Cave	200	
280	Bull Pit	40	
268	Calloway Cave	549	20
284	Campbell Pit		
2756	Can't Miss It Cave	38	
na	Cassius Cave	80	30
na	Cat Toe Hole		
73	Clemons Cave	85	15
1805	Clemons Spring Cave	170	
na	Cot Monster Pit		
78	Cox Cave		
3400	Cramped Well	10	68
na	Ctenacanthus Well		
80	Devils Stair Steps	365	
1071	Donnas Pit	5232	200
752	Dynamite Drop	10	96
266	Engle Double Cave	24279	520
2014	Five Points Cave	200	10
78	Frenchmans Pit		
na	Gastropod Rebelay		
na	Godman's Cave		
4024	Harold Lees Pit	60	
394	Hidden Cave	304	
2553	Honey Hollow Horror	70	
2551	Honey Pot	70	

na	Horace’s Hole	70	50
1151	Hunters Hole	10	110
na	Jungle Boys Cave		
883	K Cave	230	70
79	Keel Cave	618	
78	Keel Sinks entrance		
1558	Langston Cave		
1021	Little Big Cave	33	
2650	Little Pack Rat Cave	93	
na	Lucindas Hole	80	83
na	Lucindas Trap Door	51	38
na	Making Coffee Well	30	50
266	McFarland Blowing Cave		
65	McFarland Cave	1063	10
67	McFarland Spring Cave	564	
na	Padgett Pit No. 1		38
936	Padgett Pit No. 2	10	139
946	Polack Pit	1826	176
2552	Pooh Cave	65	
2586	Red Ribbon Pit	40	
74	Saltpeter Cave	3729	
267	Sandy Cave	300	35
na	Shagbark Cave	500	40
3072	Single Engle	118	
2015	Sisk Cave	1390	65
na	Sleeping Baby Pit	15	77
908	Snow Hole	30	
na	Steamed Chicken Pit		
na	The Covered Jewel		
na	Tom Rea Plunged Well	150	140
77	Tony Cave	344	5
78	Tony Sinks Cave System	20,000	600
1267	Waterfall Cave	702	80
na	Wet 30' Pit just above Pooh Cave		
3429	Whooz Cairn Cave	40	
281	Wiegand Pit	600	261
	minimum total underground passage	67,154 feet or 12.7 miles	

Out of the total of 67 known caves within the preserve boundary and vicinity, biological observations and collections have been made in approximately 26 of the caves, plus a few of the karst features (Table 2). Results of these biological observations and collections are summarized below.

Table 2. Caves from which biological collections and observations were made and the number of taxa documented. Caves are listed in descending order of number of taxa.

Cave or Karst Feature	**Number of taxa documented from cave or karst feature**
Tony Sinks System	46
McFarland Cave	31
K Cave	27
Tony Cave	27
Bear Bone Cave	24
Bo's Cave	23
Polack Pit	23
Sandy Cave	19
Waterfall Cave	18
Cassius Cave	16
Saltpeter Cave	14
Cox Cave	13
Making Coffee Well	11
Engle Double	10
Shagbark Cave	10
Brewer Spring Cave	8
McFarland Blowing Cave	8
17' pit (karst feature)	8
Covered Jewel	7
McFarland Spring Cave	7
Padgett Pit # 1 (karst feature)	7
Clemons Cave	6
Gastropod Rebelay	6
Godman's Cave	6
Devils Stair Step	5
Lucindas Hole	5
Steamed Chicken	5
Keel Cave	4
Padgett Pit # 2	3
Sisk Cave	3
Tom Rea	3
Cat Toe Hole	2
Horace's Hole	2
Brain Wave Cave	1
Dry Spring Cave	1

©Alan Cressler

Biological Inventory

The list of known biota reported from caves of the Sharp-Bingham Mountain Preserve and immediate vicinity includes five phyla, 16 classes, 29 orders, 58 families, and 98 species (Table 3). The majority of the list is invertebrate as the vertebrates constitute only one phylum, eight orders, 12 families, and 30 species. The overall total can be substantially increased with the identification of currently unidentified specimens. Due to the paucity of taxonomic experts for many of these groups, identifications of specimens may take an extended period of time.

Seventeen species identified are being tracked by the Alabama Natural Heritage Program. These include four terrestrial snails, one isopod, one crayfish, two spiders, one harvestman, one cricket, two beetles, two salamanders, two bats, and one woodrat. Distribution maps of significant groups follow this section (Figures 3-15).

Table 3. A listing of the fauna reported from and collected from caves and karst features of The Nature Conservancy's Sharp-Bingham Mountain Preserve.

Category & Scientific Name	Common Name	NatureServe Rank
Phylum Nematomorpha		
Class Gordioidea	horsehair worm	
Phylum Annelida		
Class Oligochaeta		
Phylum Mollusca		
Class Gastropoda		
Order Basommatophora		
Family Carychiidae		
Carychium sp. c*lappi*	no common name	
Order Basommatophora		
Family Pupillidae		
Pupisoma sp.	no common name	
Order Sigmurethra		
Family Discidae		
Anguispira alternata	flamed tigersnail	G5 S1S2[1]
Family Helicodiscidae		
Helicodiscus sp.	no common name	
Family Zonitidae		
Glyphyalinia cf *indentata*	carved glyph	G5 SNR
Mesomphix capnodes	dusky button	G5 SNR
Mesomphix pilsbryi	striate button	G4 SNR
Mesomphix cf. *anurus*	no common name	
Family Haplotrematidae		
Haplotrema concavum	gray-foot lancetooth	G5 SNR
Family Polygyridae		
Inflectarius inflectus	shagreen	G5 SNR
Inflectarius rugeli	deep-tooth shagreen	G5 SNR
Lobosculum pustuloides	tiny liptooth	G4 SNR
Mesodon normalis	grand globe	G5 SNR[1]

Mesodon zaletus	toothed globe	G5 SNR
Patera perigrapta	engraved bladetooth	G5 SNR
Patera sargentiana	grand bladetooth	G2 S2[1]
Stenotrema exodon	Alabama slitmouth	G2 S2[1]
Stenotrema stenotrema	inland slitmouth	G5 SNR
Family Polygyridae		
Triodopsis tridentata	northern threetooth	G5 SNR
Phylum Arthropoda		
Class Crustacea		
Order Amphipoda		
Order Isopoda		
Family Trichoniscidae		
Miktoniscus medcofi	a cave isopod	GNR SNR[1]
Family Ligiidae		
Ligidium elrodii	no common name	G4G5 SNR
Order Decapoda		
Family Cambaridae		
Cambarus tenebrosus	cavespring crayfish	G5 SNR
Orconectes australis australis	Southern cave crayfish	G5T4 S3[1]
Class Arachnida		
Order Pseudoscorpiones		
Family Chthoniidae		
Chthonius tetrachelatus	a pseudoscorpion	GNR SNR
Kleptochthonius sp.		
Family Neobisiidae		
Novobisium ingratum	a pseudoscorpion	GNR SNR
Order Aranae		
Infraorder Mygalomorphae		
Family Antrodiaetidae		
Antrodiaetus unicolor	A foldingdoor trap-door spider	GNR SNR
Infraorder Araneomorphae		
Family Hypochilidae		
Hypochilus thorelli	Thorell's lampshade-web spider	G4 SNR
Family Theridiidae		
Family Linyphiidae		
Family Agelenidae		
Family Pholcidae		
Pholcus sp. C	cellar spider	GNR SNR[1]
Family Cybaeidae		
Cybaeus sp.	a spider	GNR SNR
Famiily Linyphiidae		
Eperigone maculate	a spider	GNR SNR
Phanetta subterranean	a cave obligate spider	G5 SNR
Family Clubionidae		
Liocranoides unicolor	a cave obligate spider	G5 SNR
Anahita punctulata	southeastern wandering spider	G4 SNR[1]
Family Theridiidae		
Achaearanea porteri	a spider	GNR SNR
Achaearanea rupicola	a spider	GNR SNR
Paidisca marxi		
Family Tetragnathidae		
Meta ovalis	a spider	GNR SNR
Family Agelenidae		
Calymmaria cavicola	a spider	GNR SNR
Family Micryphantidae		
Origantes rostratus	a spider	GNR SNR

Order Opiliones		
Family Cladonychidae (= Erebomastridae)		
Thermomaster brunnea	s harvestman	GNR SNR
Family Phalangodidae		
Bishopella jonesi	a cave obligate harvestman	G1 S1[1]
Bishopella laciniosa	a harvestman	GNR SNR
Order Acarina		
Oribatid mites		
Class Isopoda		
Family Trichonescidae		
Miktoniscus medcofi	a cave isopod	GNR SNR
Family Ligiidae		
Ligidium elrodii	a cave obligate isopod	G4G5 R SNR
Class Diplopoda		
Order Chordeumatida		
Family Cleidogonidae		
Pseudotremia sp.	a millipede	
Order Chordeumatida		
Family Abacionidae		
Tetracion jonesi	a cave obligate millipede	G3G4 SNR
Family Trichopetalidae		
Scoterpes sp.	a millipede	
Trichopetalum sp.	a millipede	
Family Macrosternodesmidae		
Chaetaspis sp.		
Family Spirobolide		
Narceus americanus	a millipede	G5 SNR
Family Glomeridae		
Onomeris sp.	a millipede	
Family Xystodesmidae		
Undetermined sp.		
Class Chilopoda		
Class Parainsecta		
Order Collembola		
Family Entomobryidae		
Pseudosinella spinosa	a cave obligate springtail	G5 SNR
Class Insecta		
Order Diplura		
Family Campodeidae		
Plusiocampa spp.	a dipluran	
Order Thysanura		
Order Odonata		
Family Corduliidae		
Somatochlora tenebrosa	clamp-tipped emerald	G5 SNR
Order Orthoptera		
Family Rhaphidophoridae		
Ceuthophilus stygius	a camel cricket	GNR SNR[1]
Ceuthophilus ensifer n. ssp. a*p*		
Hadenoecus jonesi	a camel cricket	GNR SNR
Order Coleoptera		
Family Carabidae		
Pseudanophthalmus alladini	a cave obligate beetle	G3G4 S2[1]
Pseudanophthalmus n. sp. B	a beetle	
Family Pselaphidae		
Batrisodes valentinei	a beetle	G2G4 S2
Subterrochus ferus	a cave obligate beetle	G2G3 SNR

Family Leiodidae		
Adelopsis cumberlanda	a small carrion beetle	GNR SNR
Catops gratiosus	a small scavenger beetle	GNR S2[1]
Ptomaphagus hatchi	a cave obligate beetle	G5 SNR
Family Staphylinidae		
Atheta troglophila	a beetle	G1 SNR
Omalium sp.		
Family Curculionidae		
Order Diptera		
Order Siphonaptera		
Order Hymenoptera		
Phylum Craniata		
Class Amphibia		
Order Anura		
Family Bufonidae		
Bufo americanus	American toad	G5 S5
Family Hylidae		
Hyla chrysoscelis	Cope's gray treefrog	G5 S5
Pseudacris crucifer	spring peeper	G5 S5
Pseudacris feriarum	upland chorus frog	G5 S5
Family Ranidae		
Rana catesbeiana	bullfrog	G5S5
Rana clamitans	green frog	G5 S5
Rana palustris	pickerel frog	G5 S5
Rana sphenocephala	southern leopard frog	G5 S5
Order Caudata		
Family Ambystomatidae		
Ambystoma maculatum	spotted salamander	G5 S5
Family Plethodontidae		
Desmognathus fuscus	northern dusky salamander	G5 S5
Desmognathus monticola	seal salamander	G5 S5
Desmognathus ocoee	mountain dusky salamander	G5 S2[1]
Eurycea lucifuga	cave salamander	G5 S5
Gyrinophilus palleucus	pale salamander	G3 S2[1]
Plethodon glutinous	northern slimy salamander	G5 S5
Plethodon ventralis	southern zigzag salamander	G4 S4
Pseudotriton ruber	red salamander	G5 S5
Family Salamandridae		
Notophthalmus viridescens	eastern newt	G5 S5
Class Reptilia		
Order Squamata		
Family Dipsadidae		
Carphophis amoenus	worm snake	G5 S5
Class Chelonia		
Order Cryptodeira		
Family Emydidae		
Terrapene carolina	eastern box turtle	G5 S5
Class Aves		
Order Passeriformes		
Family Tyrannidae		
Sayornis phoebe	eastern phoebe	G5 S5
Class Mammalia		
Order Chiroptera		
Family Vespertilionidae		
Corynorhinus rafinesquii	Rafineque's big-eared bat	G3G4 S2[1]
Eptesicus fuscus	big brown bat	G5 S5

Lasionycteris noctivagans	silver-haired bat	G5 SNR
Lasiurus borealis	eastern red bat	G5 S5
Lasiurus cinerus	hoary bat	G5 SNR
Lasiurus seminolus	Seminole bat	G5 S4S5
Perimyotis subflavus	eastern perimyotis	G5 S5
Myotis septentrionalis	northern long-eared bat	G4 S2[1]
Order Rodentia		
Family Muridae		
Neotoma magister	Allegheny woodrat	G3G4 S3[1]
Order		
Family Cervidae		
Odocoileus virginianus	white-tailed deer	G5 S5

[1]Tracked by ALNHP

The majority of the species recorded are accidentals, i.e. species which would not normally live in caves. For some of these species their occurrence in the cave leads to their mortality. An extreme example is the deer which fell about 60 feet to the bottom of a pit, but in most instances the individual animal has been washed in, walked in, or fell in and is still living but will die a protracted death due to lack of food or acclimation to the subterranean environment. Other species find the cool and moist environmental conditions of the cave, particularly near the mouth, to be favorable. Terrestrial snails and plethodontid salamanders are two groups which favor a cool and moist environment and cave entrances and passages provide this, most notably during the latter days of summer.

Twenty-six, or approximately 25%, of the fauna identified may be considered as having some degree of adaptation to living in the cave environment. The more pronounced forms, the stygobites and troglobites, were represented by two and 12 species, respectively. One stygoxene was noted, and there were seven trogloxenes. The list included three troglophiles (Table 4).

The faunal list includes seven Alabama endemics, two terrestrial snails, one harvestman, one cave cricket, and three beetles. These species are: *Stenotrema exodon*, *Patera* (*Mesodon*) *sargentiana*, *Bishopella jonesi, Ceuthophilus stygius, Pseudanophthalmus alladini, Pseudanophthalmus* n. sp. B, and *Subterrochus ferus.*

Table 4. Species of the Sharp-Bingham Mountain Preserve listed by their cave-adapted ecological categories.

Stygobite	Troglobite	Stygoxene	Trogloxene	Troglophile
Orconectes australis australis	*Miktoniscus medcofi*	*Cambarus tenebrosus*	*Ceuthophilus stygius*	*Pholcus* sp. C
Gyrinophilus palleucus	*Pseudotremia* sp.		*Ceuthophilus ensifer* n. ssp. a*p*	*Atheta troglophila*
	Scoterpes sp.		*Hadenoecus jonesi*	*Eurycea lucifuga*
	Trichopetalum sp.		*Corynorhinus rafinesquii*	
	Tetracion jonesi		*Eptesicus fuscus*	
	Pseudosinella spinosa		*Perimyotis subflavus*	
	Bishopella jonesi		*Myotis septentrionalis*	
	Pseudanophthalmus alladini		*Neotoma magister*	
	Pseudanophthalmus n. sp. B			
	Batrisodes valentinei			
	Subterrochus ferus			
	Ptomaphagus hatchi			

The current taxonomic list of the cellar spiders (*Pholcus*) in North America is short with only three species. This genus is under revision by Dr. Bernhard Huber of the Museum Koenig in Bonn, Germany. From the southern Appalachian Mountain chain of Alabama, Georgia, and Tennessee he has recognized eight undescribed species of which *Pholcus* sp. C is one. Specimens from the Sharp-Bingham Mountain Preserve have been forwarded to Dr. Huber and he has confirmed that the specimens from the preserve belong to what he has termed *Pholcus* sp. C.

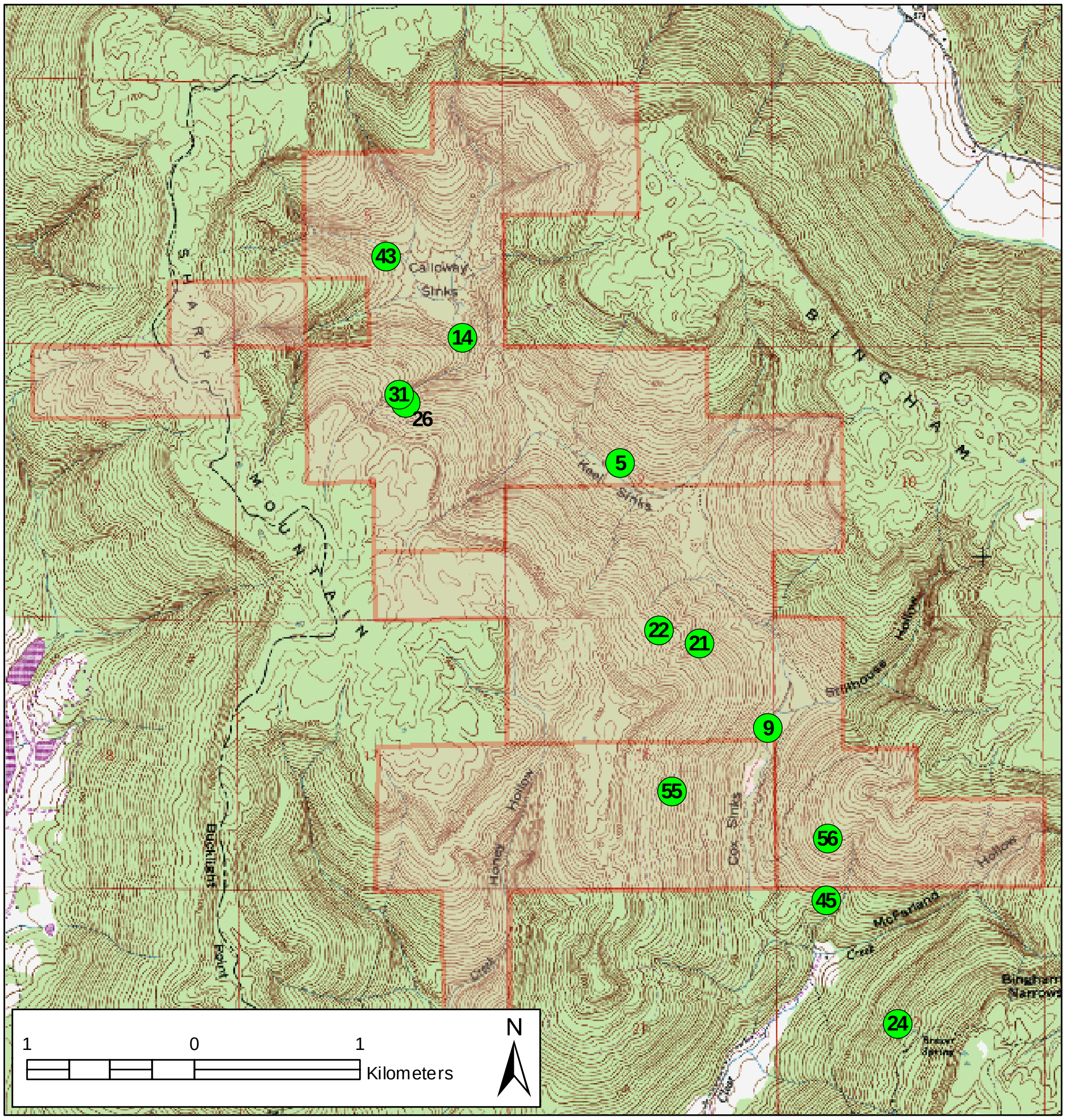
©Alan Cressler

The Tony Sinks Cave system supports a large population of *Gyrinophilus palleucus*, with individuals having been observed throughout much of the cave wherever appropriate aquatic habitat was available. Specimens have been previously reported from McFarland Cave, but relatively few. McFarland Cave is south and downstream of the Tony Sinks system and, in all likelihood, is, or has been, connected to the Tony Sinks system. Thus, the population of *G. palleucus* in Tony Sinks may be the source of the few individuals which have been observed in McFarland Cave. Salamanders of this population tend to be spotted and an illustration of the typical color pattern can be seen in Figure 7E of Miller and Niemiller (2007). *G. palleucus* is a neotenic species, that is, as a reproductive adult an individual retains morphological larval characteristics. With *G. palleucus* these characters include the retention of gills and caudal fin. Few metamorphosed *G. palleucus* have been reported. In December 2007 while on a collecting trip in the upper passages of Tony Sinks Cave a metamorphosed individual of the Tennessee cave salamander was observed and collected.

Eight bat species are listed but only three were seen in caves. The most commonly observed species was *Perimyotis subflavus*; *Eptesicus fuscus* and *Myotis septentrionalis* were seen but only rarely and in few caves; the *Corynorhinus rafinesquii* listing is based on an old record for Saltpeter Cave. Mist netting was done on two occasions adding the four additional species, these being forest-dwelling bats. The gray bat, *Myotis grisescens*, is known to occur within a few miles of the preserve; thus; it potentially could be found on the property but this species was never observed in any caves of the preserve.

©Alan Cressler

Figure 3. Distribution of snails in caves on The Nature Conservancy's Sharp-Bingham Mountain Preserve.



Species	Caves	Species	Caves
Anguispira alternata	5, 26	*Mesomphix capnodes*	14
Carychium sp. clappi	9, 21, 31, 45, 55	*Mesomphix cf. anurus*	26
Glyphyalinia cf indentata	9, 21	*Mesomphix pilsbryi*	22
Haplotrema concavum	14, 21	*Patera perigrapta*	21
Helicodiscus sp.	21, 43	*Patera sargentiana*	5, 9, 21, 22, 24, 26, 43, 45, 56
Inflectarius inflectus	5	*Pupisoma sp.*	21
Inflectarius rugeli	9	*Stenotrema exodon*	9, 45, 55
Lobosculum pustuloides	9	*Stenotrema stenotrema*	14, 24
Mesodon normalis	43	*Triodopsis tridentata*	22
Mesodon zaletus	5, 22, 24		

Figure 4. Distribution of crayfish in caves on The Nature Conservancy's Sharp-Bingham Mountain Preserve.

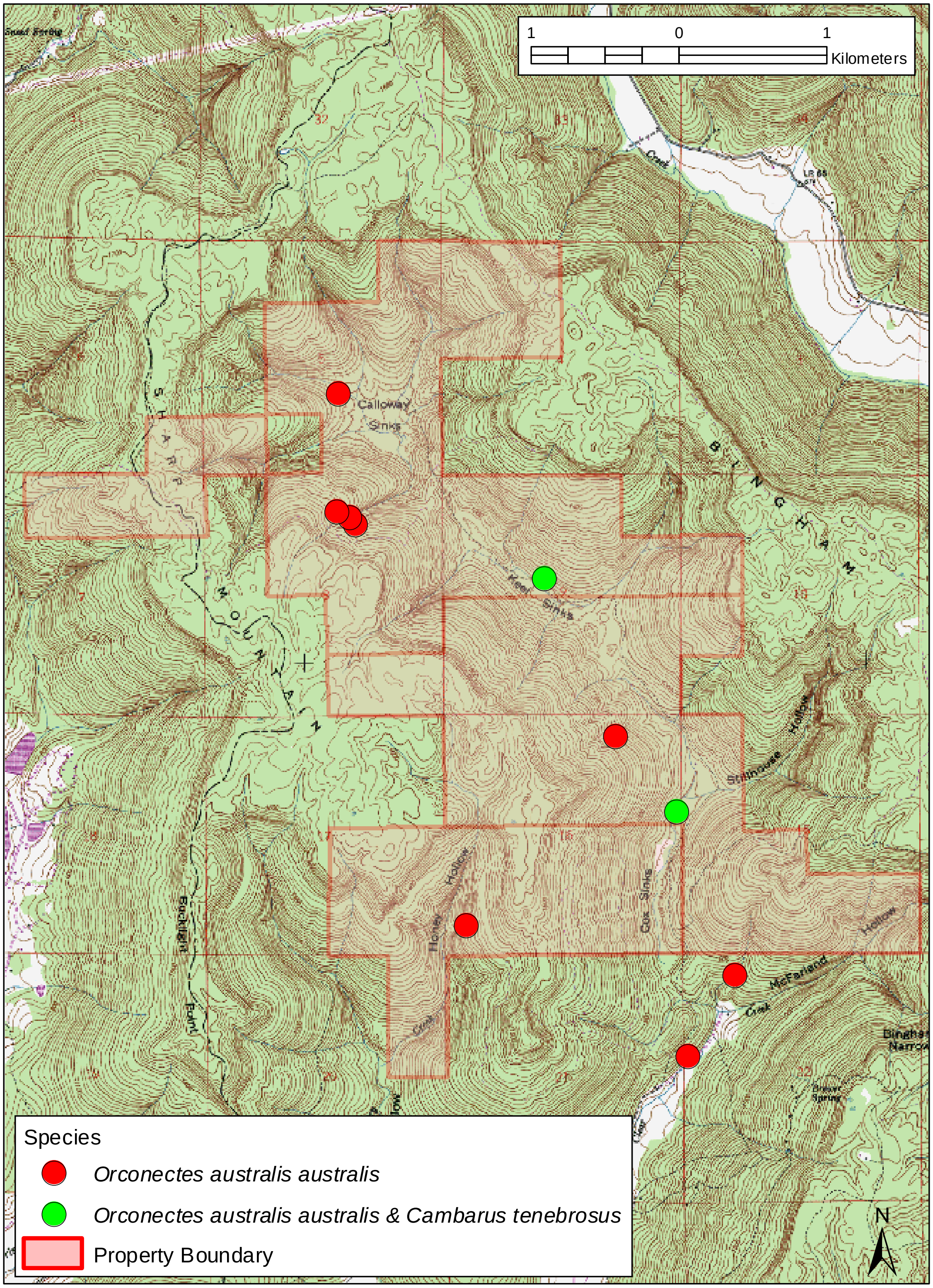


Figure 5. Distribution of pseudoscorpions in caves on The Nature Conservancy's Sharp-Bingham Mountain Preserve.

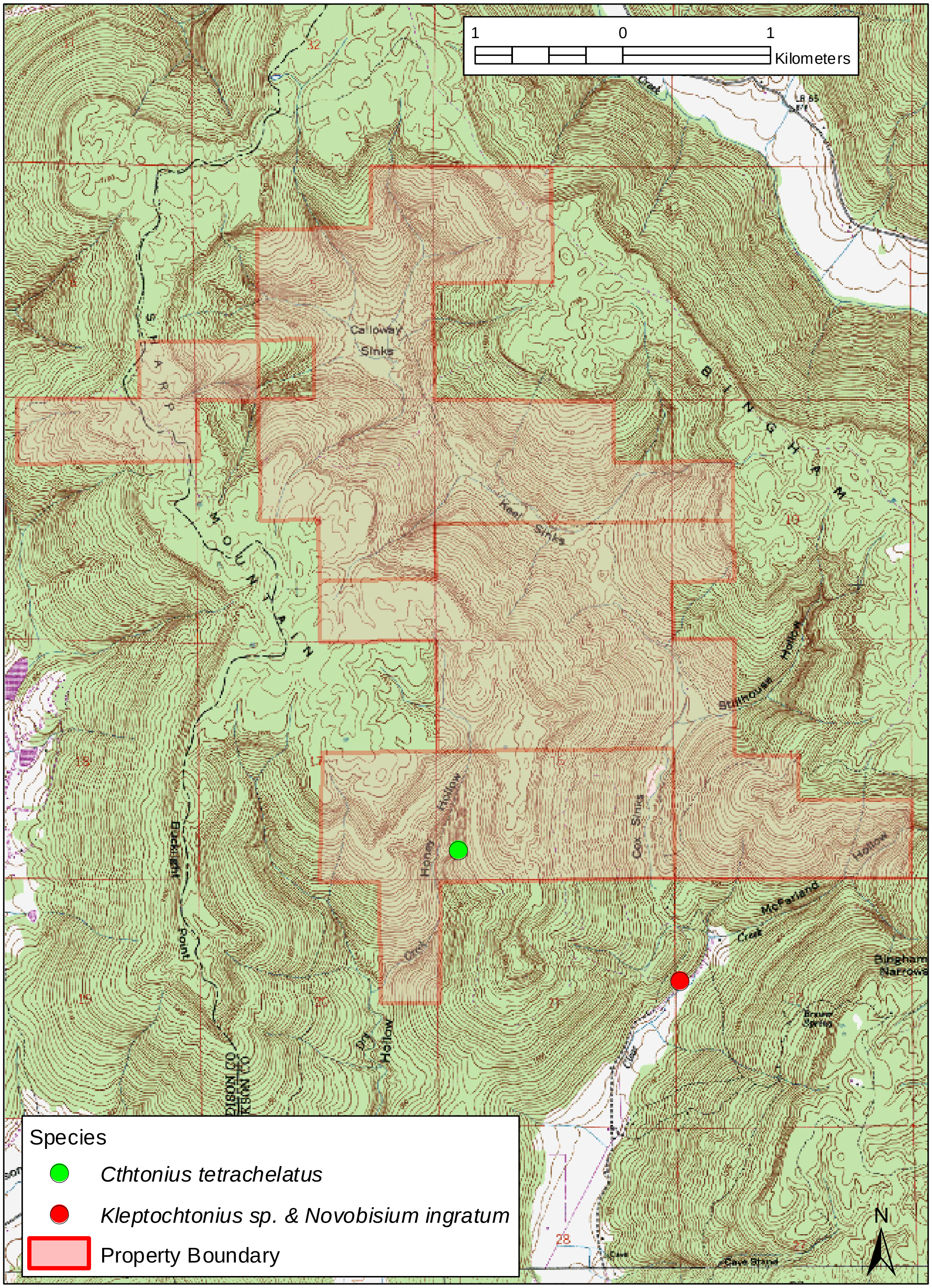
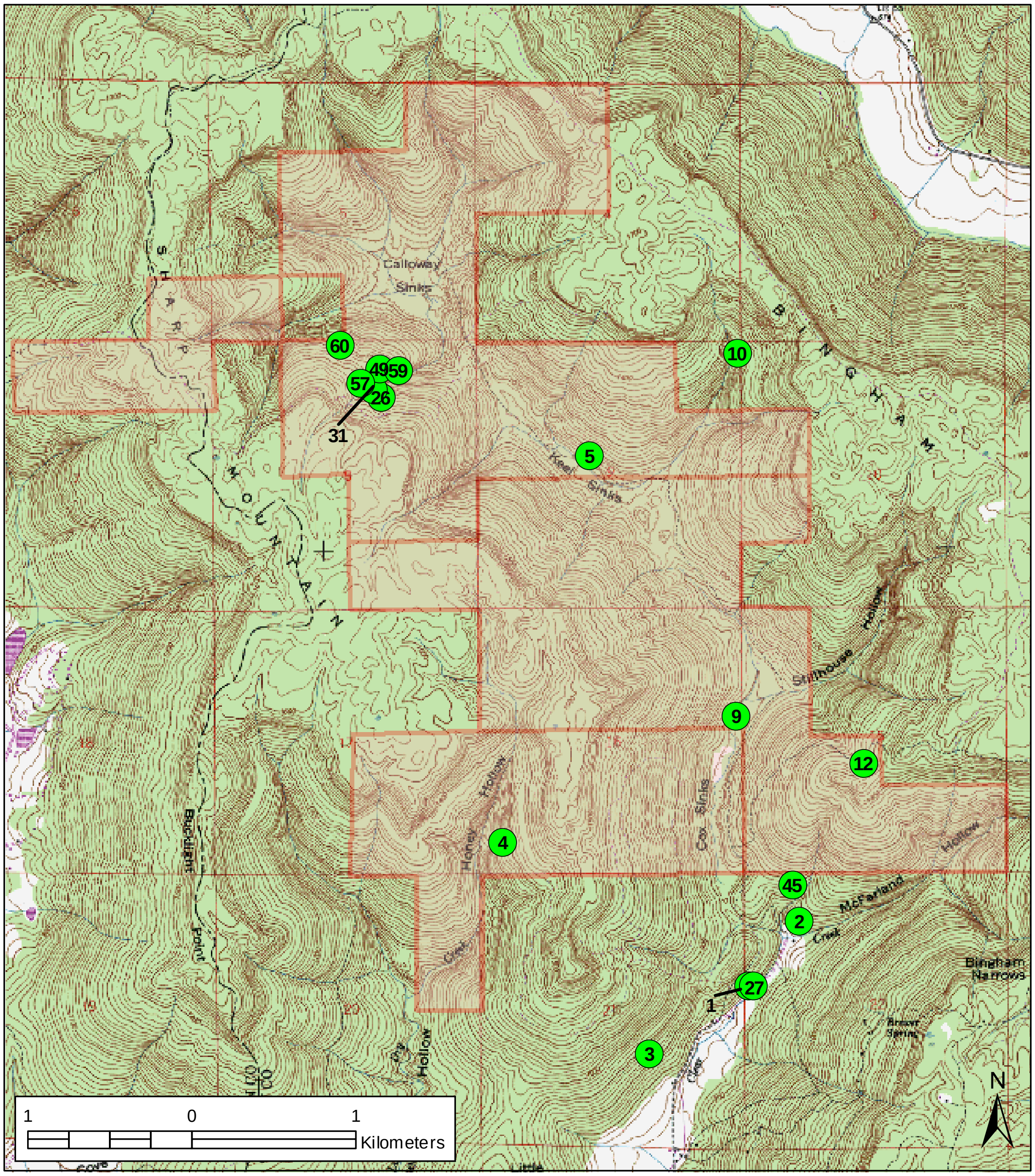


Figure 6. Distribution of spiders in caves on The Nature Conservancy's Sharp-Bingham Mountain Preserve.



Species	Caves	Species	Caves
Achaearanea porteri	1	*Hypochilus thorelli*	1, 5
Achaearanea rupicola	4	*Liocranoides unicolor*	1, 3, 10, 12
Anahita punctulata	12	*Meta ovalis*	2, 4, 5, 26, 31, 49, 57, 60
Antrodiaetus unicolor	5	*Origantes rostratus*	1
Calymmaria cavicola	5, 12	*Paidisca marxi*	1
Cybaeus	59	*Phanetta subterranea*	1, 9, 10, 12
Eperigone maculata	9	*Pholcus* sp. C	1, 2, 4, 5, 27, 31, 45, 59

Figure 7. Distribution of harvestmen in caves on The Nature Conservancy's Sharp-Bingham Mountain Preserve.

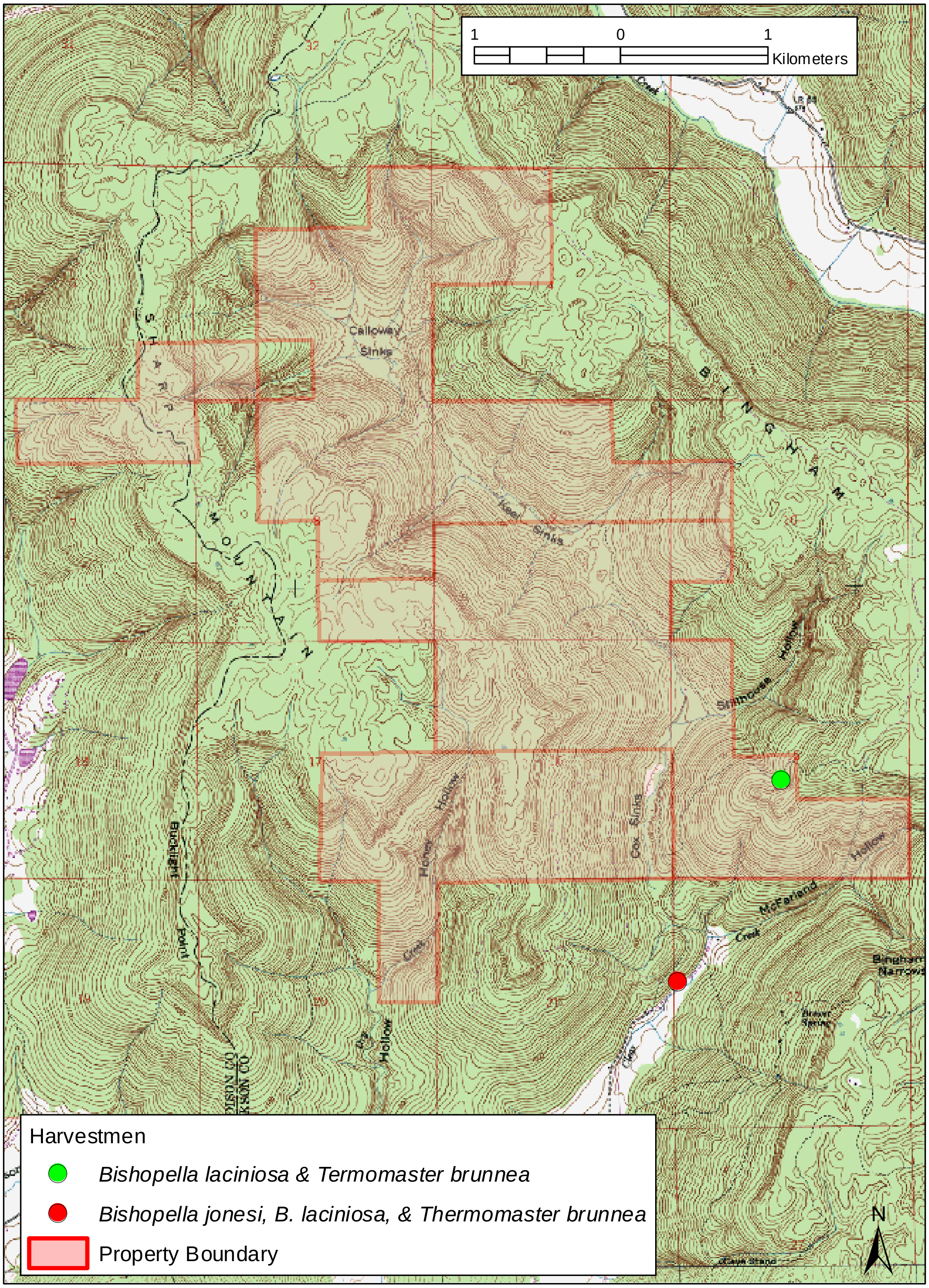
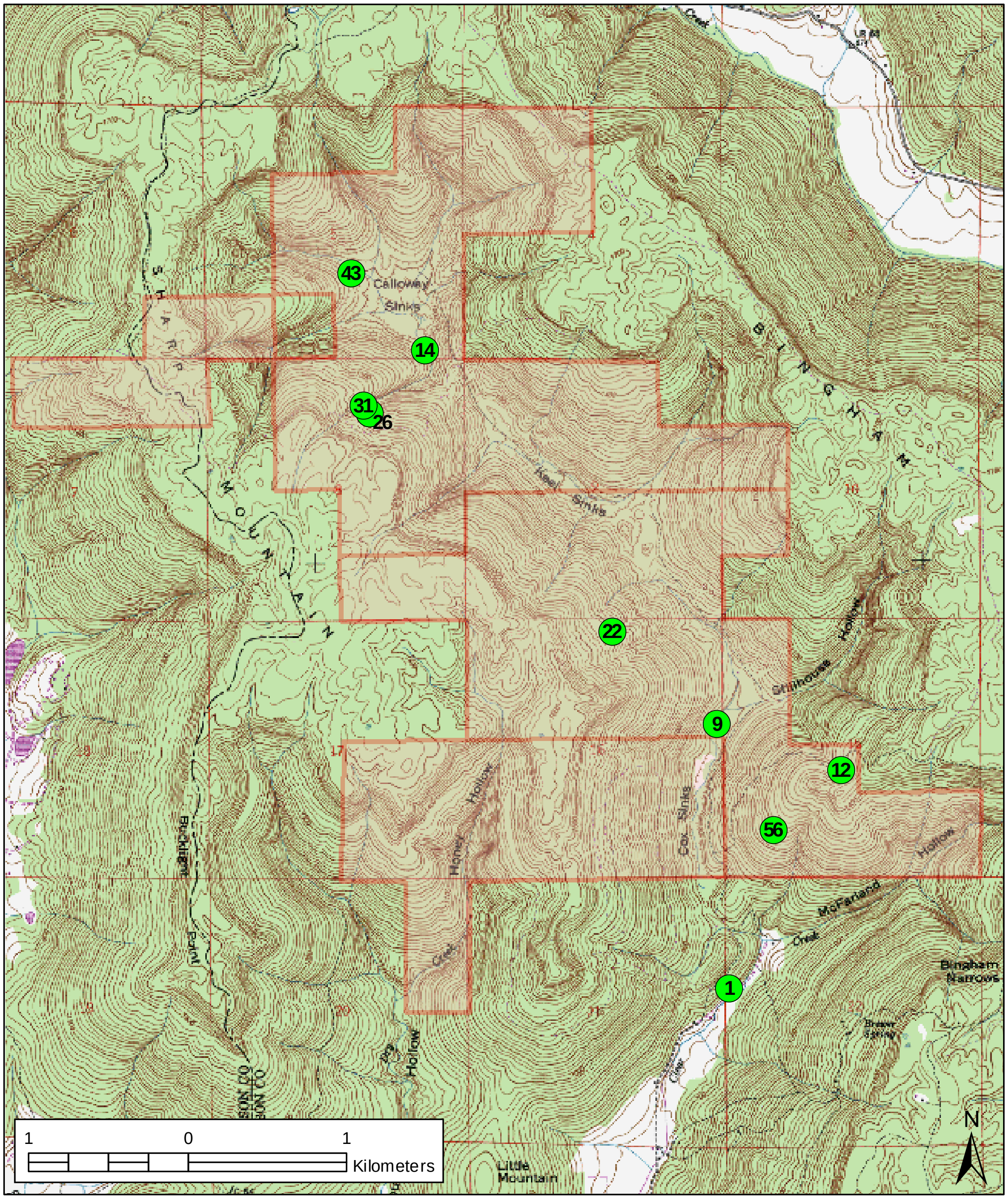


Figure 8. Distribution of millipedes in caves on The Nature Conservancy's Sharp-Bingham Mountain Preserve.



Species	Caves	Species	Caves
Miktoniscus medcofi	31	*Trichopetalum* sp.	9
Ligidium elrodii	26, 56	*Chaetaspis* sp.	9
Pseudotremia spp.	1, 9, 26	*Narceus americanus*	43
Scoterpes spp.	1, 9, 14	*Onomeris* sp.	9
Tetracion jonesi	1, 9, 12, 14, 22, 26, 43		

Figure 9. Distribution of springtails in caves on The Nature Conservancy's Sharp-Bingham Mountain Preserve.

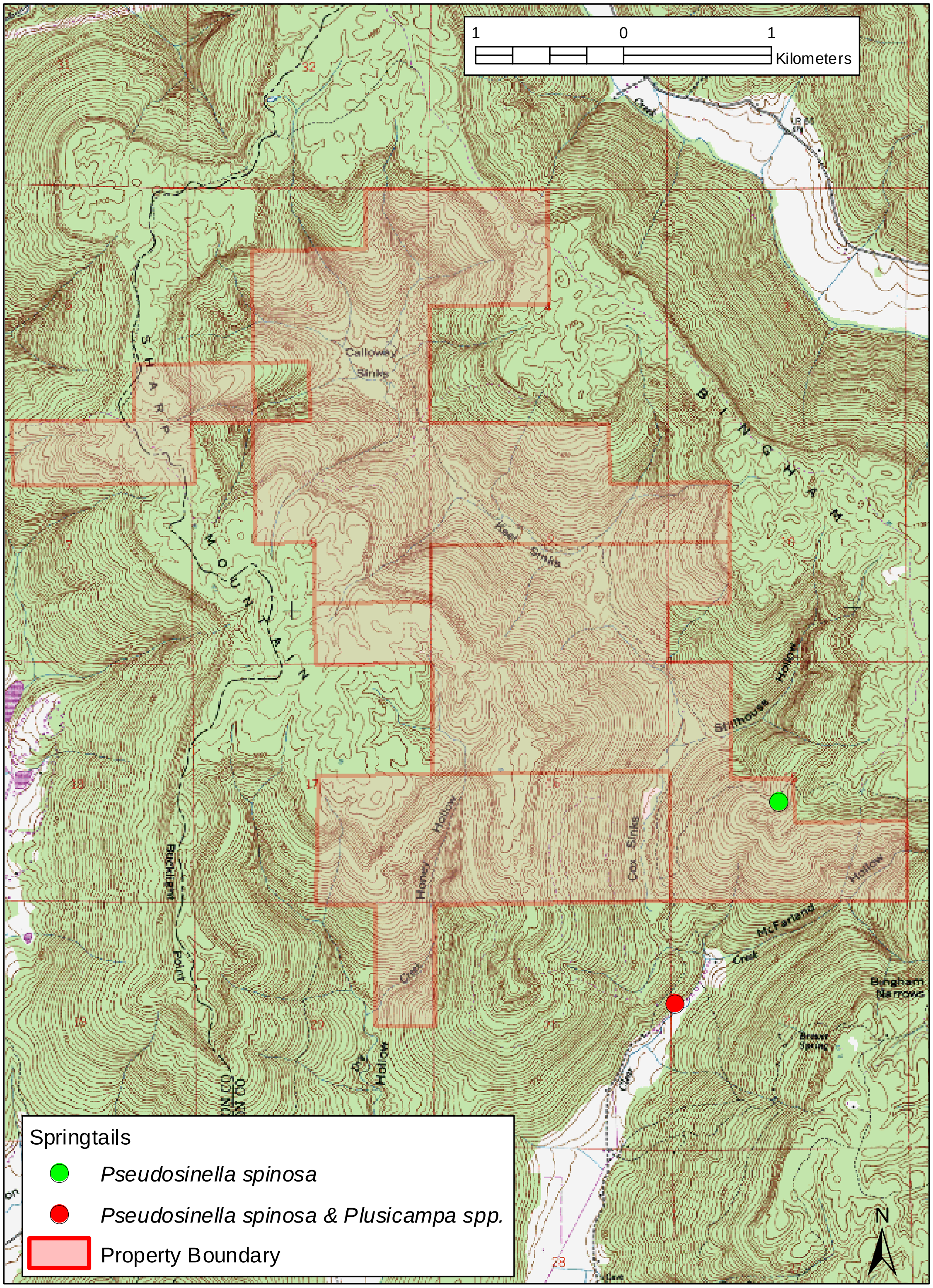


Figure 10. Distribution of crickets in caves on The Nature Conservancy's Sharp-Bingham Mountain Preserve.

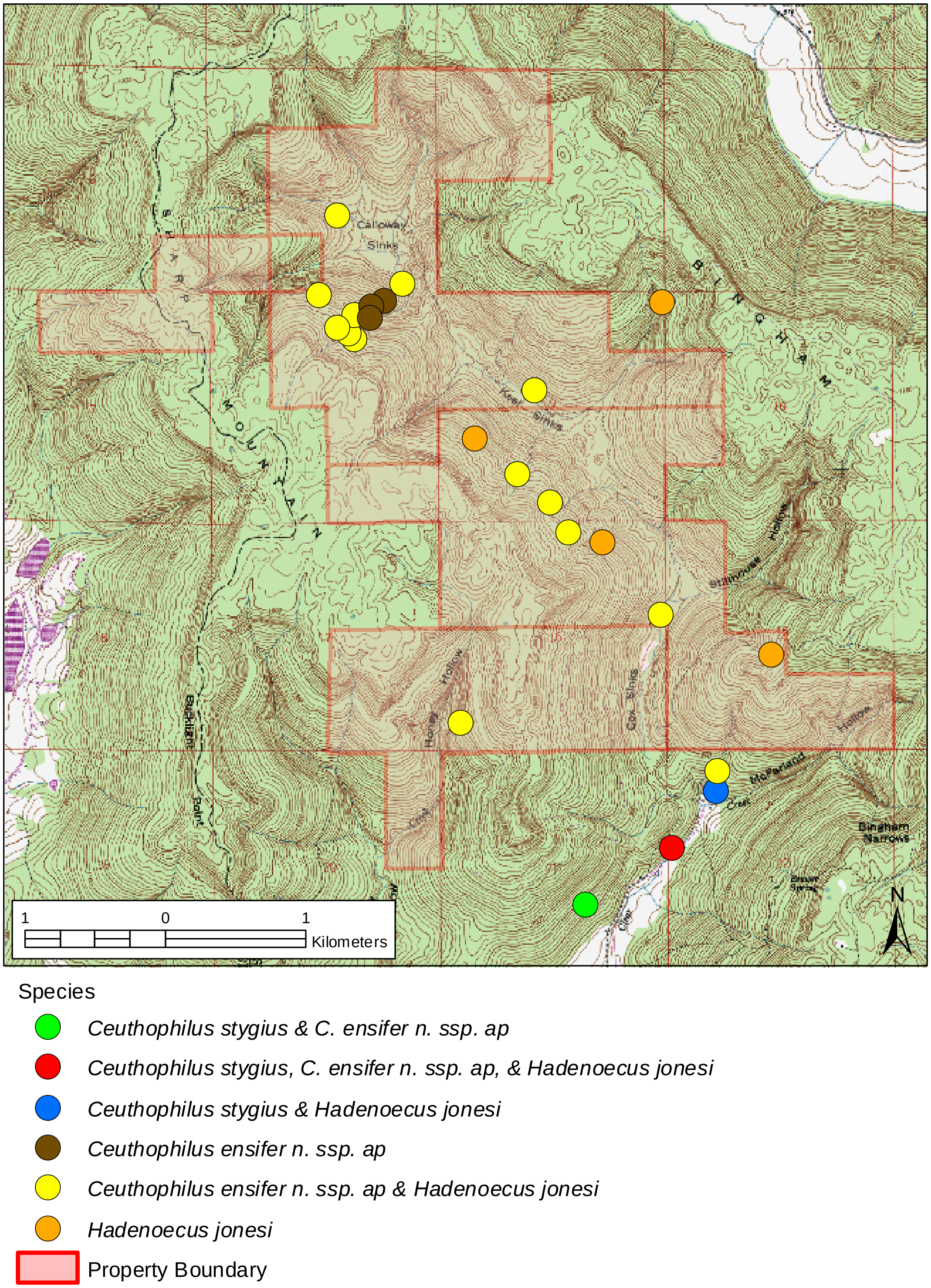
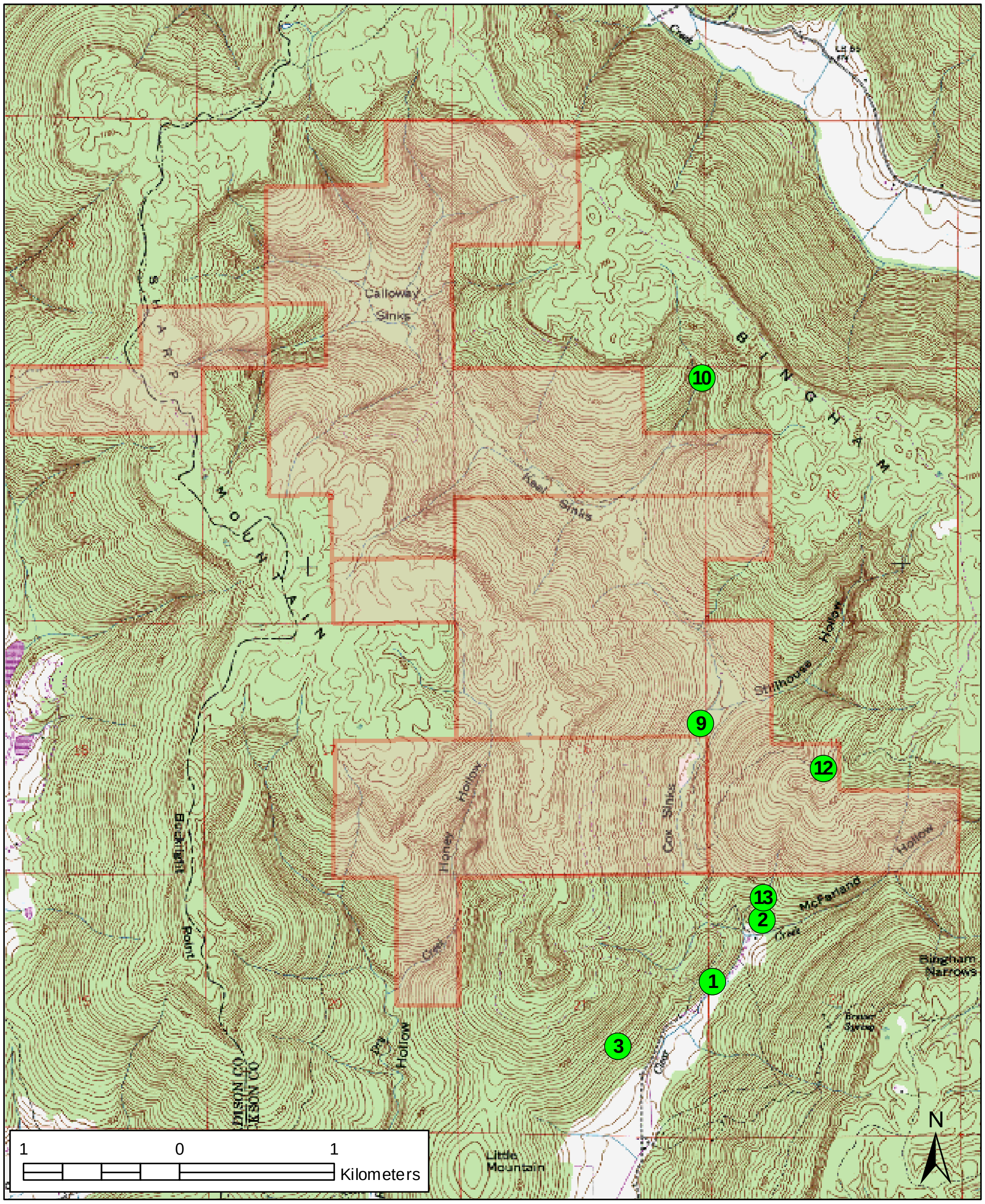
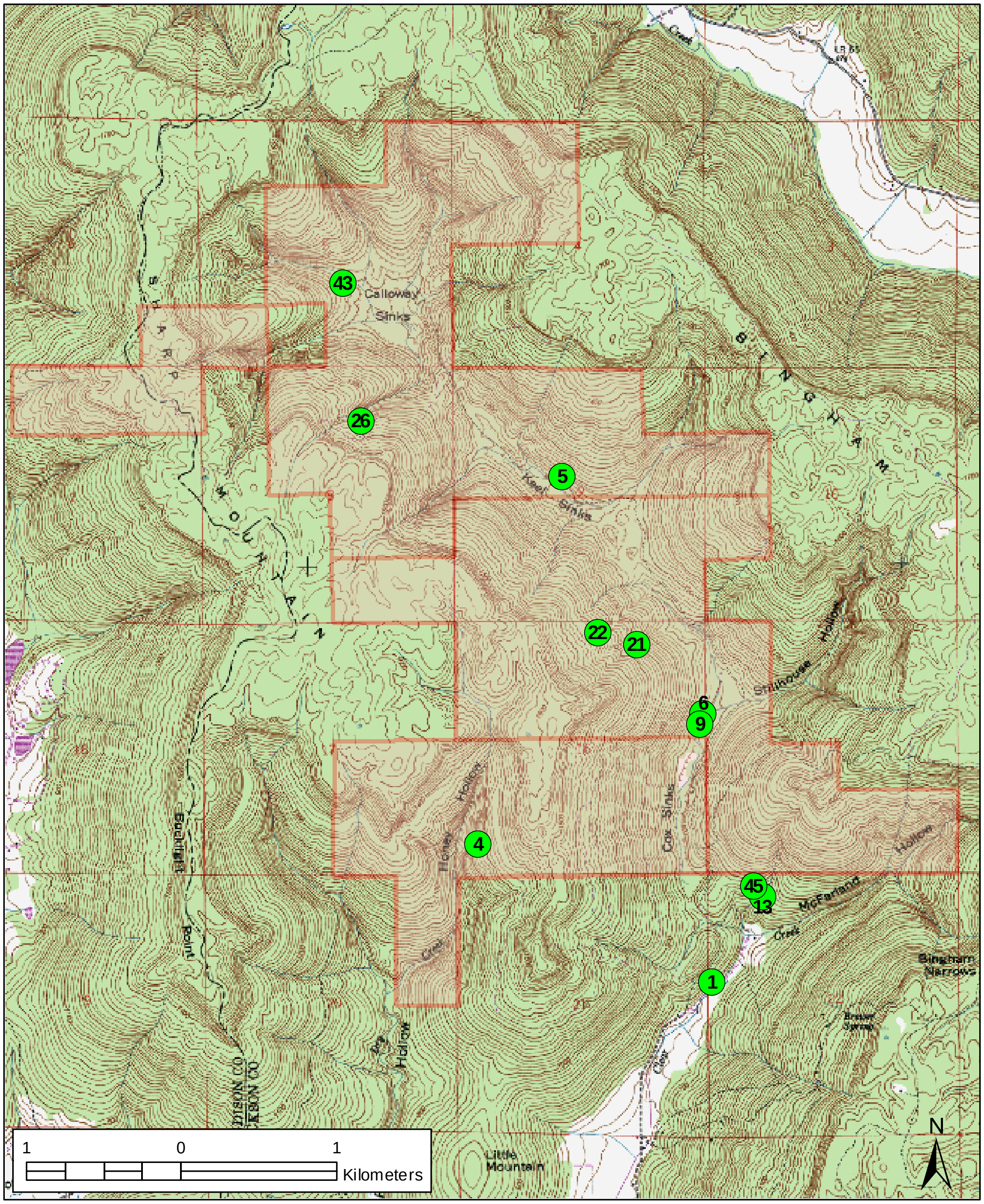


Figure 11. Distribution of beetles in caves on The Nature Conservancy's Sharp-Bingham Mountain Preserve.



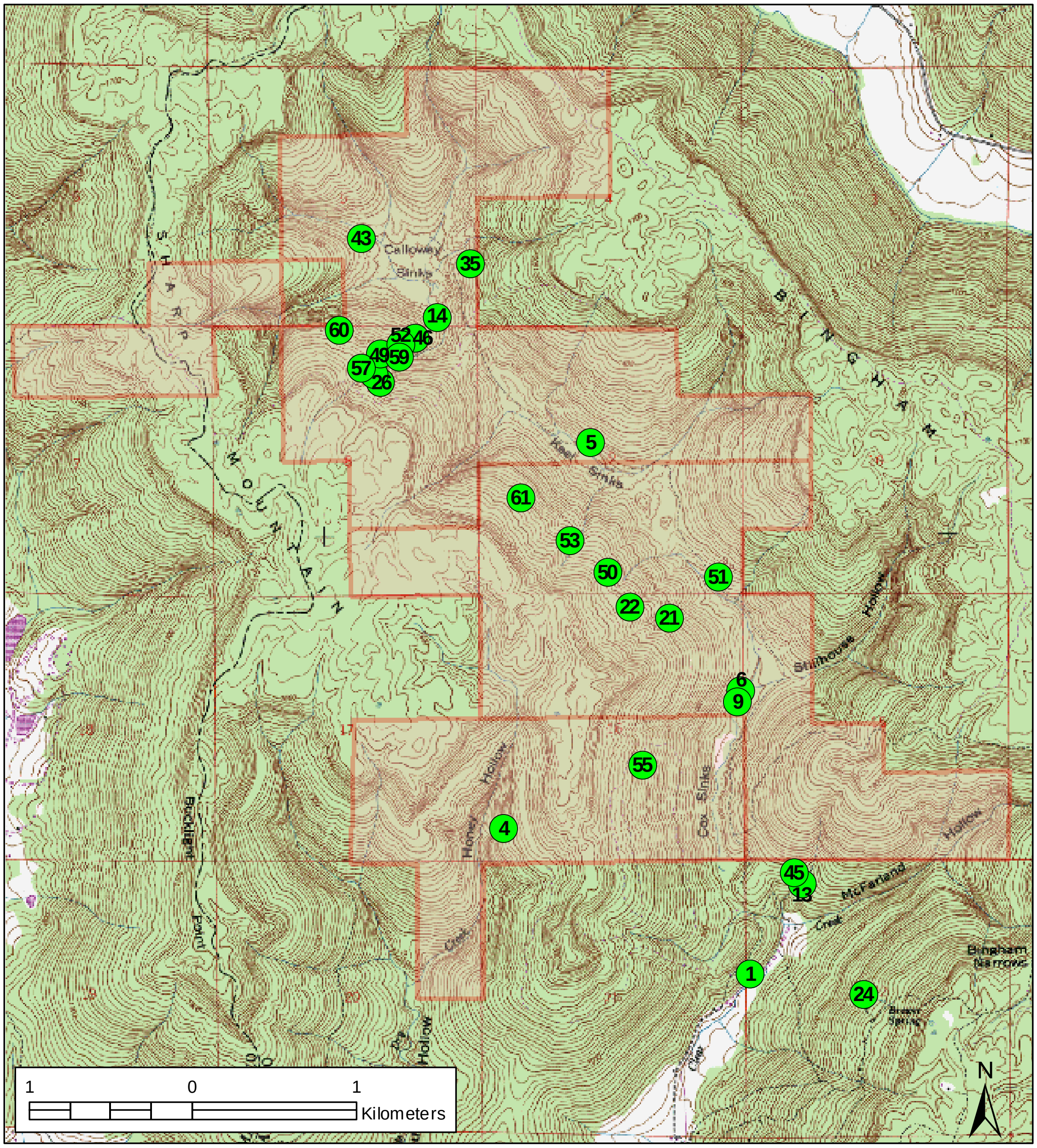
Species	Caves	Species	Caves
Adelopsis cumberlanda	3, 10	*Omalium* sp.	9
Atheta troglophila	1, 9	*Pseudanophthalmus alladini*	1, 12
Batrisodes valentinei	3	*Pseudanophthalmus* n. sp. B	1
Catops gratiosus	9	*Ptomaphagus hatchi*	1, 2, 3, 13

Figure 12. Distribution of frogs and toads in caves on The Nature Conservancy's Sharp-Bingham Mountain Preserve.



Species	Caves	Species	Caves
Bufo americanus	9	*Rana catesbeinana*	9
Hyla chrysoscelis	9, 26	*Rana clamitans*	5, 9, 43
Pseudacris crucifer	9, 21, 22	*Rana palustris*	1, 4, 5, 6, 9, 13, 21, 43, 45
Pseudacris feriarum	22		

Figure 13. Distribution of salamanders in caves on The Nature Conservancy's Sharp-Bingham Mountain Preserve.



Species	Caves
Ambystoma maculatum	6, 9, 22, 24
Desmognathus conanti	4, 5, 9, 21, 31, 35
Desmognathus monticola	5, 31, 35
Desmognathus ocoee	31
Eurycea lucifuga	1, 9, 13, 14, 21, 22, 43, 45, 46, 49, 50, 52, 53, 57
Gyrinophilus palleucus	1, 9
Notophthalmus viridescens	21
Plethodon glutinous	1, 5, 14, 21, 22, 26, 43, 45, 49, 50, 51, 52, 53, 55, 57, 59, 60, 61
Plethodon ventralis	13, 14, 21, 22, 26, 43, 50, 57, 60
Pseudotriton ruber	5, 9, 60

Figure 14. Distribution of reptiles in caves on The Nature Conservancy's Sharp-Bingham Mountain Preserve.

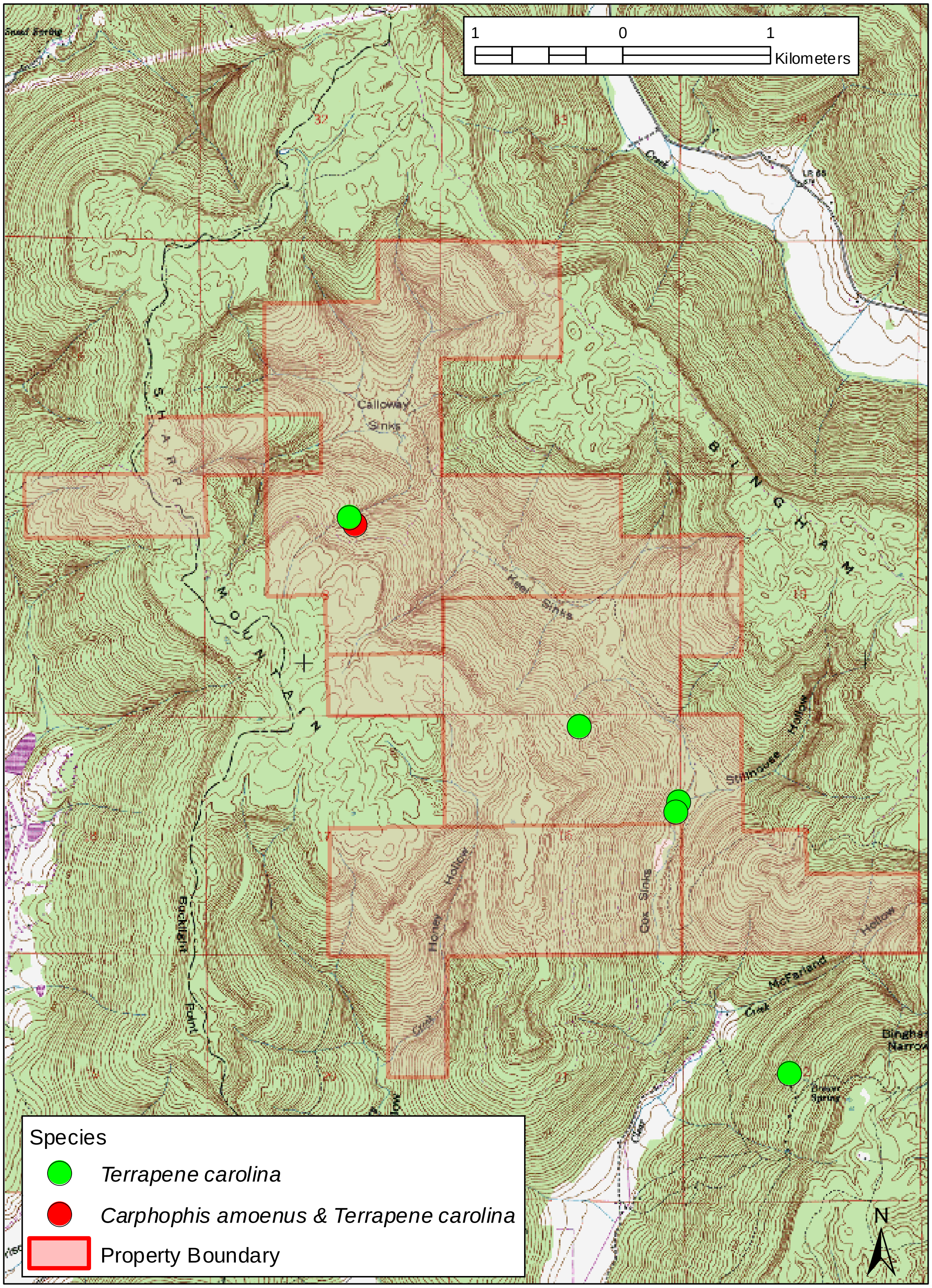
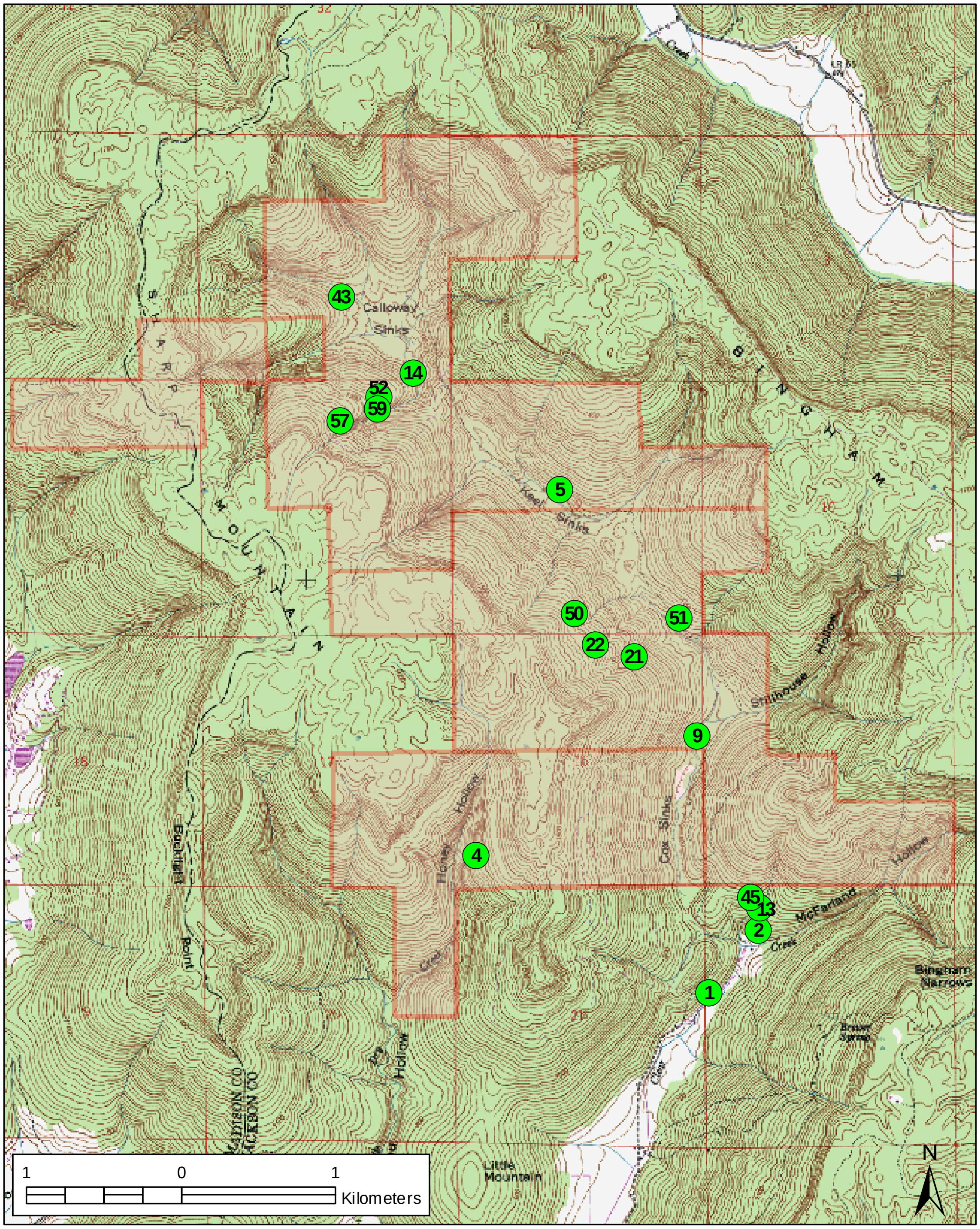


Figure 15. Distribution of bird and mammals in caves on The Nature Conservancy's Sharp-Bingham Mountain Preserve.



Species	Caves	Species	Caves
Corynorhinus rafinesquii	4	*Neotoma magister*	1, 2, 4, 5, 14, 21, 22, 45, 51, 52, 59
Eptesicus fuscus	4	*Perimyotis subflavus*	2, 4, 9, 13, 14, 21, 22, 43, 57
Myotis septentrionalis	4, 14, 43	*Sayornis phoebe*	1, 5, 21, 22, 50, 52

Management Recommendations

Roads

Proper road maintenance is a critical issue on the Sharp-Bingham Mountain Preserve. The goal regarding roads should be to eliminate soil erosion which enters caves, yet maintain passable roads. A first step would be to map all the roads on the preserve and determine which roads should be retained, which ones should be periodically closed, and which ones should be closed. No new roads should be created.

Some amount of sediments in caves is natural whether produced within the cave or brought in from the surface, but roads can introduce an unnaturally elevated sediment load. Excessive sedimentation has detrimental potential to the caves. In addition to the particulate material, sedimentation from roads may introduce automotive byproducts such as oil or antifreeze which can be fatal to cave life. The main north-south road through the preserve requires regular maintenance but this should be done in a manner to minimize sediment movement, particularly in the vicinity of open sinks, such as Keel Sinks, and stream crossings. Roads cross a number of ephemeral drainages, most if not all of which lead to the central ephemeral drainage, which ultimately drains into Cox and Keel sinks. The close association of roads, food plots, and stream drainages may be sites needing additional sediment control measures.

Food plots

Food plots are one other source with potential detrimental impacts upon the subterranean systems. The very creation and maintenance of food plots requires a disruption of the forest, exposure of soils, distribution of non-indigenous seeds, and application of chemicals. Many of the recommendations regarding roads apply to food plots.

The locations and sizes, with acreages estimated, of food plots should be mapped along with their proximity to open sinks, stream courses, and roads. The existence of food plots has the potential to increase sediment loads into caves and introduce vehicular byproducts, as well as introduce exotic or at least non-indigenous plant species into the preserve.

Food plots should be evaluated regarding location to stream courses, sinkholes, and caves. Based on these criteria some food plots should be eliminated and allowed to regenerate to native vegetation. For remaining food plots a maximum allowable size should be established and those that exceed this size should be reduced and the excess returned to a natural state or converted to buffer. Between the food plot perimeter and stream course or road (no food plot should remain if near a cave or sinkhole) a buffer of native vegetation at least 20 m wide should be established. The function of the buffer is to trap sediments, chemicals, and non-indigenous plant products which could be carried into caves.

Exotic Vegetation

Exotic plant species have been observed on the preserve and, while their presence appears to be limited, a complete list of species and occurrence is needed. The non-native species need to be identified and mapped, particularly regarding their proximity to caves and sinkholes. Questions pertaining to the interactions of non-native species and cave life include: 1) Do non-native species affect the subterranean cave life, and; 2) Does the organic material from non-natives have a physical structuring or chemical composition which has a negative impact upon the system? Regardless of the potential effects of non-natives upon subterranean systems, either negative or positive, these species should be removed from the preserve.

©Alan Cressler

Additional Research Needs

Hydrology

The Tony Sinks Cave system carries a large volume of water and many of the outlier caves have either a small stream or have evidence of occasional water passage through them. The source of the water in Tony Sinks Cave is not known, nor is the outflow known. Knowing the origin of the waters, the hydrological connectivity of the individual caves to the overall system, and where and how the waters feed into the Paint Rock River drainage are crucial to the long-term protection of this unique, intact, and immense subterranean system. Similarly the understudied Engle Double cave system is in need of a hydrological study, as well as Saltpeter Cave.

©Alan Cressler

Hardwood forest

The cave systems of the Sharp-Bingham Mountain Preserve lie within the natural community type of a mesic hardwood forest and the intact condition of this forest has undoubtedly contributed to the continuance of the cave systems in a near pristine state. But the true ecological interactions between the surface and subsurface ecological communities have not been examined. For long-term protection the effects of forest management upon the underground fauna is in need of elucidation.

Acknowledgements

A number of people assisted with this project and the listing is in alphabetical order with one exception. Horace and Elizabeth Clemmons deserve special recognition for having the foresight to pass this property on to TNC for long-term conservation. Alphabetically, the cavers, biologists, friends, and family members who spent some time underground or on the preserve: Manuel Beers, Julie Schenk Brown, Ashley Chan, Alan Cressler, Katharina Dittmar de la Cruz, Annette Engel, Scott Engel, Debbie Folkerts, Sara Gardner, Nela, Gareth, Art, and Hugh Godwin, Horton Hobbs, Brian Killingbeck, Chris Leggett, Jerry Lewis, Shawn Lindey, Michele Maxson, Doug Moore, Jeff Moore, Ryan Moran, Matthew

Niemiller, Andy Porter, Megan Porter, Steve Samoray, Katie Schneider, John Schwartz, Marion O. Smith, Tim Smith, Geoff Sorrell, Lesley de Souza, Doug Strait, Shane Stacey, Mike Venarsky, Matt Williams, Beth Young, Andy Zellner, and members of the Alabama Cave Survey.

Horace Clemmons on rope and prepared to descend into Cassius Cave.

©Alan Cressler

The author while on a collecting trip in the Tony Sinks system.

©Andy Porter

References

Adams, G.I., C. Butts, L.W. Stephenson, and W. Cooke. 1926. Geology of Alabama. Special Report No. 14, Geological Survey of Alabama. University, Alabama. 312 pp.

Culver, D.C., H.H. Hobbs III, M.C. Christman, and L.L. Master. 1999. Distribution map of caves and cave animals in the United States. Journal of Cave and Karst Studies. 61:139-140.

Culver, D.C., L.L. Master, M.C. Christman, and H.H. Hobbs III. 1999. Obligate cave fauna of the 48 contiguous United States. Conservation Biology 14:386-401.

Culver, D.C. and B. Sket. 2000. Hotspots of subterranean biodiversity in caves and wells. Journal of Cave and Karst Studies. 62:11-17.

Culver, D.C., M.C. Christman, W.R. Elliott, H.H. Hobbs III, and J.R. Reddell. 2003. The North American obligate cave fauna: regional patterns. Biodiversity and Conservation 12:441-468.

Culver, D.C., L. Deharveng, A. Bedos, J.J. Lewis, M. Madden, J.R. Reddell, B. Sket, P. Trontelj, and D. White. 2006. The mid-latitude biodiversity ridge in terrestrial cave fauna. Ecography 29:120-128.

Hubricht, L. 1985. The distributions of the native land mollusks of the eastern United States. Fieldiana: Zoology 24:1-191.

Lacefield, J. 2000. Lost worlds in Alabama Rocks. Alabama Geological Society. Tuscaloosa, AL. 124 pp.

Miller, B.T. and M.L. Niemiller. 2007. Distribution and relative abundance of Tennessee cave salamanders (*Gyrinophilus palleucus* and *Gyrinophilus gulolineatus*) with an emphasis on Tennessee populations. Herpetological Conservation and Biology 3(1):1-20.

Palmer, A.N. 2007. Cave Geology. Cave Books. Dayton, OH. 454 pp.

Peck, S.B. 1998. A summary of diversity and distribution of the obligate cave-inhabiting faunas of the United States and Canada. Journal of Cave and Karst Studies 60:18-26.

Taylor, C.A., G.A. Schuster, J.E. Cooper, R.J. DiStefano, A.G. Eversole, P. Hamr, H.H. Hobbs III, H.W. Robinson, C.E. Skelton, and R.F. Thoma. 2007. A reassessment of the conservation status of crayfishes of the

United States and Canada after 10+ years of increased awareness. Fisheries 32:372-389.

Veni, G., H. DuChene, N.C. Crawford, C.G. Groves, G.N. Huppert, E.H. Kastning, R. Olsen, and B.J. Wheeler. 2001. Living with karst. A fragile foundation. American Geological Institute. AGI Environmental Awareness Series, 4. 64 pp.

White, W.B. 2008. "**cave**." Encyclopædia Britannica. 2008. Encyclopædia Britannica Online. 19 May 2008. <http://www.britannica.com/eb/article-49710>.

©Alan Cressler

©Alan Cressler