SHARP-BINGHAM MOUNTAIN PRESERVE MANAGEMENT and PROTECTION PLAN (For Internal Use) THE NATURE CONSERVANCY 2008

Introduction

The landscape of the rugged Southern Cumberlands is undeniably beautiful. It is also home to one of the richest hotspots of biological diversity in temperate North America. More than a million acres of rich mature Appalachian hardwood forests blanket the rugged plateaus, cliffs and coves, and provide important nesting habitat for birds such as cerulean warblers, wood thrush, and scarlet tanagers that migrate thousands of miles from Central America every year. These forests are home to hundreds of species of plants and animals, including globally imperiled species such as the green salamander, Tennessee cave salamander, gray bat, Indiana bat, Morefield's leatherflower, limerock arrowood, and the smooth woodmint among many others. Flowing through the heart of the Southern Cumberlands, the Paint Rock River is one of the South's last free-flowing rivers. Its amazing aquatic diversity includes more than 98 species of fish and 58 species of mussels, including dozens of imperiled species, some of which are found nowhere else on Earth. These forested mountains and valleys are honeycombed with thousands of caves and sinkholes, creating extensive underground ecosystems populated by colonies of endangered gray and Indiana bats, and unique cave-restricted species of blind salamanders, crayfish and other unique species. The underlying caves and sinkholes create habitat for an amazing array of rare animals. This area contains the highest degree of cave biological diversity in the United States.

The Nature Conservancy and many public and private partners have been working over the past ten years to safeguard this crown jewel of our Appalachian natural heritage. The Southern Cumberlands Project area encompasses nearly 1 million total acres in Tennessee and Alabama (Figure 1). The project includes several partners working together to develop and strengthen partnerships with the local community, corporations, and other conservation groups to protect the area's unique ecological integrity. To date, The Nature Conservancy and partners have encountered both landowner cooperation and community support for this area's protection. Noteworthy successes include the acquisition of 21,000 acres of forestland around the spectacular Walls of Jericho along the Alabama-Tennessee border, the creation and expansion of other new public conservation areas such as the Henshaw Cove acquisition totaling about 1,600 acres at the confluence of the Paint Rock river, and the establishment of three new Conservancy preserves totaling more than 4,000 acres.

Starting in 2005 The Nature Conservancy began the acquisition of the largest of these preserves known as the Sharp-Bingham Mountain Preserve near the Jackson/Madison County line. Currently at around 3,000 acres this is the largest Conservancy preserve in Alabama. The Sharp-Bingham Mountain Preserve was targeted for acquisition because it contains a wealth of unique biodiversity including over 60 known caves, healthy populations of Tennessee cave salamanders, populations of rare endemic plant species such as the Morefield's leatherflower and limerock arrowwood, and intact hardwood forests with high concentrations of rare or declining neotropical migratory breeding birds such as the worm eating warbler, wood thrush and Kentucky warbler. The preserve encompasses portions of the plateaus of both Sharp and Bingham Mountains and includes the forested slopes and flats of the valley that separates the mountains (Figure 2).

A grant by the Alabama Department of Conservation and Natural Resources through the State Wildlife Grant program funded The Nature Conservancy to contract with Auburn University, Alabama A & M University and the Alabama Natural Heritage Program to inventory the mammals, birds, reptiles amphibian and cave fauna on the preserve. Based off of that work The Nature Conservancy has identified six conservation targets that will drive our management efforts on the site.

Conservation Targets of the Sharp-Bingham Mountain Preserve

- Allegheny-Cumberland Dry Oak Forest and Woodland
- South-Central Interior Mesophytic Forest
- Southern Ridge and Valley Dry Calcareous Forest
- Isolated Wetlands
- Interior Breeding Birds
- Cave and Karst Features

Allegheny-Cumberland Dry Oak Forest and Woodland

Covering an estimated 40% of the current preserve boundaries this natural community primarily occurs on upper slopes and plateaus (Hitch etal., 2008). Located primarily on acidic sandstone substrates this plant community is a fairly common dry hardwood forest type throughout the Southern Cumberlands area. For the most part this is a closed canopy forest dominated by white oak (*Quercus alba*), rock chestnut oak (*Quercus prinus*), southern red oak (*Quercus falcata*), scarlet oak (*Quercus coccinea)*, post oak (*Quercus stellata*), black oak (*Quercus velutina*) and hickorys (*Carya spp*). Sub-canopy species can include red maple (*Acer rubrum),*serviceberry *(Amelanchier arborea),* pignut hickory *(Carya alba), Carya glabra,* dogwood *(Cornus florida)*, witchhazel (*Hamamelis virginiana),* blackgum *(Nyssa sylvatica),* sourwood *(Oxydendrum arboretum),* white oak (*Quercus alba)*, and Sassafras (*Sassafras albidum)*. Shrubs include persimmon (*Diospyros virginiana*), Horse Sugar (*Symplocos tinctoria*), and sparkleberry (*Vaccinium arboreum)* among others (NatureServe, 2008)

Threats

Non-native Invasive Species or Pathogens

Non-native invasive plant species such as the following are present or possible on the site: tree of heaven (*Ailanthus altissima,* Chinese privet

(*Ligustrum sinense),* princesstree (*Paulownia tomentosa),* Bush honeysuckle (*Lonicera spp*), Japanese honeysuckle (*Lonicera japonica),* Periwinkles (*Vinca spp),* and Nepalese Browntop (*Microstegium vimineum).* Bird surveys have also detected brown-headed cow birds on the preserve which continue to become more common in all types of habitat. These birds which lay there eggs in other birds nests are particularly threatening to smaller warblers and vireos. Although, not currently detected in Alabama Sudden Oak Death and other pathogen born diseases will likely be a future threat to the preserve. The emerald ash borer, (A*grilus planipennis),* an exotic beetle that feeds on ash leaves is continuing to move south causing major damage and destruction to forests throughout the upper east coast.

Altered Fire Regime

It is not fully understood but widely believed that fire played some role in the Southern Cumberland landscape. Most likely fire occurred primarily on the ridge or plateau tops and possibly on south or west facing slopes. Fire likely started by lighting on the ridge tops and burned with low to moderate intensity the drier vegetation. The fire would have likely gone out as it went into more moist shaded areas such as mesic coves or north facing slopes. Evidence that fire once played at greater role around the Sharp-Bingham Mountain Preserve is documented by the fact that portions of the plateau on Sharp Mountain have a fair amount of shortleaf pine in the canopy and areas which have been clear-cut surrounding the preserve have a diversity of herbaceous grasses and forbs more common in fire dependent ecosystems that have emerged from the seed bank.

Altered Plant Community Composition

All of the plant communities on the Sharp-Bingham Mountain Preserve have suffered from habitat alteration and are 2nd or 3rd generation forests. Much of the lower valley floor was likely farmed in the 1800’s and early 1900’s. Timber removal continues within the proposed conservation boundary on lands not yet acquired. The loss of the American Chestnut also likely had a significant impact on the plant community composition on the preserve.

Sources of Threats

Invasive Species

Invasive species and pathogens have made there way to the United States in a variety of ways. Some of the more common ways are through trade, agriculture and accidental transport. The horticultural trade where plants not native to this country are brought in and sold with unintended consequences as they escape into the wild has long been one of the top sources.

Incompatible Forestry Practices

Much of the incompatible forestry practices have been alleviated by the acquisition of lands within the Sharp-Bingham Mountain Preserve. However, there are still lands within the preserve design that are privately owned that are being clear-cut or have recently been clear-cut. No active fire management is going on in the preserve either and may prove difficult due to access and topography.

Strategies (Management Actions)

- Non-native invasive species are currently having a minimal impact on the property. By identifying the pathways through which invasive species arrive, action can be taken to prevent future invasions.
- Map and control know populations of non-native invasive species.
- Work with surrounding landowners on compatible forestry practices.
- Develop and implement an experimental prescribed burning regime on a portion of the plateau.
- Work to secure additional land protection in the preserve design.

South Central Interior Mesophytic Forest

This Forest type makes up approximately 29% of the Sharp-Bingham Mountain Preserve occurring in bottoms (Hitch, et. al.). This system contains high species diversity dominated by deciduous forests occurring on deep and enriched soils. These soils often have a presence of limestone or associated basic geological properties in non-montane settings commonly located in a fairly protected landscape positions including such as coves or lower slopes (NatureServe 2008). The center distribution of the South Central Interior Mesophytic Forest rest in the Cumberland and Allegheny plateaus and extends into the adjacent southern Ridge and Valley as well as portions of the Interior Low Plateau where it is located entirely south of the glacial boundary (NatureServe 2008). Dominant species include *Acer saccharum, Fagus grandifolia, Liriodendron tulipifera, Tilia americana, Quercus rubra, Magnolia acuminata*, and *Juglans nigra*. Trees may grow very large in undisturbed areas. The herb layer is very rich, often with abundant spring ephemerals (NatureServe 2008).

Threats

Non-native Invasive Species or Pathogens

Several non-native plants occur on the preserve including Chinese Privet (*Ligustrum sinense*), periwinkle (*Vinca minor*), tree of heaven (*Ailanthus altissima*), and Nepalese browntop (*Microstegium vimineum*).

Sources of Threats

Vehicles

Vehicles and ATV act as vectors for many invasive species. The invasives may become attached in the tires by embedding into the soil trapped in the lugs, seed may also collect on parts of the vehicle or machine and fall off as travel occurs.

Nearby introductions

Other non-native invasive plants occur on nearby lands and threaten to invade. One species that has been an issue on nearby lands outside of Huntsville is bush honeysuckle (*Diervilla sessilifolia*).

Incompatible Forestry Practices

Clearcuts are common practice and the high disturbance of soils creates a suitable environment for invasive species.

Stratagies (Management Actions)

- Control existing populations of invasive species.
- Restrict vehicle and ATV use within the preserve.
- Complete visual check-ups of any new infestations of invasive species.
- Work to secure additional land protection within the preserve design.

Southern Ridge and Valley Dry Calcareous Forest (Plateau)

This system includes dry to dry-mesic calcareous forests of the Southern Ridge and Valley region of Alabama and Georgia, extending north into Tennessee, Kentucky, Virginia and adjacent West Virginia (Natureserve 2008). This forest type makes up approximately 31% of Sharp-Bingham Mountain Preserve occurring primarily on top of the plateau. It includes calcareous forests on lower escarpments of the Cumberland Plateau and other related areas. Examples occur on a variety of different landscape positions and occur on generally deeper soils than glade systems of the same regions. This system is distinguished from systems farther north in the Ridge and Valley because of its southerly location in the region, an area which is transitional to the "Oak-Pine-Hickory" region. High-quality and historic examples are typically dominated by combinations of *Quercus* species and *Carya* species, sometimes with *Pinus* species and/or *Juniperus virginiana* as a significant component in certain landscape positions and with particular successional histories. These forests occur in a variety of habitats and are the matrix vegetation type that covers most of the landscape under natural conditions. Examples can occur on a variety of topographic and landscape positions including ridge tops and upper and mid slopes. Fire frequency and intensity are factors determining the relative mixture of deciduous hardwood versus evergreen trees in this system. Much of this system is currently composed of successional forests that have arisen after repeated cutting, clearing, and cultivation of the original forests. The range of this system is primarily composed of circumneutral substrates, which exert an expected influence on the composition of the vegetation. (NatureServe 2008)

Threats

Non-native invasive plants

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Sources of Threats

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Nearby introduction

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It is not fully understood but widely believed that fire played some role in the Southern Cumberland landscape. Most likely fire occurred primarily on the ridge or plateau tops and possibly on south or west facing slopes. Fire likely started by lighting on the ridge tops and burned with low to moderate intensity the drier vegetation. The fire would have likely gone out as it went into more moist shaded areas such as mesic coves or north facing slopes. Evidence that fire once played at greater role around the Sharp-Bingham Mountain Preserve is documented by the fact that portions of the plateau on Sharp Mountain have a fair amount of shortleaf pine in the canopy and areas which have been clear-cut surrounding the preserve have a diversity of herbaceous grasses and forbs more common in fire dependent ecosystems that have emerged from the seed bank.

Strategies (Management Actions)

- Restrict vehicle and ATV use within the preserve.

- Educate users of vehicles and ATV on the importance of washing the motorized vehicles free of any invasive seed or plant material.

- Complete visual check-ups of any new infestations of invasive species.

- Re-introduce fire through a prescribed setting.

- Work to secure additional land protection within the preserve design.

Isolated Wetlands

The isolated wetlands found on the Sharp-Bingham Mountain Preserve primarily occur on the plateau and are mostly ephemeral with water present in the wetter months of winter and spring. They are perched wetlands over an impermeable substrate. They are typically small with most less than a tenth of an acre. An inventory of the herpetofauna by the University of North Alabama showed that amphibians found in the ponds include Red Spotted Newt (*Notophthalmus* *viridescens*), Spotted Salamander (*Ambystoma maculatum*), American Toad (*Bufo americanus*), Southern Leopard Frog (*Rana sphenocphala*), Four-toed Salamander (*Hemidactylium scutatum*), and Midland Water Snake (*Nerodia sipedon pleuralis*) (Wang 2008). The ponds substrate is organic matter typically having swamp black gum (*Nyssa biflora),* Sweetgum (*Liquidambar styraciflua)* and red maple (*Acer rubrum).* Buttonbush (*Cephalantus occidenatalis)* is sometimes dominant throughout the wetland with various sedge dominating in some instances. These wetlands are critical to the continued survival of many disjunct populations of amphibian species known to occur in this landscape. Corser, 2007 surveyed these vernal pools throughout the Cumberland plateau and noted 18 species of amphibians of the 21 that are known from the region. He also noted that many of these populations of amphibians are disjunct from those of the coastal plain and that many of the plant species that occur in these wetlands are also much more common in the coastal plain. These wetlands are tremendously important and contain a significant concentration of biodiversity for their relatively small size.

Threats

Sedimentation

Sedimentation is one of the greatest threats to the isolated wetlands causing poor water quality and filling of the wetlands.

Altered Hydrology

Since these wetlands are so small and isolated any manipulation of the surrounding landscape could alter their hydrology.

Sources of Threats

Roads

A network of road and trails throughout the preserve are the biggest contributor of sedimentation in the isolated wetlands. Road maintenance and travel create an unprotected substrate that is susceptible to erosion during heavy precipitation. Vehicle/ATV usage on the roads loosens the soil and prevents vegetation from establishing causing erosion during heavy precipitation.

Forestry Practices

Past forestry activities on some portions of the preserve have ignored SMZ around the buffer of these wetlands. This is currently going on mostly in areas that are in the desired protection boundary for the preserve but not yet acquired.

Impoundment

Several of the isolated wetlands on the Sharp-Bingham Mountain Preserve appear to have been created by dikes. More research is needed to determine the functionality of these man-made wetlands. It is likely that some of these areas already held water but have been mechanically improved to hold water for longer periods of time.

Foodplots

Foodplots are not a major threat but may contribute to some erosion into the isolated wetland since they leave the ground unprotected during tillage. A food plot on adjacent land was observed coming up to the edge of one of these wetlands.

Strategies (Management Actions)

- Inventory, map and characterize the isolated wetlands on Sharp and Bingham mountains.
- Implement better BMP's during road maintenance.
- Reduce number of roads and trails present near wetland, possibly rerouting existing roads if necessary.
- Work to create buffers around food plots on private lands within the preserve design.
- Reduce amount of traffic from vehicle and ATV and eliminate usage on some roads and trails.

Interior Forest Breeding Birds

The large forest blocks found in the Southern Cumberlands are a globally important area for a whole suite of neotropical migratory breeding birds. Numerous sources suggest that many bird species especially neotropical migrants have had significant declines over the last 30 years or so. Surveys conducted by Auburn University in 2006 indicated that the Sharp-Bingham Mountain Preserve has at least 46 bird species that are likely breeding throughout the hardwood forest communities on the preserve (Table 1). Interestingly the preserve contains healthy populations of three priority bird species; the wood thrush, Kentucky warbler and worm eating warbler which are indicators of the large blocks of relatively undisturbed forests on the preserve an in the surrounding area.

Table 1. Birds detected on Surveys at Sharp-Bingham Mountain Preserve Listed in order of highest detection	
Red-eyed vireo	American goldfinch
Eastern tufted titmouse	Downy woodpecker
Acadian Flycatcher	Great-crested flycatcher
Wood Thrush	Brown-headed cowbird
Blue-gray gnatchatcher	Barred Owl
Scarlet tanager	Broad-winged hawk
Carolina Wren	Morning dove
Summer tanager	Blue-headed vireo
Carolina chickadee	American redstart
Northern cardinal	Ruby-throated hummingbird
Hooded warbler	Black and white warbler
Red-bellied woodpecker	Eastern wild turkey
Indigo Bunting	Hairy woodpecker
Blue jay	Common yellowthroat
Worm-eating warbler	Northern parula
Yellow-billed cuckoo	White-eyed vireo
American crow	Yellow-throated vireo
Ovenbird	Grey catbird
White-breasted nuthatch	Field sparrow
Chipping sparrow	Louisiana waterthrush
Pileated woodpecker	Red-shouldered hawk
Eastern phoebe	Yellow-breasted chat
Eastern wood pewee	
Kentucky warbler	

Threats

Fragmentation

Fragmentation of the forest into smaller blocks or varying age classes could have detrimental effects on some of the more interior forest dwelling birds such as the wood thrush, worm eating warbler, Kentucky Warbler etc.

Pest and Pathogens

Pest and pathogens either currently known or unknown to occur in the United States could eventually spread to the Cumberland Plateau region of Alabama thus altering the forest composition and structure.

Sources of Threats

Roads and Food Plots

A network of road, trails, and food plots throughout the preserve is a contributor to fragmentation of the forest. This source is believed only to have a minimal impact on this threat.

Forestry Practices

Past forestry activities on some portions of the preserve have left immature early successional vegetation which while good for some species is not the best habitat for forest interior bird species. There is currently clearcutting and thinning going on mostly in areas that are in the desired protection boundary for the preserve but not yet acquired.

Introduced Pests and Pathogens

Introduced pests such as cowbirds and emerald ash borer, and introduced pathogens such as sudden oak death could potentially alter the neotropical migratory bird populations on the property by either direct take or habitat alteration.

Strategies (Management Actions)

- Continue to monitor bird populations through point counts.
- Work to secure additional habitat protection to ensure that habitat Fragmentation does not occur and that larger blocks of forest remain intact.

Cave and Karst Features

The Cave and Karst features at Sharp-Bingham Mountain are the most significant conservation target on the preserve and are the reason that The Nature Conservancy decided to focus conservation efforts on this site. ***(The following pages are taken directly from "Biological Inventory of the Cave and Karst Systems of The Nature Conservancy's Sharp-Bingham Mountian Preserve", Godwin, 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.

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.

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.

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.

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.” Table 2 shows a listing of cave associated fauna found on that has been documented on the Sharp-Bingham Mountain Preserve.

Table 2. 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 alternate	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[1]
Mesodon normalis	grand globe	G5 SNR
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	a 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. ap		
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 rubber	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

Threats

Sedimentation

Due to the isolated nature of the cave watersheds on the Sharp-Bingham Mountain Preserve, sedimentation is currently the greatest potential threat to the integrity and function of the cave systems on the preserve.

Pollution

Pollution from various sources could be detrimental to the unique balance of the cave systems on the preserve. Additional research will be necessary to map the entire cave watersheds to protect these systems from pollution.

Over Use-Recreation

There is much demand for recreational caving. This will have to be carefully managed as to not harm the cave system.

Sources of Threats

Roads

Proper road maintenance is a critical issue on the Sharp-Bingham Mountain Preserve. 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.

Non-native Invasive Plants

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.

Strategies (Management Actions)

- 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. Road sections near caves or which are crossed by ephemeral streams should be identified and steps should be taken to minimize erosion in these areas such as gravel, pavement, water bars, etc.

- 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.

- 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.

- Determine the appropriate amount of recreational use and develop a policy for recreational cave use. Explore partnering with the Southeastern Cave Conservancy or local cave grottos to help manage the process.

APPENDIX

Figure 1. Southern Cumberlands Project Area

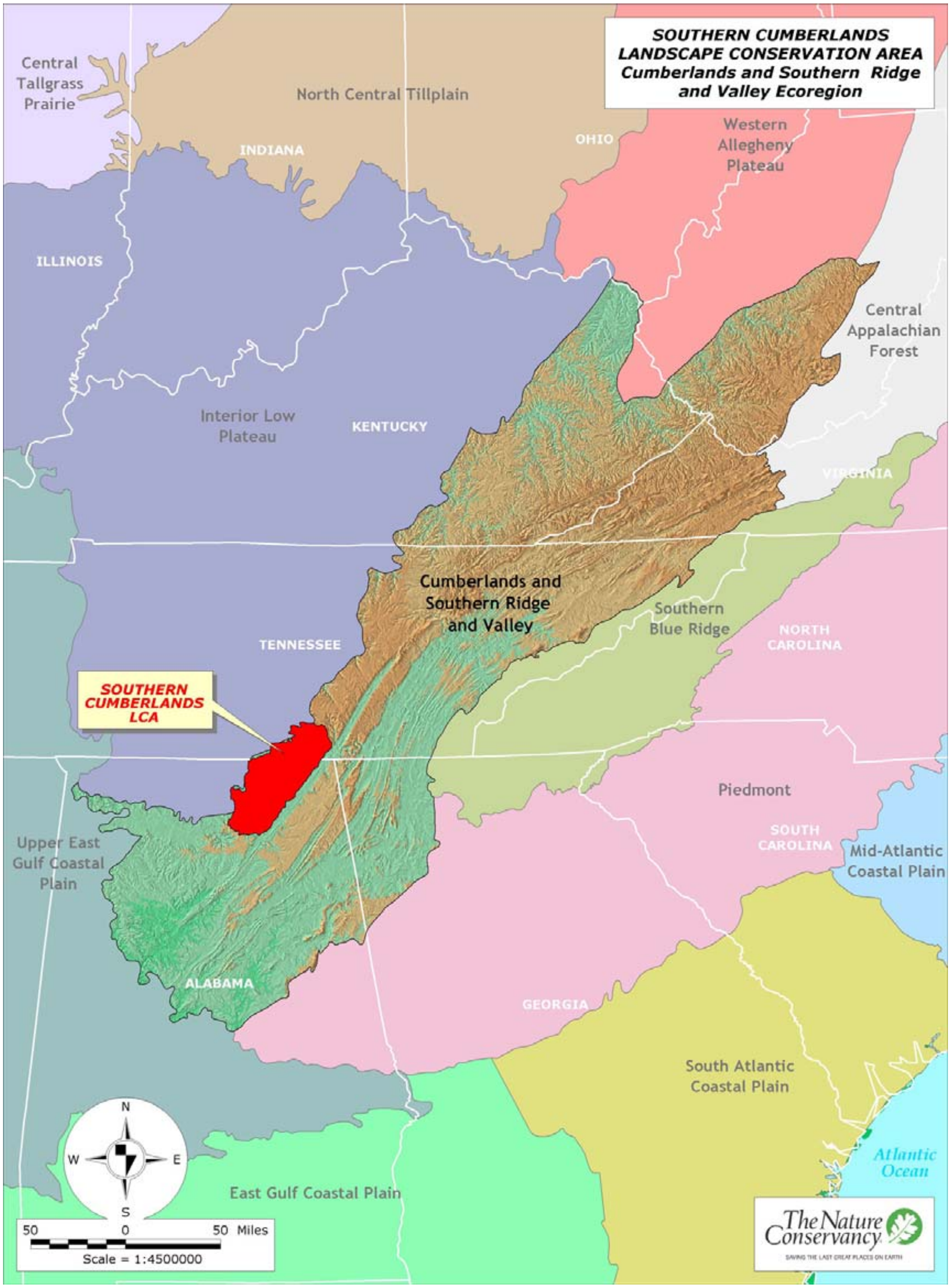
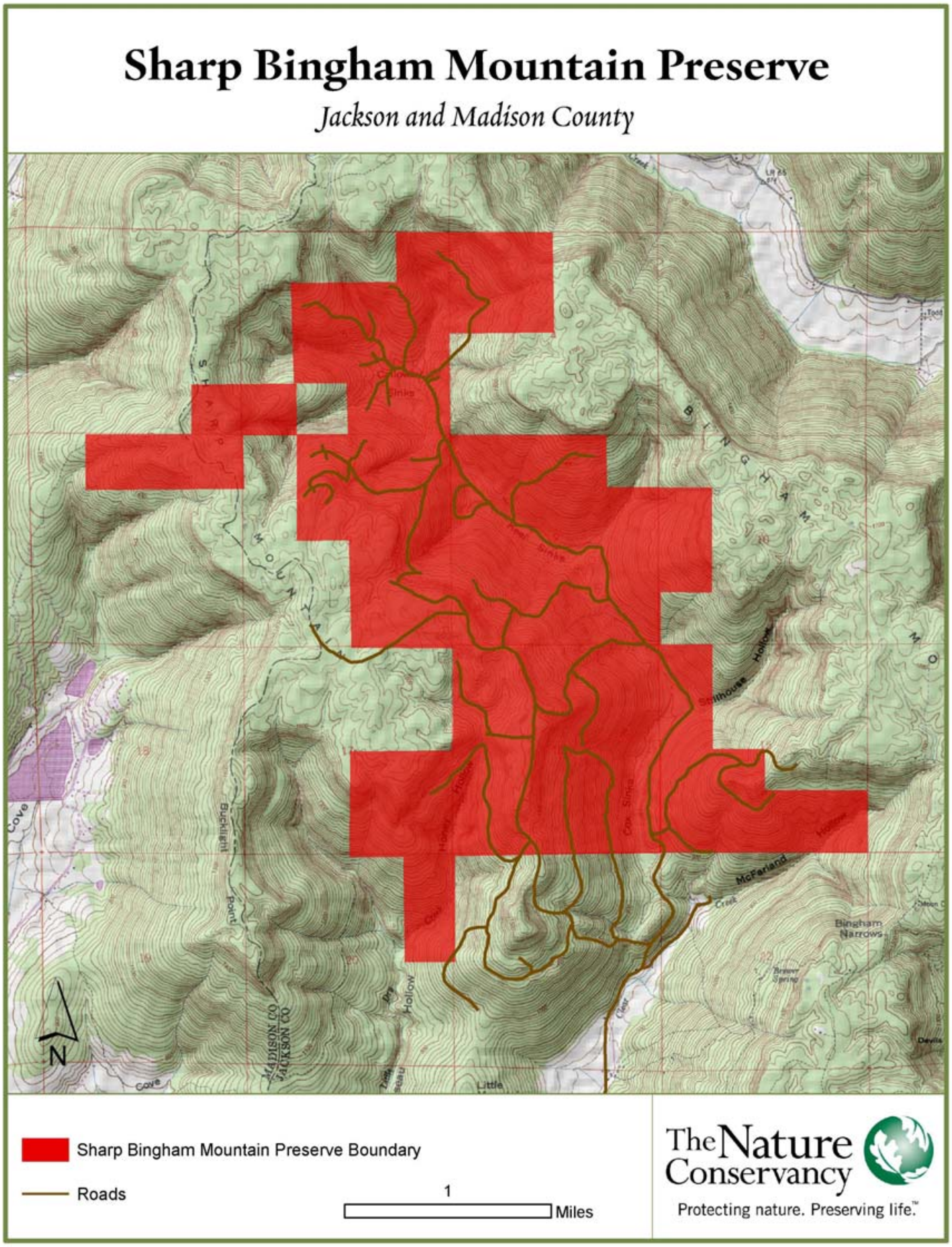


Figure 2. Map of Sharp-Bingham Mountain Preserve with Road System



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