4.4.1 Caves and Mines

4.4.1.1 Ecosystem Description

The majority of documented caves occur in the Mountain ecoregion, though there are some caves present in all regions of the state, including the Coastal Plain. There are several different types of natural caves; however, the most common types are solution caves, fissure caves, and rock shelter/boulder caves. These types differ primarily in the way they are formed.

Solution caves are created by the action of water dissolving the underlying rock to form tunnels. Over time, solution caves get larger and larger and are generally the most extensive (size and length of passage). There are a few areas of North Carolina with underlying limestone geology which lend themselves to solution cave formations. Most notably the Nantahala Gorge and North Fork Catawba River/Linville Mountain area of western North Carolina and parts of the Coastal Plain are underlain with limestone (marble, dolomite, and marl respectively).

Fissure caves are formed by movement of the earth's surface, which results in cracks in the rock layers. Depending on the actual events which spawn the development, fissure caves have varying sizes and configuration. Fissure caves occur in many places in North Carolina, though one of the most well-known and largest fissure cave systems in the world occurs in Hickorynut Gorge in Rutherford County.

Rock shelter/boulder caves are formed by erosive forces, weather events, earth surface movements, and other factors which essentially leave spaces underneath/behind surface rock. The vast majority of caves in North Carolina are rock shelter/boulder caves. Owing to their diversity of formation, geology, and range in the state, caves in North Carolina are quite variable in terms of both the plant and animal communities adapted to, and found in them.

In addition, an extensive mining history in North Carolina has provided numerous subterranean excavations which can and do mimic the environmental conditions of natural caves. Like caves, mines come in many shapes and forms, depending upon numerous factors. There are many mines which do not provide conditions similar to those found in caves, such as open pit mines, strip mines, and quarries. Our definition of the caves and mines habitat type is intended to include only mines which include subterranean excavations with conditions inside the mine shafts and tunnels that resemble conditions in natural caves. That being said, the range of variability of those conditions is extensive.

Caves and mines were described in the 2005 WAP as a priority habitat (see Chapter 5) (NCWRC 2005).

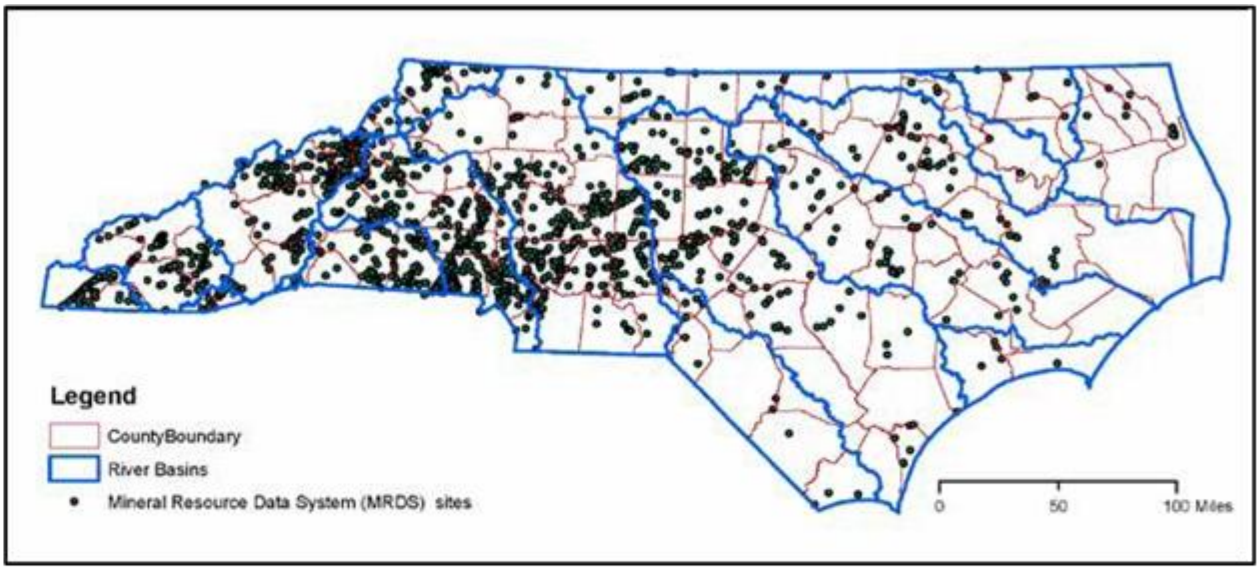
4.4.1.2 Location of Habitat

According to Christman and Culver (2001), caves are common in the United States. Details about cave locations in North Carolina are not provided in this document in order to protect them from vandalism and degradation that can occur when used by casual or recreational visitors. Old mines that may pose a geologic hazard (pre–North Carolina Mining Act) and have subsurface workings have been documented in a database previously maintained in the Mineral Resource Data System (MRDS) of USGS and the

Mineral Availability System/Mineral Industry Locator System (MAS/MILS) in the US Bureau of Mines (USBM), which is now part of USGS.

Figure 4.5 represents generalized location information of this dataset (McFaul et al. 2000); however, we have made no attempt to verify the type of subsurface feature or location represented by the data. While this data set was developed by USBM/USGS to portray the distribution of old mine workings in North Carolina and contains non-confidential data, it should be recognized that these sites are located on privately owned land in most cases.

Figure 4.5 Statewide location of subsurface mines (McFaul et al. 2000).



4.4.1.3 Problems Affecting Habitats

Given the variability in cave types, mine types, and a host of different substrates, orientations, positions on the landscape, etc., the condition of caves and mines in North Carolina is quite variable. Caves and mines occur across all land ownership types. Several of the most significant sites have received attention in the past to protect resources (wildlife or geological in most cases). Bat-friendly gates have been installed in some locations to prohibit or regulate human entry and subsequent impacts upon cave resources. However, modifications at cave entrances and gate design and placement will potentially impede air exchange, ultimately exerting influence on the ambient and substrate temperatures inside caves, which in turn will influence the body temperature and metabolic rates of hibernating bats (McNab 1974; Humphrey 1978; Martin et al. 2006).

We have no accurate assessment of the wildlife habitat potential of abandoned mines in North Carolina, and certainly have little idea as to their individual suitability for use by cave-dwelling animals or plants. Some portion of abandoned subsurface mines are likely to function similarly to caves in providing the range of microhabitat conditions which cave-obligate species need, especially larger mine excavations that can provide the volume and air flow needed by cave-dwelling species (particularly bats of various species). Smaller mines may support minor levels of use, or use by small numbers of individuals.

Seasonal variations in surface climate, entrance characteristics (Tuttle and Stevenson 1978) and physical structure of the cave itself (Twente 1955; Raesly and Gates 1987) are thought to have the greatest impact on the climate of cave interiors (Martin et al. 2006). Changes in precipitation may contribute to variation in moisture and temperature but may not be drastic. Drought conditions cause moisture gradients in caves and mines to change, especially those with groundwater seepage contributing to the humidity level. Warmer temperatures will change the suitability of this habitat for species adapted to historic microclimate conditions.

Human activities alter the microclimate, biogeochemistry, and balance of organic matter in caves, which also impacts microbial communities (Saiz-Jimenez 2012). Several research articles have reported on declines of cave-obligate bats caused by human disturbance at caves (Martin et al. 2006). In many states, and throughout the world, many caves have been developed into tourist attractions, often with lighting, tours, gates, etc. All of these activities have resulted in degraded habitat conditions for cave-dwelling animals as well as disrupted normal behavior patterns, effectively eliminating habitat for many cave animals. The Southern Blue Ridge Ecoregional Conservation Plan noted recreation, including developed tourist caves and recreational caving/exploration, to be the greatest threat to cave and cave species conservation (TNC and SAFC 2000).

4.4.1.4 Climate Change Compared to Other Threats

Comparing climate change to other ecosystem threats can help define short- and long-term conservation actions and recommendations. While climate change is not the most severe threat, a combination of synergistic effects with other existing conditions could stress these systems to the point where several species are unable to persist. The Southern Blue Ridge Ecoregional Conservation Plan identifies recreation as the greatest threat to cave and cave species conservation (TNC and SAFC 2000). Communities and species associated with cave and mine habitats are likely to be affected by changes in temperature and mild winters associated with climate change. Table 4.26 summarizes the comparison of climate change with other existing threats.

Table 4.26 Comparison of climate change with other threats to mountain bogs and fens

Threat	Rank Order	Comments
Pathogens/ Disease	1	White-nose syndrome (WNS) has devastated bat populations roosting in caves in the northeastern states, including North Carolina, over the past 5–10 years. Several bat species have declined in the state by over 95% due to the death caused by this fungus.

Threat	Rank Order	Comments
Recreation	2	Disturbance from human intrusions can disrupt normal animal activities (hibernation, roosting) and introduce contamination from other sites (fungal spores, disease). Most accessible caves or mines experience some level of human visitation by caving and rock climbing enthusiasts.
Development	2	Caves are at risk of being developed into tourist attractions, often with lighting, tours, gates, etc. These activities result in detrimental impacts to habitat conditions for cave-dwelling animals, as well as disrupted normal behavior patterns, effectively eliminating habitat for many cave animals. Linville Caverns is the only cave complex that has been commercially developed as a recreational destination in the state.
Climate Change	3	Caves and mines provide unique microclimates that some species require during key phases of their life history (e.g., bat hibernation). Even slight increases in temperature can change the humidity in these environments and increase the potential for fungal and bacterial growth. Evidence of temperature variability is the increased occurrence of WNS in winter hibernating bats.

4.4.1.5 Impacts to Wildlife

Appendix G provides a list of the SGCN and other priority species for which there are knowledge gaps and management concerns. Appendix H identifies SGCN that depend on or are associated with this habitat type. Subterranean aquatic communities are described in Section 4.2.6.

White-nose syndrome (WNS), a fungal disease that affects hibernating bats, is reported to be caused by *Pseudogymnoascus destructans* (Blehert et al. 2009; Frick et al. 2015), formerly *Geomyces destructans* (Lorch et al. 2011; Hayes 2012). The first evidence of the disease was documented in 2006 and since then there has been widespread evidence of its impact on bats. WNS has already decimated populations of most cave-dwelling species of bats in the state, especially Northern Long-eared Bat and Little Brown Bat. Chapter 5 provides additional information on disease and pathogens affecting wildlife, including WNS.

Nearly a thousand species and subspecies known from caves and associated subterranean habitats in the United States have been described (Culver et al. 2000; Christman and Culver 2001). Various surveys and investigations have been conducted in many caves and mines in attempts to document significant wildlife or geological resources in North Carolina. However, no comprehensive evaluation has ever occurred in the state other than for bats in caves. Caves also provide important habitat for cavespiders (*Nesticus* spp.), millipedes, crustaceans, pseudoscorpions, and crickets (TNC and SAFC 2000). Not only is the condition of caves and mines quite variable in North Carolina, but our state of knowledge about the use of caves and mines by plants and animals is extremely variable. Habitat specialists and species with restricted ranges will likely be some of the greatest affected by the combined effects of habitat loss and climate change.

Troglobites are cave-dwelling organisms that have adapted to darkness, have no skin pigment, and are blind because they spend their entire lives underground. Troglobites include fish, salamanders, crayfish, insects, and spiders. They cannot live outside a cave and their survival may be threatened if the cave environment is damaged or altered. The National Speleological Society (NSS) notes that water pollution, visitor traffic, trash, flooding, and a change in air patterns and temperature contribute to disturbing a cave's fragile food web and ecosystem.

One cave complex has been developed as a recreational destination in North Carolina and many other cave or mine systems have experienced some level of human visitation. Many of the wildlife species that use caves, if not the caves themselves, have been impacted by human activities, including both direct impacts (e.g., repeated disturbance during bat hibernation) and indirect impacts (e.g., habitat changes that make microhabitat conditions inside the cave or mine unsuitable). Human use of caves can cause alteration of the physical structure of the caves themselves, changes in the water chemistry or hydrology within the cave, or destruction of cave structures and cave-dwelling organisms (Fleury 2009). Dripwater flows are critical both to cave biota and to the microclimates of the caves them- selves, and if those flows carry surface-level contaminants, the entire cave environment is affected (Fleury 2009).

It is believed many smaller caves and mines have been impacted by nearby development, though there is little to no documentation of the occurrences. Careless disposal of wastes or excessive fertilization in agricultural areas can have devastating impacts on cave life by altering the water chemistry (Watson et al. 1997; Gillieson 1996). Though it rarely happens, caves can also be destroyed by aquifer drawdown, as sinkholes can form on the surface and collapse so they fill in the cave. It is usually not possible to restore a cave to its original condition after it has been degraded by human activity; for that reason, conservation is a preferred strategy (Elliott 2004).

4.4.1.6 Recommendations

Caves and mines occur across all types of land ownership. Several of the most significant sites have been identified as conservation priorities. The North Carolina Cave Survey has documented over 1,300 caves in the state (NCWRC 2005). We have no accurate assessment of the availability of abandoned mines in North Carolina, nor do we possess information on their individual suitability for use by cave-dwelling animals or plants.

Surveys. Distributional and status surveys need to focus on species believed to be declining or mainly dependent on at-risk or sensitive natural communities.

- Create a comprehensive, prioritized list of significant caves, including the factors which add significance (e.g., roost of endangered bats, rare geologic formations, other rare plants or animal use).

- Survey for potential nesting birds in caves such as Turkey Vultures, Black Vultures, and Common Ravens.

- Inventory salamander communities associated with cave habitat (particularly in the twilight zone of caves).

- Conduct bat surveys in caves and mines that have not been previously evaluated.

- Conduct surveys for Cave Salamanders (*Eurycea lucifuga*) in areas along the Tennessee/ North Carolina border.

Monitoring. Long-term monitoring of caves and mines is critical to assessing species and ecosystem health over time and gauging the resilience of organisms to a changing climate. These efforts will inform future decisions on how to manage species and their habitats. Studies should include identification of population trends, as well as assessment of impacts from conservation or development activities. Long-term monitoring sites need to be identified and monitoring protocols developed for all priority species. Monitoring plans should be coordinated with other existing monitoring programs where feasible.

- Establish and implement long term monitoring protocol to document bat use of significant cave/mine roosts, especially in those caves and mines that are affected by WNS.

- Develop protocols and procedures for long-term bat banding study and data storage throughout the state.

- Establish protocol for periodic monitoring and assessment of Allegheny woodrat populations.

- Develop and implement systematic, long-term population monitoring protocols for cave-dwelling salamanders.

Research. Research topics that facilitate appropriate conservation actions include habitat use and preferences, reproductive behavior, fecundity, population dynamics and genetics, feeding, competition, and food web dynamics. Increased understanding of life histories and status helps determine the vulnerability of priority species to further imperilment, in addition to identifying possibilities for improved management and conservation. All studies should provide recommendations for mitigation and restoration. Formal descriptions for known or putative undescribed species and investigations aimed at resolving taxonomic status are needed.

- In some areas of its range, the Longtail Salamander is associated with caves or portions of caves. Investigate its habitat use in North Carolina in conjunction with more generalized research on this species' distribution, status, and habitat in the state.

- Conduct studies to document maternity sites used by bats from specific hibernacula (e.g., find maternity colonies utilizing radio telemetry of individual Virginia Big-eared Bats that hibernate in known caves/mines, or track any Indiana or Gray bats captured to their maternity sites or hibernacula).

Management Practices. Management practices that reduce impacts and work synergistically with other conservation actions are needed to enhance the resilience of natural resources. Particular needs include preserving biodiversity, protecting native populations and their habitats, and improving degraded habitats.

- Where feasible and cost effective, install gates to limit access (similar to protective measures used at Cranberry Mine). Inspection and monitoring may be needed to detect vandalism and illegal entry.

- Identify ways to address the effects of WNS where it occurs in the state.

Conservation Programs and Partnerships. Conservation programs, incentives, and partnerships should be utilized fully to preserve high-quality resources and protect important natural communities. Protective measures that utilize existing regulatory frameworks to protect habitats and species should be incorporated where applicable. Land conservation or preservation can serve numerous purposes in the face of anticipated climate change, but above all, it promotes ecosystem resilience.

- Acquire cave habitat through purchase, conservation easement, or other perpetual management agreements (potential for partnerships with NC Natural Heritage Program, The Nature Conservancy).

- Develop plans to protect caves where roosting bats or other cave resources are at risk from human intrusion.

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