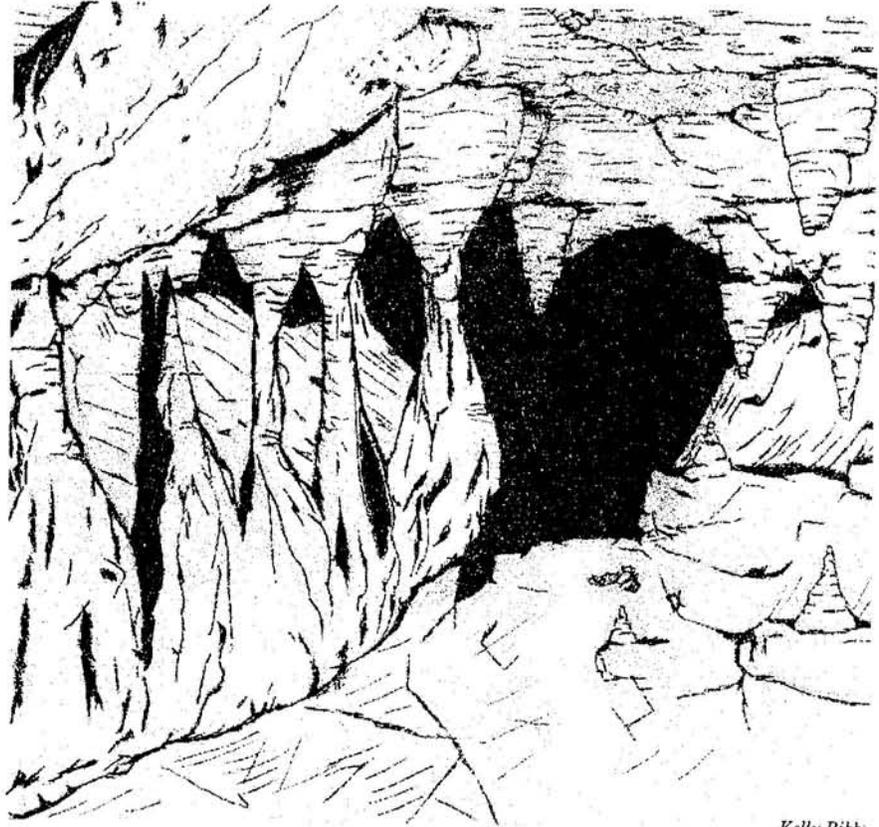


Tennessee's Caves

What is a Cave?

Hidden within middle and eastern Tennessee's abundant limestone bedrock are a network of secret worlds—cave ecosystems. There are more than 7,000 caves in the state. Beautiful and mysterious, these cave systems support a highly specialized and diverse group of animals. Caves are usually thought of as natural openings in the ground, large enough for a human to enter, and extending beyond the zone of light. From the surface a cave may appear to simply be a dark hole in the ground. Yet any cautious explorer who is lucky enough to enter a cave may see incredible sights—gently flowing streams and roaring waterfalls, quiet clear pools, gardens of rock and twinkling crystal formations, vertical columns, and curtains of stone—all hidden within the darkness. Crucial to the health of these underground ecosystems are the cedar glades, barrens, forests, streams, and other ecosystems that lie on the surface.

Tennessee's caves form in a topography called karst, which includes sinkholes, sinking streams, subterranean drainage, and springs. The formation of karst topography is dependent on the high solubility of rocks like limestone and dolomite. Falling rain absorbs carbon dioxide from the air and vegetation, forming a mild acid that slowly dissolves the rock. As the rock dissolves, tiny cracks in the rock grow to form underground openings that over thousands of years can become large rooms and interconnecting passages extending for miles and having many levels. As the underground water flows through small cracks and passages within the soluble rock, it becomes saturated with calcium carbonate and other minerals. When this saturated water reaches a larger passage or room, the water evaporates and the dissolved minerals are deposited as beautiful calcite, gypsum, and other mineral formations like hanging stalactites, rounded stalagmites, flower-shaped



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rocks, flowstone, and soda straws. As long as the water continues to drip, the formations will continue to grow and change. Not all caves are formed or decorated this way. Tectonic caves, for example, are formed by faults and fractures in the Earth's crust.

Why are Caves Important?

Caves house spectacularly beautiful ecosystems and often provide valuable habitat for many species of wildlife. Some species are so fully adapted to this habitat that they can live in no other place. Caves have also played an integral role in human history. Early humans found shelter from the elements, protection from enemies and animals, and burial sites for their dead in caves. Caves were the sights for ceremonies that produced underground "art galleries," such

as the Mud Glyph Cave in eastern Tennessee. Some cultures considered caves to be pathways to the underworld.

During the War of 1812 and the Civil War, caves were valuable sources of saltpeter, which was used to make gunpowder. Nitrogen-rich soils and rocks found in caves were mined in vast quantities to use for saltpeter production, and many relics of this historical mining activity are preserved in caves. Hundreds of artifacts, including ladders, bridges, water troughs, and saltpeter vats, remain as evidence of this era. Today we are still drawn to caves because of their beauty and mystery and the thrill of exploration.

Habitat and Species Diversity

Caves are surprisingly diverse ecosystems that provide habitat for a variety of highly specialized wildlife.

You Can Help!

While carefully walking, crawling, or even climbing through a cave's sandy and muddy passages, it can be fun to imagine what the cave looked like thousands of years ago. If steps are taken to protect these secret worlds, we can ensure that our cave ecosystems will continue to grow and change for years to come. Enjoy and take pride in Tennessee's cave ecosystems! Pay attention to signs outside of caves; never remove a cave conservation sign. Always dispose of trash properly. Never enter a significant bat cave when bats are present. Many important bat caves have seasonal closures. Caves closed in the winter to protect hibernating bats are often open to visitors in the summer. Prevent nonpoint source pollution and learn more about the connection between surface and underground ecosystems. Continue to learn about cave ecosystems and the species they support and teach others about them.

Several factors influence the physical environment of caves—temperature, humidity, free-flowing water near the entrance, air flow, and available light. Different combinations of these factors create different habitats within caves. Hundreds of invertebrates, such as isopods, amphipods, snails, mites, millipedes, and beetles, are adapted to these specific conditions and are found nowhere else in the world. While exploring a cave you may be lucky enough to see members of three groups of creatures that depend on the habitats found in cave ecosystems. Bats, wood rats, and some cave crickets are known as **trogloxenes**—cave visitors. These creatures spend only part of their lives in caves. **Troglophiles**, or cave lovers, such as some cave spiders, can live out their lives in caves but can also be found in dark, damp places in other ecosystems. Finally, there are the cave dwellers, or **troglobites**, such as blind cave fishes, crayfishes, cave beetles, and the Tennessee cave salamander. They spend their entire lives in caves, having evolved to survive in the absence of light, and are often colorless, and eyeless or blind.

Cave systems can be divided into generally distinct areas. Upon entering a cave you will first encounter the **cave entrance**. Depending on the season, air temperature in a cave may be warmer or cooler than the outside area. The cave may feel cold in the summer and warm in the winter. While hillsides may be baking in the summer sun, a cave entrance will often remain moist and cool. Some plants, like the endangered American hart's-tongue, have evolved to take advantage of this, and in Tennessee they grow only within cool, moist cave entrances. Many terrestrial frogs and salamanders also take advantage of the cool moisture found in this zone.

Following the cave entrance is the **twilight zone**, which extends from the entrance to the deepest part of the cave that is still touched by light. The cave entrance and twilight zone are the only places where photosynthesizing plants can be found. Phoebes and barn owls build their nests in the shelter of these twilight zones. Eastern wood rats build their nests here and even further into caves. Because they tend to collect human-made odds and ends, these pale brown mammals have been called "pack rats." A wood rat nest may be decorated with coins, flash bulbs, bits of rope, and cigarette packs lost or left behind by careless humans. Cave salamanders can be found clinging to the rocks and walls in this zone as well.

Reaching past the twilight zone further into the depths of the cave is the **dark zone**. Here there is total darkness, and the creatures that live here can survive nowhere else. A few of these highly specialized creatures are the blind cave crayfish, Southern cavefish, cave glow worm, and blind cave cricket and the State amphibian—the Tennessee cave salamander. They live on tiny organisms, such as fungi and bacteria, that grow on decaying organic matter brought into the cave by streams or on bat guano droppings. The dark zone is the seasonal home of hibernating bats. Endangered Indiana bats and gray bats cluster in the dark quiet reaches of caves from October to May. Female Indiana bats leave the caves to raise their young in the forest, while gray bats and several other species of bats depend on cave ecosystems year-round.

Rare and Unique Species Depend on Cave Ecosystems

Many of these creatures are rare and unusual; some are endangered or threatened. The American hart's-tongue, Indiana bat, and gray bat are all federally listed species. Many

species that are not federally listed are considered endangered or threatened at the state level. The state-listed species in Tennessee include the Eastern big-eared bat, Eastern small-footed bat, Tennessee cave salamander, Southern cavefish, long-headed cave beetle, and searcher cave beetle.

Threats to Cave Ecosystems

Caves and the karst areas that are often associated with them have formed slowly over hundreds of thousands of years. Caves are delicate ecosystems that are especially sensitive to environmental degradation. Although seemingly isolated in their dark underground environment, their health is dependent on the health of the forests, grasslands, cedar glades, and river ecosystems that lie above them. Careless human actions can quickly damage or destroy these irreplaceable resources. For example, activities on the surface can cause contamination of the ground water that flows into and through cave systems. Nonpoint source pollution from a variety of sources (including pesticides and herbicides); erosion; and storm-water run-off from agricultural, residential, and urban areas. Run-off from urban areas often contains oil, grease, lead, and asbestos. Poorly designed and maintained septic systems and trash and waste dumped into sinkholes also contribute to ground-water pollution. Contaminated ground water is often considered to be "out of sight, out of mind." However, caves and karsts are part of the water cycle; therefore, what goes down, must come up. Contaminated water that flows into caves harms not only the plants and animals living there but us as well. When water emerges at the surface at a spring or is pumped up from wells, it is not suitable for drinking and can adversely affect us and other plants and animals, not just those that live in caves.

The construction of highways and reservoirs and other types of development can threaten cave ecosystems. If not carefully planned and constructed, these activities may alter the water and air flow into and out of caves and cause flooding or the collapse of cave passages and chambers.

Cave-dependent bats have suffered drastic declines because of thoughtless vandalism. A single ill-timed visit to a hibernation site can result in the death of thousands of bats. Humans can wake the bats, causing them to use the precious energy they need to make it through the winter. A single incident of human disturbance in a bat maternity cave can cause the death of the young bats because the startled mothers will drop their pups.

Formations that have taken untold centuries to develop into spectacular natural creations are sometimes broken off by tourists and rock collectors who don't realize the irreparable damage they are causing.

What's Being Done?

Humans are the problem; fortunately, however, they are also the solution. Increased awareness of the value of cave-dependent species such as bats and the fragility and vulnerability of other cave resources have led many of us to a better understanding of the consequences of our actions.

Many organizations exist today solely to protect, conserve, explore, and educate others about the cave ecosystems of the world. The National Speleological Society was founded to advance the study, conservation, exploration, and knowledge of caves. The American Cave Conservation Association was formed for the purpose of protecting karst lands and caves. They develop public education programs and professional services that address caves, karsts, and ground-water

problems and promotes the proper stewardship and land-use planning of caves and karsts.

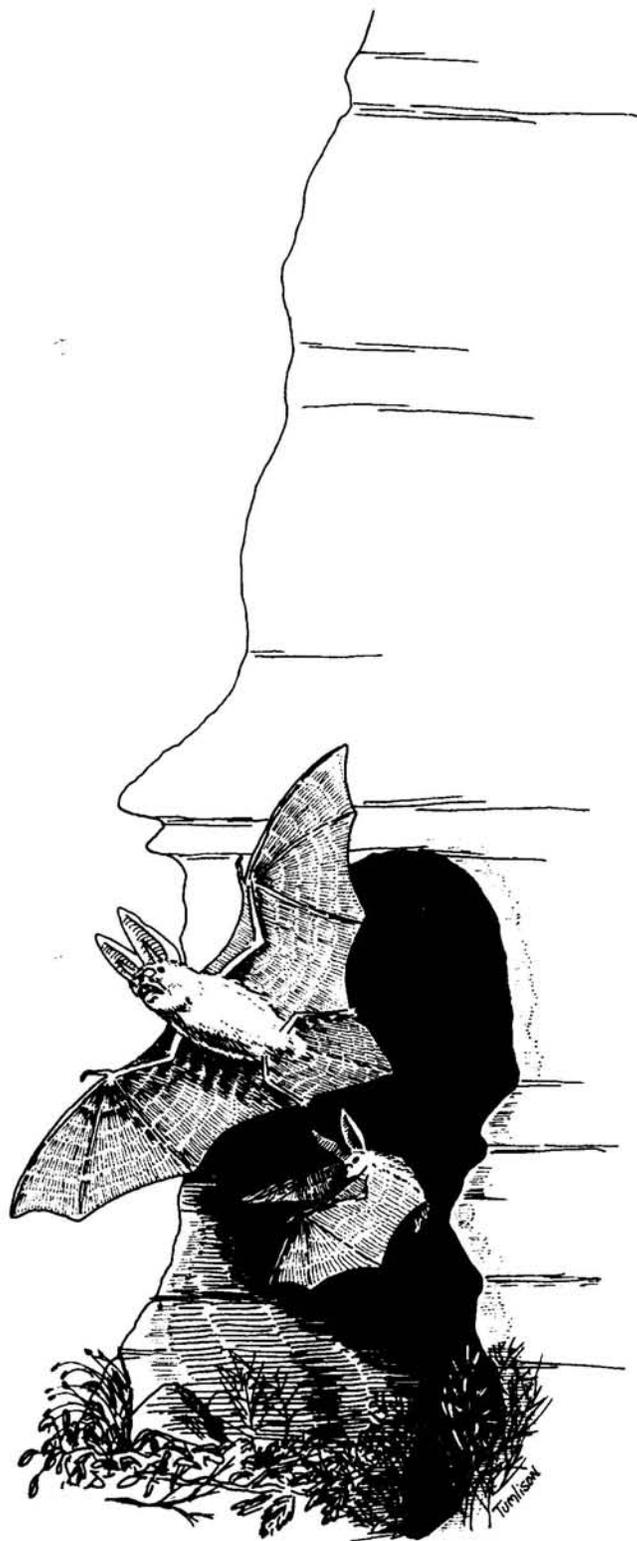
The management and recovery of the rare and unique species that depend on cave ecosystems sometimes involves the construction of gates to control human access. These gates prevent unauthorized access to caves but, if properly designed, do not disturb the movement of air, water, or bats into and out of caves. Frequently signs will be posted outside of caves alerting visitors to the sensitive creatures within. Because the surface environment supplies water and energy to cave ecosystems, management must include surface ecosystems as well.

Many cave ecosystems today are protected by law. The Federal Cave Resources Protection Act was signed into law by Congress in 1988. It was designed to protect and preserve caves on federal land. Tennessee has legislation in place to protect caves from vandalism, making it illegal to remove or harm cave formations, plants, or animals. It is also illegal to tamper with or remove locks, gates, and other structures designed to prevent entrance into a cave.

Seeing is Believing!

Tennessee has many trails, parks, and natural areas where you can get a close-up view of wild plants and creatures and their habitats. Using the supplemental *Tennessee Wildlife Viewing Guide*, locate and visit a cave or karst ecosystem near you!

Consider joining the American Cave Conservation Association or a local grotto of the National Speleological Society to learn more about caves and how to safely explore them. Never enter a cave alone; learn how to safely explore cave ecosystems before entering one.

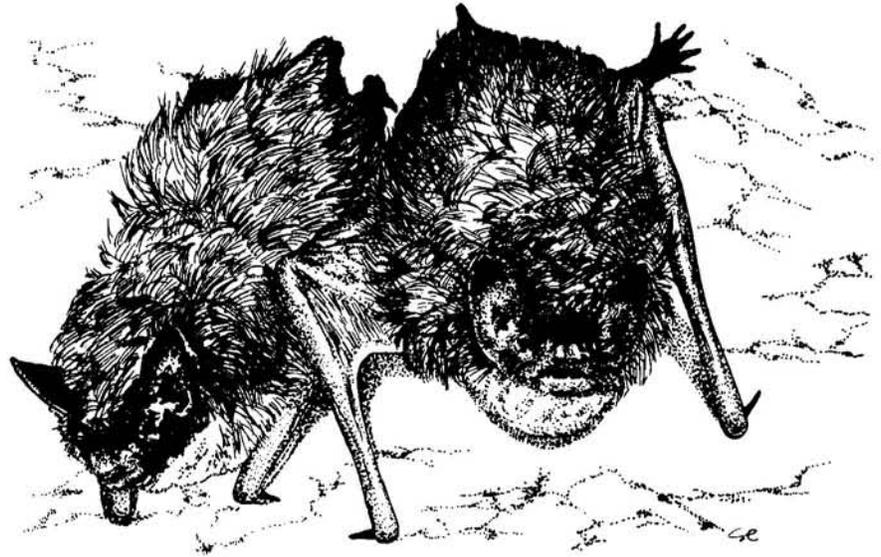


Indiana Bat

(*Myotis sodalis*)

You Can Help!

Tell a friend about the Indiana bat. Pay attention to signs outside of caves. Dispose of trash properly. Avoid entering significant bat caves. Prevent nonpoint source pollution. Take pride in Tennessee's wildlife!



Status

The Indiana bat was listed as endangered on March 11, 1967.

Description

The Indiana bat is a small flying mammal with a dull, grayish chestnut back and a light pinkish to cinnamon buffy underside. Its 10-inch wingspan supports a small body that weighs about as much as two toothbrushes. This small creature could easily fit in your hand. Indiana bats have small delicate feet and tiny sharp teeth.

Habitat

The Indiana bat occurs in the Midwest and Eastern United States. Indiana bats hibernate in caves during the winter. They spend the rest of the year in forests, resting in hollow trees, under tree bark, and in caves.

Life History

Indiana bats breed in early October. They hibernate through the winter and cluster together in tight groups for warmth. Each individual bat hangs by its feet from the cave ceiling. In late March the hibernating colonies break up, and the females give birth during June to a single bat. Females join together to form maternity colonies, where they raise their young under loose bark in old and dead trees. Young bats are capable of flight within a month of birth.

Role in the Ecosystem

Indiana bats use sonar to detect and capture moths and other flying insects near riparian and floodplain treetops. A single bat can eat up to 3,000 insects in one night! Bats are the only major predator of night-flying insects. Cave ecosystems depend on bats as a source of organic matter, as many cave creatures feed on bat guano.

Threats

The decline of the Indiana bat has been caused by the commercialization of caves, vandalism, and cave destruction. When a hibernating colony is disturbed, bats use up the stored energy that they need to survive the winter. The majority of the population winters in only seven caves, making the species extremely vulnerable. Indiana bats have also been directly killed by humans. The use of insecticides and the destruction of stream-side vegetation can harm bat populations as they feed on insects. Old and dead trees are often removed for use as fuel, decreasing the amount of important roosting habitat.

Recovery

Recovery measures include controlling access to caves with properly designed gates across cave entrances. Some gating has already been accomplished on public land. The National Speological Society and other caving organizations are taking steps to prevent the disturbance of Indiana bat habitat and hibernating colonies.

American Hart's-tongue

(*Asplenium scolopendrium* var. *americana*)

You Can Help!

Tell a friend about the American hart's-tongue. Pay attention to signs outside of caves. Dispose of trash properly. Remember to stay on trails to avoid trampling plants and wildlife. Prevent nonpoint source pollution. Take pride in Tennessee's wild plants!



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Status

The American hart's-tongue was listed as threatened on July 14, 1989.

Description

The American hart's-tongue (a fern) has evergreen strap-shaped fronds that arise in a cluster from a short underground root. Cinnamon-colored scales cover the fronds. Each frond is 5 to 17 inches long and 3/4 to 1 3/4 inches wide. Each frond of this rare plant resembles a long pointed tongue!

Habitat

This species requires deep cool shade, constant high humidity, moist soil, and the presence of limestone that is high in magnesium. Southern populations are restricted to limestone pits and sink holes that occur in or around caves. Small northern populations exist in Canada, New York, and Michigan. Southern populations are found in Alabama and Tennessee. Of the two populations found in Tennessee, a 1981 survey found that one has been extirpated and that the other supports only 17 plants, so it is also in danger of extirpation. Another variety of American hart's-tongue is found in Europe.

Life History

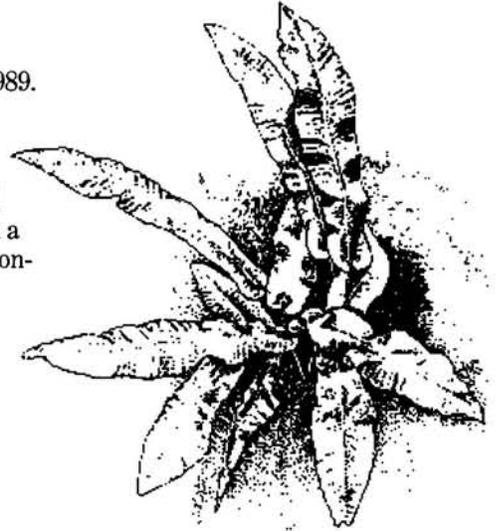
The cinnamon-colored scales that cover the fronds are actually spore-producing reproductive structures known as "sporangia." The spores require cool moist environments to develop into ferns.

Role in the Ecosystem

It is an important component of the biodiversity of the cave ecosystem. The greater the diversity of species in an ecosystem the healthier the ecosystem.

Threats

The American hart's-tongue is threatened by trampling and habitat alteration, including construction, development, timber removal, and



quarrying for limestone. Insect infestations, which destroy the leaves of shade-producing trees, also pose a threat. The collection of wild plants remains a threat to the small isolated populations of American hart's-tongue.

Recovery

Management and recovery goals include habitat protection and further research on this rare fern's biology and life history. The Nature Conservancy has leased the land that contains the last remaining population of American hart's-tongue in Tennessee in an effort to protect this rare plant.