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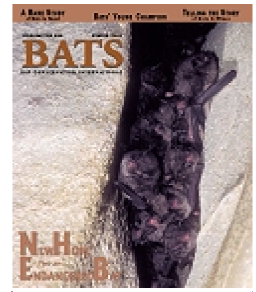

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Balancing Energy for Survival

Merlin D. Tuttle

Bats heading into a winter of hibernation face a crucial energy-balancing act: Body fat stored at summer roosts must first get them to their hibernation sites and then keep them alive, albeit with a drastically reduced metabolic rate, through the winter. Energy burned in migration is no longer available for supporting hibernation. That balance explains many of the problems – and solutions – in saving the endangered Indiana myotis.
Bats are among the few animals that truly hibernate. The winter sleep of animals such as bears is often called hibernation, but it lacks the marked metabolic and physiological shutdown of a true hibernator. The breathing of a hibernating bat is imperceptible. Its heartbeat drops from roughly 400 beats per minute while awake to about 25 in hibernation. Its body is cold to the touch, as body temperature drops to within a few tenths of one degree of the cave's temperature.
Bats can be aroused from hibernation if they are disturbed by humans or if cave temperatures fluctuate too much. A single arousal can burn two months' worth of stored fat reserves, so conserving energy is vital. Undisturbed caves with stable temperatures in the bats' required range are rare and thus of premium value.

Rebuilding the huge Indiana myotis populations of the past requires attracting migrants from areas that sometimes approach 100,000 square miles (260,000 square kilometers) across several states. But such long-distance travel can cost as much of a bat's fat reserve as a whole winter of hibernation. To survive, these travelers must find ideal roost temperatures where they can sleep as long as possible between arousals. Even a few degrees of deviation, or a few extra arousals caused by human disturbance, can mean the difference between life and death. There is little margin for error.
Only caves with ideal temperatures that minimize the bats' energy requirements are able to maintain hibernating populations of hundreds of thousands or more.
In some cases, smaller numbers of Indiana myotis (hundreds or thousands) can survive stressful temperatures and disturbances because they hibernate in caves near their summer homes. By avoiding migration, these bats have extra energy stores to survive high hibernation costs.

This has led to confusion regarding the winter needs of Indiana myotis and to the protection of marginal caves that contain barely surviving local groups despite unfavorable conditions. Since preferred roosts are almost always in the extra-large and complex caves that are most frequented by humans, these were the first to be abandoned. Local survivors that are found hibernating in marginal sites too often have attracted protection to locations with no potential for meeting the long-term needs of large populations.
Successful recovery efforts must consider a variety of factors that affect the bats' energy balance, as experience at Indiana's Wyandotte Cave demonstrates. Roost-staining evidence suggests that past populations likely totaled millions of Indiana myotis at this huge cave. But it was repeatedly mined for saltpeter and then commercialized for tourism. Finally, an entry gate was built that restricted airflow and raised temperatures to intolerable levels. By the 1970s, only 2,000 Indiana myotis remained.
The gate was removed in 1977, and the population grew by -about 1,212 bats a year for 22 years, despite continued disturbance by commercial tours. Managers, who kept visitors as

quiet as possible, argued that human disturbance was not a problem since the bat population was growing. But when we convinced the state to discontinue winter tours in 2003, the bat population suddenly jumped to 54,800 in just two years – a rate of 11,789 per year. Clearly, the energy savings from not being disturbed made a big difference.

Just one easy step remains to achieve even greater success. When the cave was originally commercialized, the floor through the main entrance was dug lower so visitors would not have to bend over to enter. This seems to have greatly increased the outflow of cool air in summer. For every cubic foot of cool air lost, a similar quantity of warm air is drawn in through other entrances, needlessly raising cave temperatures. This, and possibly other changes, has boosted roost temperatures above the bats' preferred range. By simply providing a low wall to dam up the outflow of cool air, it may be possible to return roost temperatures to the ideal range. Even a sandbag barrier could test the impact of such a wall. This has the potential to someday re-establish a population larger than is currently known for the whole species rangewide, a truly exciting possibility.

Understanding the species' total energy requirements is critical. BCI analyzed 20 years of data collected by the U.S. Fish and Wildlife Service Recovery Team at monitored Indiana myotis caves. That analysis documented that populations in caves outside the species' preferred temperature range of 37 - 44.6 degrees F (3 - 7 degrees C) declined by 185,117 bats, while those within that range increased by 97,339.
Our subsequent field studies and a review of existing data suggest that Indiana myotis do best in caves with the most stable temperatures of from 37 - 43 degrees F (3 - 6 degrees C). Ideal caves provide temperatures ranging from just above freezing to 55 degrees F (13 degrees C) or more, which allow bats to shift in response to mild or severe winters or long-range climate change.

A growing body of evidence indicates that large and rapid recovery can occur when Indiana myotis' hibernation needs are met. For example, BCI staff discovered ideal temperatures in the Unimin Corporation's huge Magazine Mine in Illinois. Since protection was provided through a BCI partnership with state, federal and private groups in 1996, numbers of Indiana myotis have grown from a few hundred to 9,074 in 1999, 14,679 in 2001, 26,325 in 2003 and more than 33,000 in 2005.
Unfortunately, only the largest, most complex caves or mines can combine ideal temperature ranges and stability, and these are also the most sought-after for commercialization and recreational caving, which puts bats and humans in direct competition. A large proportion of the Indiana myotis' historically best hibernation caves has been lost to commercialization, making any that remain extraordinarily important.

That is why we are so concerned about finding traditional hibernating caves that can be restored. Only a few successes could more than double the species' current population. In fact, just one success at a site like Wyandotte Cave could achieve such a goal.

Tracking Saltpeter

by Jim Kennedy

The future of the endangered Indiana myotis may hinge on restoring hibernation caves that once held great colonies but are now mostly empty because they have been altered by humans. The first step is finding those caves, and their names may serve as signposts.

Alterations that changed airflow and pushed temperatures beyond those tolerated by the hibernating bats were often made by 19th century miners. They were usually mining potassium nitrate, known as saltpeter – an essential component of gunpowders of the time. A prime source of saltpeter is bat guano, so the guano found in bat caves was aggressively mined.
That mining history offers a powerful clue to finding abandoned bat caves: Many caves in the Indiana myotis' range include the word "saltpeter" in their formal or local names. These clearly are choice candidates for past use by bats. Bat Conservation International is beginning to search them out through its Appalachian Saltpeter Caves Project.

The Kentucky phase of the program, in what was historically the most important state for hibernating Indiana myotis, is identifying and exploring these saltpeter caves and assessing their previous use and potential for restoration for Indiana myotis. Databases and local contacts have identified well over 650 caves (more than 150 in Kentucky alone) with 'saltpeter' in their names or a known history of saltpeter mining within the bats' range. Thanks to support from the Offield Family Foundation, Project Crew Chief Cat Kennedy and five cavers were hired for the surveys. They visited 39 caves in southeastern Kentucky during two weeks of fieldwork in 2005. Thirteen had been mined for saltpeter, while the others were checked because of their proximity to target caves.

Conditions justified detailed assessments of 15 caves, and five were found to have once housed significant populations of hibernating bats. Evidence suggests more than 2 million Indiana myotis once hibernated in these caves, and two of them offer good potential for restoration.

Surveys resume in 2006, with up to 25 more Kentucky saltpeter caves on the schedule. The research team also learned, through contacts with landowners and cavers, of another 16 saltpeter caves in Kentucky that warrant a closer look. And 500 more saltpeter caves in other states still must be examined as funding becomes available.

You can support this vital project to save the endangered Indiana myotis by contacting BCI's Development Office at (512) 327-9721 or development@batcon.org.

Indiana myotis
Myotis sodalis

The Indiana myotis (still frequently called the Indiana bat) was one of the first animals in the United States to be recognized as endangered under the Endangered Species Act. These bats are found throughout most of the Eastern United States from the central Midwest and upper New England states, south to the northern Gulf States and into northern Florida. But the largest hibernating populations occur in just three states: Kentucky, Missouri and Indiana, where they form large, highly vulnerable aggregations in relatively few caves.

In spring, summer and fall, Indiana myotis use a wide variety of deciduous-forest habitats. These highly maneuverable bats often feed in or beneath the forest canopy, along streams and farm ponds, in forest clearings and occasionally along fence rows. Their diet is primarily moths, but they readily eat flies, caddisflies, beetles, true bugs, flying ants and other insects.

Nursery colonies usually form beneath loose tree bark, especially on snags heated by exposure to the sun. They rarely use buildings. Males and non-reproductive females choose similar but cooler crevices for summer roosts.

In the fall, Indiana myotis from throughout the species' range migrate up to 300 miles (500 kilometers) or more to reach a few suitable hibernation caves.

Most mate in fall, with females entering hibernation immediately afterward. Pregnancy begins soon after they emerge from hibernation in the spring. Gestation lasts about 60 days, with a single offspring born in June or early July. Pups can feed on their own at 25 to 37 days.

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