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Breaking Beams to Count Bats
Technology monitors colonies around the clock
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Entering a cave where bats are hibernating always carries a risk for the bats, whether by casual visitors, experienced cavers or dedicated scientists. Any disturbance can cause hibernating bats to awaken and burn the precious energy they stored as fat to survive the winter. When bats use up their energy stores, they starve to death. The problem is magnified many times over where White-nose Syndrome is present or threatened. Yet scientific information is critical in conserving bats and confronting WNS. Biologists too often are forced to weigh the harm caused by entering a cave against the value of the data they need.

Now Bat Conservation International and its partners are tapping powerful new technology that promises more and better information about hibernating bats â€“ without venturing into their caves. It should also provide an early warning of the arrival of WNS at a cave.

Bat Ecologist David Redell of the Wisconsin Department of Natural Resources began with well-established infrared technology that is commonly used in motion detectors. From that he developed an automated bat-counting system that can precisely track the comings and goings of bats at specific roosts 24 hours a day, 365 days a year. The GateKeeper beam-break system operates remotely and requires only occasional human attention.

By stacking paired sets of infrared-beam emitters and receivers across a cave or mine opening, GateKeeper can record each time a bat passes through a beam. The system also determines whether the beam-breaking bat is entering the cave or leaving it.

GateKeeper's continuous bat count can be automatically uploaded to a dedicated Internet site over a cell phone or satellite network and made available to researchers virtually anywhere. This remote-reporting capability not only makes data quickly available, but conserves scarce conservation dollars by allowing biologists to collect critical data from far-flung sites without the expense of getting there.

The beam-break system will, for example, determine exactly when and how rapidly bats begin entering a hibernation site in the fall and when they emerge in the spring, as well as how long these movements last and when they peak. Overwinter mortality estimates could also be found in the data, along with the timing and pace of warm-weather nightly emergences and returns. The results from a range of sites and climates can be compared, including differences between sites that are subject to human disturbance and those that are not.

This information can be vital in areas that lie in the expected path of White-nose Syndrome, which is decimating hibernating-bat populations. WNS is now in 14 states and 2 Canadian provinces, and it continues to spread rapidly. Our first series of GateKeeper installations is in Kentucky, apparently untouched so far by the infection, but encased on three sides by WNS-stricken states.

Bats infected by WNS typically arouse frequently from hibernation and are often emaciated. Any disturbance of such sites could increase the losses. Infected bats also sometimes exhibit very abnormal behavior: they emerge too soon from hibernation and are reported flying around in midwinter, occasionally during the daytime. Beam-break systems will document such behavior and could even be programmed to send an immediate email or text message to local biologists.

Scientists and wildlife managers consider it crucial to know exactly where the expanding WNS front is located. That lets them track how fast the disease is spreading and determine where funds and conservation efforts can be most effective. The dreaded arrival of WNS in a new state or region also triggers emergency response plans. Non-disruptive monitoring will become essential to track the immediate impact of WNS and the long-term effects on each colony.

Also, of course, a continuous stream of data from multiple sites can help researchers learn much about bat behavior â€“ and what is normal and abnormal for different areas and weather conditions. Such analyses should prove invaluable for all cave-bat populations, not just those facing the specter of White-nose Syndrome.

Traditional bat counts, limited by available technology, typically collect a "snapshot" of a hibernating population â€“ and that single count often varies according to the skill and experience of the counter. At least since the 1960s, such efforts typically involve a team of counters who move through a hibernation cave, examining clusters of bats, counting each visually or after taking photographs. Depending on the size of the colony and the complexity of the cave, the total number is estimated with various extrapolation techniques.

Besides the inherent disturbance of hibernating populations, such low-tech bat counts are basically estimates, with an uncertainty â€“ a margin of error â€“ that can rarely be stipulated. GateKeeper is designed to resolve that shortcoming.

The beam-break count will be somewhat conservative. Since some bats are likely to slip through without breaking a beam and others might hit a beam at exactly the same time, the final count will probably be a bit low. On the other hand, it should prove virtually impossible for the system to report more bats than the site contains. GateKeeper is not meant to immediately replace traditional counts. Using comparisons among these and other counting techniques at the same sites will, over time, allow GateKeeper counts to be statistically adjusted to produce more accurate numbers and predictable margins of error.

The prospect of multiple bats breaking a beam at the same time â€“ and being counted as a single pass â€“ suggests beam break could significantly undercount emerging bats at large colonies. And current beam-break systems likely would be ineffective with populations such as the millions of Mexican free-tailed bats (Tadarida brasiliensis) that often share single caves.

For such huge colonies (and probably in other situations, as well), novel thermal-imaging video systems being developed separately by Boston University and the U.S. Army Corps of Engineers offer an alternative. These systems use automated-counting software to tag each bat's thermal (infrared) signature. They have been tested successfully at several freetail caves. The video can be streamed onto the Internet, although the systems require more human interaction and cannot be left unattended for long periods.

BCI teamed with the Kentucky Department of Fish and Wildlife Resources (KDFWR) this

year for initial GateKeeper installations to monitor high-priority hibernation caves in Kentucky used by Indiana myotis (Myotis sodalis) and gray myotis (M. grisescens), both federally listed as endangered species.

The first site we outfitted was Saltpetre Cave, where BCI has been working for a decade on behalf of the Indiana myotis. BCI discovered in 1998 that Saltpetre, a popular tourist site at Carter Caves State Resort Park, displayed extensive roost stains on its ceiling â€“ evidence it once was used by hundreds of thousands of Indiana myotis. Only a few dozen bats remained. Winter tours of the cave were halted that year, however, and the bat population began to rebound.

More dramatically, BCI Caves Coordinator Jim Kennedy worked with partners and volunteers to restore the historic airflow conditions that had originally attracted so many hibernating bats â€“ and which had been lost to a century of alterations for mining and tourism. By 2007, some 7,000 Indiana myotis were hibernating at Saltpetre Cave each winter, confirming the potential of systematic cave restoration for species recovery. Now White-nose Syndrome threatens these and other bats in Kentucky, and non-contact monitoring is critical.

So we â€“ Redell, KDFWR Bat Ecologist Brooke Slack, Endangered Species Biologist Mike Armstrong of the U.S. Fish and Wildlife Service's Kentucky Field Office and I â€“ brought beam break to Saltpetre early this year. The installation turned into a challenge because the primary entrance is protected by an unusual bat-friendly gate. With a solid roof and bars on all four sides, the gate looks a lot like a frontier "jail house." Bats emerge through all four sides, but the cost of covering all those gates with infrared beams was prohibitive. So we chose an alternative.

The jail house sits over a four-foot-wide (1.2-meter) stairway that leads down into the cave. We placed an upright post â€“ one bearing beam emitters and the other with paired detectors â€“ on either side of this constriction through which the bats must pass as they come or go through the gate.

The associated dataloggers, circuit boards and assorted wiring are tucked inside a waterproof box inside the gate structure. This GateKeeper system, operating off an existing electrical system, draws a paltry seven watts and, with continuous operation, should cost about 35 cents a month to operate. And the bats of Saltpetre Cave are being counted around the clock.

In the spring, we completed beam-break installations at the James and Coach caves in southeastern Kentucky. Together, these two sites host some 300,000 hibernating gray myotis each winter, as well as smaller numbers of Indiana myotis. Both caves are part of the privately owned Park Mammoth Resort, which is cooperating with the installation.

We plan one more installation in Kentucky this summer and, as funding permits, we will set up GateKeeper systems to monitor two near-legendary Indiana myotis hibernacula: Wyandotte Cave in Indiana and Magazine Mine in Illinois. These two are among five hibernation sites that give refuge to half of all the remaining Indiana myotis in America. An installation at the critical gray myotis site of Bellamy Cave in Tennessee is also in the planning stage.

This new ability to systematically collect such basic data day after day will allow us to learn much that we have never understood about bat behavior and conservation needs. Such

knowledge will certainly help us manage many sites that are vital to bat populations, whether threatened by WNS or not. In the wake of WNS, however, automated monitoring will be an essential part of species-recovery efforts. There are countless sites around North America and much of the world where beam-break systems would be invaluable.

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