Defending Bats in Ukraine

Bags of Bats

When is a Species Not a Species?

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Spring 2009

BATS

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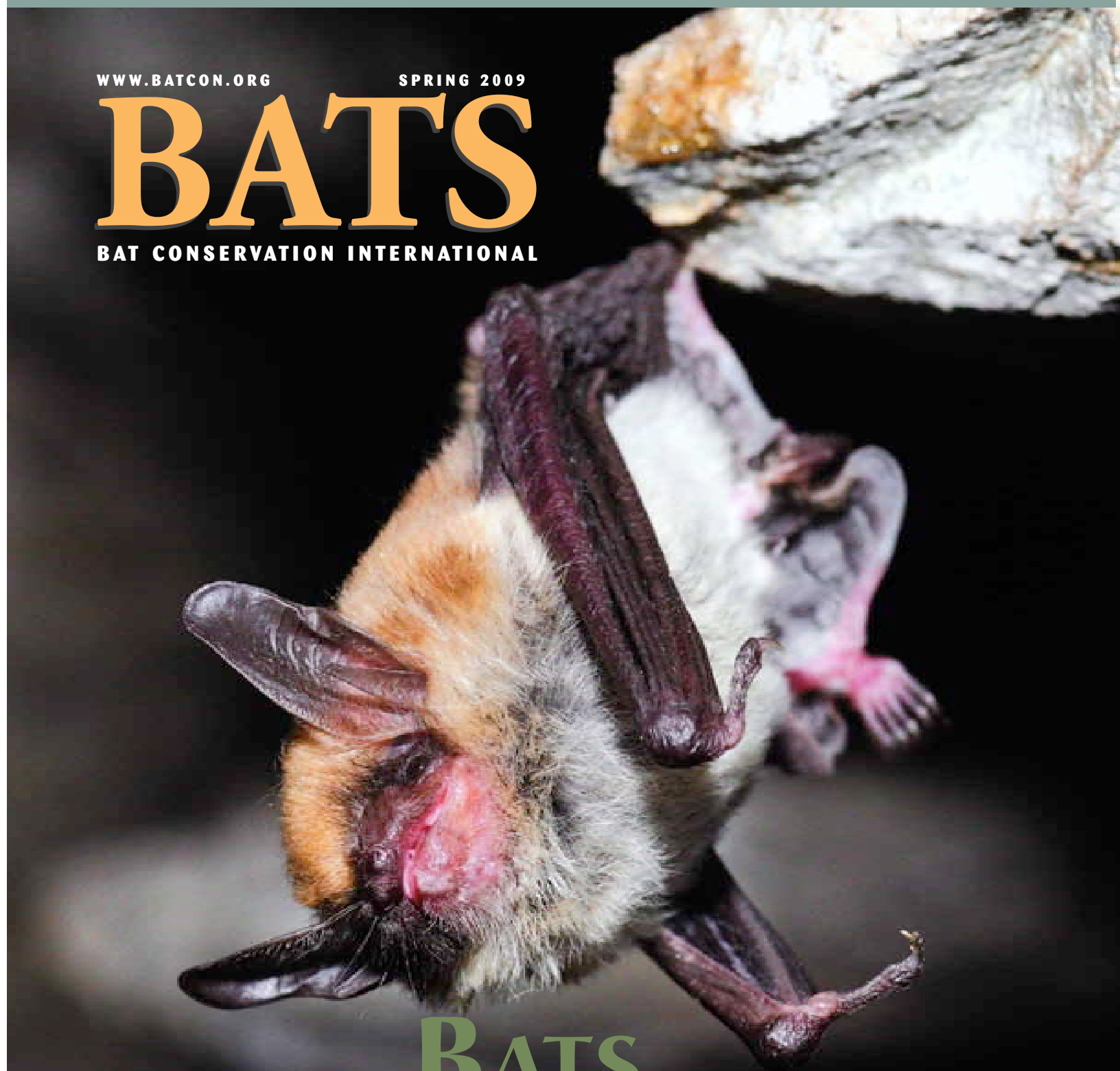

Bats Face Climate Change

BATS

Volume 27, No. 1, SPRING 2009

BAT CONSERVATION INTERNATIONAL
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FEATURES

NEWS & NOTES

COVER PHOTO: Scientists studying fringed myotis, like the bat on the cover, found that, at least in Colorado, reduced precipitation resulting from climate change could dramatically reduce the ability of female bats to reproduce. (Story on Page 1.)

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BATS (ISSN 1049-0043) is published quarterly by Bat Conservation International, Inc., a nonprofit corporation supported by tax-deductible contributions used for public education, research and conservation of bats and the ecosystems that depend on them.

Bat Conservation International's mission is to conserve the world's bats and their ecosystems in order to ensure a healthy planet.

A subscription to *BATS* is included with BCI membership: Senior, Student or Educator $30; Basic $35; Friends of BCI $45; Supporting $60; Contributing $100; Patron $250; Sustaining $500; Founder's Circle $1,000. Third-class postage paid at Austin, Texas. Send address changes to Bat Conservation International, P.O. Box 162603, Austin, TX 78716.

The Threat of Climate Change

Bat reproduction may suffer in the American West

by Rick A. Adams

The Rocky Mountains of Colorado offer a wondrous mosaic of habitats from lowland prairies to treeless alpine tundra. At the 40th parallel near Boulder, the Continental Divide reaches its easternmost point in the United States, producing steep and convoluted relief across which climate and ecology differ dramatically. The abrupt topography compresses habitats and ecotones (the transitions between habitats) into remarkably condensed communities of animals and plants. Thus, ecologists can study a diversity of ecosystems in one local area that is equivalent in scope and richness to that which occurs across the 1,200 miles (2,000 kilometers) between Boulder and the Canadian Arctic. For bats, this remarkable landscape provides for the coexistence of a diverse assemblage of species.

The long-legged myotis, such as this one in a rocky roost, is among Western bat species that face growing threats from global climate change.

This Townsend's big-eared bat wears a tiny radio transmitter that allows researchers to track it to favored water sources, which are becoming scarce in many Western states.

My students at the University of Northern Colorado and I have been conducting research on bat populations in the region for 13 years. This persistence illuminates long-term population trends in this richly varied medley of bats. The underlying questions of our studies have been: (1) do the limited water resources of arid landscapes influence roost-site preferences and reproductive ecology of bats, and (2) does water availability influence how bat populations and communities are structured?

Our research produced a number of unexpected results, especially concerning what appears to be surprisingly complex cooperative behavior, as well as mineral acquisition, maternal-roost clustering and the critical importance of near-roost water sources for milk production by mother bats. After 13 years, we are beginning to stitch together the natural history of the nine resident bat species and the importance of water sources to stability and sustainability of populations.

Unfortunately, our data also strongly suggest a potentially devastating impact of climate change on these bats: increasing regional temperatures, declining precipitation and reduced stream flow appear to negatively influence the ability of females to reproduce.

Upon leaving their high-elevation hibernation sites in late April or early May, bats descend into the food-rich lowlands. Males and females, which hibernated together, break away into bachelor and maternity groups. Females typically return year after year to the same rock-crevice roosts, usually located near small-stream water sources. We consistently find maternity roosts of various species located close to relatively stable but small-scale water features.

Some of these pools are less than six feet (1.8 meters) in diameter, yet they buzz with activity after sunset, as hundreds of bats descend to the surface to drink. They must replenish water lost during their daytime siestas within sun-baked rock crevices where higher roost temperatures help with gestation. Some bats have been shown to lose more than 30 percent of their body mass through evaporative water loss over a single 12-hour roosting cycle. When females are lactating water-rich milk for their young, water loss may even be higher.

The combination of hot, dry roosts, small body size and lactation suggests that reproduction in these female bats is a staggering effort that likely explains why we find maternity colonies of multiple species near reliable pools of water. At dusk, water-stressed females descend to drink soon after emerging from their day roosts, skimming the surface multiple times before leaving the area.

It is not only the crevice-roosting bats that come to drink. At many watering sites, we catch all nine resident species, including less abundant species, such as the hoary bat (*Lasiurus cinereus*) and silver-haired bat (*Lasionycteris noctivagans*), that use trees as roosts. Their presence increases the already-high numbers of bats trying to squeeze into these small pools for a drink. Nights following the hottest, driest days correlate with the highest activity levels at water sources, where, at first glance, the scene looks like sheer chaos.

Upon closer examination, however, the apparently lawless free-for-all turns out to have a definite and unexpected order and process. As various species leave their roost sites within minutes of each other, they do not all come to the pool simultaneously. Instead, they arrive in species or colony groups in a specific and predictable order night after night, year after year.

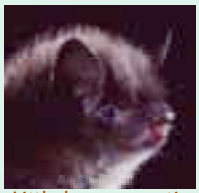
Peaks of activity are distinctive for each species. We confirmed this phenomenon by recording exact capture times of each bat that visited to drink and by compiling data over several years. The pattern was consistent: bats drinking at these small pools are organized by predictable visitation times, without which individual access to the water would be problematic at best.

Even more astonishing, however, is the discovery that the bats actually line up to drink, rather than simply diving in from every direction. The chaos of bats zipping and milling a few feet above the water is completely at odds with what is happening at the surface. Working with Dr. James Simmons of Brown University, we used a thermal-imaging camera to record this amazing behavior at the smallest, most active pools.

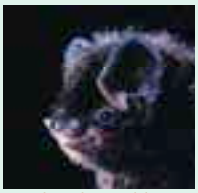
All bats that approached for a drink did so singly. Each one

Rocky Mountain Bats

These diverse species were routinely captured in the author's study area in Colorado.


Little brown myotis (*Myotis lucifugus*)


Big brown bat (*Eptesicus fuscus*)


Silver-haired bat (*Lasionycteris noctivagans*)


Hoary bat (*Lasiurus cinereus*)

Finding Water for Bats

Wildlife water supplies have been dwindling across the American West for decades, and climate change is making the problem worse. But BCI's Water for Wildlife Project is working with ranchers, land managers and partner agencies to ensure safe and reliable water supplies for bats and other wildlife across the West, especially by modifying and maintaining livestock watering tanks.

The 5-year-old project and its partners are restoring, enhancing and creating bat-accessible water resources in areas with the greatest bat diversity and worst water shortages. For example, Project Coordinator Dan Taylor and Defense Department biologists recently replaced more than a dozen aging, inaccessible watering sites on New Mexico's White Sands Missile Range with larger, bat-compatible waters that are already being used by 13 bat species. Similar collaborative projects are under way or planned in four other states.

Water for Wildlife is also conducting workshops around the region, teaching hundreds of livestock operators and natural-resource managers how to make both natural and artificial water sources safer and more accessible to bats. Graduates of these workshops are improving wildlife water supplies throughout the West.

Yet vast expanses of the Western landscape still lack reliable water sources, putting countless bats at risk. Your support of Water for Wildlife can help these thirsty bats find a safe place to drink. Make your donation today at *www.batcon.org/donate*.

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A Townsend's big-eared bat swoops down for a drink of water. BCI is working to ensure safe and secure water supplies for Western bats.

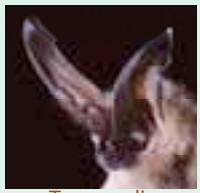
came in from a specific direction and followed a drinking pathway – not unlike a landing strip at an airport. Further, the film revealed that bats entering the 'drinking queue' did so by making a wide turn away from other bats above the pool, then circling into the precise approach path. We observed multiple bats entering the drinking path one after the other and following one another across the water's surface in a single-line approach.

While filming in July, when the pups begin to fly, we watched this finely tuned drinking game suddenly break down as some bats caused near-collisions by trying to drink from the "wrong" direction. We can only suppose that these were inexperienced juveniles, perhaps making their first attempt at water-hole etiquette. When this occurred, the bat that was in the correct pathway would call out a distinctive, audible buzz at the wayward intruder. It appears that young bats need to learn the rules of the game from adults.

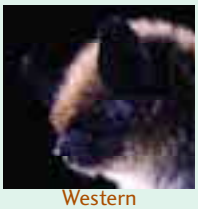
We have found that female bats apparently can determine the mineral content of drinking water and that they lead their young to pools with higher levels of dissolved calcium, perhaps to help with skeletal development (see "The Lure of Dirt," *BATS*, Winter 2006). Females benefit from these high-mineral pools because insects provide scant calcium and they typically end up calcium-deficient during their reproductive period. In some cases, we have radiotracked lactating females flying sever-

Fringed myotis (*Myotis thysanodes*)

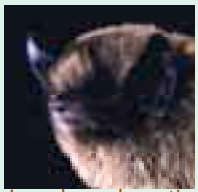
Long-eared myotis (*Myotis evotis*)



Townsend's big-eared bat (*Corynorhinus townsendii*)



Western small-footed myotis (*Myotis ciliolabrum*)



Long-legged myotis (*Myotis volans*)

PHOTOS ©MERLIN D. TUTTLE, BCI

al miles to reach small, inconspicuous but calcium-rich pools hidden in the forest, bypassing more obvious water sources to reach them. We found no apparent relationship between male bats and these high-calcium drinking opportunities.

But while mineral content may play a role in which pools adult females and their young visit, the proximity of water to maternity roosts is the most critical aspect. We demonstrated this through an experiment in summer 2006. We marked 29 female fringed myotis (*Myotis thysanodes*) from a maternity colony by inserting a passive integrated transponder – a PIT tag – just beneath the skin of females that were either lactacting or nonreproductive. The tiny tags do not require batteries and can be read by a scanner to identify the individual.

We placed an antenna (the scanner) in a small pool near the roost site to record visitation patterns of bats of known reproductive status. The results were sobering. Lactating females drank at the pool 13 times more often (236 visits) than nonreproductive females (18 visits) over an 11-day period. Lactating females clearly have very high water requirements and having a water source near the maternity colony may be one of the criteria females use in choosing roost sites.

Next, we plotted our 13 years of data against annual weather conditions, including mean monthly high temperature, mean monthly precipitation and mean monthly stream-discharge rates. What we found was disconcerting. In years with warmer, drier conditions, reproductive outcomes dropped precipitously. The long-term trend in the data showed a steady increase in numbers of nonreproductive females captured during such years. In the warmest, driest year of our study, 2007, more than 50 percent of the adult females we captured were nonreproductive – a huge difference from years when weather conditions were closer to average and only 11 to 15 percent of captured females were nonreproductive. Virtually all climate-change models predict warmer and drier summers in this region.

Analyzing the data showed that the availability of water and especially precipitation were most closely correlated to reproductive status. Precipitation, of course, feeds local streams and our data reveal a sudden crash in female reproduction when flow rates of Boulder Creek (the only drainage in our field area that is monitored for flow rates) falls below 247 cubic feet (7 cubic meters) per second. When this large stream falls to such a low flow rate, smaller streams near roost sites may, in fact, be almost completely dry. This sudden crash in reproductively active females implies that there is a threshold of minimum water availability required to support local bat populations. These data, of course, fit well with our PIT-tag study of female reproduction and visitation frequency to water sources.

We often think of bats as highly mobile mammals capable of travelling large distances to forage and find water. Maternity roost sites, however, provide well-established anchors that help support local bat populations over the long term. Females return to these sites year after year to give birth to and raise their young, and females in maternity colonies seem to resist abandoning such areas, even when water resources dwindle. Instead of leaving, females apparently are shutting down – or being forced physiologically to halt – reproductive output that the environment can no longer support. The long-term risk to these populations appears substantial.

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Western bats, such as this long-eared myotis carrying a captured moth, are primary predators of night-flying insects, including many crop pests.

Climate change in western North America is expected to increase in coming years, with still-greater reductions in summer precipitation and winter snowpack. Already the loss of accumulated snowpack, combined with spring runoffs that begin up to a month earlier than in the past and reduced summer rainfall, has measurably affected regional patterns of stream flow. Thus, the outlook for future water availability in natural ecosystems is grim. Climate-change models for the Colorado River Basin predict that for every 0.6-degree F (1-degree C) increase, we can expect 24 percent less snow, 3 percent less summer precipitation and 36 percent less water storage.

If there is one spark of hope in all this, it is that we can begin to mitigate some of these effects by developing management plans that include artificial water sources to support high-risk maternity colonies. Climate change is upon us, and we can do little to stem the tide in the short term, but fast-track solutions to immediate problems may just be enough to avoid a sudden collapse of distressed ecosystems.

RICK A. ADAMS is Professor of Biology at the University of Northern Colorado in Greeley. He studies the ecology and evolution of bats.

Defenders of Ukrainian Bats

An unprecedented program challenges misplaced fears

by Alexander V. Naglov

PHOTOS COURTESY OF ALEXANDER V. NAGLOV

The first large, systematic bat-education program in Ukraine used an array of colorful and informative posters, leaflets and pocket calendars to challenge long-standing misperceptions of bats as "devilish, nocturnal" animals that threaten public health. With support from BCI's Global Grassroots Conservation Fund, we focused on three urgent threats in and around Kharkov, the third-largest Ukrainian city with about 1.5 million residents.

We also conducted educational programs for children in 10 Young Naturalists clubs in and around Kharkov, especially in areas with at-risk bat habitats.

Public attitudes about bats in northeastern Ukraine and nearby Russian territories never recovered from the tragic rabies death 20 years ago of a child bitten by a bat. Although this is the only bat-related rabies fatality ever documented throughout the region, public health and veterinary officials promptly added bats to their catalog of most-dangerous animals.

Biologist Alexander Naglov (*top photo*) directed a major education effort in Ukraine. Members of a Young Naturalists Club (*above*) examine colorful brochures about bats.

Bats remain on that list today, and public officials still equate them with danger in official leaflets, meetings and television interviews. As a result, many Ukrainians view bats with revulsion and fear. A group of Kharkov National University students and I, an associate professor of biology, set out to change that.

We identified three specific "hot spots" where bat-friendly information was urgently needed and where we felt our intervention could be most effective. These are:

- **Bats in Forests:** Supervisors of forests around Kharkov were mostly unaware of the importance of bats in maintaining healthy timberlands and gave them little thought when harvesting timber and managing woodlands. A critical issue was the preservation of large, hollow trees needed for roosts.

- **Bats in Summer Cottages:** Before the Soviet Union ended, thousands of people obtained small plots of land, built summer cottages and planted small orchards. These new "villages" sprouted in especially scenic areas with forests, streams and lakes. Used mostly on weekends and holidays, the cottages are usually empty and very attractive to bats – much to the owners' chagrin. Bats that move into attics and other parts of cottages are often simply killed, although a few enlightened owners live with them quite happily.

- **Bats in Windows:** Europe's largest and most northeasterly population of hibernating common noctule bats (*Nyctalus noctula*) is in Kharkov, where most spend winters in buildings of Kharkov National University. The bats hibernate in deep crevices of the walls. During the fall and spring migrations, however, groups of up to 100 bats often attempt to fly through windows at the university. Because of the windows' design, many of these bats become trapped between the frames, where they frequently die. Our group tries to save these bats whenever possible, but our resources are limited.

Our first step was to design and print 4,000 pocket calendars, most with a photo of one of eight local bat species on the front. The calendar-cards identify the bat and briefly describe its value and conservation needs. Other calendar styles illustrate issues of bats in buildings and bats and forest management. The idea was to provide a handy bat-education tool that people would keep for months. The calendars proved very popular, and we included some with most of our education kits and when delivering lectures.

Next, we designed posters aimed at protecting the university bats and those that live in summer cottages. The university posters describe why these windows are potentially deadly traps for so many bats, what people can do to prevent them from being trapped and why we should care. They also explain

Ukrainian conservationists used part of their BCI Global Grassroots Conservation Fund grant to design and print posters that describe the benefits of bats and how they should be protected in forests (*right*) and at villages of summer cottages.

what students should do to safely help the bats escape. "The university is a center of education and culture," the poster states, "and should not become a cemetery for wildlife."

We hung these posters in university areas that are most popular with students and at hostels where many students live. We also distributed calendars and leaflets, which describe in more detail the bats, their values and how the window threat can be minimized to students, in areas of especially high risk and to various departments of the university.

We distributed hundreds of the cottage-bats posters, plus calendars and leaflets, at vacation communities in areas of known or likely bat habitats. These materials stress the importance of bats, especially their role as predators of insect pests, and explain why bats should be accepted rather than killed. We also urged residents to ensure forest roosts are protected or even improved. During the fall migration, when bats are on the move, we met with residents and put posters on community bulletin boards.

Packets of Bats in Forests posters, calendars and other material were given to local forestry districts, where we discussed bats' values and roosting needs with officials.

Meanwhile, in 2008, a major renovation was undertaken at the historic Gosprom building, a monumental structure in downtown Kharkov that was the first skyscraper in the Soviet Union when it was built in 1928. Workers discovered a large colony of noctule bats roosting in a wall crevice of the building. Our group was not in Kharkov at the time, but local animal-protection organizations rescued the bats.

Immediately upon our return, we launched a major education effort among construction crews and people who work in the building. Now we are notified whenever bats are found inside Gosprom and can handle safe exclusions. We also periodically inspect the building and have located and excluded colonies.

Last summer, we visited Young Naturalist clubs at five schools in Kharkov and others in the nearby communities of Pervomaysky, Izum and Volchansk and at the Kharkov Zoo. We delighted the youngsters by adding bats to their list of valuable animals that need protection. We even conducted several evening field lessons with ultrasonic bat detectors.

Alona Gukasova and Daria Elagina worked with students at the Summer School for Young Nature Conservationists at a regional national park. These students, already active in protecting Ukraine's natural world, clearly enjoyed learning the facts about our long-misunderstood bats.

We directly reached several thousand people during the program and most seemed receptive to our message. Thousands more have seen our posters, leaflets and calendars. Our bat-conservation efforts, however, are only beginning. The educational resources we developed with BCI's support and our current momentum will serve us well in the future.

We hope that we have achieved the goal we set when we began this effort: "In the near future, a forester will not cut down a hollow tree, a pensioner will not disturb bats in the attic of a cottage, and a professor will save the bats trapped in a classroom window."

And we'll still be there working and educating about the invaluable bats of Ukraine.

COURTESY OF ALEXANDER V. NAGLOV

The team found that the unusual design of windows at Kharkov National University (*above*) frequently trapped and killed bats searching for a place to roost. Visits and posters taught students and faculty how to prevent these needless deaths.

ALEXANDER V. NAGLOV is Associate Professor of Biology at Kharkov National University. ANTON VLASCHENKO, a BCI Scholar (see BATS*, Fall 2008) who recently received his Ph.D. at the university, was part of the education team and contributed greatly to this article.*

This pioneering bat-conservation program was made possible by Anton Schindler, in loving memory of his wife, Valerie. You can help grow bat conservation around the world by donating to BCI's Global Grassroots Conservation Fund at:

www.batcon.org/grassroots.

Bags of Bats, Fruits and Seeds

The long road to a book on Neotropical seed dispersers

by Cullen Geiselman, Tatyana Lobova and Scott Mori

It's hard to imagine that this small cloth bag has anything to do with forest regeneration. It punches the damp night air as it dangles from a hook in our primitive shelter, little more than a roof and a floor tucked into the rainforest of French Guiana. The bag bumps others hanging from the same hook and soon they're all twitching. Despite appearances, this isn't some supernatural puppet show. It's bat research.

Inside each bag, a single fruit bat awaits its turn to be identified and measured. These bats, captured in mist nets set along trails and near fruiting trees, have only been in their bags for an hour or two. They are the focus of our multidisciplinary study, but the bags are crucial to linking these frugivores to the plants that depend on bats to disperse their seeds. Once a bat has been removed from its temporary cocoon, everything left in the bag is meticulously collected, especially the essence of rainforest regeneration – seed-filled feces.

By comparing seeds left in bat bags with those taken directly from plant specimens, we can identify the plant species – at least those with seeds small enough to be swallowed – that have been visited by bats prior to capture. This form of seed transport is referred to as "endozoochory," meaning seeds are swallowed, carried within the animal and passed through its digestive tract prior to dispersal elsewhere. Seeds that can be swallowed by most Latin American fruit bats are no larger than peas. Many of these come from pioneer plants, such as *Piper, Cecropia* and *Solanum*, which are the first to colonize previously forested areas disturbed by large tree falls or

(*Above*) Bat bags – each containing a captured bat and anything it was carrying, including seeds – wait to be opened and their contents identified. (*Top photo*) A great fruit bat (*Artibeus lituratus*) feeds on a *Cecropia* fruit in Costa Rica.

by human activities. Unlike most birds, bats frequently defecate in flight and readily fly over large forest openings. This combination of behaviors makes fruit bats indispensible for rainforest regeneration.

At a table illuminated only by a candle and our headlamps, we begin the nightly tasks of our study – quietly, so as not to awaken our expedition's botanists, who spent the day collecting plants. Cullen Geiselman identifies each bat and records its forearm measurement and weight. Tatyana Lobova examines the contents of the bat bag, using forceps to inspect each seed and place it in a labeled, glassine envelope. Using only a hand lens, she identifies most seeds to genus level and whispers her findings: "*Piper amalago. Ficus*." It is not uncommon to find seeds from several species in the same bag, indicating that the bat fed at multiple plants before becoming ensnared in our nets. One silky short-tailed fruit bat (*Carollia brevicauda*) left seeds from five species at once.

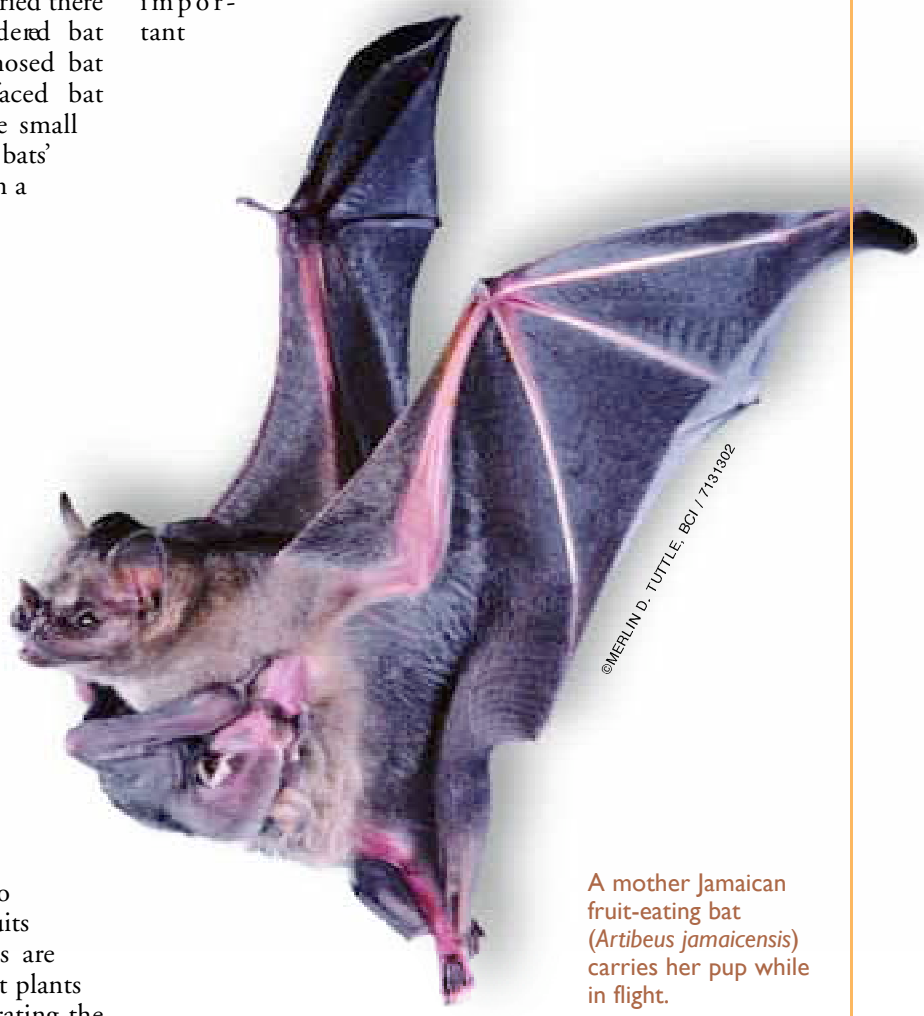
Seeds from plants with no edible fruit also turn up in our bags. These have not been eaten but instead caught a ride with fruit bats by adhering to their fur with barbs and hooks. This is referred to as "epizoochory," in which seeds attach themselves to the outside of the animal and are carried until they fall or are groomed off in another location. During our studies in French Guiana, seeds of one species in the amaranth family turned up multiple times in our bat bags, carried there by individuals of two species of yellow-shouldered bat (*Sturnira lilium* and *S. tildae*), the lesser spear-nosed bat (*Phyllostomus elongatus*) and the great stripe-faced bat (*Vampyrodes caraccioli*). Finding the seeds of these small shrubs in our bat bags tells us something about the bats' foraging behavior: they must have been flying within a meter of the ground to pick up these hitchhikers.

Sometimes Lobova will open a bag only to find a mess of seedless pulp. This is all that remains of a large-seeded fruit eaten by the bat prior to capture. Though many bat-dispersed plants are small-seeded, some have large seeds surrounded by fruit pulp or a fleshy appendage called an aril. Bats pluck these fruits (or their seeds in the case of those with arils) and carry them to feeding roosts, where they chew off the edible parts. They drop the remaining seeds at the roost or in flight. This form of seed transport is "stomatochory," meaning seeds are carried in the mouth of the animal and dropped after the fleshy reward has been eaten from around the seed.

Studying this mode of dispersal proved difficult since pulp has fewer identifiable characteristics than seeds. Identifying large-seeded fruits in bat diets requires catching the bat with the fruit in its mouth or, more likely, collecting the seeds from beneath a feeding roost. For example, large fruit bats in the genus *Artibeus* are known to feed on the 2.4- by 1.5-inch (6- by 4-centimeter) fruits of the tonka bean (*Dipteryx odorata*). These bats are responsible for carrying large seeds of primary forest plants into secondary forests, an essential step in regenerating the high species diversity of the original forest.

Our approach to investigating bats' roles as seed dispersers is hardly new. Thousands of bats throughout the American tropics have been captured and delicately placed in bat bags that danced in the night. Over the last 40 years, researchers have painstakingly studied the seeds left in their bat bags, sometimes even planting them in hopes of identifying seedlings. Since they usually had no guides, each bat researcher had to learn to identify area plants and build a reference collection of fruits and seeds for comparison with those gathered from captured bats. This was no easy task, especially given the small size of many bat-dispersed seeds and the great many fruiting species in tropical forests. Wouldn't a botanist make an ideal collaborator for such a project?

This is exactly what passed through Scott Mori's mind when he met BCI Founder and President Merlin Tuttle for the first time in 1986. Mori and John D. Mitchell, honorary curator at the New York Botanical Garden (NYBG) and current chair of BCI Board of Trustees, invited Tuttle to join them on a field expedition to central French Guiana, where the two botanists were inventorying vascular plants. That marked the beginning of a 22-year collaboration between BCI and NYBG – a combined effort to uncover the important



A mother Jamaican fruit-eating bat (*Artibeus jamaicensis*) carries her pup while in flight.

role bats play as seed dispersers in the Neotropics. Since that time, the two organizations have sponsored various research projects in which botanists and bat researchers work together to identify plants dispersed by bats, especially in French Guiana.

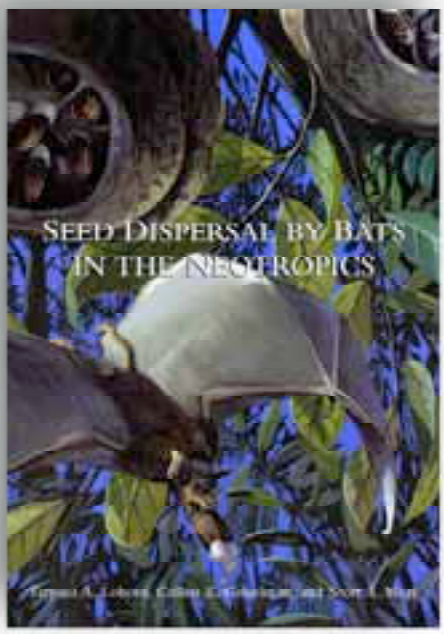
The years of collaboration have culminated in a 465-page book entitled *Seed Dispersal by Bats in the Neotropics*, published this year by NYBG Press. This book is not only a guide for identifying seeds, but also a summary of current knowledge of bat-dispersed plants and the diets and behaviors of frugivorous bats. We list a total of 549 plant species in 191 genera from 62 families as dispersed by bats in the New World tropics. We delve deeper into the subject by focusing specifically on the flora of central French Guiana, home to over 1,900 flowering plant species and 50 species of potential seed-dispersing bats. We discovered that 15 percent of the native flowering plant species and 29 percent of those bearing fleshy fruits may rely on bats to disperse their seeds. Many of these are essential for forest regeneration or have major economic value. And that doesn't even consider bats' critical role as pollinators of many important plants.

COURTESY OF SCOTT MORI

Botanist Tatyana Lobova removes bat-carried seeds from a bat bag and places them inside glassine envelopes for future examination. Lobova and other plant specialists proved an invaluable part of this multidisciplinary research effort to detail the critical role of bats in dispersing seeds in the New World tropics.

Our goal in compiling and analyzing the data gathered over the past 40 years is to stimulate future research in the many areas that remain unstudied. In addition, we intend for this guide to provide bat conservationists in Latin America with a much-needed tool for detailing the role frugivorous bats play in reseeding tropical forests.

A single bat bag remains on the hook near our table. Inside is a male Peters' spear-nosed bat (*Phylloderma stenops*). He is docile and does not resist being measured. Geiselman stands to release him at the edge of our shelter. From her opened palm, the bat surveys his surroundings, gives a strong pump of his wings and is gone into the dark forest. Lobova peers into the bat bag. "*Passiflora*!" she exclaims as she smiles down at the passionflower seeds in the bag. And a new species is added to our ever-growing list of bat-dispersed plants – proof yet again that botanists make some of the best bat researchers.



The result of the authors' long collaboration and research is *Seed Dispersal by Bats in the Neotropics*, published by the New York Botanical Garden Press.

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The authors thank the friends and colleagues who helped net bats and collect data for their book: Brian Keeley, Chris Sanders, Heather Peckham Griscom, Nancy Simmons, Robert Voss, Vanessa Hequet, Adrian Tejedor and Ya-Yi Huang.

When is a Species not a Species?

Genetic techniques complicate taxonomy

by Cori Lausen

Little brown myotis roost in an old, abandoned church.

What, exactly, is a species? The answer to that question used to be fairly straightforward: a species was defined as a group of organisms that could naturally interbreed to produce fertile offspring. Bat species were usually described by appearance – size, color, external characteristics, skeletal structure, etc. – and by range.

COURTESY OF CORI LAUSEN

Cori Lausen, at work in her laboratory, combined field research with extensive lab investigations to question the growing use of mitochondrial DNA evidence alone to propose new species.

But the past few decades have produced revolutionary techniques for exploring species at the genetic level. By analyzing chromosomes and sequencing the DNA of genes, evolutionary patterns were unraveled and the definition of species became much more genetic in nature. This led to the notion of "cryptic species" – those that are nearly identical in appearance but genetically distinct. Quite a few cryptic species have been confirmed among bats and many other animals.

My research on the little brown myotis (*Myotis lucifugus*) suggests that this recent trend of taxonomy via genetics may have gone one step too far.

The little brown myotis, with six generally accepted subspecies, is one of the most widespread bats in North America and one of the most studied, yet we know surprisingly little about its taxonomy. With the exception of *M. lucifugus occultus*, the original definitions of its subspecies have not been reviewed. Because of the difficulty in telling these subspecies apart visually, biologists in the field tend to determine subspecies based on a 1981 map of their ranges.

In 1980, biologists M. Brock Fenton of the University of Western Ontario and Robert M.R. Barclay of the University of Calgary noted in their *Mammalian Species* account that the overlap zones of these subspecies' ranges needed additional study to better understand subspecies designations. Nearly 30 years later, we are finally starting to make progress in this area.

The genetics of the little brown myotis were not studied until 2006, when Tanya Dewey of the University of Michigan sequenced mitochondrial DNA and discovered surprisingly

These two little brown myotis show sharp differences in color and size, but the author's genetic analysis demonstrates that they are nonetheless members of the same species.

COURTESY OF CORI LAUSEN

large differences among some of the subspecies. In fact, some of the differences were so great that she suggested certain subspecies might actually be separate species. These types of taxonomic conclusions based on mitochondrial DNA are becoming more common.

Mitochondrial DNA (mtDNA) is found inside structures called mitochondria, energy-producing units that exist outside the cell's nucleus. These generally small strands of mtDNA are distinct from nuclear DNA, which comprises the organism's chromosomes.

The International Barcode of Life Project, which originated in Canada, is dedicated to cataloguing all species on Earth by sequencing mitochondrial DNA and providing open access to the database of those genetic codes. While project founder Paul Hebert, a zoologist at the University of Guelph in Ontario, Canada, has cautioned biologists about using these sequences to draw taxonomic conclusions about species, such conclusions are nonetheless being drawn. A quick scan through the scientific literature and media headlines reveals new species of fish, butterflies and, yes, even bats, being defined solely on mitochondrial DNA sequences. The suggested presence of cryptic species among little brown myotis based on differences in mtDNA is hardly unprecedented.

Under the traditional "Biological Species Concept," to suggest two groups are separate species implies limited interbreeding. So the suggestion that two of the little brown subspecies, *M. lucifugus lucifugus* and *M. lucifugus carissima*, could be cryptic species suggested limited interbreeding between these two groups. This is where research by me and Isabelle Delisle of the University of Alberta enters the picture.

We focused on these two subspecies, which are sympatric (their ranges overlap) in southern Alberta and northern Montana. We investigated colonies of little brown myotis roosting along the Milk and Missouri Rivers and found several maternity colonies that included both subspecies.

It was immediately clear that little browns come in various colors in these areas: some had dark-brown fur, while others were almost blond. The original subspecies definitions for little brown bats describe *M. l. carissima* as pale brown and *M. l. lucifugus* as darker and larger.

In collaboration with Tanya Dewey and Jan Zinck of Portland State University, we investigated the genetic identities of these little brown myotis and found that color did not differentiate the two subspecies; both exhibit the full range of colors. Nor does size differentiate, as forearm length varied geographically – generally increasing from south to north across our study area – regardless of subspecies. Neither fur color nor size provided a reliable characteristic with which to differentiate these subspecies. In our data, the only thing that seemed to define the two groups of little brown myotis was mitochondrial DNA.

Previous research on other animals, such as grizzly bears, has demonstrated that taxonomic conclusions based solely on mitochondrial DNA can be very misleading. This is because mitochondrial DNA is inherited as a single unit, moving intact from mother to offspring. That's in stark contrast to nuclear DNA, which is shuffled like a deck of playing cards, with half coming from the mother and half from the father. So we turned our attention to nuclear DNA.

We wanted to know whether these two groups of little

brown myotis interbreed. By analyzing nuclear DNA markers (repeated sequences called microsatellites), we showed that this was indeed occurring on the Missouri River. The two supposed cryptic species were not only roosting together, they were interbreeding.

How can two groups of interbreeding animals retain such large differences in mitochondrial DNA? Recall that mitochondrial DNA is inherited as a complete unit, rather than being mixed between generations. It is difficult to say with certainty when in the evolutionary past groups of little brown myotis were isolated from each other, but the mitochondrial DNA differences indicate a long-term separation that gave each group time to evolve its own unique set of mtDNA sequences. Now that these animals are able to move freely across the continent and to once again interbreed, their nuclear genes have been – and still are – shuffled with each new generation. But remnants of those long-ago separations are still seen in the mtDNA.

And now to put the whole story together. We determined that *Myotis lucifugus carissima* and *M. lucifugus lucifugus* are interbreeding in a zone where their ranges overlap. As such, can they be called separate species as Dewey speculated? Not according to the Biological Species Concept. But a newer Genetic Species Concept allows intact (nuclear) gene pools to retain species status despite some interbreeding in overlap zones. Therefore, as long as there is an area where we can find "pure *lucifugus*" individuals and an area where we can find "pure *carissima*" bats, then they could be designated as separate species.

There are, however, two complications that keep this from happening. First, there seem to be no morphological features that differentiate these two groups of bats, only differences in their mitochondrial genomes. And the currently recognized taxonomic system does not accommodate a designation based only on mtDNA. Perhaps a new category, such as a "Genetically Identifiable Unit," is in order, but that is beyond the scope of this discussion.

Second, and most importantly, Dewey recently found *M. lucifugus lucifugus* individuals spread across North America. Originally thought to be largely an eastern subspecies, it is now known that this subspecies is sympatric with most, if not all, of the other little brown subspecies in western North America. As we have shown, sympatry (overlapping ranges) seems to result in interbreeding, so widespread hybridization in the little brown myotis may be occurring. Without intact gene pools to define these supposedly different groups of little browns, it is unlikely that *M. lucifugus* will be divided into several species. In fact, it is not even clear whether subspecies designations should be retained. Certainly for the case of *M. l. carissima* and *M. l. lucifugus*, it seems appropriate that these distinctions be dropped.

The take-home lesson from the little brown myotis: mitochondrial DNA can be misleading. While substantial mtDNA differences between similar or identical-looking individuals *might* reveal cryptic species, it may instead provide only a glimpse into the evolutionary past of animals that are now one population of interbreeding individuals. While the Barcode of Life project will be able to categorize mitochondrial-genome diversity on Earth, species diversity still requires further investigation.

The little brown myotis is one of the most widespread bats in North America.

CORI LAUSEN recently earned a Ph.D. from the University of Calgary in Alberta and currently works as an independent biologist in British Columbia, Canada. This research was recently published in the Canadian Journal of Zoology *by C.L. Lausen, I. Delisle, R.M.R. Barclay, and C. Strobeck.*

Closing caves for WNS

As White-nose Syndrome continues to spread beyond the northeastern United States, leaving hundreds of thousands of dead bats in its wake, the U.S. Fish and Wildlife Service (FWS) is urging that no one enter caves in affected or neighboring states except scientists conducting sanctioned research.

The request for a voluntary, year-round moratorium on caving in the region is an effort to slow the spread of WNS and buy time to confirm the cause and determine potential solutions for this devastating threat to American bats. The FWS says at least 60 hibernation caves in nine states (Connecticut, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Vermont, Virginia and West Virginia) are known to be affected by WNS.

Bat Conservation International endorses the agency's recommendations and is reviewing its own activities and programs to ensure compliance. Given the many unanswered questions about WNS, BCI also urges conservationists, cavers and others throughout North America to exercise extreme caution in and around all bat caves. BCI is working with a variety of partners, including cavers, scientists, agencies and other organizations to understand and deal with this dire threat to bats.

Current evidence suggests a recently identified fungus probably is responsible, at least in part, for WNS. The syndrome's rapid spread suggests that bats are the primary carrier, but the service also cites "mounting evidence that human activity may also be responsible for spreading the causative agent(s) of WNS, even during seasons when bats are not occupying caves."

With mortality exceeding 90 percent at many affected sites, the circumstantial evidence "for human-assisted spread justifies that we exercise an abundance of caution in managing activities that impact caves and bats," the Service said.

The Fish and Wildlife Service recommends:

1. A voluntary moratorium on all caving activity in states known to have hibernacula affected by WNS, and all adjoining states, unless conducted as part of an agency-sanctioned research or monitoring project.
2. Cavers in regions outside the WNS-affected and adjacent states should use clothing and gear that has never been used in caves or mines in the affected or adjacent states. The agency also recommends that clothing and equipment used outside the affected region be decontaminated following the protocols available on the Service's WNS website (*www.fws.gov/northeast/white_nose.html*).
3. All scientific activities that involve entry into caves or mines where bats reside should be evaluated to determine if the activity has the potential to facilitate the spread of WNS. Potential benefits of research will be weighed against the risk posed to bats.
4. For all scientific activity, no equipment or clothing that has been used in any cave or mine in a WNS-affected or adjacent state should be used in a cave or mine in an unaffected state. Within an affected state, no equipment or clothing that has been used in a WNS-affected county should be used in an unaffected or unknown county. As an added precaution, researchers should decontaminate all clothing and gear when exiting any hibernacula.

Bat Conservation International is supporting targeted research to answer critical questions about White-nose Syndrome. Your help can make a difference. Donate to BCI's WNS Emergency Response Fund at www.batcon.org/wnsdonate.

A helping hand

One morning over breakfast, Kaleb and Hali Cook of Keene Valley, New York, examined a picture of animals at a wildlife museum. Seven-year-old Kaleb decided: "Mommy, I want to help these animals." Their mom, BCI Member Angie Cook, a staffer at the The Nature Conservancy, asked which ones he had in mind.

Then "both kids started in on a conversation that I just listened to," Angie recalled. "They went back and forth about which animal they would each like to save. Kaleb thought tigers, while Hali, age 5, favored whales."

COURTESY OF ANGIE COOK

Hali came up with a solution: "Kaleb, how about we put our allowances together for one animal that we could save?" Kaleb considered that a fine idea and added: "How about bats? They're dying. Let's help them!" In this environmentally conscious family, even youngsters knew that White-nose Syndrome is killing hundreds of thousands of bats.

Mom suggested, "Maybe we could do a fundraiser, and your friends at school could help. Halloween is coming up – perfect timing!" That morning, Angie said, "both kids went to school, told their friends that they were going to save the bats and asked if anybody wanted to help. Many of their friends said yes."

With some help from Mom, Kaleb and Hali bought kids' temporary bat tattoos and *Amazing Bat Facts* cards from BCI's catalog and, on Halloween, all three went to school to hand them out at $2 apiece. "We went to each classroom, and the children helped me collect money and distribute the items. After it was all said and done, we raised just over $100 [for BCI's WNS Fund], plus one of my colleagues bought a membership to BCI and the children's grandparents pitched in, too."

On Christmas morning, Kaleb and Hali each received a special gift from Santa: Adopt-a-Bat packets from Bat Conservation International. "I told them that Santa must have been so proud of them for helping bats that he wanted to thank them."

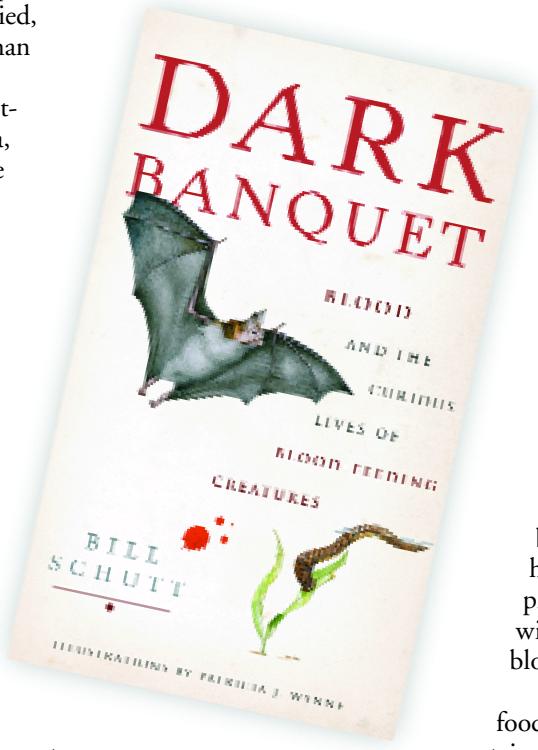
Remember Kaleb and Hali the next time you wonder if there's anything you can do to help.

Book Review: *Dark Banquet* The fascinating lives of blood-feeders

The "expert" vampire eradicators rolled a tank of propane gas into a Brazilian cave some years ago, opened the valve and remotely triggered a flashbulb. The explosion was awesome. After the clouds of smoke cleared, a visiting scientist found thousands of dead bats of varied species, but not a single vampire. The vampire bats were found a little deeper into the cave – quite healthy and unruffled. The bats that died, the scientist said, were "more delicate" than the hated vampires.

Similar disasters have occurred countless times throughout Latin America, where millions of beneficial bats have been destroyed by dynamite, poison, flamethrowers and other weapons in usually vain attempts to kill vampires.

"Feeding on blood is a tough way to make a living," the scientist told biologist/author Bill Schutt, who says that's precisely why the common vampire bat (*Desmodus rotundus*) "evolved to become extremely opportunistic, extremely intelligent and extremely difficult to eliminate."



Much the same can be said of the many other reviled and feared blood-feeding creatures – the sanguivores. In *Dark Banquet: Blood and the Curious Lives of Blood-feeding Creatures* (Harmony Books, 2008), Schutt describes not only vampire bats, but also chiggers, ticks, leeches, bedbugs, mosquitoes and others, plus the often-remarkable adaptations that let them fill their unsavory niches.

The author's conversational style and gentle sense of humor serve the topic well, allowing the painless delivery of some impressive lessons in biology, evolution and how science works.

Schutt, associate professor at C.W. Post College of Long Island University, is a bat biologist and, while he examines exotic qualities of all sorts of sanguivores, vampire bats get top billing. The three species of vampire bats (out of more than 1,100 bat species) are all limited to Latin America and were unknown to Europeans until the Spanish explorations of the sixteenth century.

Early naturalists were so dumbfounded by them that centuries of wildly inaccurate information followed. They insisted, for example, that the triangular nose leaf atop the snout of many bat species was a deadly stiletto used to pierce the flesh and release a bloody meal. This bizarre mistake contributed to the misidentification of many beneficial bats as vampires. In fact, nose leaves are actually soft and pliable and used mostly to focus echolocation calls. In vampires, the vestigial leaf is packed with thermoreceptors so the bat can identify where warm blood is flowing near the skin.

The common vampire feeds on the blood of mammals, and its predilection for domestic livestock brings the loathing of ranchers. This bat evolved into a largely terrestrial animal that not only walks and runs easily, but can jump up to three feet (a meter) off the ground. These are worthy traits for feeding on large mammals – and for escaping them.

The other two species – the white-winged vampire (*Diaemus youngi*) and hairy-legged vampire (*Diphylla ecaudata*) – prefer trees and feed on bird blood. A captive colony that Schutt once maintained revealed a remarkable trick that white-winged vampires learned to safely feed on chickens: They pretend to be chicks. The targeted hen actually seems to relax as the much smaller vampire bat snuggles beneath her. As the hen hunkers down contentedly, the vampire almost painlessly pierces a vessel with razor-sharp teeth and laps the blood.

Blood, however, is hardly the perfect food. Because it's mostly water and protein, vampire bats can't store the energy – as fat, for example. They must eat at least half their body weight in blood every night or risk starving to death in a very short time. This probably led to the vampires' unusual altruism: they frequently regurgitate part of a blood meal and share it with roostmates that were unable to find food.

Another problem blood-feeders must overcome is blood's tendency to clot and quit flowing. Vampire bats and leeches, among other sanguivores, solve the problem by including a powerful anticoagulant in their saliva. "These natural anticoagulants are often far more efficient than anything produced by man," Schutt writes, "and several have become important medications." The vampire version is used to prevent strokes and the leech provides a compound used in hip-replacement surgery.

These superficially "icky" creatures turn out to be completely fascinating and, at least in some cases, quite useful. *Dark Banquet* will hold your attention as Schutt tells you all about them.

– *Robert Locke*

The bats in the wells

Old hand-dug water wells often provide a refuge for Rafinesque's big-eared bats (*Corynorhinus rafinesquii*) and southeastern myotis (*Myotis austroriparius*) when winter temperatures fall in southwestern Arkansas. As natural habitat disappears, these bats have come to depend increasingly on abandoned buildings in summer and on those crumbling old wells during winter cold spells. But the wells often have, at best, casings that are very low to the ground, raising the risk of unwary humans falling into them. Others are used as garbage dumps by local residents.

To keep these old wells available for bats, while also protecting people, Blake Sasse of the Arkansas Game and Fish Commission, David Saugey of the U.S. Forest Service and Dan England, retired from Southern Arkansas University, decided to install steel covers over the well openings with gaps for the bats to enter and exit.

The researchers, who have been studying bats in the area for many years, asked Mylea Bayless, Coordinator of BCI's Southeast Rare Bats Initiative for help. BCI, with funding from the National Fish and Wildlife Foundation, supported a pilot program to cap three wells.

Sasse and Saugey installed the caps on one well on property owned by the Oak Grove Methodist Church in Lafayette County and two on Deltic Timber Company property in Nevada County. Each well had been used as a winter roost by about 10 to 30 bats. These increasingly rare species typically form rather small colonies.

This past winter, Sasse took advantage of a blast of cold weather to check the three wells. "We can definitely say that the bats were not offended by the covers, as there were [Rafinesque's big-eared] bats in all of them and at higher numbers than seen in the previous two winter visits," he concluded.

The pilot project seems to prove the utility of the metal covers, at least as far as the bats are concerned. BCI, in collaboration with colleagues in Arkansas, plans to protect more roost sites this winter. You can help protect these winter roosts of last resort for two rare species by donating to BCI's Rare Bats Initiative at *www.batcon.org/donate*.

David Saugey of the U.S. Forest Service attaches a bat-friendly cover to keep unwary humans from falling into an old well.

COURTESY OF BLAKE SASSE

Federal partnership award to BCI

The U.S. Forest Service and the U.S. Bureau of Land Management honored Bat Conservation International as this year's Conservation Leadership Partner of the Year. The award cited BCI's "outstanding leadership in developing and implementing conservation programs designed to directly benefit wildlife, namely bats, and their habitats on public lands." Ed Arnett, BCI's Co-director of Programs, accepted the award at the North American Wildlife and Natural Resources Conference in Washington, D.C. BCI and the federal agencies partnered on such programs as North American Bats and Mines, Bats and Caves, Bats and Forest Initiative, Water for Wildlife, the Bats and Wind Energy Cooperative and the BCI Student Research Scholarship Program. The agencies concluded: "BCI is at the forefront of bat conservation and we are proud to have them as a partner."

COURTESY OF CHERYL CARROTHERS, US FOREST SERVICE

(From left: Ed Arnett; Joel Holtrop, Deputy Chief of the National Forest Service; and Mike Pool, Acting Director of the Bureau of Land Management.)

BCI Member Snapshot

"If I can get a handful of kids excited about bats, and even just one decides to go into a field such as bat research or conservation, then I've done my duty as a BCI member," says Dr. Todd Austin of Virden, Illinois. The doctor of chiropractic has for years given frequent bat-education talks to schools and clubs in and around his hometown. He recently fascinated these youngsters at Virden Elementary School. "My mission as a BCI volunteer is to drum up some good public relations for bats," he says.

Share a snapshot of your bat activities with fellow members: Email it to pub@batcon.org *or mail it to Snapshot, Bat Conservation International, PO Box 162603, Austin, TX 78716.*

The Wish List

Your help with any of these special needs will directly improve BCI's ability to protect bats and bat habitats. To contribute or for more information, contact BCI's Department of Development at (512) 327-9721 or development@batcon.org.

A Film for Flying Foxes

The Marianas flying fox has almost disappeared from many of the Pacific islands it once called home. The island of Rota in the Northern Mariana Islands hosts one of the few remaining significant populations of this endangered species, known locally as *fanihi*. But these bats, too, are declining in the face of habitat loss and illegal hunting. Jim Tharp, a graduate student at Montana State University, hopes to reverse that trend by creating a video that reveals the beauty and fascinating nature of these bats, as well as their critical importance as pollinators and seed-dispersers. The goal is to give islanders a pride of ownership in these valuable but vulnerable animals. The Mariana Division of Fish and Wildlife is cooperating with Tharp and will distribute the video as a free DVD. It will also be available on the Internet and will be broadcast on a local TV station. Tharp needs a BCI Global Grassroots Conservation grant of $4,000.

Recovering from Storms

Two of America's largest and most important maternity colonies of rare southeastern myotis are at risk because of damage from recent storms. The two Florida caves had been fenced by the state Fish and Wildlife Conservation Commission to prevent human disturbance and vandalism of the roosts where female bats give birth and raise their young. But the storms blew down trees and destroyed much of the protective fencing. BCI's Southeastern Rare Bats Program is working with the state commission to repair the fences and restore protection to both caves. Repairs will cost approximately $2,000 at each site.

Saving a Bat Barn

More than 1,500 bats, mostly little brown myotis, are roosting in a dilapidated old barn on New Jersey's Supawna Meadows National Wildlife Refuge, according to a survey last summer. But old wooden barns increasingly are being demolished throughout the region, often depriving bats of homes. Now it is this barn's turn to face the wrecking ball. This comes at a time when bat populations throughout the Northeast are being decimated by White-nose Syndrome. Friends of Supawna Meadows NWR won a temporary reprieve to raise funds for stabilizing the barn for use solely as wildlife habitat. The health of its bat colony will be monitored. The nonprofit organization requests $3,500 to help with the stabilization.

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