BAT RESEARCH NEWS

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Front Cover

This is *Hipposideros diadema* (Diadem Roundleaf Bat) from the Gomantong Caves on the Malaysian side of Borneo. Of the hundreds of thousands of bats in the caves, there was just a single colony of 50–60 of this species. Photo by Keith Christenson, with support from the National Geographic Society. Thank you, Keith!

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RECENT LITERATURE

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ANATOMY

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ANNOUNCEMENTS

Basically Bats Wildlife Conservation Society Announces Student Research Scholarships

Basically Bats Wildlife Conservation Society is offering two student research scholarships for the 2015-2016 academic year. Scholarships of up to **$5,000 each** will be awarded during the Fall of 2015 for research directly related to **white-nose syndrome** (WNS) in North American bats. All students, including postdoctoral students who are enrolled in an **accredited United States** or **Canadian college** during the 2015-2016 academic year are eligible to apply. Applications should include: a brief, one- to three-page description of the WNS-related project; a budget for the project that includes how the funds will be used; the applicant's Curriculum Vitae; and a brief letter of support from the applicant's supervisor. Applications are competitive and will be reviewed by at least two experts in the field of bat biology. **Deadline** for submission of applications is **June 15th, 2015**. Applications should be submitted in PDF format to Dr. Steve Burnett (**sburnett@clayton.edu**).

Request for News

As you can tell from this extremely sparse issue, *Bat Research News* needs your help. Please consider submitting news from your lab group, your field work, or any bat-related news. Also please consider submitting short articles, notes, or letters on a bat-related topic (see below). Thank you in advance for considering us as a place for bat, bat worker, and bat lab news items.

Request for Manuscripts — *Bat Research News*

Original research/speculative review articles, short to moderate length, on a bat-related topic would be most welcomed. Please submit manuscripts as .rtf documents to Allen Kurta, Editor for Feature Articles (akurta@emich.edu). If you have questions, please contact Al. Thank you for considering submitting your work to *BRN*.

Change of Address Requested

Will you be moving in the near future? If so, please **send** your **new postal and e-mail addresses** to Margaret Griffiths (margaret.griffiths01@gmail.com), and include the date on which the change will become effective. Thank you in advance for helping us out!

FUTURE MEETINGS and EVENTS

2015

The 45th Annual NASBR will be held October 28–November 1, 2015, in Monterey, California. See the NASBR website for more in formation — http://www.nasbr.org/.

2016

The 46th Annual NASBR will be held October 12–15, 2016, in San Antonio, Texas. See the NASBR website for future updates — http://www.nasbr.org/.

2017

The 47th Annual NASBR will be held in Knoxville, Tennessee, dates to be determined. Check the NASBR website for future updates — http://www.nasbr.org/.

BAT RESEARCH NEWS

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Front Cover

Platyrrhinus helleri (Heller's broad-nosed bat), Paramaribo, Suriname. Photo by Keith Christenson. Thank you, Keith!

BAT RESEARCH NEWS

Volume 56: Number 2 Summer 2015

Bat Research News is published four times each year, consisting of one volume of four issues. *Bat Research News* publishes short feature articles and general interest notes that are reviewed by at least two scholars in that field. *Bat Research News* also includes abstracts of presentations at bat conferences around the world, letters to the editors, news submitted by our readers, notices and requests, and announcements of future bat conferences worldwide. In addition, *Bat Research News* provides a listing of recent bat-related articles that were published in English. *Bat Research News* is abstracted in several databases (e.g., BIOSIS).

Communications concerning feature articles and "Letters to the Editor" should be addressed to Dr. Al Kurta (akurta@emich.edu), recent literature items to Dr. Jodi Sedlock, (sedlockj@lawrence.edu), and all other correspondence (e.g., news, conservation, or education items; subscription information; cover art) to Dr. Margaret Griffiths (margaret.griffiths01@gmail.com).

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Letters to the Editor

Editor's Note: Unlike technical articles, letters are not peer-reviewed, but they are edited for grammar, style, and clarity. Letters provide an outlet for opinions, speculations, anecdotes, and other interesting observations that, by themselves, may not be sufficient or appropriate for a technical article. Letters should be no longer than two manuscript pages and sent to the Feature Editor.

Rabies: Low Probability, Not Low Risk

Charles H. Calisher

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The first description of rabies dates from the 23rd century B.C. in a Babylonian document, and the disease was recognized during those times as having some relationship with dogs. Owners of dogs in the Babylonian city of Eshnunna, for example, were fined heavily for human deaths cause by bites of their animals (Baer, 1991). It was not until 1530 A.D. that the physician Girolamo Fracastoro of Verona described the disease and its routes of transmission. Today, we know that rabies virus is endemic in bats of diverse species within North America and probably throughout most of the world. Although this virus has not caused large die-offs of bats, some individuals in any given population are likely infected and ultimately capable of transmitting the virus by bite.

Modern viral taxonomists place rabies virus in the family *Rhabdoviridae* (from the Sanskrit word *rabhas*, meaning to do violence) and the genus *Lyssavirus* (from the Greek word *lyssa*, referring to one of the Greek spirits of madness). Rabies virus (RABV) is not the only lyssavirus. In 1982, Shope (1982) described antigenic relationships between RABV and other viruses in Africa, including Mokola virus from shrews, cats, and a human, Lagos bat virus from fruit bats, and Duvenhage virus from bats and a human. Since then, other lyssaviruses have been isolated from bats: Aravan virus, Australian bat lyssavirus, Bokeloh bat virus, European bat lyssaviruses 1 and 2, Irkut virus, Khujand virus, Shimoni bat virus, and West Caucasian bat virus (Calisher and Ellison, 2012). These viruses have been variously detected in bats of the genera *Eidolon*, *Eptesicus*, *Hipposideros*, *Miniopterus*, *Saccolaimus*, *Murina*, *Myotis*, and *Rousettus*. Some of these viruses have caused fatal human rabies. Although RABV is the likely cause of most rabies in humans, it is only one of the many etiologic agents of that disease, which is an acute, progressive, usually fatal encephalomyelitis caused by neurotropic lyssaviruses.

The question of whether the standard vaccine for the rabies virus protects against infection with all lyssaviruses is of critical importance. Rigorous studies of the efficacy of rabies virus vaccine in humans are absent for moral reasons. Experimental studies, however, can be summarized by saying that protection afforded by standard rabies vaccine against a given lyssavirus is proportional to the genetic distance between it and RABV. That is, the more distant the virus is genetically, the less likely the vaccine will confer protection (Hanlon et al., 2005).

An important question for anyone handling live or dead bats or their tissues, exudates, or secretions is how to protect oneself from RABV and other bat-associated pathogens. Fortunately for humans, few bats are infected with a lyssavirus, not all accidents with lyssaviruses result in infection, and there is an excellent vaccine for prevention of infections by RABV. Nonetheless, safety precautions should be taken as a first phase of prevention; for field biologists, these always include pre-exposure vaccination and wearing adequate gloves on both hands. Detailed information about safety for field workers can be obtained from institutional biosafety committees or from the web site of the Centers for Disease Control and Prevention (2013).

Although many types of anti-RABV vaccines exist, with varying immunization schedules, pre-exposure vaccination usually consists of a series of three injections with human diploid cell rabies vaccine or purified chick embryo cell vaccine. After vaccination, it is incumbent upon the vaccinee to have her or his serum tested and antibody titer to the vaccine measured (Centers for Disease Control and Prevention, 2012). Testing by enzyme-linked immunosorbent assays (ELISA) may reveal antibody that binds RABV antigen, but such a test does not indicate neutralizing antibody. Both the U.S. Advisory Committee on Immunization Practices and the World Health Organization recommend use of the Rapid Fluorescent Focus Inhibition Test (RFFIT), which detects neutralizing antibody. Antibody should be detectable within 7–10 days after vaccination and may persist for 2 years or more. However, individual responses to prophylactic vaccination against RABV may vary, and regular testing for levels of antibody against RABV using RFFIT (not ELISA) is prudent. If the titer falls below an acceptable level (<100% neutralization at a serum dilution of 1:5—Rupprecht et al., 2010), a booster vaccination is necessary.

In summary, rabies is a rare human disease in developed regions but annually kills more than 60,000 people world-wide (World Health Organization, 2015). Although the probability of encountering an infected bat is low, this should not be confused with a low risk. The infrequent occurrence of rabies in bat handlers likely can be attributed to both professional and general public awareness of its danger and the availability of effective vaccines. Still, no matter the low probability of contracting rabies, all precautions should still be taken to avoid this almost inevitably fatal illness. There is no value in disregarding obvious risks as being insignificant or irrelevant. Rabies clearly is an example of a preventable disease, and it is tragic when those at known risk—including bat biologists—do not take adequate precautions to prevent infection of themselves, their assistants, or their students.

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First Capture of *Cyttarops alecto* in the Costa Rican Cloud Forest

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The short-eared bat, *Cyttarops alecto*, is a rare species, with a spotty distribution, that occurs in northern South America and from Nicaragua to Panama in Central America (Tavares et al., 2012; Velazco et al., 2011). Most captures to date have been single individuals, although a few groups of up to twelve bats have been found beneath palm fronds (Velazco et al., 2011). The species previously has been found exclusively in Neotropical lowlands below 500 m in elevation (LaVal and Rodríguez, 2002; Tavares et al., 2012; Velazco et al., 2011), but during a recent study on the distribution of bats between the canopy and understory in the cloud forest of Monteverde, Costa Rica (10°18'10" N, 85°12'14"), we captured two male *C. alecto* at 1,700 m above sea level.

In May 2014, we mist-netted along a trail, the Sendero Wilford Guindon, which included a 100-m-long suspension bridge in the canopy of the forest. Two mist-nets were placed in the understory, about 1 m above the ground, and two were opened along the bridge. The four nets were used over six nights, between 1800 and 2100 hours, and checked every half hour.

The two *Cyttarops alecto* were captured in the same net attached just above the bridge's hand-rails and fastened against the suspensory cables. They were found during the same net check at 2100 hours on the third night of the study, 13 May 2014. Earlier in the night, heavy mist and fog occurred, and at the time of capture, light rain was falling. Both bats had forearm lengths of 46 mm, weighed 7 grams, and appeared fully mature. Both matched published descriptions of *C. alecto* (LaVal and Rodríguez-H., 2002; Starrett, 1972; Timm and LaVal, 1998). Each was an all-gray emballonurid, lacking sacs in the propatagium and uropatagium. The last phalanx of the thumb was free of the propatagium, and the uropatagium attached to the top of each foot and extended broadly between them.

Changes in rainfall and loss of primary forest are well documented in this part of Costa Rica (LaVal, 2004). Therefore, we speculate that global warming and deforestation explain the appearance of a species in the cloud-forest canopy that had previously been documented only in lowlands. Biologists studying bats should collaborate with those studying climate change and changes in forest structure, to establish a clear cause for the presence of uncommon species appearing in Monteverde and other high-elevation sites.

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ANNOUNCEMENTS

Death Notice

We received sad news that Dr. Rhonda (Ronnie) Sidner was killed in an automobile accident on 2 August 2014. According to her husband, Dr. Russell Davis, Ronnie was returning home late at night from Ramsey Canyon, Sierra Vista, Arizona, where she had taken a group of people to watch nectar-feeding bats feed. Her good friend and co-worker, Debbie Buecher, was quoted as saying, "(Ronnie) had a gentle spirit that could turn peoples' minds around about bats with a single talk." Ronnie was a champion of bats and devoted much of her time to educating the public about bats and their importance to ecosystems and society, in addition to her field work and scholarly research. Ronnie's obituary was published in the *Arizona Daily Star* and can be found at: http://tucson.com/news/local/renowned-arizona-bat-scientist-sidner-killed-in-crash/article_bd042d48-9596-5aad-917d-72097cf5b96c.html. Ronnie will be sorely missed.

Request for News

Please consider submitting news from your lab group, your field work, or any bat-related news. Also please consider submitting short articles, notes, or letters on a bat-related topic (see below). Thank you in advance for considering us as a place for bat, bat worker, and bat lab news items.

Request for Manuscripts — *Bat Research News*

Original research/speculative review articles, short to moderate length, on a bat-related topic would be most welcomed. Please submit manuscripts as .rtf documents to Allen Kurta, Editor for Feature Articles (akurta@emich.edu). If you have questions, please contact Al. Thank you for considering submitting your work to *BRN*.

Change of Address Requested

Will you be moving in the near future? If so, please **send your new postal and e-mail addresses** to Margaret Griffiths (margaret.griffiths01@gmail.com), and include the date on which the change will become effective. Thank you in advance for helping us out!

FUTURE MEETINGS and EVENTS

2015

The 45th Annual NASBR will be held October 28–October 31, 2015, at the Monterey Plaza Hotel in Monterey, California. Registration is open. Please see the NASBR website for more in formation — http://www.nasbr.org/.

2016

The 17th International Bat Research Conference will be held in Durban, South Africa, July 31–August 5th, 2016. More information will be available at a later date. Please see: http://www.eurobats.org/bat_news/17th_international_bat_research_conference_2016

The 46th Annual NASBR will be held October 12–15, 2016, in San Antonio, Texas. See the NASBR website for future updates — http://www.nasbr.org/.

2017

The 47th Annual NASBR will be held in Knoxville, Tennessee, dates to be determined. Check the NASBR website for future updates — http://www.nasbr.org/.

BAT RESEARCH NEWS

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BAT RESEARCH NEWS

VOLUME 56: NUMBER 3 **FALL 2015**

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Front Cover

This Peter's Epauletted Bat (*Epomophorus crypturus*) was photographed in the gardens of a farm just east of Lusaka, Zambia. Lots of fruit trees can mean lots of fruit bats. And this landowner was really cool with having the bats feeding in his garden. Photo by Keith Christenson.

BAT RESEARCH NEWS

Volume 56: Number 3 Fall 2015

Bat Research News is published four times each year, consisting of one volume of four issues. *Bat Research News* publishes short feature articles and general interest notes that are reviewed by at least two scholars in that field. *Bat Research News* also includes abstracts of presentations at bat conferences around the world, letters to the editors, news submitted by our readers, notices and requests, and announcements of future bat conferences worldwide. In addition, *Bat Research News* provides a listing of recent bat-related articles that were published in English. *Bat Research News* is abstracted in several databases (e.g., BIOSIS).

Communications concerning feature articles and "Letters to the Editor" should be addressed to Dr. Al Kurta (akurta@emich.edu), recent literature items to Dr. Jodi Sedlock, (sedlockj@lawrence.edu), and all other correspondence (e.g., news, conservation, or education items; subscription information; cover art) to Dr. Margaret Griffiths (margaret.griffiths01@gmail.com).

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Back issues of *Bat Research News* are available for a small fee. Please contact Dr. Margaret Griffiths (margaret.griffiths01@gmail.com) for more information regarding back issues. Thank you!

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Letters to the Editor

Editor's Note: Unlike technical articles, letters are not peer-reviewed, but they are edited for grammar, style, and clarity. Letters provide an outlet for opinions, speculations, anecdotes, and other interesting observations that, by themselves, may not be sufficient or appropriate for a technical article. Letters should be no longer than two manuscript pages and sent to the Feature Editor.

Relative Rarity of the Short-eared Bat, *Cyttarops alecto*

Richard K. LaVal

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In reporting the occurrence of the short-eared bat (*Cyttarops alecto*) for the first time from Peru, Velazco et al. (2011) questioned, "Only hard to find or truly rare?" Their point was that this emballonurid has been captured infrequently and at widely separated localities from Nicaragua to Brazil and Peru, but perhaps it is only difficult to capture. The unexpected capture of two specimens in the Monteverde Cloud Forest of Costa Rica at 1,700 masl suggests that we know little about the true distribution of this species, which was formerly thought to be restricted to tropical lowlands (Andrews and Chinchilla, 2015).

Although *C. alecto* may be difficult to capture, it is easily recognized by its echolocation signature (Jung et al., 2007). *C. alecto* produces calls of nearly constant frequency that are of short duration (pulse interval of 154 or 265 ms) and at an average frequency of 35.9 kHz; the terminal portion of its call is usually higher in frequency than the initial part. None of the other, eight, non-diclidurine emballonurids in Costa Rica echolocate at this frequency. Calls of the shaggy-haired bat (*Centronycteris centralis*) appear similar but have a higher frequency, shorter pulse interval, and almost identical initial and terminal frequencies (Jung et al., 2007; R. K. LaVal, unpublished data).

As part of a long-term study to map the distribution of insectivorous bats in Costa Rica, I recorded (Anabat II, Titley Scientific, New Ballina, Australia) echolocation calls of bats all night, typically on 1–5 nights, in the years 2000–2015, at 54 localities scattered around Costa Rica. Thirty-nine of these sites were in the lowlands, both on the Caribbean and Pacific sides of the country. Recording took place in disturbed areas at all localities, although often adjacent to primary forest. An approximate total of 100,000 files was recorded at these 39 sites combined. In this note, I used these recordings to gauge whether *C. alecto* was truly rare.

I compared the number of sites at which *C. alecto* was recorded to the number of sites at which three other emballonurid species were detected. These species included *C. centralis*, the greater white-lined bat (*Saccopteryx bilineata*), and Wagner's sac-winged bat (*Cormura brevirostris*). LaVal and Rodríguez (2002) considered *S. bilineata* to be very common in Costa Rica; *C. centralis*, in contrast was regarded as uncommon or rare, and *C. brevirostris* and *C. alecto* were described as rare. Of the 39 sites at which recording occurred, I detected *S. bilineata* at 34 sites, *C. centralis* at 14, *C. brevirostris* at 13, and *C. alecto* at only 5.

Clearly, among the three species previously considered rare by LaVal and Rodríguez (2002), *C. alecto* appears to be the least commonly encountered, having been recorded at the fewest localities. This suggests that *C. alecto* is truly a rare species, and relatively more rare than the other two emballonurids considered rare in Costa Rica, *C. centralis* and *C. brevirostris*, although they appear to be more common than the literature would suggest. Another possibility, which I consider unlikely, is that *C. alecto* forages deep in the forest, where I did not record, and that my few recordings were from bats in transit to more remote foraging areas. However, Jung et al. (2007) described *C. alecto* as an edge-foraging species, suggesting that such a scenario is unlikely.

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RECENT LITERATURE

Authors are requested to send reprints or PDF files of their published papers to the Editor for Recent Literature, Dr. Jodi L. Sedlock (Lawrence University, 711 E. Boldt Way, Appleton, WI 54911, U.S.A., e-mail: **sedlockj@lawrence.edu**) for inclusion in this section. Receipt of reprints is preferred, as it will facilitate complete and correct citation. However, if reprints and/or PDF files are unavailable, please send a complete citation (including complete name of journal and corresponding author mailing address) by e-mail. The Recent Literature section is based on several bibliographic sources and for obvious reasons can never be up-to-date. Any error or omission is inadvertent. Voluntary contributions for this section, especially from researchers outside the United States, are most welcome and appreciated.

ANATOMY

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ANNOUNCEMENTS

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2016

The 17th International Bat Research Conference will be held in Durban, South Africa, July 31–August 5th, 2016. More information will be available at a later date. Please see: http://www.eurobats.org/bat_news/17th_international_bat_research_conference_2016

The 46th Annual NASBR will be held October 12–15, 2016, in San Antonio, Texas. See the NASBR website for future updates — http://www.nasbr.org/.

2017

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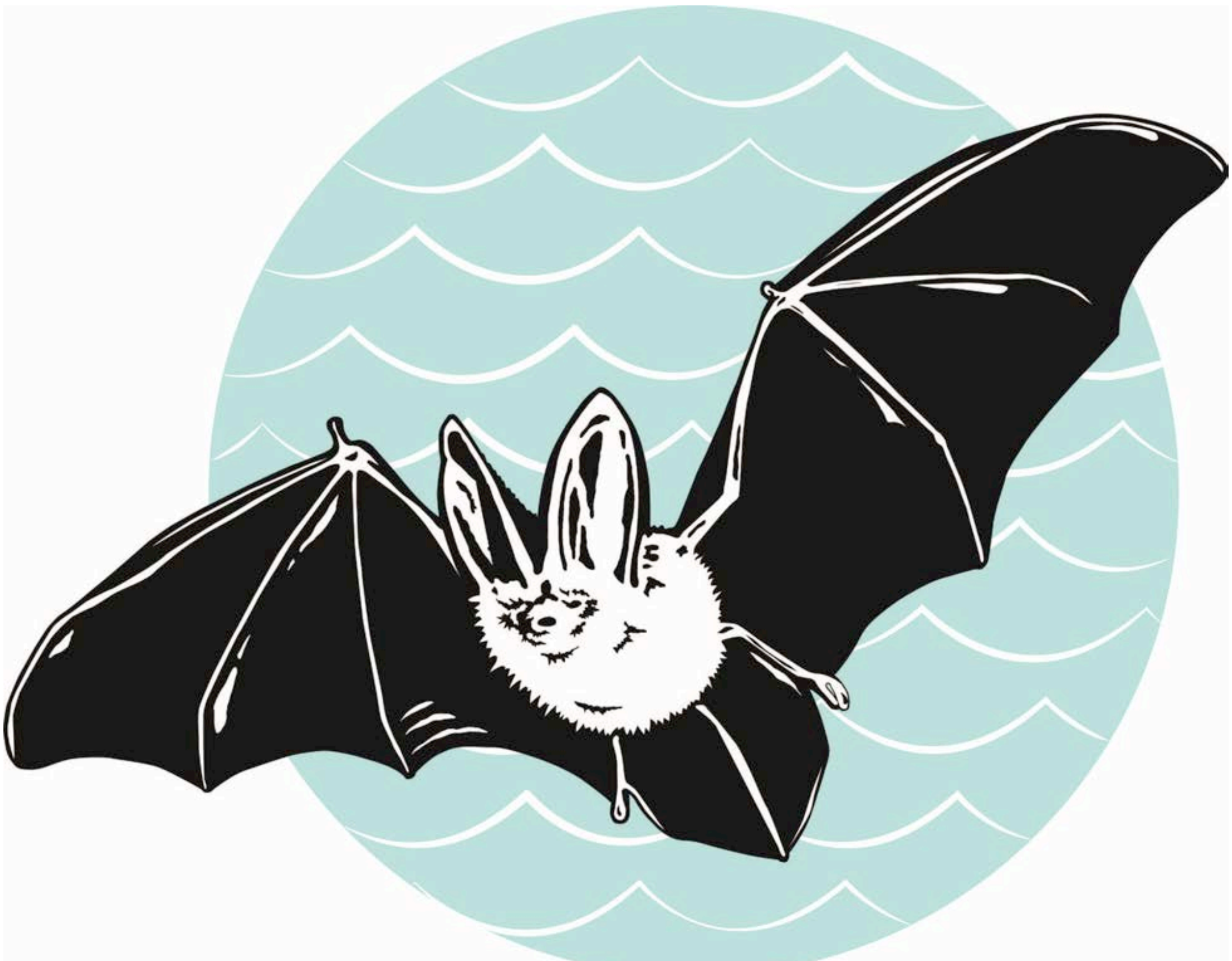

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Front Cover

Logo (*Corynorhinus* flying over water with the moon in the background) from the 45th Annual North American Symposium on Bat Research held in Monterey, California, 28–31 October 2015. The 45th Annual NASBR meeting hosted by Dave Johnston and Shahroukh Mistry. Meeting logo by Kelly Terry. Many thanks to Kelly, Dave, Shahroukh, and the NASBR for allowing us to use the logo.

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Letters to the Editor

Editor's Note: Unlike technical articles, letters are not peer-reviewed, but they are edited for grammar, style, and clarity. Letters provide an outlet for opinions, speculations, anecdotes, and other interesting observations that, by themselves, may not be sufficient or appropriate for a technical article. Letters should be no longer than two manuscript pages and sent to the Feature Editor.

Derivation of the Generic Name *Tadarida* (Rafinesque, 1814)

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Tadarida is a genus of bat in the family Molossidae, described by Constantine Samuel Rafinesque (1783–1840). He published the original description in Palermo, Italy, in French, under the name Rafinesque-Schmaltz, with the title “Précis des découvertes et travaux somiologiques de Mr. C.S. Rafinesque-Schmaltz entre 1800 et 1814” (Rafinesque-Schmaltz, 1814). The derivation of the name *Tadarida* has been subject to various assumptions, sometimes quite imaginative (Stangl et al., 1993; Ammerman et al., 2012), and often it is assumed that the name means nothing and was invented by Rafinesque (e.g., Gannon et al., 2005).

Rafinesque, however, lived in Sicily from 1805 to 1815, when he published his description of a new species of bat, initially called *Cephalotes teniotis* (Rafinesque-Schmaltz, 1814, p. 12) but later changed to *Tadarida teniotis* (Correction, p. 55). Even today, the word “*tadarida*,” with variations, including *taddarita*, *taddarida*, *tallarita, tallarida*, and *taddrarita*, is frequently used in Calabria and Sicily to refer generically to “bat,” regardless of species (Pasqualino, 1790; Mortillaro, 1862; Forsyth Mayor, 1893; Garbini, 1925; Eggenschwiler, 1934; Consolo, 1976; Camilleri, 2001). The first mention of the word "*tallarita*" dates to a manuscript in Latin in 1348: "*vespertilio . . . avis noctua, que no nisi in nocte volat, que dicitur tallarita*" [bat . . . nocturnal bird that flies only at night, which is called tallarita] (Marinoni, 1955). These local names also are used for “bat” in Sicilian beliefs, legends, and poems (Pitrè, 1889). Therefore, Rafinesque did not invent the word but used a word from the language that he heard during his life in Sicily.

With good grounds the etymology of "tadarida" is from Greek. The feminine Greek noun νυκτερίς (nykterís) = "bat" [genitive νυκτερίδος (nykterídos)] and became "tadarida" in southern Italy (Sicily and Calabria) due to apheresis and dialect deformation (Lanza, 2012). The Greek etymology is also supported by Forsyth Major (1893) and Garbini (1925), with documented steps through several Greek local dialects.

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Abstracts of Papers Presented at the

45th Annual Symposium of the North American Society for Bat Research Monterey, CA, USA October 28–31, 2015

The following abstracts are from papers presented at the 45th Annual Symposium of the North American Society for Bat Research (NASBR). The local hosts for the meeting were Dave Johnston and Shahroukh Mistry. Meeting abstracts were submitted by Frank Bonaccorso, Gary Kwiecinski, and Shahroukh Mistry, Program Directors for NASBR. Abstracts are arranged in alphabetical order by first author and, except for minor formatting changes, are published as received. Abstracts are considered the property of the authors and we request that you please contact the author to request further information about their work. **Student award recipients** are indicated by an asterisk (*) next to the title of their paper. E-mail contact information for authors is not available.

Communication Networks in Groups of Echolocating Bats

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For more than 60 years researchers have puzzled over how echolocating bats avoid interfering with each other's echolocation while flying in dense swarms or within noisy, day roosts. It's unknown how bats sharing the same acoustic space manage to coordinate their echolocation without sacrificing navigational accuracy. Echolocating bats may have evolved a transmission-delay algorithm similar to those used in artificial communications networks to optimize sonar performance in social contexts. Crawling bats will decrease calling rates in the presence of other bats, which has been hypothesized to be a social adaptation that provides a net increase in information gleaned from each pulse; however it is unknown whether flying bats would also use this strategy. We tested the hypothesis that bats in flight would cooperatively optimize sonar performance at the group-level by slowing their pulse emission rates proportional to population density. We analyzed how *Tadarida brasiliensis* altered their echolocation to accommodate the flight-paths of neighboring bats, and secondly measured changes in pulse emissions associated with a neighboring bat's pulse emissions independent of flight patterns. We found that bats respond to the movement of other bats as obstacles by increasing their call emission rate; however the overall increase in pulse emissions was tempered by an inhibition triggered by hearing other bats' pulses. In simulated groups, call emission rate was reduced by 15% when flying in both an empty room and when performing a challenging navigational task. By characterizing these behavioral algorithms we hope to reveal an important adaptation for echolocating in social contexts.

Seasonal and Nightly Activity of Mexican Long-nosed Bats in Texas

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We examined activity of Mexican long-nosed bats (*Leptonycteris nivalis,* MLNBs) in Texas to better understand their use of Mount Emory Cave, the northernmost maternity roost for this species. Historically the colony has been studied by visual surveys, radio telemetry study, and an annual thermal imaging census, but data gaps persist. To further examine nightly and seasonal activities of MLNBs, we installed a fly-through Passive Integrated Transponder (PIT) tag reader-antenna system at the cave. Over two seasons we implanted 104 MLNBs with PIT tags, 47% were adults (48F:1M) and 53% were juveniles (24F:31M). In 2015, 23% of females PIT tagged in 2014 (6 of 26) were detected again. We documented MLNBs using the cave from 26 April to 1 September, increasing their known seasonality in the region. MLNBs were active an average of 7 h 42 min per night (range: 4 h 05 min – 9 h 09 min) based on overall entry and exit records of 52 individuals, and the most PIT tagged bats were detected during the second week of July. Juveniles were more frequently detected than adult MLNBs. Thermal imaging censuses before and after the PIT tag detection system was installed were approximately 2200 individuals in the colony. Therefore, census data did not indicate that the PIT tag system had an impact on bats using Mount Emory Cave.

New Insights into the Mating Ecology of Epauletted Fruit Bats in Kruger National Park, South Africa
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The mating ecology of epauletted fruit bats is poorly understood. Of the eight known species living in Sub-Saharan Africa, two, *Epomophorus crypturus* and *E. wahlbergi*, coexist in Kruger National Park, South Africa. In June 2009, a drought year, very little fruiting of sycamore fig trees was noted. Serendipitously one night we found an area where 20 male *E. wahlbergi* were calling in proximity to five synchronously fruiting fig trees along a 10km distance of the Sabie River. We recorded mating calls of males over two consecutive nights and used call intensities to estimate individual positions in the forest. Results show that the distribution of calling perches was clumped ($R = 0.75$) near fruiting trees. In addition, we found that a 2km section of the corridor containing the majority of calling males had the tightest clumping ($R = 0.58$). Distances among calling males and their nearest neighbor were significantly less on average in the higher density area, than in the lower density areas. However, males maintained a minimum dispersion (25m) and never were observed calling from the same tree. Some males appeared dominant over others and consistently positioned themselves closest to where females were foraging for figs. In addition, analysis of recordings of male mating calls from *E. wahlbergi* and *E. crypturus* showed significant differences in five call structure attributes, making each species mating call unique.

Unraveling Zero Crossing and Full Spectrum
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Full spectrum and zero-crossing recording technologies have been used to record and analyze the echolocation calls of bats for decades. More recent advances in analysis software combine these technologies by extracting zero crossing information from full spectrum recordings using different combinations of signal processing techniques. The purpose of this paper is to explain the physics behind full spectrum and zero crossing technologies and modern hybrid algorithms for bat biologists and ecologists to better understand and appreciate the advantages, disadvantages, and modern capabilities of available technology. We first look at zero crossing and full spectrum recording technologies, how they work, and their relative advantages and disadvantages. We then explore a simple technique for extracting zero-crossing data from full spectrum recordings using band-pass filtering and adaptive thresholds. Finally, we explore advanced signal processing techniques including Gaussian noise reduction, echo cancellation, call tracing, adaptive filtering and interpolation to study how they can be used to enhance a full spectrum signal in order to extract richer zero crossing data. We conclude that while zero crossing recordings do have some advantages in limited circumstances, it is far better to record bats in full spectrum and use modern signal processing techniques to enhance the signal before either analyzing the data with full spectrum tools or extracting zero crossing information and then analyzing the data using zero crossing or hybrid tools.

Cactophily Extends to Frugivory in *Antrozous pallidus
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* **Jaclyn Aliperti** received the **Luis F. Bacardi Bat Conservation Award**.

Seasonal diet plasticity is rare in temperate insectivorous bats. The pallid bat, *Antrozous pallidus*, is an exception and consumes cactus nectar during spring when columnar cacti bloom in the Sonoran Desert. Cactophily is common among nectar-feeding glossophine bats, including *Leptonycteris* species that migrate to the Sonoran Desert when columnar cacti bloom and fruit. We recorded bat foraging at 163 fruits of the cardón cactus (*Pachycereus pringlei*) on the Baja California peninsula to determine whether cactophilic diet habits extend to fruit-eating in *A. pallidus*. We measured stable isotope ratios of carbon in wing tissue (n=37) and exhaled breath (n=35) of *A. pallidus* to quantify the importance of fruit in their summer diet. *Antrozous pallidus* accounted for approximately 28% of bat visits to fruit (and removed an average of 8.9% of fruit mass), whereas *L. yerbabuenae*, a migratory species seasonally dependent on cactus nectar and fruit, accounted for approximately 72% of bat visits (removing an average of 13.3% of fruit mass). The proportion of cactus-derived carbon in the diet was significantly greater in *A. pallidus* wing tissue than in breath ($p<0.001$), suggesting *A. pallidus* exhibit stronger seasonal reliance on cactus nectar during spring than on fruit in summer. Our results confirm that cactophily in *A. pallidus* extends to frugivory, showcasing unusual diet plasticity in a temperate bat. Although reliance on fruit in summer may be less than on nectar, our results support conclusions that *A. pallidus* is an important mutualist to columnar cacti in parts of the Sonoran Desert.

Structure of the Plagiopatagiales Muscles in Bats
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The plagiopatagiales proprii are an array of muscles within the skin of the armwing that may contribute to active control of wing shape, and thus, modulation of magnitude and orientation of aerodynamic forces. They also lack direct attachment to bones in all bat species we have examined, a distinctive trait among striated skeletal muscles of mammalian limbs. To gain improved insight into the functional architecture of the plagiopatagiales, we examined details of the structure of the muscles, their tendons, and their attachments in two phyllostomids, *Carollia perspicillata* and *Artibeus lituratus*. The anatomical configuration of the muscles suggests a proprioceptive function, so we examined the array for presence and density of muscle spindles. Although major wing and hindlimb muscles possess typical mammalian spindles, we found none in any plagiopatagiales. At their caudal attachment, the plagiopatagiales in both species insert via a collagenous tendon on a bundle of elastin fibrils that runs proximodistally (spanwise). The rostral attachment of these muscles differs between our study. In *A. lituratus*, the collagenous wrapping of muscle fibers coalesces to form a tendon that uniquely consists primarily of elastin. These tendons intersect elastin fibril bundles that run in the spanwise direction. In *C. perspicillata*, most muscle fibers terminate directly on spanwise-running elastin fibril bundles, but the collagenous wrapping of some appears to be continuous with the relatively disorganized collagenous extracellular matrix. The attachments might allow the plagiopatagiales to distribute contractile force across the wing via the mesh-like elastin network and play critical roles in muscle force production.

A Decade of Bat Monitoring in the Missouri Ozarks
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Climate change, human-induced land-use change, wind energy development and introduced disease all threaten bat populations and underscore the need to detect population changes. We used acoustic detection of bats to estimate probability of detection and site occupancy of forest bats in the Ozark Region of Missouri in 2001-2003 and resampled sites in 2010-2012 to evaluate differences. We fit single-species site occupancy models to estimate detection probability and site occupancy. We evaluated *a priori* hypotheses in an information theoretic approach by evaluating support for candidate models that included habitat and landscape. Eight species were detected at 20 % or more of the sites in the 2001-2003 sample and five species in the 2010-2012 sample. Detection probabilities varied among species but were similar within species across time. Species responded to landscape pattern at different spatial scales (2, 8, and 16 km). Habitat, patch and landscape characteristics (e.g., terrestrial and aquatic habitat type, road density and interspersion of contrasting habitats) were important covariates in estimates of site occupancy for most species. Riparian features, aquatic habitats and bottomland forests were important to most species. All species used landscapes with high percentages of forest. We found more consistent and larger effect sizes for landscape- than habitat-scale relationships in both sample periods. Wildlife managers can use this information and approach to evaluate bat population status and trends locally and regionally for planning appropriate conservation strategies.

***Factors Influencing Emergence Times of Indiana Bats in Central Indiana**
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* **Robert Arndt** received the **Titley Electronics Award**.

Variation in emergence times in bats could be explained by a range of factors, including predation risk, food competition, reproductive state, or changes in weather. The aim of this analysis was to determine the set of factors that best explains the variation relative to sunset in emergence times in a population of Indiana bats from summer tree roosts. Emergence time data were collected from March to October, 2003 to 2014, at a site in central Indiana that has long hosted maternity roosts of Indiana bats. Roosts were observed from 30 minutes before sundown until

10 minutes had passed without an exiting bat. Bats showed a strong tendency to leave a roost earlier as (i) the reproductive season progressed through pregnancy and lactation, and (ii) cloud cover at dusk increased. Emergence times were also earlier at roosts farther from forest edge, in larger colonies, and in relatively humid conditions. Moon phase and temperature had little impact on emergence times. Many of the variables with strong effects may be associated with either predation risk or food competition. The effect of reproductive period suggests that bats were taking greater risks by emerging earlier (often before sunset) when their energetic demands were highest. The tendency to leave earlier from larger colonies suggests a role for competition in emergence times. Emergence times are less correlated with cloud cover during times of high energetic demand, suggesting riskier behavior. A relatively strong effect of relative humidity may indicate an underlying unmeasured factor, perhaps related to food availability.

Abundance of Eastern Red Bats over a Six-year Period in the Eastern United States

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Populations of tree bats are difficult to monitor over time, in part because individuals are typically solitary, long-lived, and highly mobile. However, these bats are facing serious threats such as habitat loss, mortalities at wind-energy facilities, and increased exposure to pesticides. Because of these threats, I hypothesized that one such species, the eastern red bat (*Lasiurus borealis*) would have detectable declines in abundance. To test this hypothesis, I examined a long-term mist-netting dataset accumulated in the context of pre-construction surveys for bats prior to building pipelines, roadways, and other development projects. Data were collected throughout Ohio, Pennsylvania, Virginia, and West Virginia, between 15 May and 15 August from 2006 to 2015. For each mist-net site, I found the average number of eastern red bats captured per net night. I then performed linear regression to look for negative gradients in collective annual captures of bats. While analyses are ongoing, a total of 525 eastern red bats, obtained during 1,042 net nights, were included in our preliminary exploration. Linear regression did not show a strong relationship between date and number of captures ($r = 0.004$; $P = 0.468$). While these findings do not provide evidence for declining eastern red bat populations, the geographic variation present in this study may have inhibited the ability to detect such decreases.

Bats and the Vertebrate Skin Microbiome: Multiple Factors Influence Skin Symbiont Communities in North American Bat Species

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We know that bats are a crucial part of the ecology of ecosystems around the world, but we are only beginning to understand the community of microbial symbionts that make up the bat microbiome. Bats inhabit many unique environments and may harbor bacteria derived from their habitats. In addition, bats can have both intra- and inter-species interactions that may permit an exchange of microbial symbionts. How do these influences drive the formation of the skin microbiome in bats, and are the observed patterns different or similar when compared to other vertebrate groups? A literature survey was conducted to assess the observed relative abundances of different microbial taxa using 10 studies across 5 vertebrate groups. For bat skin microbial data, two data sets were combined from a sample set of 57 bats in the Eastern United States and 147 bats in Colorado. DNA from skin swabs was extracted and then sequenced using the Illumina Hi-Seq (Eastern bats) or MiSeq (Colorado bats) at the University of Colorado Boulder. Raw sequences were trimmed to a uniform 100 bp length before analysis using UPARSE and the QIIME pipeline. We found significantly distinct microbial assemblages on different bat species, within different states, and by each sample site (ANOSIM $p < 0.01$). Within bacteria specific to the host, classes included *Gammaproteobacteria, Alphaproteobacteria, Actinobacteria, Betaproteobacteria, Bacilli,* and *Flavobacteria.* In addition to harboring distinct bacterial taxa when compared to other vertebrates, a combination of species, site, and regional influences drive the composition of the bat skin microbiome.

An Assessment of Social Transmission of Migratory Behaviours among Bats
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Migratory animals rely on endogenous, genetically inherited programs, or socially transmitted information about routes and behaviours, or a combination of the two. Social transmission of migratory is most likely from mother to offspring, but perhaps also from other conspecifics. In long-lived animals with extended parental care, as we see in bats, migration tends to be socially transmitted rather than endogenous. For a young bat to learn migration via social transmission, they would need to follow an experienced individual, most likely one roosting nearby. Therefore, I predicted that bats travelling together on the same night originate from the same place. It is also likely that young bats follow their mothers or other kin, so I predicted that bats travelling together on the same night are more closely related to each other than bats travelling on different nights. To test my predictions, I used microsatellite genotypes and stable isotope values of $\delta^{13}C$, $\delta^{15}N$, and $\delta^{2}H$ to analyse the relatedness and geographic origins of migrating hoary bats (n = 133) and silver-haired bats (n = 87) killed at a wind energy facility in southwestern Alberta over two consecutive autumn migrations. Contrary to my predictions, there was no evidence that related dyads of hoary bats (*Lasiurus cinereus*) or silver-haired bats (*Lasionycteris noctivagans*) were killed on the same night more frequently than expected by chance or that the number of days between the fatalities of dyad members was influenced by relatedness or latitude of origin. Thus, it does not appear that bats learn migration from close kin.

A Cry in the Dark: Using Acoustics to Determine Habitat Use of the Florida Bonneted Bat
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The federally endangered Florida bonneted bat is endemic to southern Florida. Little is known about the range and habitat requirements of this species, but it is believed to have one of the most limited geographic distributions of any bat in the United States. As south Florida continues its rapid urbanization, there is an urgent need to better understand the distribution and habitat usage of this species. We conducted a large-scale acoustic survey of 340 sites spread across approximately 38,000 km^2 of south Florida over a two year period. We recorded over 500 bonneted bat call sequences in ten different counties; three of these counties had no previous records of the species. Bonneted bat acoustic activity was concentrated relatively early in the night, with over 80% of the calls being recorded before midnight. The detection probability over one survey night was low ($p < 0.20$). Bonneted bats were detected in all four major land cover types sampled (agricultural areas, wetlands, upland forests, and developed areas) with relatively equal frequency. Preliminary results indicate that the amount of surrounding wetlands had a positive effect on the probability of bonneted bat occurrence and that bonneted bats preferred areas of continuous habitat with reduced habitat diversity. In conclusion, we determined that acoustics are a viable method for detecting bonneted bats, although we recommend that detectors should be left out for a minimum of six full nights to reliably determine presence.

Biometric Recognition of Individual Bats
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Knowing the identity and age of individuals is essential for many studies in ecology and behavior. For bats, individual recognition most commonly is achieved by some form of physical alteration, such as use of bands. An alternative to physical alteration is biometrics, which is the recognition of individuals based on behavioral and/or biological characteristics. Successful biometric recognition is dependent on one or more characteristics that have wide variation among individuals in a population and that are permanent or consistent over time. In humans, fingerprints and facial patterns are widely known examples that are used to verify identity, although the branching pattern of veins in the human hand also is unique to individuals, even in twins, and remains stable over time. A bat wing is homologous to the human hand, and we hypothesized that the pattern of wing venation could be used to identify individual animals. From May 2011 through August 2015, we captured and banded 563 adult and juvenile big brown bats (*Eptesicus fuscus*) at three maternity colonies in Illinois. We recorded the pattern of venation for each bat by taking photographs of the trans-illuminated wing. More than 275 bats were recaptured at least once and photographed again, and of these, about 118 were captured both as juveniles and adults. We found that the venation pattern did not change over time and that these patterns are recognizable in juveniles before volancy. Recording the venation pattern using photography allows researchers to keep permanent records of individuals without the possibility of endangering them or altering their behavior with a physical marker.

White-nose Syndrome Lesions in European Bat *Myotis myotis* Linked with Hematology and Blood Chemistry

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Experimental inoculations of the North American bat *Myotis lucifugus* with the white-nose syndrome fungus *Pseudogymnoascus destructans* have revealed that extensive wing membrane skin damage disrupts blood physiology. There is, however, lack of data on blood parameters in naturally infected bats or bats from Europe. Here, we evaluated responses of *Myotis myotis* bats hibernating in three European hibernacula. A total of 59 bats were blood sampled in Nietoperek (Poland), and Mala Moravka mine and Sloupsko-Šošůvské cave (both in the Czech Republic) in March and April 2015. At the same time, bat wings were photographed over a 368 nm wavelength UV lamp to allow for image analysis of WNS lesions in both wing membranes. Using VetScan i-STAT 1 analyser (Abaxis, CA, USA) we measured Na^+, K^+, Cl^-, TCO^2, pCO^2, $HCO3^-$, pH, base excess, anion gap, urea, glucose, haemoglobin and haematocrit. We found significant differences among hibernation sites in the numbers of WNS lesions as well as acid-base balance. Acidosis was more severe as the number of WNS lesions increased. Likewise, bats were dehydrated. To conclude, our study documents pathophysiological changes of blood parameters in European bats that survive the WNS infection.

Variation in Bat Fur: an Ignored Trait with Implications for Thermoregulation, Aerodynamics and Ectoparasite Load

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Fur of mammals plays various important roles, including insulation, camouflage, and visual display. It is particularly important as insulation for small mammals and it was thus surprising to us that there is almost no literature on how bat fur varies among and within species. We developed hypotheses to investigate variation in the properties of bat fur, based on such factors as geographic distribution and habitat, body size, coloniality, roosting behaviour, and sex. We tested specific predictions by measuring the length and density of fur on museum specimens and live individuals from a number of locations. We will present our preliminary results, including an assessment of variation within species (across a wide latitudinal range, between habitats at the same latitude, and between males and females), and among species with different roosting behaviours and degrees of coloniality. For example, there are differences among species of similar size but different degrees of coloniality, in the same habitat. While insulation may be the primary selective pressure on fur, the influence of fur on aerodynamics and the ability of ectoparasites to avoid grooming by bats, must also be considered.

Conserving the Bats of Argentina: a Challenge of 40 Years

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Studies of bats in Argentina were hampered in the past decades due to government policies and cultural attitudes of people who did not supported the growth of biology, especially everything related to projects for conservation. The growth and consolidation of the current generation of professionals, active in chiropterology, was achieved thanks to an extreme perseverance and passion for the study of bats, which were stronger than the obstacles. The first steps were very difficult due to the extreme lack of knowledge of the species inhabiting the entire country, where only 29 species were known by the early 70s, and there were no field guides or books that could help in the task. Then, to study bats one should enter into the systematics, distribution and ecology of one of the most poorly known group of mammals in Argentina, with minimal information on distribution and ecology. After learning the basics of bat biology across the complex landscapes of Argentina, we were challenged to convey the information to government officials to gain support for conservation actions, fighting against many folk tales, myths, and fears, which were part of the public perception. At the present time the studies of bats in Argentina has continued with their primary scientific aspects, but adding to their concerns the object "conservation" by creating the PCMA (Argentine Bats Conservation Program) which, by joining the RELCOM (Latin American Network for Bat Conservation) has started to work in conservation of the species and areas in Latin America and the Caribbean.

Behavior Meets Immunology: the Relationship between Personality and Immune Function in *Myotis lucifugus*

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Understanding predictors of parasite and pathogen loads, and immune function in bats has become increasingly important with the emergence of white-nose syndrome and an improved understanding of the role of bats as reservoirs for zoonotic pathogens. Consistent individual differences in behavior or personality can influence parasite exposure and could also be related to immune function. We tested the hypotheses that activity and exploratory tendencies of individual little brown (*Myotis lucifugus*) would influence: 1) the prevalence and intensity of infection with ecto- and blood-borne endoparasites; and 2) immune system function. We predicted that more bold, active and explorative bats would have higher parasite/pathogen loads and exhibit a corresponding increase in immune activity. We captured 102 bats over 3 weeks during the fall swarm of 2015 at a cave near Lake St. George, Manitoba. We sampled approximately 2.5µL of blood from the inter-femoral vein of each bat for preparation of a blood smear and then quantified personality traits of individuals using a standard hole-board test. When completed, our analysis will provide important information on the role of behavior in shaping parasite and pathogen risk, as well as immune performance for temperate, hibernating bats.

Bats and Human Disease Incidence: the Need for Accurate Bat Databases

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Bats are linked in the eyes of many with human disease causation, including rabies and other lyssavirus infections, SARS, Ebola/Marburg hemorrhagic fevers, and histoplasmosis. Some species of bats, however, consume mosquitoes, vectors of several important human diseases. We show that reported West Nile virus (WNV) infection in humans and mosquitoes is highly correlated in several states. Accurate bat census data would permit tracking incidence of such mosquito-borne diseases in these states as a function of bat population and give impetus for bat conservation efforts. Numbers of reported human and mosquito WNV infections from the United States Geological Survey were correlated from 2003 to 2014. Seven states with the most complete data were examined on a yearly basis by county. In Connecticut, Arizona, California, and Nevada, correlation of reported incidence of human and mosquito infections was consistently >0.6. Mosquito-consuming bats in these states include the Eastern and Western pipistrelle, the endangered Indiana bat, the silver-haired bat, and the Eastern small-footed bat. The first two of these are not included in the Bat Population Data Project material and information on the other species is limited. Lack of accurate bat census information over time does not permit us to examine whether changes in specific bat populations affects WNV incidence. A comprehensive database of bat population counts is needed enable cross-disciplinary projects designed to study possible positive effects of bats on human disease incidence, such as WNV encephalitis. Future work could focus on bat population numbers and malaria, dengue, or yellow fever.

The Dietary Breadth of Bats Captured During Winter in the Southeastern U.S.

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We used NextGen sequencing of fecal DNA to investigate the food habits of bats active outside of five hibernacula during winter in middle and eastern Tennessee. Our objectives were to 1) identify the composition of prey consumed by bats during winter; 2) determine if there are differences in composition of prey consumed between bat species; and 3) determine if bats found PCR positive for *Pseudogymnoascus destructans* (Pd), consume different prey items when compared to PCR negative bats captured during the same intervals. During this preliminary study, we analyzed fecal pellets from 117 individuals representing nine of the ten species known to hibernate in the region. On average, bats consumed 11 different species of prey or OTUs (Operational Taxonomic Units; range from 1 to 33 OTUs). Males (n = 88) consumed an average of 11.48 OTUs, whereas females (n = 29) consumed 9.55 OTUs. Using epidermal swab results from a previous study, 36 of the 117 bats examined for dietary analysis were found PCR positive for Pd, the causative agent of white-nose syndrome. On average, individuals found Pd positive consumed less OTUs than Pd negative individuals (Pd+ = 9.72 OTUs; Pd- = 12.02 OTUs). We also found a weak correlation between the number of OTUs consumed versus the load of Pd of an individual. More specifically, male bats with a higher load of Pd were more likely to consume more OTUs than males with very low loads of Pd. Future work will contrast diets in winter with insects consumed during warm season activity.

***Surface Texture Discrimination by Bats: Implications for Reducing Mortality at Wind Turbines**

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*** Christina Bienz** received the **Organization for Bat Conservation Award.**

One proposed hypothesis to explain why bats are coming into contact with wind turbines is that the turbines themselves provide or may be perceived to provide one or more important resources. Previous studies show that bats misidentify artificial smooth surfaces to be water and that bats approach wind turbine towers with the same posture as bats drinking at water. Thus if wind turbine tower surfaces were textured rather than smooth, we predict that bats would spend less time investigating the tower surface and therefore less time in the rotor swept zone, thereby reducing the risk of collision with rotating blades. Using wild-caught bats, we conducted a series of behavioral experiments in a flight facility in 2014 and 2015 to identify a surface texture (grade and type) that bats show little or no interest in approaching. We presented bats with a smooth, painted surface to which a range of textured surfaces (coarse, intermediate, and fine grain sand; applique consisting of 1 cm^3 foam strips spaced 0.5 m apart and woodchip) could be applied. We recorded the number of passes, drinking attempts, and contact made by bats with each surface type. Preliminary analysis confirmed that bats attempted to drink from the smooth painted surface. In contrast, not one drinking attempt was observed at the textured surfaces. Furthermore as predicted, texturizing the surface led to a reduction in the number of passes made by bats (with the exception of the applique). Data collection and analysis is currently ongoing.

Little Brown Bats in Southeast Alaska Hibernate in Holes: Implications for the Spread of White-nose Syndrome

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Little brown bats in eastern North America typically hibernate in caves and mines, often in large numbers, however few large hibernacula have been identified in the West and none have been found west of the Rocky Mountains. We used radio-telemetry to identify hibernation roosts of little brown bats in Juneau, Alaska. We captured and radio-tagged adult bats in early fall and radio-tracked them daily from the air and on the ground. We located 10 hibernation roosts on 2 ridge systems; distances from the capture site to the roost ranged from 1.3 to 24.1 km. Two roosts were under root wads on level ground at elevations ≤ 86 m. Eight roosts were located on steep, forested hillsides at elevations ranging from 128 to 452 m; 3 were rock roosts located in colluvium, 3 were associated with large rock outcrops, and 2 were in rocky soils. At least one roost was used in successive years. We compared winter temperatures and relative humidity inside (~0.3 – 0.5 m from the opening) and outside of 4 roosts located in 2013. Relative humidity dropped as low as 40-60% outside of roosts, but remained near 100% inside the roosts throughout the winter. Average temperatures were also higher and more stable inside the holes (-1.04 to 2.03 °C) than outside (-2.33 to -0.63 °C). If roosting solitarily in holes in the ground is a common overwintering strategy of little brown bats in the West, western populations should be much less vulnerable to white-nose syndrome than their eastern counterparts.

Population Estimates and Emergence Trends of Mexican Free-tailed Bats Using Image Processing Tools
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Mexican free-tailed bats *(Tadarida brasiliensis*) form large cave-roosting maternity colonies in the southwestern United States. Obtaining accurate population counts is difficult because of the vast number of individuals and challenging access to the inside of the caves. Additionally, the bats emerge at high densities making traditional census methods (e.g., visual counting, mark and recapture, as well as thermal and radar imaging) very problematic and costly. Here we report on a low-cost, efficient approach for abundance estimates, and describe the daily variation in emergence for a large maternal colony of *T. brasiliensis*. A GoPro video camera (wide angle, 240 frames/second) was placed on the ground, facing the sky, ca. 5 m in in front of the cave opening. Data were collected during emergence on 10 days in June 2015. Bat abundances were determined from single video frame analysis (every 10 seconds) using ImageJ and Dot-Count software, and patterns of emergence were compared across recording nights. Emergences varied nightly based on size, time, density, and pattern. These image processing tools provide an accurate and efficient way to census bat populations and analyze emergence patterns and swarm density.

Insights on the Evolution of Bat Song from Five Molossid Species
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Birds are well known for songs while bats are well known for their developed sonar system. However, recent research has revealed that in addition to echolocation, bats produce highly sophisticated "songs" whose complexity is only rivaled by birds, humans and cetaceans. The evolution of the form and complexity of songs still remains enigmatic even though it has been studied extensively in songbirds over the past 50 years. Bats may provide insight into many of these unanswered questions. Here, I present acoustic analyses of echolocation calls and territorial/courtship calls for five species of Molossids: *Tadarida brasiliensis*, *T. teniotis*, *Nyctinomops laticaudatus*, *Molossus molossus* and *M. rufus*. The two *Molossus* species produce short 4 – 7 syllable calls whereas the remaining species produce complex songs with multiple types of phrases that vary from one rendition to the next. The two *Tadarida* species' songs are especially similar indicating that song evolved prior to the divergence of *Tadarida* species. Other remarkable similarities include the use of echolocation-like pulses in songs, the use of buzzes and spectrally complex "Chirp B syllables". Finally we compare *T. brasiliensis* and *N. laticaudatus* song syllable variation and show that *T. brasiliensis* have highly stereotyped syllables within individuals that vary minimally between regions. *N. laticaudatus* on the other hand have little individual stereotypy and great regional variation. Thus, the function and development of song including vocal learning likely varies considerably between these species.

A 45-year History of NASBR
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During the Thanksgiving holidays on 27 and 28 November 1970, a group of chiroptologists met at the University of Arizona in Tucson, to hold a *Symposium of Bat Research in the Southwest.* This symposium consisted of 24 oral presentations on topics including physiology, anatomy, systematics, developmental biology, ecology, behavior, and a single presentation on bat sonar. At the conclusion of the symposium the attendees agreed by unanimous vote to reconvene in the fall of 1971 at the University of New Mexico. My presentation today will highlight major milestones in the history of what now is the North American Symposium on Bat Research and its parent scientific society, The North American Society for Bat Research. I will highlight in this presentation: key founding members, the evolution of program format and social activities, the formalization of the society as a non-profit organization, the origins of student awards and distinguished honors of the society, and the Teacher Workshop.

Acoustic Monitoring, Species Diversity and an Endangered Bat in the Florida Everglades
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Everglades National Park (ENP) and the adjacent Everglades ecosystem are globally recognized for their unique biotic communities; however, very few data exist on the bat communities in this system. Furthermore, little is known about the occurrence and habitat use of the federally endangered Florida bonneted bat (*Eumops floridanus)*, which is endemic to South Florida. The Everglades have experienced historic habitat degradation due to rapid development, changes in hydrology, fire suppression and climate change, amongst others. There is a critical need to develop a standardized monitoring protocol to track long-term population trends and habitat use of the bat species within the Everglades. Although acoustic monitoring of bats is now widespread worldwide, there is little empirical data to determine what methodologies best represent dynamic bat communities. To provide recommendations for a long-term bat monitoring protocol on this world heritage site, we tested three commonly used methods (driving transects, temporary-passive detectors and stationary-passive detectors) during two seasons (dry and wet) across three habitats (fresh-water marsh, pines and mangroves). With these data, we can determine the method, spatial extent and temporal timeframe that optimally represent species diversity, rare species occurrence, habitat use and seasonal patterns, while minimizing resources spent. Preliminary results suggest that driving transects underrepresented bat activity, that there was higher activity in pinelands and over water bodies, and that seasonality influenced habitat selection. Our ultimate recommendations are directly relevant to long-term conservation goals of bats within the Everglades ecosystem as well as to protected areas nationwide.

Population Genetics of *Artibeus jamaicensis* in Mangrove Forests along the South Coast of Guatemala
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Site fragmentation may affect certain aspects of some taxa, including a reduction in genetic diversity. Dispersal habits, diet and foraging strategy, along with bat-human relationships, may lead to a gene pool reduction and threaten population conservation. In this study, a first glimpse at the population genetics of *Artibeus jamaicensis* was analyzed using Cytochrome-*b* sequences. Sequences were aligned to generate phylogenetic relationships using Maximum likelihood methods and Bayesian inference along with a correlation between geographical and genetic distance. Results show homogeneity among the population of Tecojate and a much more differentiated population in Monterrico. When comparing both populations, isolated groups form in Monterrico, as well as another group compiled of members from both sites. This points to the possibility of migration tendencies between sites in search of resources and shelter. Also, an analysis using *Artibeus lituratus* as an out-group revealed closer phylogenetic relationships among individuals from both populations. The conclusions of our research state a degree of genetic differentiation between the two sites but, at the same time, harbor evidence of a genetic exchange contemplated throughout any season. Furthermore, conservation actions for bats should become part of the environmental education efforts in the area, portraying the importance of *Artibeus jamaicensis* as a major seed disperser and a key component in plants with commercial interest.

Yuma Myotis Social Calls Attract Bats to Artificial Roosts
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Bats use echolocation calls primarily for navigation and foraging, though these calls can also convey social information about the caller. Social calls are less constrained in structure and have the potential to convey a wider variety of information, such as group association, age or sex of caller. Recent research suggests bats may use vocalizations as acoustic cues to locate potential roost locations. We describe the characteristics and call structure of two social calls emitted by Yuma myotis (*Myotis yumanensis*) at roost sites. In the summer of 2013 and 2014, we recorded calls from flying and roosting Yuma myotis in Benbow, CA and Smith River National Recreation Area, CA. Two distinct social calls were isolated and identified as Type 1 and Type 2 social calls. Additionally, we broadcast Type 2 social calls and echolocation calls of Yuma myotis and Mexican free-tailed bats (*Tadarida brasilensis mexicana*) from newly erected roost sites and assessed bat behavioral responses to these acoustic cues using infrared video. Bats activity was significantly higher during playbacks of myotis social calls compared to other playback treatments or silent control nights. Additionally, bat activity remained elevated after playback treatments, indicating a latent effect of playbacks at a roosting site. This study provides one of the first descriptions of social calls in a North American myotis species and suggests that understanding the social relationships of bats at roosting and foraging sites may be useful for informing conservation and management decisions.

From the Tidepool to the Stars: Scaling from the Individual to the Population in Bat Ecology

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Bats have received increasing attention in recent years for their posited role as natural reservoirs for a number of high profile, zoonotic viruses (i.e., Ebola and Marburg filoviruses, Hendra and Nipah henipaviruses, SARs coronavirus). Spillover events for bat-borne pathogens demonstrate a distinctive seasonal signature, peaking at the close of the resource scarce dry season and coincident with the timing of parturition in synchronously breeding female bats. Traditional epidemiological models, incorporating basic host demography, appear incapable of explaining pathogen persistence among bat reservoirs with small population sizes, leading researchers to posit the existence of unique within-host processes of pathogen tolerance and control. We carried out an eighteen-month longitudinal field study, monitoring the interacting dynamics of within-host immune, reproductive, and nutritional status on infection prevalence and intensity for a suite of diversely functioning microparasitic infections among three endemic fruit bat species in Madagascar (Pteropus rufus, Eidolon dupreanum, Rousettus madagascariensis). Our data highlight seasonal nutritional and reproductive mass : forearm deficits concomitant with elevated infection prevalence and intensity in all three species. These patterns underpin our development of a within-host model exploring the contributions of host adiposity to intracellular pathogen control in bat systems; we suggest that extra-efficient pathways of cellular autophagy, as mediated via host nutritional condition, could explain bats' seemingly 'special' role as pathogen hosts. Our study emphasizes the importance of holistic biological science, as individual within-host processes can have important consequences for species- and population-level processes.

Bat Use of Forest Openings in Relation to Landscape Characteristics and Prey Abundance

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Numerous studies have shown that bats frequent forest openings, although little is known about how bats select these openings. Understanding how bats select openings and where to forage within them is important for making forest management decisions. In this study, we asked (1) do bats select openings based on prey availability or opening size and (2) do bats select where they forage within openings based on prey availability or the presence of forest edge? We placed Anabat SD2detectors and lighted Malaise traps at the interior and edge of 20 forest openings ranging in size from 0.2ha to 18.5 ha in the Nantahala National Forest, NC between June and August 2014. Species activity was determined using AnalookW and Kaleidoscope Pro. Captured insects were identified to Order and counted. The effect of opening characteristics and insect abundance on bat activity was tested using a mixed general linear model with fixed (size, location, size x location, total insect abundance) and random (opening within size) effects. There was a significant effect of distance from edge (P=0.07) and total insect abundance (P=0.07) on hoary bat (*Lasiurus cinereus*) activity with higher activity in opening interiors and openings with higher insect abundance. The effect of size, distance from edge, and insect abundance was not significant for all other species and overall activity. These results suggest that most bat species opportunistically exploit forest openings, although hoary bats are more likely to forage in opening interiors and where insects are more abundant.

Tough Conservation Decisions in an Overcrowded World

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In a world overcrowded with humans, biodiversity is being lost despite conservation efforts. Most conservation issues raise difficult moral, ethical, economic, and political questions. How do we balance preserving nature with meeting human needs? When should we let nature take its course and when should we intervene to protect biodiversity? Should an invasive species be eradicated, ignored, or preserved? Can biotourism be regulated so that it does not damage very natural resources that humans come to see? How should we allocate limited monetary and human resources among competing conservation priorities? These are not scientific questions. Society must decide what attitudes, policies, and management activities are in the public interest and should be implemented. The role of science should be to provide the public, politicians, policymakers, and managers with our best understanding of how nature works – the implications of current trends and the most likely consequences of alternative decisions and actions. I will present examples from my personal experience to illustrate how science can inform – but not make – difficult conservation decisions.

Are All Bat Gates Created Equal?

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Bat-compatible closures have been installed in thousands of caves and mines across North America to prevent human entry for safety and resource protection. This form of roost protection can inhibit the spread of white-nose syndrome (WNS) via human transport. The timing of surveys and methods influence the ability to detect seasonal bat use. Many bat species use a variety of roosts throughout their annual cycle as dictated by physiological and behavioral needs. The goal is to identify and protect the most important bat cave and mine roosts, and to avoid installation of incompatible closures that may cause roost abandonment. Not all types of cave and mine closures are acceptable to all species of bats at all times of year, and suitability may depend on colony size as well as closure size and design. Some colonies do not accept some culverts (or even gates). Corrugated culverts may deter bat entry due to the acoustic properties of the spaced "rings", as will be shown in videos of laboratory experiments conducted by Dr. Jim Simmons and colleagues at Brown University. The interpulse-interval patterns of the bats' sonar signals reveal that the task is very difficult with regard to perceptual ambiguity associated with acoustic clutter. Following installation of any "bat-compatible" closure, a monitoring program should be implemented to assess its effects. The availability of a shared database of closure design effectiveness for various bat species could guide the installation of bat-acceptable closures.

Two Convergent Lines of Evidence that Noise Pollution Alters Bat Behavior

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Anthropogenic noise is a pervasive and chronic source of disturbance, posing many challenges for a variety of taxa. Bats are acoustic predators, making their foraging vulnerable to a louder soundscape. Pallid bats rely on low frequency prey-produced sounds to hunt and are exposed to numerous sources of noise pollution, including sounds produced by traffic and energy extraction infrastructure, which are both prevalent throughout their range. Using played-back treatments in a laboratory experiment, pallid bats took up to three times longer to find prey when exposed to traffic and gas compressor noise as far away as 640 m from a busy road and 320 m from a gas compressor station. Additionally, an investigation of bat activity in a natural gas extraction field using passive acoustic monitoring and a paired design revealed that low frequency (<35 kHz) echolocating bats are less active at sites with constant compressor noise. Bats echolocating below 35 kHz exhibit 70% less activity as sites with noise as compared to quieter, control well pads. Brazilian Free-tailed bats were 40% less active at sites with compressor noise, indicating that habitat with noise pollution is less desirable for this species. These findings add to the evidence that bats are sensitive to anthropogenic sounds and that noise pollution should be considered when managing bat habitat and designing infrastructure.

Winter Activity of *Lasionycteris noctivagans* in British Columbia

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Silver-haired bat (*Lasionycteris noctivagans*) is commonly considered a long-distance migrant across much of its range; however, there is evidence that this species utilizes a latitudinal migration to coastal regions of the Pacific Northwest or that some populations are year-round residents in inland regions with mild winter climates. Silver-haired bat foraging activity has been identified during winter at temperatures as low as 6º Celsius, and records indicate that activity is most likely in areas with average January temperatures above -7º Celsius. Overwinter passive acoustic monitoring data were collected at ten sampling sites located in regions of varying winter climates across British Columbia, Canada. Acoustic data were analyzed at three sites on the North Coast, two sites on Vancouver Island, four sites in the West Kootenay, and one site on Haida Gwaii. Three locations were in proximity to known winter roosts. We analyzed patterns of activity in relation to ambient air temperature, humidity, barometric pressure, wind speed, and moon phase. We use percentage thresholds to compare activity between sample sites and nights. Silver-haired bat activity was documented during winter at all sites but Haida Gwaii, providing further evidence that this species overwinters across the southern portion of B.C., and suggests that its hibernation bouts may be regularly interrupted with periods of flight outside its hibernacula. Periods of activity generally increased with temperature, with the coldest winter flights documented at mine sites where this species was found hibernating.

Winter Activity Patterns of Bats on the Cumberland Plateau

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As winter is an energetically expensive time for temperate bats, a better understanding of their winter activity can provide insight to inform conservation strategies in the face of white-nose syndrome and climate change. We investigated winter bat activity in Big South Fork River and Recreation Area in Tennessee and Kentucky by continuously monitoring bat presence and activity with AnabatII detectors from October 2014 to April 2015. We sampled 10 sites in a variety of habitats: 3 recently burned (<2 years) forests, 3 unburned forests, 3 fields adjacent to ponds, and an over-wintering rock shelter. At each site we measured structural characteristics and temperature. Echolocation files were separated into high (≥36 kHz) and low (≤35 kHz) phonic groups with AnalookW software, and identified to species when possible using qualitative identification. Identified species included *Eptesicus fuscus*, *Lasiurus borealis, L. cinereus*, *Perimyotis subflavus* and *Myotis* spp. Bat activity was observed during 408 of 1507 total detector nights, with 21072 bat passes recorded; only 3759 of which were recorded from November through March. The number of detections per month was positively related to average monthly temperature, with a marked decrease in activity during February, the coldest month. While all detectors documented bat activity throughout the winter, activity was greatest at sites close to ponds, with significantly less activity recorded in the forested sites. Greater activity near water suggests that bats were primarily arousing to drink during the winter months, as gleaning insects—an important cold-temperature foraging strategy—is likely easier in forested areas.

Informal Education for the Conservation of Bats in Puerto Rico: Citizen Participation

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We have previously reported on the development of a citizen science project to educate the public about the importance of bats to ecosystems. Here we report on the latest developments of this project as it enters third and final stage. The project has three main objectives: 1. Gather information on richness and diversity of bat species in areas with various degrees of human impact; 2. raise awareness on the role played by bats in the ecosystem; and 3. develop regional bat conservation groups that are part of the PCMPR. We report the results for objectives 2 and 3. At this moment the project is in its third of three years. We have identified two core volunteers. Ten volunteers repeated the activity two to nine times. Five percent of the volunteers were over 51 years old, 14% between 41 and 50 years, 17% between 26 and 40, 30% between 19 and 25, and 34% under 19 years. After field activities, nearly 100% of the participants indicated that their appreciation and knowledge about bats has improved. The two core volunteers have initiated monitoring programs of bats on the eastern and the central part of the Island. Both these volunteers have also developed, in collaboration with the PCMPR, educational talks that they offer to their communities. In addition we present data on strategies and levels of awareness demonstrated by the volunteers. The project shows the positive impact of informal education on local communities.

Evolution by Terminal Addition Generates Diverse and Adaptive Skull Shapes of Phyllostomid Bats

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The New World leaf-nosed bats (Phyllostomidae), arguably the most ecologically diverse clade of mammals, have evolved extraordinarily diverse faces and skulls adapted for many different food types, such as insects, fruit, nectar, other vertebrates, and blood. To understand the processes that generated this diversity, we employ a phylogenetically informed geometric morphometric approach analyzing the variability of 3D skull landmarks from developmental and adult data from several lineages. Principal components analyses of phylogeny and ontogeny demonstrate widespread peramorphosis in phyllostomid skull morphologies and reveal that their distinctive ecomorphologies are largely achieved through "terminal addition" as the evolutionarily more recent features in cranial morphology emerge later in bat development by building on an ancestral structure. Phyllostomids, thus, provide a real-world example of "ontogeny recapitulates phylogeny" with important implications for understanding the evolution of adaptive morphological diversity in vertebrate body form.

Why Vampires Network

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Regurgitated food donations by common vampire bats (*Desmodus rotundus*) appear to provide both reciprocal and kin-selected benefits. Reciprocal sharing among close kin should therefore provide the largest possible inclusive fitness benefits. Why then do females with maternal kin roost-mates bother at all to help non-kin? I describe four lines of evidence that non-kin cooperation provides donors with a 'backup' donor network for when close kin donors are unavailable. First, by comparing allogrooming rates of vampires with other group-living bats (*Artibeus jamaicensis*, *Carollia perspicillata*, *Eidolon helvum* and *Rousettus aegyptiacus*) under the same captive conditions, I found that self-grooming did not differ but allogrooming rates were ~14 times higher in vampires. Second, by tracking food-sharing and allogrooming among 30+ vampire bats over 4 years, I show that the best predictor of donation rate overall was reciprocal donation rate but allogrooming was the best predictor among non-kin. Third, playback trials show that vampire bats are attracted to contact call based more on a caller's past sharing rather than caller kinship. Fourth, by experimentally preventing donations in seven bonded dyads (14 females), I show that bats that fed more non-kin in previous years coped better with the absence of a primary kin donor: they had more donors and received more food. These finding are consistent with hypotheses that (1) elevated allogrooming in vampire bats is a social adaptation, (2) allogrooming promotes food-sharing bonds among non-kin, and (3) investing in non-kin leads to larger and more robust cooperation networks.

Integrating the Ontogeny of Echolocation with the Development of Flight in Bats: Evolutionary Implications

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The evolution of flight and echolocation in bats is one of the most compelling questions in biology. Yet, revealing a clear delineation of adaptive stages from nonvolant ancestor to volant (flying) descendant and the relationship between the origination and evolution of these key innovations remains elusive. Fundamentally lacking from this discussion is the sequential ontogeny of how these two systems develop in relation to one another and become functionally integrated. We found consensus across nearly all species studied that: 1) emission of sonar-like calls preceded flight ability and emission rate accelerated in concert with increasing crawling capability. 2) drop-tests on prevolant juveniles resulted in further increases in sonar call emission rates, but equally important was a significant change in frequency range (bandwidth) that progressed lock-step with increasing flight ability. 3) Morphological analysis of the cochlea of newborns showed that they already possessed the unique cochlear structures and innervation required to receive and process sonar call echoes. 4) Morphological changes, apparently the product of increasing rates and power of laryngeal muscles correlated with increases in sonar emission rates and increases in bandwidth. We interpret these ontogenetic data as evidence that a simple echolocation system was inherited by early protobats from a shrew-like ancestor, rather than an *in situ* evolutionary innovation of bats. From these humble beginnings, elaboration and refinement of this system coevolved with the evolution of sustained flight and eventually led to the sophisticated echolocation system of present day bats.

Nectar Feeding Schedules of Two Species of Bat

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An obligate nectar-feeding bat, *Leptonycteris yerbabuenae,* and a facultative nectar-feeding bat, *Antrozous pallidus,* share a common resource–the nectar of the cardón cactus, *Pachycereus pringlei*, in Sonoran desert habitats on the Baja California Peninsula in northwestern Mexico. We recorded the timing and amount of visits by both bat species to *P. pringlei* flowers during the spring flowering season across six years to determine the annual variation in flower visitations of each species and whether activity of *L. yerbabuenae* influenced the amount and timing of *A. pallidus* visits to flowers. We found that *L. yerbabuenae* visitation rates to flowers were highly variable from year-to-year and could differ by almost two orders of magnitude while *A. pallidus* had low but consistent visitation rates each year. Activity of *L. yerbabuenae* influenced the timing, but not the total amount of flower visits by *Antrozous pallidus*. On nights with low *L. yerbabuenae* activity, visits by *A. pallidus* were spread throughout the night, whereas when *L. yerbabuenae* visits are high, *A. pallidus* concentrated flower visits in the early evening just after flowers open and before *L. yerbabuenae* began visiting flowers. Our results show a residential species (*A. pallidus*) shifting the timing of nectar-feeding in response to high activity by a migratory and more variable species (*L. yerbabuenae*), demonstrating temporal resource partitioning of a shared nectar resource.

The Environmental Reservoir of *Pseudogymnoascus destructans*

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White-nose syndrome (WNS) has caused catastrophic declines in hibernating bats since it emerged in 2006. The fungal pathogen, *Pseudogymnoascus destructans* (Pd), that causes WNS is known to occur in the environment and persistence in hibernacula has important ramifications for long-term disease dynamics. We examined the temporal progression and persistence of Pd loads in hibernacula environments and investigated biotic and abiotic variables contributing to environmental prevalence and loads over time. We analyzed Pd environmental loads at 300 sites in North America across the 7-year invasion history of WNS. Our results show that Pd loads increase in the first year of WNS detection but remain constant over time even at sites with small remnant bat populations. We found that bats directly contribute to substrate load likely via spore shedding onto hibernacula walls, and that clusters size of hibernating bats was positively associated with substrate load. These results suggest that hibernacula with large clusters of bats with high infection loads will directly contribute to high loads and prevalence in the environmental reservoir. However, Pd continues to persist in hibernacula environments even after mass mortality has occurred and therefore likely functions as a continued source of infection for remnant populations. Management options focused on reducing the environmental reservoir of Pd may be useful for preventing further proliferation of disease outbreaks and bat mortality.

Living on the Edge: a Community Approach to Molecular Food Webs in the Texas Desert

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DNA is one of the best-used tools to understand bat diet. We have used this method to study interactions within entire communities of species. Here we report the first molecular study of foraging ecology in a desert bat community (Big Bend National Park, Texas). We analyzed 292 fecal samples from 17 bat species and compared dietary richness and overlap and the impact of body size, echolocation call frequency and hunting style on this use of resources. We contrasted this food web with those we have measured in Costa Rica and Jamaica. Morphology and echolocation did not predict dietary niche size. *Corynorhinus townsendii*, *Myotis thysanodes* and *Nyctinomops femorosaccus* had the largest dietary richness. We observed a significantly greater dietary niche overlap within feeding guilds, particularly edge foragers, than among the general community. Vespertilionidae consumed more

Diptera while Molossidae consumed more Lepidoptera and Hymenoptera. Compared with food webs in tropical localities, this desert network has far lower connectance, fewer links between species and thus lower robustness to prey loss. It has more compartmentalization and greater nestedness decreasing overall stability. For example, *Tadarida brasiliensis* in Jamaica appear to consume as many as a thousand species of prey, while their diet is much more restricted in Texas with an estimated dietary richness of only about 100 prey species. This suggests desert bats utilize fewer species of prey and the food web is less robust to losses within those prey groups. This may make the community more vulnerable to ecosystem perturbation.

Assessing Bats at Effigy Mounds National Monument (Iowa) for Exposure to *Pseudogymnoascus destructans*
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We were asked to assess bats at Effigy Mounds National Monument (EFMO) for exposure to *Pseudogymnoascus destructans* (*Pd*), the fungus that causes white-nose syndrome (WNS). We sampled bats at eight locations within EFMO by using mist nets. All captured bats were weighed, measured, and examined. In addition, DNA samples were taken from the oral cavity and facial region using Isohelix® DNA swabs; these samples were used to test for the presence of *Pd*. In total, five bat species were captured in mist nets between mid-July and late September 2014 with *Myotis septentrionalis* (Northern long-eared bat) and *M. lucifugus* (little brown bat) being the most common. *Eptesicus fuscus* (big brown bat), *Lasionycteris noctivagans* (silver-haired bat), and *Lasiurus borealis* (eastern red bat) all were represented by single captures; all three are species that have historically yielded positive detections of the WNS fungus at different locations. All captured bats appeared healthy after physical examination and wing scores provided no evidence for prior exposure to the WNS fungus. A BLAST analysis after DNA sequencing confirmed positive exposure from samples obtained from the lone *Lasionycteris noctivagans* captured during this study. The detection of *Pd* from a bat at EFMO reinforces the need for further assessment at this eastern Iowa location.

Applications of Fatty Acid Signatures in Tree Bat Migration Ecology
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Bat migration ecology is an important yet understudied facet of natural history and conservation. We know little about the movement patterns of migrating bats and the physiological demands associated with migration. The absence of effective, high-resolution methods to study migrating bats has made conservation efforts challenging. We used a non-lethal adipose biopsy method, fine needle adipocyte aspiration, to investigate the potential use of fatty acid signatures as an intrinsic geo marker to answer questions about migration ecology. Specifically, we used fatty acid signatures to investigate questions about the origins of migrating individuals, the number of unique sub-populations being supported by a migration route (uniqueness), and the physiological factors, such as nutritional needs, that shape migration patterns through space and time. We gathered lipid samples from silver-haired bats (*Lasionycteris noctivagans*) in the summer of 2014 at a resident site and in the fall of 2014 at a migratory site. The adipose tissue was primarily characterized by 16 and 18 carbon saturated and mono-unsaturated fatty acids. We observed differences in the proportion of individual fatty acids and used non-metric multidimensional scaling to identify an overall separation of fatty acid signatures between the migrants and residents. Our results suggest that the observed difference between the groups is driven by geographic segregation of summer resident groups or by rapid temporal shifts in diet during the migratory period. This study provides preliminary results suggesting that fatty acid signatures are useful data in the investigation of tree bat migration ecology.

White-nose Syndrome in 2015
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Since 2007 the infectious disease white-nose syndrome (WNS) has decimated hibernating bat populations in eastern North America. The causative fungus *Pseudogymnoascus destructans* is now present in 29 states and 5 provinces in North America, where 7 bat species have been confirmed with the disease and 5 others identified bearing *P. destructans*. The fungus infects torpid bats resulting in physiological and behavioral impacts, often leading to mortality. Population declines exceeding 90% have been documented in affected hibernacula and corroborated by summer population estimates from counts at maternity colonies and by acoustic and trapping indices. Sister national plans in the U.S. and Canada provide the framework for a comprehensive North American response, and establish topic-focused working groups to address research and management needs for WNS. The U.S. Fish and Wildlife Service is the lead federal agency coordinating the response in the U.S., and since 2008 the agency has provided $24 million to researchers, conservation organizations, and state and federal agencies to address WNS. Scientists are contributing to our understanding of this disease from all angles, including the life history and ecology of this newly described fungus, the dynamics of fungal infection and transmission, and bat hibernation physiology and immunology in their search for a way to control *P. destructans* and conserve our native bats. These efforts have also led to advances in our understanding of hibernation physiology, bat population dynamics, disease ecology, and general bat behavior.

How Moths Escape Bats: Mathematical Models Explain Predator-Prey Interactions

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What determines whether prey escape from a pursuit predator? Mathematical models have been developed to explain the conditions that should allow escape, but these models have rarely been tested with empirical kinematic and flight trajectory data from actual predator-prey attacks. We attempted to bridge this gap of knowledge by recording multi-camera infrared videography of bat-insect interactions in a large outdoor enclosure. We recorded 235 attacks by four *Myotis volans* on a variety of moths and 50 high-quality attacks were reconstructed in 3-D. Despite bats having higher maximum velocity, deceleration, and overall turning ability, prey escaped 115 of 184 attacks (62.5%). Existing escape models failed to accurately reflect prey behavior or predict the outcomes of attacks. Prey Radial acceleration and escape angle correctly classified the outcomes of 44 of 50 attacks (88%). In contrast to all other prey that have been studied, moths escaped by turning toward the threat in a majority (71%) of trials. Based on these findings we developed a novel geometrical model of predation that incorporates predator reaction time, relative prey velocity and turning radius, and escape angle. Based on this model we make predictions about optimal pursuit and escape behavior in the context of the co-evolution of predator and prey communities.

Species Limits and Cryptic Diversity of the Widespread Genus *Miniopterus* (Chiroptera: Miniopteridae) in Kenya

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Miniopterus is a diverse bat genus distributed in the tropics and subtropics of Africa, Asia and Australia. Many species of *Miniopterus* are morphologically similar and thus difficult to recognize, and this is true of those inhabiting tropical Africa. Several previous studies have shown that some widely distributed "species" are actually species complexes. We studied different populations of *Miniopterus* in Kenya, using mitochondrial DNA (cytB), external measurements, and echolocation calls to establish species variation and range limits. We have identified 7 mitochondrial lineages in Kenya so far. We also found that both *Miniopterus africanus* and *Miniopterus natalensis* show morphological and molecular divergence between populations. In view of names previously proposed for African *Miniopterus*, at least two new names may be needed to identify the species of *Miniopterus* in Kenya. Further molecular and morphometric analyses are necessary to better understand the phylogenetic relationships inside this genus.

Are Prescribed Fire and Overstory Thinning Treatments Beneficial to Bats in Southeastern Upland Hardwood Forest?

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We examined bat response to prescribed fire and overstory thinning in Southeastern upland hardwood forest. We used acoustic recording of bat echolocation calls to assess bat activity in hardwood forest stands subject to 4 prescribed fire and overstory thinning treatments (spring and fall prescribed fire with high [SpH and FaH] or low overstory thinning [SpL and FaL]), as well as untreated controls. We classified recorded echolocation call sequences to species using automated identification software. To minimize errors in species classification of recorded calls, we combined similar species in groups based on call characteristics. We found total bat activity ($P \leq 0.001$), as well as activity of LANY (eastern red bat [*Lasiurus borealis*] and evening bat [*Nycticeius humeralis*]; $P = 0.001$), EPLA (big brown bat [*Eptesicus fuscus*] and silver-haired bat [*Lasionycteris noctivagans*]; $P \leq 0.001$), PESU (tricolored bat [*Perimyotis subflavus*]; $P = 0.001$), and LACI (hoary bat [*Lasiurus cinereus*]; $P = 0.005$) was greater in SpH and FaH stands. Activity of these bat species was influenced by live overstory basal area and was lower in Control, SpL and FaL stands where basal area was higher ($P \leq 0.001$). Our results suggest these basal area reductions reduce structural clutter leading to improved foraging and commuting conditions for bats, particularly larger bodied species with low call frequencies that are adapted to more successfully fly and forage in open conditions. In areas where conservation of these bat species is a priority, prescribed fire and overstory thinning provide useful tools for their management.

Wind, Precipitation and Feeding during Hawaiian Hoary Bat Acoustic Detections on Oahu; July 2013 - August 2015

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Distribution and activity of the Hawaiian hoary bat are not well known on Oahu, Hawaii. Recovery on Oahu has not been part of the federal Recovery Plan. We recorded vocalizations for two years using 72 Wildlife Acoustics SM2BAT+ detectors on the north shore of Oahu in a 12 km^2 area at between 100 to 300m altitudes. Nightly presence at each detector during the peak summer month varied from 0 to 81% and during the winter low months varied from 0 to 6%. The mean nightly presence near gulches, open fields and forests edges, and at 100m were 13% (range 6 to 26%), 10% (range 4 to 36%) and 3% (0 to 10%), respectively. Only 4.5 % of detections during all 10 minute intervals occurred during measurable precipitation. Mean wind speed measured at 100m during all 10 min periods with detections at gulch, ground and 100m height was 4.9, 4.5 and 2.9 m/s, respectively. Fifty percent of all detections at ground level and 90% of all detections at 100m height occurred during winds of less than 5 m/s measured at 100m. Mean wind direction for gulch, ground and 100m was from 88, 87 and 105 degrees, respectively. Feeding buzzes were recorded during 8 and 1% of all 10 minute periods at ground and 100m detectors, respectively. Hawaiian hoary bat activity varies widely and feeding occurs at ground level and at 100m and throughout the year with highest rates at ground level, especially in or near gulches and during summer and fall.

White-nose Syndrome Does Not Alter the Visible Behaviors of Hibernating *Myotis lucifugus* in Obvious Ways

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Bats with white-nose syndrome (WNS) arouse from hibernation more than usual during later stages of the disease. One hypothesis for increased arousals in WNS bats is that they groom more often. To test this hypothesis, a colony of hibernating *Myotis lucifugus* was non-invasively monitored in a cave over the course of six winters, both before and after the arrival of WNS. Bats were recorded at hourly intervals using near-infrared surveillance video cameras. Visually obvious behaviors, such as grooming, were characterized and tallied. The video cameras sampled more than 32,000 camera hours of bat hibernation in the cave, which is still used by *M. lucifugus* two winters after clear signs of WNS appeared. Bats moved less than 10% of the time they were observed and most events involved just one or two individuals moving within clusters of many. Bats were seen grooming in about half of the samples with obvious movement. If the frequency of grooming increased after the arrival of WNS, the effect was subtle. Dramatic changes in bat behaviors with the arrival of WNS, including grooming, crawling on conspecifics, flying, and mating, were not obvious. These results suggest that it may be "business as usual" during winter for *M. lucifugus* with WNS, that increased WNS arousals are not associated with obvious movement, and/or that increased arousals occur outside of regular hibernation areas. Answering such remaining questions may help determine whether this species has the capacity to behaviorally adapt to WNS.

Cold-hearted Bats: Cardiac Function and Metabolism during Torpor in Two Species of Australian Bats

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Torpor is crucial for the survival of many bats. However, among bats, the patterns of torpor vary between daily heterothermy and multiday hibernation. To date, studies investigating the difference between these patterns have focused on thermal energetics with little information regarding likely differences in cardiac function between the groups. We therefore aimed to quantify the cardiac physiology of two bat species that express either strict daily heterothermy (18g *Syconycteris australis; Sa*) or hibernation (10g *Nyctophilus gouldi; Ng*). We compared heart rate (HR), oxygen consumption ($\dot{V}O_2$), and subcutaneous temperature (T_{sub}) at rest and throughout all phases of torpor over a range of ambient temperatures (T_a). Resting HRs were similar for both species at T_a ~15°C (*Sa*; 482 ± 42bpm, n=3, T_{sub}=33.8 ± 0.9°C and *Ng*; 431 ± 88bpm, n=7, T_{sub}=34.4 ± 1.5°C). Yet, during torpor, HR only reached a minimum of 74bpm in *S. australis* (T_{sub} =16.3°C) whereas that of *N. gouldi* fell as low as 14bpm (T_{sub} =15.6°C). Entry into torpor differed substantially between the two species as HR, $\dot{V}O_2$ and T_{sub} all fell at a slower rate in the daily heterotherm than the hibernator. Interestingly, time taken to rewarm from torpor did not differ between the species (ANCOVA, p=0.508). Our study provides the first quantitative data of HR as a function of temperature for a 'fruit bat' during torpor and demonstrates a clear difference between HR, $\dot{V}O_2$ and T_{sub} during daily heterothermy and hibernation in bats.

Something to Sniff at: The Hidden Anatomy of Emballonurid Noses

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Emballonuridae is a pantropical family including 13 genera and >50 species of insectivorous bats. Emballonurids are characterized by possession of many glandular structures (including complex wing sacs) that are important in social behavior and that suggest odor detection is particularly important to these bats. However, little is known about nasal structures or sinuses in emballonurids because they are small and hidden within skulls. Sinus structure in particular has never before been studied in detail in bats. Variation in external rostral shape suggests considerable variation in underlying sinus morphology across emballonurid taxa. We used high-resolution microCT scans to quantify sinus and nasal fossa anatomy for 23 emballonurid species representing 12 genera to test how sinuses affect nasal morphology. We identified three different sinuses within the maxilla (up to two in any given species). A sphenoid sinus occurs in all New World emballonurids sampled and presence of this structure appears to be a synapomorphy of that clade. Two taxa, *Saccolaimus* and *Taphozous*, have an olfactory recess, which is an isolated pocket in the posterior nasal chamber that is associated with increased olfactory ability. Sphenoid sinuses of New World emballonurids block airflow to the olfactory recess, suggesting that sinuses can modify nasal fossa shape, potentially affecting airflow patterns and odorant deposition. Nasal fossa volume and turbinal surface area were strongly correlated with basicranial width, however sinus volume was not correlated with basicranial width, nasal fossa size, or turbinal surface area, suggesting no tradeoff between sinus size and nasal morphology.

A Method for Quantifying Summer Populations of the Eastern Small-footed Bat

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The introduction of white-nose syndrome (WNS) into eastern North America has required wildlife managers to assess the status of multiple bat species. This has most often been attempted using counts at hibernacula, but the method is not equally effective across species. Development of alternative monitoring techniques may be particularly warranted for eastern small-footed bats (*Myotis leibii*) because their hibernating habits are different than other species of bats in eastern North America. We piloted a non-invasive and randomized method to quantify populations of small-footed bats at their summering grounds in the Blue Ridge Mountains of Virginia. Bat populations present on talus slopes were surveyed visually during summer 2013 to 2015, using 3 different sized quadrats. Surveying with 314-m^2 quadrats was more effective at documenting bats relative to search effort than doing so with smaller quadrats. Results also suggest that conducting surveys before bats aggregate into maternity colonies can improve statistical confidence. Radio-telemetry work suggested detection probability was <1, but this likely can be used to adjust population estimates. This new survey method holds important promise for monitoring status of small-footed bats, and perhaps other bats that roost on talus slopes. It also may reveal information that would otherwise be unattainable using traditional methods like mist-netting, acoustics, or counts at hibernacula.

The Importance of Method: Lots of Phylogenetic Signal, Lots of Problems

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Species-level phylogenies of bats rely on the vast database of mitochondrial protein-coding genes. These data often provide well-resolved relationships within genera, and even between families, but tend to infer nodes that conflict with nuclear markers. We analyzed the chiropteran cytochrome *b* database with three objectives: 1) to uncover features that potentially mislead analyses, 2) to discover statistical differences in the performance of various methods to infer phylogenies, and 3) to determine clade characteristics that mislead inference. Transitions at the third codon position were saturated, with transversions somewhat less so. Base composition heterogeneity concentrated at the third position and between families, although some significant differences were found within genera and at first positions. We compared 7 methods to initial analyses that applied a single model to the entire alignment. Model performance was analyzed using Bayesian hierarchical logistic regressions, with correct inference of family or genus clades as the response variable. Partitioning and recoding third positions substantially improved inference at the family level. Only the aminoacid model was substantially worse at inferring genera, with all other methods performing equally well. The probability that a genus was inferred decreased with increasing disparity in base composition within the genus. Our analyses reveal that chiropteran phylogenies based on the cytochrome *b* data can be misleading. These results also suggest that relatively simple and computationally affordable strategies, such as recoding third positions in partitioned analyses, can go a long way toward improving phylogenetic inference.

The Search for Visual Adaptations in Noctilionoid Bats: a First using Comparative Transcriptomics

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In the Neotropics the bat superfamily Noctilionoidea comprises ~200 species, and represents an extreme example of mammalian adaptive radiation. During their rapid diversification, noctilionoids have evolved divergent sensory systems associated with contrasting feeding ecologies. Some members hunt using echolocation, including high-duty cycle echolocation, while others are passive listeners, and some appear to be visual specialists, exhibiting well-developed eyes. To test for genetic evidence of varying reliance on vision across the clade, we quantified differential gene expression in the eyes of 11 species. Eye and heart tissue samples, with the latter acting as a control, were collected and flash frozen in the field. Total RNA was extracted and used to construct cDNA libraries for sequencing on a NextSeq platform. Clean reads were assembled into transcriptomes representing the expressed mRNA in each tissue type, against which reads were mapped to estimate the relative abundance of each expressed gene. Here we report on our preliminary results, and discuss the extent to which we detect evidence of tissue-specific expression profiles among divergent sensory specialists.

A Molecular Diet Analysis of *Parastrellus hesperus*

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The documented diet of *Parastrellus hesperus* is largely based on a single conventional identification effort that identifies eight orders and twenty-three families of prey items including caddis flies, stoneflies, moths, small beetles and flies. Using recent molecular methods to screen fecal pellets, there is the potential to expand our knowledge of the diet of this species. Therefore, the objective of this study was to determine the diet of *P. hesperus* using molecular analysis methods. We captured bats from May 2015 through July 2015 over nine nights in Big Bend National Park for a total 68 net hours. Guano pellets from 149 parastrelles (49 reproductive adult females, one non-reproductive adult female, 47 non-reproductive adult males, 33 juvenile females, and 19 juvenile males) were collected. Fecal samples from nine individuals were selected for initial analysis and DNA was extracted using the QIAamp DNA Stool Mini Kit. A fragment of the cytochrome c oxidase gene (COI) was sequenced using an Illmina MiSeq platform from the DNA extracted from the fecal pellets of each individual. Preliminary results identified 70 unique COI sequences of prey species from two classes, eight orders, and twenty families of arthropods. Among

these sequences, three orders, and fourteen families are newly identified prey species. Additional samples will be processed to evaluate potential shifts in consumption of prey across reproductive condition and age class.

Foraging Ecology of Indiana and Northern Long-eared Bats in a Managed Forest Ecosystem
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Since 2006, bat research has been conducted on the Hardwood Ecosystem Experiment in central Indiana, a 100-year project in its infancy. Active timber management and control units provide a unique opportunity to study bat responses. Our objective was to track foraging habits of Indiana (*Myotis sodalis*; MYSO) and northern long-eared (*M. septentrionalis*; MYSE) bats in 9 timber-managed units across a 19,000 ha state forest. Managed units received patch cuts/single-tree selection or clearcutting, shelterwood harvest, and fire. In 2014–2015, we tracked 28 ♀ MYSE, 6 ♀ MYSO, and 2 ♂ MYSO for 1–5 nights and collected 66 ± 25 (mean ± SD; n=36 bats) radio telemetry locations/bat. Using 95% kernel density estimates, MYSE foraging ranges averaged 166 ha, whereas MYSO ranges were 391 ha. We crossed forest management/habitat type with features (ridge, ravine, or mid-slope), and overlaid foraging areas to perform a probabilistic weighted compositional analysis and rank order of resource use. Fourteen bats used uneven-aged forest patches, 3 used even-aged patches, 8 used control units, and all were captured at small forest ponds. MYSO traveled up to 5 km from roost sites to foraging areas, while MYSE roosted on forested ridgetops and foraged along adjacent slopes. Most MYSO and MYSE foraged in recently harvested or regenerating areas in treatment/control units and surrounding forest. Use of cut areas suggests timber harvest has a neutral or positive effect on bat foraging space. Strategies to promote forest heterogeneity at multiple spatial scales may promote foraging habitat for both *Myotis* species.

Microbiomes of Neotropical Bats
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A 'microbiome' is the collective genome of the community of microbes inhabiting an organism. The gut microbiome is of particular interest because it is linked to diet and helps drive physiological processes. Given the diversity of food in the Neotropics, and the scarcity of data collected non-destructively from wild populations, we aimed to employ non-invasive techniques to quantify differences in microbiota based on taxonomy and dietary specialty of wild-caught Neotropical bats. We mist-netted tropical forests in Lamanai, Belize and sampled 8 species across 3 families representing insectivory, frugivory, nectarivary and omnivory. Using sterile techniques, we collected feces directly as bats defecated while in the net, or from cloth bags into which we placed individuals for up to two hours. Fecal samples are preferred because they are correlative of the gut microbiome and collection minimizes stress to the animal. Samples were stored at -20°C until we extracted DNA and PCR-amplified the 16S rRNA gene V4 variable region with 515/806 barcoded primers. Multiple samples were pooled together in equal proportions based on molecular weights and DNA concentrations, and then purified using calibrated Ampure XP beads. Products were used to prepare a DNA library following the Illumina TruSeq protocol. We will use Quantitative Insights Into Microbial Ecology (QIIME) software to analyze sequence data and map differences in microbial communities. Ultimately, our data may reveal unique partnerships between key microbes and bat hosts, and help explain how this partnership influences metabolic energy balance, evolution and occupation of niches, and potential fitness-related traits of bats.

Are Hibernating Bats Just Big Babies? Ventilatory and Metabolic Responses of Bats to Low Environmental Oxygen
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There are striking parallels in physiological traits between all newborn mammals and adults of species capable of hibernation. Tolerance to low environmental oxygen (i.e., hypoxia) is one of these. As hypoxia tolerance is not present in adults of most non-hibernating species, we hypothesized that differences in hypoxia tolerance in adult hibernators and non-hibernators reflect developmental changes in the way oxygen demand and supply are matched. To test this hypothesis, we exposed newborn and adult hibernators (*Eptesicus fuscus*), adult daily heterotherms

(*Eptesicus furinalis*), and adult non-hibernators (*Sturnira lilium*) to progressive reductions in inspired levels of oxygen (21, 12, 9, and 7% O_2) and measured their metabolic, thermoregulatory, and ventilatory responses. Severe hypoxia (7% O_2) led to a profound depression in oxygen demand in newborn (57 ± 6%) and adult (43 ± 12%) hibernators, and adult daily heterotherms (40 ± 14%), independent of decreases in body temperature (<2 ºC). Unlike hibernators and daily heterotherms, adult non-hibernators did not reduce oxygen demand or body temperature in hypoxia; instead they increased oxygen supply through a significant increase in ventilation (105 ± 21%,). While non-hibernating bats match oxygen supply to demand in hypoxia by a brisk ventilatory response, newborn and adult hibernators, and adult daily heterotherms do so by suppressing metabolism. Our results suggest that bats employ divergent strategies to tolerate hypoxia, and that hibernating bats may in fact just be big babies.

Movements and Demography of a US Endangered Bat at the Edge of Its Range

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Long-term studies on population demography and seasonal movements on migratory bats are lacking and represent a critical data gap in understanding the potential impacts of climate change on vulnerable ecological systems. We've initiated a long-term study on demography and seasonal movements of a nectar-feeding bat (*Leptonycteris yerbabuenae*) on the Baja California peninsula, Mexico. Using flexible cord antennae pit-tag readers at roost entrances, we established two long-term monitoring sites, one in a natural cave on an island near Loreto, BCS and a second located 250 km further south in a mine in the East Cape. We tagged 384 females over 3 years at the island site, and 68 females and 145 males since winter 2015 in the East Cape mine. We tagged an additional 200 bats in surrounding areas to assess movements. Our preliminary results suggest the island roost is used solely as a seasonal maternity colony and bat presence roughly coincides with flowering and fruiting of the cardón cactus (*Pachycereus pringlei*). In contrast, a small over-wintering population of both males and females was present at the southern mine and we observed pregnant females in January, providing the first evidence of a winter breeding deme on the Baja peninsula. We detected movements of male bats between winter roosts > 60 km apart. Our study confirms the presence of a small residential winter breeding population of *L. yerbabuenae* in southern Baja and provides future opportunities to assess long-term population dynamics of a US endangered species at the edge of their range.

Health and Immunity Differ by Sex and Reproductive Class in the Little Epauletted Fruit Bat

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The origins of many emerging zoonotic diseases in humans have been traced to bats. Understanding how bat health and immunity vary by factors such as sex, age, reproductive class, and season is important for understanding variations in spillover risk and for mitigating such risk through conservation. This study assessed the overall health of free ranging Little Epauletted Fruit Bats (*Epomophorus labiatus*) by measuring the immunological response to challenge and analysis of blood chemistry parameters. Twenty-four bats were trapped in South Sudan and their inflammatory response to injection with a foreign antigen was measured. Phytohemagglutinin (PHA) was injected in one footpad and Phosphate Buffered Saline (PBS) in contralateral footpad as control. Swelling responses were measured using digital vernier calipers after 12 hours. Blood samples were collected and analyzed for electrolyte/acid-base parameters using a VetScan iSTAT machine. Hemoparasites and neutrophil to lymphocyte ratios from white blood cell counts were determined from microscopy of blood smears. All bats mounted significant responses to PHA injection but the magnitude of this response was greater in females than males with no difference between pregnant and non-pregnant females. Pregnant females were significantly more likely to be infected by hemoparasites than non-pregnant females and males. Blood chemistry analysis revealed many conditions of imbalance ranging from electrolyte depletion, dehydration, starvation, azotemia (renal failure), stress to metabolic acidosis and alkalosis. These results show that free ranging bats face many challenges from the environment, which in turn might predispose them to pathogenic infections during certain life cycle stages like pregnancy.

Towards a Free Tool for Standardized Acoustic Identification of Bats across North America
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Acoustic monitoring is a widely applied approach to study the ecology and behavior of insectivorous bats based on their vocalizations. Ultrasonic detectors are used to record and store bat echolocation calls. Available hardware and digital storage now facilitate unprecedented collection of full spectrum recordings. These recordings are further processed to extract and classify bat calls based on acoustic call features and available classification procedures. Accurately extract and classify bat calls remain a challenge, especially when comes the time to automate these processes in order to replace time-consuming visual inspections. Several commercial programs are able to perform these tasks on full spectrum recordings, but free and publicly available implementations remain difficult to find. There is a common interest in developing a free and open source implementation which allows researchers to learn from and adapt to their specific needs. We offer to jointly develop such a tool. We translated a previous open source implementation into R and adapted our own classification procedure. We built a Web Genuine User Interface in Shiny R to provide free access for researchers, agencies and citizens. Any one will be able to integrate its own bat call database and improve the performance of the current algorithm. In a common perspective, it is important standardize the acoustic identification of bat calls, so that the results from various studies can be compared. Furthermore, open and available implementation may encourage peer review, which leads to improvements in the extraction and classification procedures.

Impact of Urban Development and Forest Fragmentation on Bat Assemblages
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As part of a citizen science project, we gathered data on the populations of bats at three localities with varying levels of urban development. Monitoring sites were located in the municipalities of Bayamón, and a Manatí, along the lowlands of the northern karst of Puerto Rico; and on the highlands of the same northern karst system in Ciales. The Bayamón site is an "island" of forest completely surrounded by high density urban development within the metropolitan area of San Juan, whereas Ciales is mostly surrounded by wilderness and rural development. At each location we set 72 m of mist nets twice a month over a period of two years (224 hours in Bayamón, 208 in Ciales, and 192 in Manatí). Mist-netting was accompanied with acoustic monitoring using ANABAT. The most abundant species at each location were *Artibeus jamaicensis* in Ciales, *Erophylla bombifrons* in Manatí and *Monophyllus redmani* in Bayamón. Out of the 13 species of bats on the Island, Bayamón showed the highest percentage at 69%, followed by Ciales (61%) and Manatí (31%). A Shannon-Wienner Index was 1.44 for Ciales, 1.42 for Bayamón and 0.93 for Manatí. Bat abundance in Ciales (n =564 individuals) was highest followed by Bayamón (n = 310 individuals) and Manatí (n=41). The differences in abundance can be explained by the proximity of roosts in the karst and the value of forest patches for the conservation of bats in disturbed habitats.

The Transcriptome of White-nose Syndrome Reveals Host Responses to Fungal Infection
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White-nose syndrome (WNS) in North American bats is caused by an invasive cutaneous infection by the psychrophilic fungus *Pseudogymnoascus destructans* (*Pd*). We compared transcriptome-wide changes in gene expression using RNA-Seq on wing skin tissue from hibernating little brown myotis (*Myotis lucifugus*) with WNS to bats without *Pd* exposure. We found that WNS caused significant changes in gene expression in hibernating bats including pathways involved in inflammation, wound healing, and metabolism. Local acute inflammatory responses were initiated by fungal invasion. Gene expression was increased for inflammatory cytokines, including interleukins (IL) IL-1b, IL-6, IL-17C, IL-20, IL-23A, IL-24, and G-CSF and chemokines, such as Ccl2 and Ccl20. This pattern of gene expression changes demonstrates that WNS is accompanied by an innate anti-fungal host response similar to that caused by cutaneous *Candida albicans* infections. However, despite the apparent production of appropriate chemokines, immune cells such as neutrophils and T cells do not appear to be recruited. We observed upregulation of acute inflammatory genes, including prostaglandin G/H synthase 2 (cyclooxygenase-2), that generate eicosanoids and other nociception mediators. We also identified several classes of potential virulence factors that are expressed in *Pd* during WNS, including secreted proteases that may mediate tissue invasion. These results demonstrate that hibernation does not prevent a local inflammatory response to *Pd* infection but that recruitment of leukocytes to the site of infection does not occur. These observations support a dual role for inflammation during WNS; inflammatory responses provide protection but excessive inflammation may contribute to mortality.

Dilution Effect and the Relationship between Habitat Degradation and Bat Fly Infestation in a Neotropical Savanna

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Recent studies show that habitat characteristics can significantly influence parasite-host relations. However, few studies have evaluated the relationship between habitat type and ectoparasites communities in Neotropical bats. The main cause for the relationship between habitat degradation and parasitism rates is the 'dilution effect', wherein there is a change in richness and abundance of hosts, which will have indirect effects on ectoparasites. In Brazilian Cerrado, there is a high degree of substitution of natural environments by other anthropogenic for agriculture, grazing and urbanization. Therefore, this study analyzes whether there is a relationship between the type of habitats, altered of not, and the parasitic rates in three areas of Distrito Federal, Brazil. Analyzes were performed by chi-square test for the prevalence, and GLM for the intensity of infestation to six host-parasite associations. We found a relation between the type of habitat and the infestation rates in four of the six associations we studied, in which parasitic rates were lower in disturbed areas. This finding is probably due to the dilution effect, since the degraded areas have greater diversity and abundance of bats. Also, the difference in responses among the species suggests that the relation between habitat and ectoparasites is species-specific, and it is not possible to draw a general pattern between environmental degradation and the level of ectoparasitism.

The Summer Roosting Ecology of *Myotis ciliolabrum* in Southeastern Alberta, Canada

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I am studying the roosting ecology and behaviour of the western small-footed bats (*Myotis ciliolabrum*) in the prairies in southeastern Alberta. The field seasons took place in Dinosaur Provincial Park in summer 2014 and 2015. Using radiotelemetry, I successfully tracked males, non-pregnant females, and lactating females over a period of seven days. The bats primarily roosted in small erosional mudholes which are common in the sandstone coulees that dominate the park topography. All bats had low roost fidelity, switching roosts every 2 days on average, but exhibited high fidelity for specific coulee valleys. I measured internal roost environmental conditions to compare with the ambient conditions. This study provides the first baseline data regarding this species in this semi-arid region of Alberta. These data can be used to create effective ecological management strategies prior to the arrival of white-nose syndrome, a disease killing bats in eastern North America.

Bats at the Beach: Northern Long-eared Bats are Alive and Well in Northeastern Coastal Communities

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Declines of *Myotis septentrionalis* (northern long-eared bat) in the Northeast following the introduction of white-nose syndrome (WNS) have been well documented. Multiple sources of information, from both summer and winter surveys, suggest that this species is much more difficult to find now than prior to the arrival of WNS. However, recent mist net and acoustic surveys on Long Island, New York, have revealed remnant populations of *M. septentrionalis*. Acoustic surveys and mist-netting were conducted during the 2012, 2013, and 2014 summer maternity seasons. Acoustic surveys detected northern long-eared bats in a variety of habitats. Although comparable pre-WNS capture data from Long Island are sparse, catch per effort was similar to that experienced elsewhere in NY before arrival of WNS. Similar abundance of this species in other coastal habitats in the Northeast has also been reported. Anecdotal reports suggest that hibernation behavior may play a role in this population's survival**.**

Bats Are Special: Genomic Comparison of Viral Interaction Genes
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Bats have been linked to a number of important emerging zoonotic pathogens and seem to have a special ability to act as reservoirs of viruses that cause high mortality in humans but not in bats. This has led to broad speculation and empirical support for the idea that bats have "special" immune systems that allow them to tolerate pathogens that are highly lethal in other species. While candidate gene approaches have shown that some bat immune genes are under strong selection, whether bat immune genes are under stronger selection pressure than other genes across the group and whether bats are "special" compared to other species is still being clarified. Using nine publicly available bat genomes (*Eidolon helvum, Eptesicus fuscus, Megaderma lyra, Myotis brandtii, Myotis davidii, Myotis lucifugus, Pteronotus parnellii, Pteropus alecto* and *Rhinolophus ferrumequinum*), we look in an unbiased manner for evidence of an excess of positive selection in genes that interact with viruses by comparing them to genes not known to interact with viruses. Further, we compare the excess of adaptation in bat viral interaction genes with that of rodents, another important reservoir group for zoonotic viruses. We find strong evidence for an excess of adaptation in 700 genes for viral interacting proteins in bats compared with other genes, suggesting bats are indeed under strong selective pressure to adapt to viruses.

Resource Selection by Foraging Big Brown Bats in Agricultural Landscapes
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Bats provide invaluable economic and environmental services in agricultural landscapes by consuming insects that damage crops and are otherwise controlled through the use of chemical pesticides. Quantifying these services is a major research focus, yet little is known about the foraging behavior of bats in such landscapes. Further, few data are available for understanding the influence of pesticide-use on bat foraging, concomitantly negating our understanding of exposure risks for bats. The aim of this research is to determine what crops are selected for by bats and whether pesticide-use influences bat foraging behavior, with the hypothesis that bats are selecting for certain crop categories and avoiding areas with high pesticide-use. Foraging data were collected on big brown bats ($n = 10$) from June-August 2015 in Kern County, California using VHF transmitter signal bi-angulation. Home range estimates (MCP) and foraging locations were overlaid onto spatial cropping and pesticide-use data. Distance metrics for used and available habitat to each of ten land-use categories, including pesticide-input, were then implemented as variables in a general linear model to characterize resource selection for foraging *E. fuscus*. Mean estimated home range size was 87.6 ± 55.9 km^2. Bats showed variable selection for crop types with overall negative selection for high pesticide-input ($\beta = -0.62$, $p < 0.05$). Importantly, overall model fit improved with the inclusion of a pesticide-input term (mean ΔAIC = 6.29). These results provide a baseline to predict exposure risk for bats and are important for enrolling specific commodity growers in bat conservation efforts.

Climate and Impacts of White-nose Syndrome
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Mortality from white-nose syndrome (WNS) has caused severe population declines of several species of hibernating bats in North America, threatening global and regional extinctions. Previous research indicates that growth of the fungal pathogen *Pseudogymnoascus destructans* depends on temperature and that mortality from WNS in little brown bats is highest at hibernacula temperatures associated with peak fungal growth rates. We tested whether geographic variation in hibernacula microclimates can predict population impacts of WNS across the range of the disease for little brown bats, a species widely distributed across North America. Using an extensive dataset of microclimate temperatures at 69 bat hibernacula spanning eastern North America, we found that annual surface temperatures predict hibernacula temperatures. We then built a data-driven model to test the effect of annual temperature on observed annual declines from WNS for little brown bats. Although declines measured from year-to-year census counts have substantial uncertainty due to observational error in censuses and in assigning the year of *P. destructans* arrival, predicted declines based on the effect of temperature and years since *P. destructans* detection were correlated with observed declines during the initial years of WNS mortality. However, stabilization in remnant populations over time eliminated the influence of climate on disease mortality. Our results suggest climate may be

an important driver of initial mortality from WNS, but that evolution of host-pathogen interactions may trump climate in predicting long-term dynamics of disease.

Description of the Wrist and Metacarpals of *Noctilio leporinus* (Noctilionidae, Chiroptera)

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In the postcranial skeleton of bats, the zeudopodium and autopodium have the greatest anatomic modification, mainly in the region of the wrist and proximal tips of the metacarpals, but this was not, however, described in detail. The aims of this research were: 1) to describe the wrist and proximal epiphyses of the metacarpals of *Noctilio leporinus* (Noctilionidae), 2) to make comparisons with other species of similar body size but belonging to other families: *Chrotopterus auritus* (Phyllostomidae), *Lasiurus cinereus* (Vespertilionidae), and *Eumops perotis* (Molossidae), based on specimens deposited at the CML (Colección Mamíferos Lillo, Argentina). Direct observations were made with a binocular microscope Leica WILD M3Z and the photos were taken with a binocular microscope Leica MZ. Nomenclature follows Vaughan (1959, 1970) and Panyutina et al. (2015), with some modifications. *Noctilio leporinus* have a set of unique characters such as: radius-scaphocentralolunatum articulation laterally shifted, scaphocentralolunatum with an articular radius-scaphocentralolunatum fovea placed on the latero-distal region, scaphocentralolunatum tunnel developed, and articulation between McII and III. Similarities with *C. auritus* (e.g., distal epiphyses of radius with lateral styloids and medial pseudostyloids little developed, scaphocentralolunatum tunnel present), and significant differences with *L. cinereus* and *E. perotis* (e.g., radius-scaphocentralolunatum articulation centered, scaphocentralolunatum tunnel absent, articulation between Mc II and III without process and articular fossa) were observed. The results give new evidence for future eco-morphological, phylogenetic, and evolutionary studies.

Association of Non-prey Objects with Prey Presence in the Fringe-lipped Bat

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Foraging bats rely on prey cues for successful prey detection or localization. These cues are often sounds produced by the prey item itself, as in the case of predatory bats eavesdropping on the mating calls of insects and frogs. Alternately, bats can use the echoes returning from prey items for prey localization. There is a third class of cues associated with prey, however, that has received less attention to date. Here we ask whether bats associate certain environmental objects or structures with prey, and whether they use these environmental cues in prey search. We studied the fringe-lipped bat, *Trachops cirrhosus* (Phyllostomidae), which is known to use prey-produced sounds such as frog calls, to detect and localize prey. Male túngara frogs call from shallow water puddles to attract females. As water surfaces are strong echo-reflectors, and there is evidence that water recognition in bats is innate, we hypothesized that *T. cirrhosus* associate the echo cues of water puddles with the presence of potential prey. We presented *T. cirrhosus* with prey items centered in water puddles, positioned in various locations in a flight cage illuminated with infra-red light, and observed the bats' search behavior. We found that *T. cirrhosus* spontaneously attack prey located in water puddles using echolocation, without additional sound cues from the prey. Using water- versus earth-filled puddles, we examine bats' rate of learning to associate different environmental cues with prey presence. Our study underlies the role of an important but often overlooked prey-finding strategy in bats.

Bat-Eco Interactions Database

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With over 1300 species worldwide, bats are critical components to many ecosystems in the form of pollinators, seed dispersers, and natural pest control. Scientific studies of these bat interactions with their environment are increasing as we understand more the critical role that bats play in nature and human economies. This ever-expanding body of knowledge has presented the challenge of keeping track of data and published papers on these topics. Therefore, we created the Bat-Eco Interactions Database to catalog all published accounts of the interactions of bats with plants and night-flying insects and to facilitate scientific research. For each interaction we include the plant family, genus, and species, bat genus and species, type of interaction (pollination, visitation, consumption, dispersal, transport), details of the location (country, habitat type, elevation, GPS), and citation. Our database is open sourced, freely available and periodically updated at a web site entitled Bat-Eco Interactions Database (www.batplant.org). Such information can be used in various ways for a vast array of professionals, students, and avid amateurs as a resource for starting studies about bats, their diets, and the ecological and economic benefits that some of their interactions with plants and insects provide to humans. Our goal though is complex and time consuming to complete, but we are moving in the right direction to facilitate more scientific studies by addressing a current gap in data gathering. We are providing a unique platform for people from around the world to contribute and find data in a concise, relevant and effective way.

Regional Differences in the Expression of Torpor

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Mammalian torpor expression differs among species and variables of torpor often are correlated with the thermal conditions of the mammal's habitat. As some species have large geographic ranges that experience different thermal challenges, we examined whether and how individuals from the same or closely related species differ in their expression of torpor. We also examined whether variables of torpor measured for one population can be extrapolated to another by using regressions of temperature-dependent physiological variables. Patterns of torpor differed among populations for several species of marsupials and bats with generally deeper (lower minimum body temperature) and longer torpor bouts in colder habitats suggesting that ambient temperature has a strong influence on selection of variables of torpor. Especially pronounced differences were observed in species with large geographic ranges or species living along altitudinal gradients, but even small-scale sexual segregations can result in different torpor patterns. Surprisingly, and in contrast to the observations on torpor expression by populations from different habitats in general, predictions of torpor variables from cold habitats to warmer habitats, even for strongly temperature-dependent variables like torpor bout duration that profoundly affect energy expenditure, substantially underestimated values measured in the wild. This suggests that other specific requirements in addition to coping with different temperatures are reflected in the expression of torpor patterns of populations.

Cutaneous Microbes of Cave-hibernating Bats: Clues to Resistance to White-nose Syndrome?

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With white-nose syndrome (WNS) causing unprecedented declines in eastern North America, it is imperative that innovative conservation solutions are developed that are both effective at inhibiting the growth of the target fungus and also harmless against non-target organisms in natural cave ecosystems. Until recently, all species of cave-hibernating bats were thought to be similarly affected by the disease. However, some species seem to be showing resistance to growth of *Pseudogymnoascus destructans*, and we propose that naturally occurring microbial communities on the skin of some species of bats allow for this apparent resistance. We collected swab samples from three body regions (i.e., forearm, muzzle, and interscapular region) of three species that are highly affected by WNS (i.e., *Myotis lucifugus, M. septentrionalis*, and *Perimyotis subflavus*) and three species that appear to show some resistance to the disease (i.e., *Corynorhinus rafinesquii*, *M. grisescens*, and *Eptesicus fuscus*) during both winter and summer for 2014 and 2015. Swabs were analyzed using a DNA fingerprinting technique (ARISA) to determine differences in bacterial and fungal communities among these species. This presentation will describe comparisons of forearm samples for all target species. The results of this study could offer important leads for development of biocontrol agents to hinder the destructive capabilities of this fungus as it continues to spread through North America.

Potential Effects of Climate Change on the Endangered *Leptonycteris nivalis* Migratory Corridor

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Modeling potential effects of climate change on the distribution of species helps guide management decisions for the conservation of endangered species. In this study, we modeled the potential distribution of an endangered migratory bat (*Leptonycteris nivalis*) and the group of plants they pollinate (*Agave* spp) during their annual migration from central Mexico to southern United States. We used Maxent and GARP, to generate current

distributions of environmentally suitable areas. We evaluated the performance of those models and selected the best algorithm to generate distributions under future scenarios. Maxent model evaluation outperformed GARP for seven of the nine Agave species, and GARP outperformed Maxent for the bat model. Our models show that the suitable environments for all of the species would retreat to higher elevation areas, and the overlap between the *Agave* and the endangered pollinating bat will be reduced by at least 75%. Overall, our findings indicate potential negative effects of climate change on this pollination interaction. The reduction of suitable areas for *Agave* species will restrict the foraging resources available for the endangered bat, threatening the survival of its populations and the maintenance of their pollination service. The loss of key pollinators results in cascading effects at the ecosystem level. The extinction of the bat *L. nivalis* will likely have a negative effect on the sexual reproduction and genetic variability of *Agave* plants increasing their vulnerability to future environmental changes. We recommend implementing a long-term annual monitoring program to document phenological mismatches in the *Agave*-*L. nivalis* interaction.

Captivity and the Genetic Diversity of a Harem-breeding Bat (*Carollia perspicillata*)

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Bats are unique mammals that are often kept in captivity for zoo exhibits, conservation programs, or scientific research. Studies on captive breeding programs have found negative impacts of captivity on the genetic diversity of multiple fauna; however, no study has yet examined the evolutionary impacts of captivity on bats using DNA analyses. For a class project, we used nuclear microsatellites and mitochondrial DNA (mtDNA) to examine the genetic diversity of a captive population of Seba's short-tailed bats (*Carollia perspicillata*) at the University of Northern Colorado. Molecular markers were used to compare the level of heterozygosity between individuals that founded the colony from the Denver Zoo, with that of the bats reared in captivity at UNC. We hypothesized that heterozygosity would be greater in bats from the original colony, because population bottlenecks often increase homozygosity, which can lead to allelic fixation. Overall, the microsatellite loci we used revealed no evidence of inbreeding depression in the colony, and just one of the alleles analyzed in this study was significantly out of Hardy-Weinberg Equilibrium. In addition, our mtDNA analysis showed that the captive colony of *C. perspicillata* used in this study originated from at least two countries in South America. Although our analyses did not indicate that the genetic diversity of *C. perspicillata* is being affected negatively by captivity (i.e., no allelic fixation), further investigations should be conducted using a greater number of microsatellites before drawing any firm conclusions on the effects of captivity on populations of bats.

Ultraviolet Illumination as a Means of Reducing Bat Activity

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Widespread bat fatalities at wind turbines have the potential to inhibit use of an abundant source of energy. Fatalities can be reduced by curtailing turbine operation at the cost of energy production, but this tradeoff might be lessened if additional ways of minimizing fatalities were available. We present results of a test of the sensitivity of ultraviolet light (UV) vision in bats, and the application of dim UV illumination as a prospective method of reducing bat activity. We used a Y-maze to test whether bats could see dim reflected UV light and whether such vision functions under the lighting conditions experienced by night-flying bats. All seven insectivorous species tested, representing 5 genera and 3 families, showed a statistically significant 'escape-toward-the-light' behavior when placed in the Y-maze. In a second study, we illuminated trees with dim UV light in areas frequented by *Lasiurus cinereus semotus*, an endangered subspecies affected by wind turbines. We used a repeated-measures design to quantify bat activity with acoustic detectors and thermal video in the presence and absence of UV illumination, while concurrently monitoring insect biomass. Ultraviolet illumination led to a general reduction in bat activity despite increased insect presence. Illumination did not completely eliminate bat activity near trees, nor did all measures of activity show statistically significant differences due to high variance in activity among sites. However, observed decreases, despite the increased presence of potential prey, justify testing of dim UV illumination on wind turbines and shows promise for reducing bat fatalities.

Estradiol Transfer from Male to Female and Between Female Conspecifics in Big Brown Bats
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Previous studies have shown that male mice are capable of transmitting 17β-estradiol (E_2), the most potent estrogen, to the neural and peripheral tissues of cohabitating females. More recently, this phenomenon has been demonstrated in the big brown bat (*Eptesicus* fuscus) during the fall mating season. The present study aims to quantify E_2 transfer from male to female bats during non-mating periods in the spring and summer, and E_2 transfer between female conspecifics. To quantify male to female E_2 transfer, a single male bat was injected with a minute quantity of tritium-labeled estradiol (^{3}H-E_2) and housed with 2 females for 48 hrs. Neural, peripheral, and reproductive tissues collected from the bats were analyzed for radioactivity. Radioactivity was reliably measured in the uterus (and other tissues) in all females across all replicates. We used a similar protocol to determine if E_2 transfers from a single injected female to 2 female conspecifics during the fall. In this case, radioactivity was either not found in the tissues of female cohabitees, or was found in select tissues but at levels much lower than male to female E_2 transfer. In mammals, estrogens promote and induce female reproductive maturation, sexual behaviour, and fertility. These results will be discussed under the hypothesis that E_2 transfer has evolved to act as a pheromone in big brown bats, allowing males to influence and exert control over the sexual behaviour and reproductive state of cohabitating females.

Patterns of Neutral Genetic Variation in Bat Populations Affected by an Emerging Wildlife Disease
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Genetic diversity is an important contributor to the fitness of a species. Variation allows species to adapt to changing environments or emerging diseases. Neutrally evolving markers such as microsatellites allow an estimate of a species' effective population size (N_e), unbiased by selective forces. Microsatellites are useful in detecting relatively recent changes in N_e due to their abundance in the genome, polymorphic nature, and high mutation rate. By looking at current N_e and at changes in this parameter over time, past events such as population bottlenecks or episodes of significant population growth can be inferred. White-nose syndrome (WNS), first detected in North America in 2006, has caused severe population declines in several species of hibernating bats. The big brown bat (*Eptesicus fuscus*) has experienced a 41% decrease due to WNS, whereas the federally endangered Virginia big-eared bat (*Corynorhinus townsendii virginianus*) has undergone increases in population size. Due to the emergence of WNS, it is likely there has been some change in diversity and N_e for both species; however, because this is such a recent event, it may be too early to be detected in the genetics of the species. Using frequency-based diversity measures and coalescent-based Extended Bayesian Skyline Plot (EBSP) analyses to estimate N_e values, we will determine whether changes in population size due to WNS are detectable at microsatellite loci.

The Response of Bats to Introduced Trout in Naturally Fishless Lakes in the Sierra Nevada, California
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Stocking of trout into naturally fishless water bodies in the mountains of western North America has reduced populations of many native species in those systems, with benthic aquatic invertebrates being particularly impacted. Although bats are known consumers of emergent aquatic insects, almost no studies have focused on how changes to these prey populations at lakes subsequent to trout stocking could affect them. This study assessed bat activity, foraging activity, and foraging rate at nine feature-matched pairs of stocked and unstocked high-elevation lakes in California's Sierra Nevada mountains in an effort to determine which provide higher quality foraging habitat for bats. Bats in the 25 kHz and 50 kHz echolocation call categories showed little to no behavioral difference between lakes with trout and lakes without. In contrast, bats in the 40 kHz group had higher levels of activity and higher foraging rates at stocked lakes. Because past studies have found that the introduction of trout results in a reduction in large macroinvertebrates and an increase in small macroinvertebrates (e.g., midges), our results may indicate that bats at those lakes are consuming numerous small insects. If this is the case, it could represent a cost to those bats due to the lower energetic return of small prey items compared to the preferred prey species.

Statewide Assessment of Townsend's Big-eared Bat in California: a Collaborative Effort for a Candidate Species

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We seek to assess Townsend's big-eared bat (*Corynorhinus townsendii*; hereafter COTO) roost sites throughout California. A broad-scale evaluation of COTO has not occurred since Pierson and Rainey's work in the late 1980s, which indicated a declining population. The species is now a candidate for listing under the California Endangered Species Act. A current understanding of the status and nature of known and potential roosts will provide vital support for conservation and management of this bat, regardless of listing outcome. Our work involves (1) revisiting historic occurrences (mainly maternity roosts and hibernacula) to determine status; and (2) sampling potential habitat in randomly selected 10 x 10 km cells drawn from the Pacific Northwest Bat Grid system (also used by the North American Bat Monitoring Program, or NABat). Field work began in winter 2014-15 and will continue through winter 2016-17. At each site, we gather information on presence/absence, number of bats (when possible), site structure and dimensions, environmental conditions (e.g., temperature, humidity), disturbance, and distances to potential foraging areas and water. These data will inform a model seeking to explain COTO occupancy. Preliminary results suggest that many historic roost sites no longer host bats, yet that a substantial amount of "historic" data on COTO have never been reported to California Department of Fish and Wildlife by individuals, land managers and other agencies. These collaborative data may represent a relatively untapped resource for research applications for COTO and other species, and we have expanded our efforts to gather missing data.

Movement and Migratory Behavior of Tree Bats (*Lasiurus* and *Lasionycteris*) within the Western Basin of Lake Erie

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New technologies are allowing researchers to more accurately quantify migratory movement and stopover behavior for a variety of species, including bats. Better understanding of the spatial and temporal scale of migration can inform conservation decisions related to sensitivity of particular locations for migratory species, especially in the face of ongoing development and climate change. Improved quantification of movement corridors can lead to proactive strategies for conservation by prioritizing areas that facilitate movement. Using passive and active telemetry, we were able to identify movement patterns of long distance migrants from east to west along Lake Erie's western basin and determine stopover duration for *Lasiurus borealis* and *Lasiurus noctivagans* (5.6 and 1 days respectively) during spring migration. During stopover, bats were selecting areas disproportionately to the availability of those areas across the landscape. Bats were more likely to be found in forests, wetlands, and developed human spaces even though those habitat types constituted a small percentage of available landcover. Bats were more likely to move east to west along the shoreline of Lake Erie as opposed to flying long distances over open water. Departures of migratory bats were also influenced by weather patterns. Bats were more likely to depart on nights with higher barometric pressure, higher dew point, and a lower wind differential (difference between wind gust and sustained wind speed). This study adds to our knowledge of bat migration and should be useful for future decisions related to conservation and management of natural resources within the western basin of Lake Erie.

Species Distribution Models to Evaluate Risk of Invasion into the United States by Common Vampire Bats

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Common Vampire bats ("Vampire bats", *Desmodus rotundus*) occur throughout much of South America to northern México. These bats feed on the blood of mammals and transmit rabies virus to livestock, causing impacts to agricultural economies. Vampire bats have not been documented in the United States in recent history, but have recently been documented within 50 km of the U.S. state of Texas. We used species distribution modeling (SDM) to map the potential distribution of Vampire bats in North America under current and future climate change scenarios.

We used 7,094 Vampire bat records from North America including over 600 new records (77 unique locations) from the northeastern portion of their Méxican range. We analyzed and mapped the potential distribution of this species using 5 approaches to species distribution modeling: logistic regression, multivariate adaptive regression splines, boosted regression trees, random forest, and maximum entropy. We then extrapolated these models into future climate scenarios for year 2070 to generate hypotheses about future distribution in North America. Some of our SDM models support the hypothesis that suitable habitat for Vampire bats may currently exist in parts of the México–US borderlands, including extreme southern portions of Texas, as well as in southern Florida and Cuba. However, this analysis also suggests that extensive expansion into the south-eastern and south-western U.S over the coming ~60 years is unlikely. Our results demonstrate how species distribution models and maps can help generate well-justified hypotheses about distributional changes within the context of wildlife disease ecology and climate change.

Disparity in the Cross Sectional Geometry of Limb Bones in Birds and Bats
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Flight evolved independently in bats and birds, but in spite of this convergence on the same locomotion mode birds occupy a wider range of niches. Bird forelimb morphology is associated with a vast array of flight modes (e.g., soaring, diving, highly-maneuverable flight, flightlessness), and variation among birds' hindlimbs reflects specializations for other locomotor functions (e.g., perching, grasping prey, swimming). In contrast with birds, almost all bats are limited to flapping flight and use their hindlimbs primarily to hang in their roosts. Given the differences between how birds and bats use their hindlimbs, we tested the hypothesis that bat humeri are stronger relative to their femora than birds' and that birds have greater disparity in cross-sectional parameters. We assessed relative strength of the femur by calculating humeral/femoral ratios from measurements derived from the cross-sectional geometry of the bones: relative cortical bone area (RCA), polar section modulus (Z_{pol}), second moment of area (I_{max}/I_{min}). Using phylogenetic comparative methods, we found that the birds (18 orders) and bats (7 families) sampled do not differ in any of their cross-sectional geometry metrics. Larger samples that include mammalian quadrupeds may shed light on whether and how this similarity relates to the evolution of flight. As expected, birds and bats do differ in the coefficient of variation for the humerus/femur RCA ratio (2.9 times higher in birds), and the humerus/femur Z_{pol} ratio (18 times higher in birds). This is a clear validation of the wider range of humeral and femoral morphologies observed in birds relative to bats.

Fur Mercury Concentrations Differ in Two Chinese Bat Species
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Mercury is a toxic heavy metal emitted by industrial practices, primarily metal smelting and coal burning. We tested total mercury content in fur from bats along a gradient of urbanization in and near the growing city of Chengdu, capital of Sichuan Province, China, hypothesizing that bats nearer the urban center would accumulate greater mercury concentrations. We also tested the relationship between fur mercury burden and bat body condition. Japanese pipistrelles (*Pipistrellus abramus*) (n=14) and Chinese noctules (*Nyctalus plancyi*) (n=30) were captured using mist nets over water at four sites in July and August 2013. Fur was clipped from the mid-dorsal region, and mercury concentrations were quantified with a direct mercury analyzer. Adult pipistrelles had significantly greater concentrations than adult noctules (log-transformed, unpaired t-test, p<.001), and adult noctules had significantly greater concentrations than juvenile noctules (p<.001). Maximum concentrations were found in adult pipistrelles: 33 ppm at one agricultural site, 21 ppm at one central urban site, 16 ppm at one peri-urban site, and 9 ppm at a second peri-urban site. 64% of pipistrelles and 0% of noctules exceeded fur mercury values associated with reduced neurochemical homeostatic control. Body condition was strongly negatively correlated with fur Hg concentration overall (r = -0.61) and for adults only (r = -0.65), however, the association was stronger for adult noctules (r = -0.48) than for adult pipistrelles (r = -0.22). These results indicate that Japanese pipistrelles accumulate more mercury than Chinese noctules, yet may be more resistant to associated health effects.

Running Hot and Running Cheap: Metabolic Analysis of Running Gaits in the Common Vampire Bat
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The common vampire bat (*Desmodus rotundus*) has evolved a unique running gait in which its forelimbs, instead of hindlimbs, are recruited for force production. Furthermore, this is at a lower stride frequency than similar sized mammals. Interestingly, the energy requirements for running in *D. rotundus* remain unknown. To determine the energy requirements of this unique gait we ran 14 *D. rotundus* on a treadmill and measured their metabolic rate, body temperature, and respiratory frequency prior to, and following exercise. On average, bats ran for 7.76 ± 0.62 min, at a mean speed of 0.48 ± 0.03 m/s, covering a mean distance of 217 ± 18 m. Following exercise, *D. rotundus* consumed, on average, 76 ± 6 ml O_2 $(kg\ min)^{-1}$, a metabolic rate 1.5 times that immediately prior to exercise. Exercise was accompanied by a switch in energy source from protein/ mixed fuel to mainly carbohydrates. Additionally, exercise was accompanied by an increase in body temperature from 38.11 ± 0.43 ˚C to 41.74 ± 0.68 ˚C, a temperature close to their lethal temperature of 42-43 ˚C. Exercise was not, however, accompanied by an increase in respiratory frequency, suggesting that an increase in tidal volume must be responsible for increased oxygen supply to match their increased oxygen demand during exercise. Unlike most terrestrial mammals that increase resting metabolism 6-8 fold following exercise, *D. rotundus* only increases metabolism 1.5 fold. We conclude that *D. rotundus* has evolved a unique running gait requiring considerably less energy than that of most other running mammals.

***Social Behavior of Indiana Bats Selecting Among Artificial Roosts**
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* **Julia Hoeh** received the **Speleobooks Award**.

Indiana bat (*Myotis sodalis*) roost characteristics are well documented; however, the way a population selects a primary roost among similar potential options is largely unknown. Studying flight and acoustic behaviors at new artificial roosts may shed light on this process. We studied roost choice by measuring frequency and patterns of behaviors at different types of artificial roosts in three different locations within the summer range of an Indiana bat maternity colony in Indiana. In March 2015 we erected three roost clusters (>0.8 km apart) in known summer foraging areas; each cluster contained three different roost styles (rocketbox, birdhouse, and BrandenBark). We conducted emergence counts (mean 4–5 nights/week/cluster), and recorded video and full spectrum acoustics simultaneously one night/week/cluster from mid-May to mid-August. Of the nine structures, two rocketboxes became primary maternity roosts. Box043 was used heavily (3–210 bats) from 29 May–22 July, while Box053 housed 1–101 bats from 18 July–15 Aug. Preliminary video analysis reveals social behaviors (e.g., checking) occurring at all clusters through end June; flight activity was >60X higher at the cluster containing Box043 (338.6 ± 26.11 instances/night) than at other clusters (<5 instances/night). Bats favored rocketbox style roosts over birdhouse and BrandenBark roosts. These data show that a single population will shift from one primary roost to another over the course of the summer. We will present data for the entire summer, evaluating flight and acoustic behaviors as the population switched to a new primary roost (Box053) in a new cluster.

Echolocation Behavior of Flying Big Brown Bats is Not Affected by Noise Exposure
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Echolocation is a highly developed perceptual modality based on acute hearing of faint echoes reflected from objects the environment. Big brown bats (*Eptesicus fuscus*) are entirely dependent on their echolocation for guidance to fly, forage, and catch prey. Echolocation performance is likely to be highly sensitive to disruption if hearing sensitivity is impaired. It is generally known that exposure to intense noise (90 - 120 dB SPL) causes temporary or even permanent loss of hearing sensitivity in terrestrial mammals. Our experiments test the hypothesis that big brown bats are less susceptible to noise-induced hearing loss than non-echolocating terrestrial mammals. Four bats were exposed to ultrasonic noise spanning their audiometric range (20 - 100 kHz, 116 dB SPL for 1 hour).

Their echolocation performance while flying through an acoustically-complex maze was compared before and after exposure. For the same maze configuration, the bats did not alter either the number or the temporal pattern (strobe groups) of their sonar calls prior to noise exposure compared to 20 min, 24 hours or 48 hours after exposure. One of the four bats showed more errors (collisions) 20 min post-exposure than pre-exposure while the other bats showed no difference in performance. Thus, it appears that noise exposure has little or no influence on echolocation behavior.

Histological Characterization of *Pseudogymnoascus destructans* in *Perimyotis subflavus*
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Seven North American bat species have been reported to exhibit clinical signs of white-nose syndrome (WNS), a disease caused by the invasion and colonization of the muzzle and wing membranes by the fungus *Pseudogymnoascus destructans*. Based upon pre-WNS and post-WNS hibernacula counts, *Perimyotis subflavus* is one of the species most severely affected with an average population decline of 75%. The purpose of this study was to examine the progression of WNS in *P. subflavus* during a single hibernation season. Our hypothesis was that tricolored bats in a WNS positive hibernaculum would develop clinical WNS characterized by white fungal growth on the muzzle and forearms, emaciation, and dehydration and histopathological examination would reveal fungal "cupping lesions" that are considered diagnostic for WNS. Ten WNS PCR positive *P. subflavus* were collected in December 2014. Initially bats were banded and sex, weights, and forearm length were recorded. Bats were monitored and maintained within the cave where initially collected from December 2014 thru March 2015. Throughout our study bats did not develop the characteristic white fungal growth on the muzzle or forearms, however bats became emaciated and lost a mean of 29.7% body mass from December to January. Upon histological examination of the wing membranes, Periodic acid–Schiff stain revealed minimal fungal colonization and invasion of wing tissue. In conclusion, disease progression caused by *Pseudogymnoascus destructans* may be different in *P. subflavus* than what has been described in the literature for *Myotis lucifugus*.

Improving Bat Conservation Strategies for Canadian Wind Farms
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Many Canadian wind farms experience high bat mortality and several provincial regulatory agencies have developed mandatory mitigation requirements in an effort to reduce these mortality rates. Current mitigation requirements, particularly in Ontario, require prolonged periods of turbine curtailment that, in some cases, are economically detrimental and may not be representative of the best balance between conservation and power generation. Our goal was to analyze trends in existing bat mortality data from Alberta and Ontario in order to provide provincial regulatory agencies with alternative mitigation options that balance bat conservation and wind power generation economics. Using data provided by several wind energy companies, we analyzed post-construction monitoring data from 40 wind farms from 9 years. Specifically, we looked in-depth at temporal trends in mortality, influences of weather and habitat, and the efficacy of different mitigation techniques. Conclusions drawn from the analysis of this large dataset could be used to make informed decisions regarding bat conservation strategies at wind farms throughout Canada.

Turning Behavior and Maneuverability in European Horseshoe Bats
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Prey capture for aerially hawking bats in or near dense vegetation is a difficult task. On the other hand, such environments attract abundant insect prey. To explore this resource, bats need to overcome sensory difficulties like avoid call masking (forward or backward) and flight challenges by being able to fly slow, hover and turn aggressively. In Southeastern Europe all five European horseshoe bat species occur sympatrically - they forage within or close to different kinds of vegetation. Field studies indicate that the species differ in diet and hunting strategies to some extent, but they also show considerable overlap. How can several of these species share the same habitats and to what extent does niche partitioning occur? We set out to understand by testing maneuverability in three European Rhinolophid species (*Rhinolophus euryale, R. ferrumequinum & R. mehelyi*) during turning in an obstacle avoidance event under controlled laboratory conditions. Minimum turning radius has been used previously as a measure of flight maneuverability. Therefore we set out to test the maneuverability of the 3 species by measuring their minimal turning radius along with other flight parameters. We employed 3D, high-speed, motion-capture with synchronized sound-recording to study the evasive maneuvers of the bats. Three-dimensional reconstructions of the bat's flight trajectories indicate that there are no significant differences between the maneuverability of the three species as measured by their minimum turning radius. Other behavioral or ecological factors likely contribute to the realized niche partitioning presumed for these closely related and ecologically similar species.

Solitary vs. Social Foraging: a Comparison of Two Myotis Species Using GPS and Audio Biologgers

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Recent advancements in miniaturization of biologgers has allowed for gathering new insight into the free forging behavior of bats. In addition to recording high resolution GPS, our technology includes onboard ultrasonic microphones which monitor the biosonar of focal and conspecific bats during commuting and foraging. Our study aims to compare the foraging behavior of two bat species, *Myotis myotis* and *Myotis vivesi*. These species share similar morphologies, yet forage on drastically different prey, terrestrial insects and marine fish, respectively. Preliminary analysis on resource distribution suggests that insect prey is consistent between nights for *M. myotis*, however, for *M. vivesi* marine prey is unpredictable. In accordance, GPS analysis shows that foraging strategy dramatically differs between these two species, with *M. myotis* returning to the same foraging locations each night and *M. vivesi* covering huge areas in search for prey each night. Moreover, *M. vivesi* frequently commute and forage in the presence of conspecifics, whereas *M. myotis* never encounters conspecifics while foraging. Our research of a completely natural system provides evidence supporting the hypothesis that searching for ephemeral resources drives social foraging.

Towards a National Acoustic Bat Monitoring Protocol: First Implementation of the Mexican Bat Acoustic Monitoring System

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In Mexico, as well as in most tropical countries, standardized, large-scale, long-term monitoring programs for determining bat population trends are non-existent despite the current threats faced by many bat species (e.g., habitat destruction, wind farming, diseases). Existing monitoring programs are limited in time and space due to high costs and the amount of human resources needed. Using automatic ultrasound recorders, we designed a standardized acoustic bat monitoring protocol for Mexico (Sistema Mexicano de Monitoreo Acustico, SIMMA) with the aim to adapt it to Mexican different ecosystems. The first implementation of this protocol was conducted in four forest sites at the Lacandona tropical rainforest in Southeast Mexico. We recorded 30 consecutive nights, at least 4 hours per night, using an SM3 ultrasound bat recorder (Wildlife Acoustics®) per site. Here, we present the preliminary results on the performance of this protocol, with speceial emphasis on evaluating effects of habitat type (edge or gap vs. forest interior), recording schedule (number of hours per night), recording time (number of nights per season), moonlight and weather on the effectiveness of the protocol at representing species richness and bat activity levels. This information will help us to evaluate the effectiveness of our protocol, improve the next implementations and allow us to establish a standardized long-term system at national scale.

Maternal Care and Mother-Pup Recognition in the Lesser Long-nosed Bat

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Mother-pup recognition is a little researched subject yet an essential aspect of the natural history of any colonial bat. We studied mother-pup recognition in the lesser long-nosed bat, *Leptonycteris yerbabuenae* in two maternity colonies of Mexico. One is the winter-breeding population in the dry tropical forest of Guerrero and the other, the spring-breeding, is the flagship colony of the species, with up to several hundred thousand females which migrate to the Sonoran Desert to give birth. While foraging the females leave the pups at the cave in clusters of up to hundreds individuals. After returning from foraging, females collect their pup and fly with it to another site in the cave where they remain together until the next foraging trip. We have recorded 48 hours of pups' cluster dynamics using video streaming, obtaining unique material in order to describe for the first time this fundamental social interaction. In order to investigate what cues are used by females to recognize their offspring amidst pup clusters, we used an experimental set up to test whether the females can discriminate their own pup using solely odor cues. Although first results indicate a preference by mothers for own pup's odor, possibly due to methodological difficulties, thus was not significantly above chance. Further experiments are needed, including investigating if odor from specific region of pup's body is particularly effective in eliciting maternal recognition.

Identifying and Characterizing Roosts of *Lasiurus ega* and *Lasiurus intermedius

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*** Citlally Jimenez** received the **Basically Bats Wildlife Conservation Society Award**.

Roosting habits of several North American lasiurines (*Lasiurus seminolus*, *L. borealis*, and *L. cinereus*) have been well studied, but those of *L. ega* and *L. intermedius* are poorly known. Previous research has shown *L. ega* to roost in the dead fronds of native palms [*Sabal texana* (*mexicana*)], and non-native palms (e.g., *Washingtonia robusta*). Roosting habits of *L. intermedius* are similar to *L. ega* with the addition of Spanish moss (*Tillandsia* spp.) as a roosting substrate. Quantitative assessments of roosting substrates, however, are lacking. Our objective was to identify and quantitatively characterize the roost palms of *L. ega* and *L. intermedius* at Sabal Palm Sanctuary in Brownsville, Texas. Through radio-telemetry, we located 17 *Sabal texana* roost palms used by 6 yellow bats (4 *L.* ega and 2 *L. intermedius*) from May – August of 2015. No yellow bat was observed to roost in the same palm more than twice. Differences between roost palms and randomly selected palms (n = 17) were contrasted; results showed yellow bats tended to select sabal palms that had a higher and thicker skirt of dead fronds, and had a smaller trunk diameter than randomly selected sabal palms. Roost palms were consistently located within 25m from a netting site or a water source and canopy coverage surrounding roost palms predominately consisted of palm fronds (dead and alive) rather than non-palm vegetation. Our results will aid in managing existing and future palm stands to provide roosting habitat for these yellow bats.

Studying Bat Behaviors and Populations using High-frequency Radio-frequency Identification Technology

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Passively powered radio-frequency identification (RFID) tags, often referred to as passive integrated transponder (PIT) tags, have been used in bat research for over two decades. Despite this long history of use and the potential to follow individually marked animals throughout their lives, the number of studies employing the technology is relatively small. This is due to limitations specific to animals that form dense social groups, as is typical of many bat species, yet occupy poorly defined physical spaces. These limitations, namely tag collision and the use of a single antenna to both power and record passive RFID tags, can be alleviated through the use of higher frequency RFID technology, which has been underused in wildlife research. To demonstrate the potential of high-frequency RFID, we subcutaneously implanted high-frequency tags under the skin of little brown myotis (*Myotis lucifugus*) at a study site in Yellowstone National Park and deployed antennas tuned to the appropriate frequency inside a single building roost. We compare data collected by high-frequency RFID antennas placed at two locations: roost entrances (mimicking the common design of low-frequency studies) and locations adjacent to roosting bats

(taking advantage of tag anti-collision technologies). These data show that the type, quality, and quantity of behavioral data collected from roosting bats can be dramatically increased by using high frequencies devices, without a similar increase in equipment cost. We outline other potential uses for this technology to study bat behaviors, social structures, and population dynamics.

Local Middle School Students Presenting their Research at a NASBR Conference

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To help expose science to more racially diverse groups through bat research, we set up a specialized afterschool program for 7th graders attending a multicultural school within a short distance of the 2015 annual North American Society Bat Research (NASBR) conference in Monterey, California. We began by advertising an afterschool Bat Club and attracted 18 students. We gave presentations every 1 to 2 months during the school year including units on 1) bats and bat biology, 2) the scientific method that included outdoor exercises, 3) how to use Google Earth to record and locate data, 4) the use of bat detectors to confirm locations of bat activity (in the evening with parents), 5) mist-netting bats in a local city park (in the evening with parents), 6) using equipment to study bats and the development of hypotheses, 7) the selection of study sites, 8) the collection of data, 9) the processing and analysis of data, 10) writing the storyline, and 11) making the poster. Students initially bonded in a cohesive group and called themselves "Team Chiroptera." They designed their own "hoodies" and liked wearing them. Because of summer vacations and students transferring to other schools, the summer break created a hiatus in the program that led to some attrition. The fall group of 2015 comprised 10 members but they continued meeting once a week to complete their poster about the differences in bat activity for differently-sized patches of Monterey pine, a rare natural habitat type located in an urban setting.

Migration Timing and Body Composition of *Lasionycteris noctivagans*

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Recent research has begun to provide important insights into the origins and destinations of migratory bats, but fewer studies have examined how bats budget their time and energy en-route. The phenology of bat migration has been documented at several sites in North America and Europe using acoustic detectors, which assess population level passage timing. Less is known about variation in the timing of individuals. Differential selection on migration timing occurs when the consequences of early or late arrival are contingent on traits such as sex, life history stage, or body condition. Here we use three years of data to investigate sex differences in spring migration arrival date phenology and body composition. We predict that female bats will arrive earlier and with greater fat stores than males. Early arrival on the summering grounds with ample energy stores should give females, but not males, a fitness advantage. In hibernating species early-born pups are more likely to survive their first winter and reproduce as yearlings. *Lasionycteris noctivagans* were captured nightly between in April and May 2012-2014 at Long Point, Ontario, Canada. We assessed bats fat and lean mass of all bats using quantitative magnetic resonance. Females passed through the study site earlier and with greater fat stores than males in two of three study years. Mean female passage date advanced in warmer years, but male passage date was not related to ambient temperature. Our findings indicate that sex does affect the timing and energy management decisions of bats during spring migration.

Bats, Insects and New Street Light Technology

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Light pollution is increasingly recognized as a major feature of global change that has consequences for biodiversity and biological processes. Being nocturnal, bats are especially affected by changes in street lighting. Traditional light types such as white mercury vapour lamps and orange sodium lights are being replaced rapidly on a large scale by more energy-efficient and controllable broad-spectrum lighting such as metal halide and light-emitting diode technologies. The biological consequences of these major changes have been little studied. Switch-overs in lighting allow before-after-control-impact (BACI) experiments to determine how bat activity is affected by changes in lighting technologies. Here we report on BACI experiments designed to determine the impacts of new lighting technologies, relate changes in bat activity to changes in insect abundance, and determine whether the escape behaviour of tympanate prey in response to bat echolocation calls is compromised under new forms of lighting.

Preliminary Analysis of the Terrestrial Abilities of Bats in the Families Emballonuridae and Vespertilionidae

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Previous morphologic studies have associated the Vespertilionidae and Emballonuridae in a category of bats with pelvic and hindlimb morphology intermediate to those bats that are either very terrestrially competent, such as the relatively robust desmodontine vampire bats and molossids, and those that are poor walkers, including other more gracile phyllostomids. Here we compare the terrestrial ability of two species, the vespertilionid Eptesicus fuscus and the emballonurid Saccopteryx bilineata, in an attempt to determine if they demonstrate similar terrestrial ability to each other, and whether they perform gaits more similar to terrestrially adept bats or to those that are considered poor terrestrial locomotors. Three individuals of E. fuscus and two individuals of S. bilineata were placed in a custom-built runway filled with calcium carbonate sand to a depth of approximately 1.5 cm and covered with a Plexiglas® lid. The bats were video recorded and photographed as they crawled along the sand surface. Videos were analyzed to determine gait patterns, and the resulting trackways were cast with dental plaster. Eptesicus fuscus performed a coordinated diagonal sequence gait and produced faint but distinctive trackways. Saccopteryx bilineata performed what we have termed a breaststroke-like crawl: an asymmetrical motion in which the forearms are used to pull the rest of the body over the sand surface. These results indicate that there is likely variability in terrestrial behavior between bats with similar pelvic and hindlimb morphology and that other ecological variables may be more important contributors to terrestrial competency in bats.

Roosting Behaviour of Reproductive *Myotis septentrionalis* in Northern Canada

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There are few studies on roosting behaviour in tree-roosting bats above 55°N latitude. At northern latitudes, bats experience cool temperatures and limited foraging time due to short summer nights. The purpose of this study was to examine roost and site selection in reproductive female northern long-eared bats (*Myotis septentrionalis*) at the northern extent of their range, to determine if they exhibit roosting behaviours that minimize the impacts of cool temperatures and limited foraging time. Females might live in larger colonies, and in trees that allow for high solar exposure, to decrease thermoregulatory costs. We captured and radio-tracked reproductive females in the summer of 2014 and 2015 in the southern Northwest Territories, Canada at 60°N latitude. We compared roost and site characteristics between roost and random available trees. Reproductive females roosted in one tree species (*Populus tremuloides*) in relatively large colonies, despite small tree diameters compared to those at southern sites. Roost trees had larger diameters and were less decayed than random trees. Bats used cavities and frost cracks equally. Roost trees had moderately high canopy closure, suggesting that larger colony size may be more important for decreasing thermoregulatory costs than solar exposure. Further analysis will examine these roost characteristics more closely, and we will also examine the first data on torpor use in free-ranging *M. septentrionalis*.

Prey Discrimination Requires both Visual and Auditory Cues in a Gleaning Bat

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Successful discrimination of prey is an important task in many predator-prey interactions. Using a choice test we show that pallid bats (*Antrozous pallidus*) are unable to discriminate between terrestrial prey unless both auditory and visual cues are present. Bats were simultaneously presented with a cricket (*Acheta domestica)* and cockroach *(Blaptica dubia*), one of which was rendered unpalatable, in several conditions that limited access to different modalities. We found that only when both simulated moonlight and insect walking noises were available were the bats able to successfully avoid the unpalatable prey item. We suggest multimodal cueing may play a greater role in bat-arthropod interactions than is currently appreciated.

Southeastern *Myotis* Roosting Habits in an Old-growth Bottomland Hardwood Forest

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There is a dearth of literature describing the roosting habits of the southeastern myotis, *Myotis austroriparius*. Southeastern myotis are considered imperiled throughout their range and knowledge of roosting habits will better inform conservation and management decisions. Our objective was to quantify roosting habits in Congaree National Park, an old-growth bottomland hardwood forest in the Upper Coastal Plain of South Carolina. We located roosts by opportunistic cavity searches and by tracking bats captured from roosts during emergence using mist nets and butterfly nets. Colony sizes were obtained during emergence observations or by counting bats within the roost using a light and mirror. We attached 0.31-0.36 g Lotek or Holohil transmitters to 12 adult females, 3 juvenile females, and 1 adult male. Bats traveled a mean maximum distance of 1.21± 1.1km from their capture roost. Two of the three bats that flew the farthest were juveniles. Bats primarily used large diameter water tupelos with basal cavities although sweetgum were also used. Bats spent 1 to 6 consecutive days in each roost and shifted roosts every 2 ± 1.5 days (range 0 to 6). Colony sizes ranged from 5 to 310 individuals per roost. Trees with the most bats tended to have the most visits from tagged bats, the most connections to other trees, and the longest occupancies suggesting that these trees may serve as hubs for bats as they move among roosts. The aggregation and splintering of maternity colonies in hub roosts warrants a more in-depth network analysis.

The Southeast Asian Bat Conservation Research Unit: A Network Approach to Regional Bat Conservation

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Regional networks provide for robust and resilient conservation efforts that promote consensus approaches to priority setting and action. The Southeast Asian Bat Conservation Research Unit (SEABCRU) was established in 2007 as an open network of researchers, educators, and conservationists promoting the conservation of Southeast Asia's bat fauna through research, capacity building and outreach. Bats are a diverse but vulnerable component of Southeast Asian biodiversity and perform critical ecosystem services. Rapid deforestation, disturbance at cave roosts and unregulated hunting for food and traditional medicine imperil many species, with < 18% of the region's 370 species considered to have stable populations. In 2011, NSF supported SEABCRU in a 5-yr regional assessment of the distribution, abundance and status of Southeast Asian bats through research and training activities centered on four priority areas identified by group consensus: flying fox distributions and population ecology; taxonomy and systematics; cave bat conservation; response of forest-dependent bats to landscape change. Each priority is led by a multinational team of experienced biologists and graduate students who identified key objectives for each priority. Workshops and conferences support a development cycle of priority setting (Indonesia 2011), expert opinion and protocol development (Thailand 2012), targeted capacity building in network gaps (Cambodia 2013, Myanmar and Vietnam 2014), and data synthesis and assessment (2015, 2016). By 2015, the SEABCRU database was developed and most priority objectives met. Consensus then identified new cross-cutting priorities for the next five years: bat-human interactions, ecosystem services, environmental change and monitoring, IUCN assessment support, and taxonomy and systematics.

Acoustic Population Monitoring at *Tadarida brasiliensis* Colonies

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Acoustic monitoring offers many advantages over traditional video-based or visual sampling methods. This technique has been widely used with bats by monitoring biosonar calls to identify species and determine spatial and temporal activity patterns. One area where acoustic methods have not yet been successfully applied, however, is in determining populations in roosts. Here, we present the first attempt at the development of a model that uses acoustics to determine the population of Mexican free-tailed bats (*Tadarida brasiliensis*) emerging from large colonies. We used a single microphone to monitor echolocation activity and simultaneously recorded the emerging bats with high-speed video flying through the same air space. To create the acoustic model, bat abundance counts determined from single video frame analysis (every 10 s) were compared to different acoustic energy measures of a

1-s long acoustic sequence recorded at the time of the analyzed video frame. To verify the standards of the model, data were acquired across multiple nights and for different colony size counts at two different locations with different regression models. Here, we describe our method and report on its accuracy, precision, and reliability.

Body Temperature and Arousal Patterns of Crevice-hibernating Big Brown Bats
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Energy saved during hibernation is largely influenced by conditions within hibernacula, such as temperature (T_a) and humidity. Optimal T_a and humidity maximize energy savings such that fluctuations above or below these optima elicit increases in metabolic and arousal rates. Not surprising then, many hibernating animals seek sheltered, thermally stable areas that closely match optimal conditions. However, big brown bats (*Eptesicus fuscus*) hibernating in rock crevices in Dinosaur Provincial Park, Alberta, Canada experience conditions within hibernacula that range from -0.6ºC to 3.0ºC and 17% to 89% RH. We measured skin temperature (T_{sk}) of individuals in this population of bats for 3 hibernation periods (November through March) from 2012 to 2015. We hypothesized that individuals would exhibit flexibility in maintaining steady-state T_{sk} and that conditions within hibernacula (T_a and humidity) would influence arousal frequency. Specifically, we predicted that changes in T_{sk} would to some extent mimic changes in T_a and that time between arousals would decrease with decreasing T_a and RH. Contrary to our predictions, we found that bats consistently maintained steady-state torpid T_{sk} independent of T_a and RH, and fluctuations in conditions within hibernacula had no influence on arousal rates. We also found a unique T_{sk} pattern characterized by drops below steady-state torpid T_{sk} during post-arousal cooling and subsequent short bouts of active rewarming, further adding to the energetic cost of arousal. Our data suggest that bats hibernating in relatively climatically-unstable crevices may experience energetic challenges not faced by those that hibernate in cave / mine systems.

Testing for Non-Allopatric Speciation in Taiwanese Tube-nosed Bats
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Cases of geographically restricted sister taxa are rare and may suggest potential non-allopatric divergence. *Murina gracilis* and *M. recondita* are both endemic to Taiwan and, based on morphology and mtDNA evidence, have been proposed as sister species. To test for non-allopatric divergence and gene flow in these taxa, we generated sequences using Sanger and Next Generation Sequencing, and combined these with microsatellite data for coalescent-based analyses. MtDNA phylogenies unambiguously supported the reciprocally monophyletic sister relationship between *M. gracilis* and *M. recondita*, however, clustering of microsatellite genotypes indicated several individuals with signatures of species admixture suggesting possible introgression. Sequencing of microsatellite flankers revealed that apparent admixture stemmed from microsatellite allele size homoplasy, and also uncovered an unexpected sister relationship between *M. recondita* and the continental species *M. eleryi*, to the exclusion of *M. gracilis*. To investigate these conflicts between ncDNA and mtDNA, we analysed sequences from 10 anonymous ncDNA loci with *BEAST and isolation-with-migration (IM) and found two distinct clades of *M. eleryi*, one of which was sister to *M. recondita*. We conclude that Taiwan was probably colonized by the ancestor of *M. gracilis* first, followed by the ancestor of *M. recondita* after a period of allopatric divergence between these two taxa. After colonization, the mitochondrial genome of *M. recondita* has been replaced by that of the resident *M. gracilis* via introgressive hybridization. Apparent signatures of sympatric divergence can thus arise from complex histories of allopatric divergence, colonization and hybridization, highlighting the need for rigorous analyses to distinguish among such scenarios.

The Health and Viral Community of African Fruit Bats from Disturbed and Undisturbed Habitats
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Characterizing the viruses of known reservoir hosts, such as Pteropodid fruit bats in high-risk geographical areas like South Sudan, is important for understanding the potential for spillover of zoonotic pathogens into humans.

Because the movement of pathogens from wildlife to humans is facilitated by habitat disturbance and human encroachment, one might expect the health status, including viral load to vary between bats in intact versus disturbed habitats. This study explores the health and viral composition of the little epauletted fruit bat, *Epomophorus labiatus*, between disturbed and undisturbed habitats in South Sudan. Habitat disturbance levels were calculated using remote sensing data, Shannon-wiener diversity index, and analysis of anthropogenic activities within fixed radii of capture locations. Blood chemistry was analyzed using a handheld i-STAT system. Bats in disturbed habitats appear to have electrolyte depletion, anemia, and are nutritionally deficient compared to bats from undisturbed habitats. pH and pCO_2 levels were higher than typical mammal ranges, which suggests that these bats experience respiratory acidosis, with elevated acidosis in bats in undisturbed habitats. Further analysis using RT-PCR will compare the presence of Coronaviruses, Filoviruses, and Parmayxoviruses in bats from varying levels of habitat disturbance. This research will help qualify how habitat loss and landcover changes may influence the health of bats and thus the potential spillover of zoonotic viruses and highlights the need for minimizing human disturbance to natural bat habitats.

Invasion Dynamics of White-nose Syndrome and Long Term Impacts on Bat Populations
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White-nose syndrome has devastated bat populations in eastern North America. We measured the prevalence and infection intensity in five species of bats at sites in the Midwestern United States in the initial years of invasion. Prevalence increased quickly to essentially 100% in the first year of invasion but caused only small to moderate population declines. In the second year, environmental contamination led to earlier infection and large population declines. Interventions to conserve bat populations must be implemented before or soon after fungal invasion to prevent population collapse.

Elephants, Bats, and Their Food: A Food Web Approach to Understanding Bat Communities
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What controls the distribution of bats? Most would argue abiotic factors, disease, interactions with other bats, and food availability. However, one ignored, but potentially large, determinant of bat abundance and diversity is the community of large herbivores with which they are codistributed. Our research focuses on a variety of interactions at different trophic levels, starting first with the impacts of elephants on desert vegetation, where the majority of productivity is nested within riparian zones. To understand whether large herbivores affect bat communities through direct impacts on vegetative structure or if effects are primarily indirect, we will address the relationship between insects and vegetation in subsequent field seasons. From December 2014 to January 2015, we conducted a pilot study along four highly ephemeral rivers in northwestern Namibia in which a total of 119 bats from four families-Molossidae, Pteropodidae, Rhinolophidae, and Vespertilionidae- were captured over artificial ponds, natural springs, and flowing river regions. We measured the relative densities of large herbivores in the same areas using dung transects. Preliminary analyses indicate that while most molossid species occur throughout the region, other families of bats associate with specific water characteristics. Herbivore biomass had a weak, positive association with the abundance of at least one species of bats, *Chaerephon nigeriae*. Given the clustered distribution of resources in deserts, intense competition between similar, but also vastly different species occupying a variety of trophic levels, may play an as yet undetermined role in structuring bat communities in this system.

Investigating the Potential for Bat-friendly Agave Management for Mezcal and Other Cultural Uses in Mexico

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Throughout Mexico, agave plants (*Agave spp.*) are used by people for the development and sale of market products (such as the alcoholic beverage mezcal) as well as for other cultural uses. During agave cultivation the stalk is often cut before flowering in order to increase the sugar yield. However, this practice removes the food source for migratory pollinating bat species, including the endangered *Leptonycteris nivalis*. Agaves are also harvested from the wild by rural communities for important cultural products, a practice which can have significant implications for the conservation of bats that feed on agaves. Several ideas have been proposed to aid in their conservation, including allowing a proportion of a farm's agaves to flower (and thereby providing critical food sources for the bats) and creating wild agave replanting programs in order to ensure sustainable populations of agaves. "Bat-friendly" products made using these practices could then potentially be sold at a price premium by farmers and communities. In collaboration with a Mexican conservation organization (Especies, Sociedad y Hábitat, A.C.), this research will be conducted in the northeast region of Mexico and will integrate analysis of the ecological aspects of the system (e.g., identifying critical bat foraging areas) with analysis of the social aspects aimed at understanding how decisions are made regarding agave management and what factors may influence the adoption of "bat-friendly" practices. This integrated approach will better enable bat conservation efforts to be implemented in a way that will benefit both the bats and the people who use agaves.

Multimodal Aposematism Increases Signal Efficacy in Bat-Firefly Interactions

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Multimodal warning signals have evolved repeatedly in insects. Using high-speed infrared videography, we show that naïve bats learn to avoid unpalatable fireflies most effectively when flight cues and bioluminescent "flashing" signals co-occur. Fireflies (*Photinus pyralis*) were pit against big brown bats (*Eptesicus fuscus*) in combinations of different flight conditions (tethered vs. free-flight) and bioluminescence (natural vs. painted abdomen) along with control scarab beetles. We found that naïve bats learned to avoid free-flying, non-flashing fireflies and free-flying, flashing fireflies, but avoided the latter significantly more often. Given these results, and the pervasiveness of noxious prey in the night sky, multimodal signals may play a crucial role in bat-insect interactions.

Use of Geothermal Heated Caves for Winter Hibernation by Subtropical Bats

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Torpor and hibernation are common physiological adaptations used by mammals to conserve energy. These behaviours have been studied mostly in the context of adaptation to negative energy balance and extended periods of water and food shortage, and have been described in species from desert and tropical habitats. We report that two species of mouse-tailed bats (*Rhinopoma microphyllum* and *R. cystops*) hibernate for five months during winter in geothermally heated caves with stable high temperature (20°C). While hibernating, these bats do not feed or drink, even on warm nights when other bat species are active. We used thermo-sensitive transmitters to measure the bats' skin temperature in the natural hibernacula and open flow respirometry to measure torpid metabolic rate at different ambient temperatures (Ta, 16–35°C) and evaporative water loss (EWL) in the laboratory. Bats average skin temperature at the natural hibernacula was 21.7+0.8 °C, and no arousals were recorded. Both species reached the lowest metabolic rates around natural hibernacula temperatures (20°C, average of 0.14+0.01 and 0.16+0.04 ml O_2 $g^{-1}h^{-1}$ for *R. microphyllum* and *R. cystops*, respectively) and aroused from torpor when Ta fell below 16°C. During torpor the bats performed long apnoeas (14+1.6 and 16+1.5 min, respectively) and had a very low EWL. We hypothesize that the particular diet of these bats is an adaptation to hibernation at high temperatures and that caves featuring high temperature and humidity during winter enable these species to survive this season on the northern edge of their world distribution.

Urbanization Effects on Bats across Multiple North Carolina Cities within the NABat Sampling Framework

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The North American Bat Monitoring Program (NABat) is a continental-wide long-term survey effort to promote effective bat conservation. In partnership with biologists in South Carolina we piloted a Carolinas NABat program by extensively sampling the state of North Carolina in 2015. In 2015, we used AnaBat SD2 acoustic detectors to conduct driving transect and/or stationary site surveys on 37 NABat grids (10km x 10km) throughout the mountain, piedmont and coastal plain regions. Preliminary analyses reveal species distributions consistent with regional variation. For example, the southeastern Myotis (*Myotis austroriparius*) was primarily recorded at grids in the coastal plain whereas the Indiana bat (*Myotis sodalis*) was only recorded in the mountain region. In addition, variation between species recorded from sampling method was as expected. For example, interior foraging species including *Myotis* spp. and Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) were primarily recorded at stationary sites whereas driving transect surveys recorded mostly open adapted foraging species such as eastern red (*Lasiurus borealis*), evening (*Nycticeius humeralis*), and big brown (*Eptesicus fuscus*). Within 6 grids sampled with stationary sites, we selected urban – nonurban stationary site pairs to test predictions about urbanization effects on bat community structure, foraging rate, and time of peak nightly activity. We are also constructing a model to compare grids at the landscape scale to explore how bat community structure, foraging rate, and time of peak nightly activity vary along the urbanization gradient. We will present these results and highlight ways that ecological questions can be addressed within the NABat sampling framework.

White-nose Syndrome Survivors Have Pre-WNS Hibernation Patterns Despite *Pseudogymnoascus destructans* Infection

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White-nose syndrome (WNS) has devastated bat populations in North America, with millions of bats dead. WNS is associated with physiological changes in hibernating bats, leading to increased arousals from hibernation and premature consumption of fat reserves. However, there is evidence of surviving populations of little brown myotis (*Myotis lucifugus*) close to where the fungus was first detected nearly ten years ago. We examined the hibernation patterns of a surviving population and compared them to patterns in populations before WNS and at the peak of mortality. Despite infection with *P. destructans*, the survivor population displayed less frequent arousals from torpor and lower torpid body temperatures than bats that died from WNS during the peak mortality phase of the syndrome. The hibernation patterns of the remnant population resembled pre-WNS patterns with some modifications. Bats may be adapting their thermoregulatory behavior and microhabitat selection to avoid WNS-associated mortality.

Phylogeography of Caribbean Bats and Systematic Relationships across the Neotropics

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The majority of the terrestrial mammalian fauna in the Caribbean are bats, and of these, more than half are endemic species. However, this biogeographic region is a noticeable gap in world coverage for this vertebrate group on the International Barcode of Life (iBOL) reference database. Recent biodiversity surveys of bats from Jamaica and the Dominican Republic represented the first sequences of the cytochrome c oxidase subunit I (COI) mitochondrial gene from the Greater Antilles and complemented previous DNA barcoding from the Lesser Antillean island of Martinique. Phylogenetic analyses of similarity matrices for 28 species summarized by neighbor-joining trees allowed for the quick identification of taxonomic groups that warrant more thorough systematic study. Well-supported monophyletic clades were recovered for currently recognized species in the Caribbean except for the fruit bat *Brachyphylla pumila*. There was low intraspecific variation but the insectivorous bat *Macrotus waterhousii* and the nectar-feeding bat *Monophyllus redmani* had high sequence variation. In addition, six other taxa had deep divergence across the Neotropics suggesting the potential for the recognition of increased species diversity. Phylogeographic patterns included (1) discrete populations between northern and southern Dominican Republic as seen in capromyid rodents, birds and reptiles; (2) genetically distinct allopatrically distributed island populations; and (3) broader relationships of some Caribbean taxa to Central America than to South America. This geographic structuring indicates that the biodiversity of bats in the Caribbean is at least 25% underestimated based on current taxonomy.

Morning Cave Re-entry of Mexican Free-tailed Bats: Acoustical and Behavioral Observations

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The Mexican free-tailed bat (*Tadarida brasiliensis*) is known to aggregate in colonies of over one million individuals. Typically around sunset the bats leave the roost to fly to their feeding grounds. All bats emerge during a short time window creating a constant and dense stream of bats flying in the same direction. However, when returning to the cave the behavior is remarkably different. Here, we report acoustical and behavioral observations during morning re-entry of a colony of approximately 1.2 million individuals. The project took place at a lava tube and canyon cave system on private land in New Mexico, USA, on three days between 5:00 and 6:30 am in June 2015. Using a six-channel ultrasonic microphone array, placed ca. 5 m in front of the cave entrance and tilted towards the sky, echolocation signals of individual bats were recorded during morning re-entry. Flight behavior was also monitored using a thermal camera, high speed video cameras, and visual observations. Unlike emergence, morning re-entry demonstrated no group coordination, and individual bats returned from high altitudes flying at steep angles and high speeds. Acoustic analysis shows single bats use echolocation calls with long duration (8 to 14 ms) and long inter-pulse intervals (50 to 250 ms), which is typical for long-range echolocation – with the cave entrance serving as the likely target point. However, the call design (duration and frequency modulation) is affected by the density of bats calling in the same air space and thus the degree of signal overlap in time.

Are Bats and Sport Climbing Compatible? A Pilot Study

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Sport climbing is a rapidly growing sport in the US and elsewhere. Although several species of bats commonly roost in cliff faces, the potential for impacts of climbers on bats has received very little study. We initiated a pilot study on the potential impacts of sport climbing on bats in Obed Wild and Scenic River in eastern Tennessee during June-August 2015. Our objectives were to 1) examine small-footed bat (*Myotis leibii*) roost use to determine if they avoided climbed cliffs, and 2) determine if overall bat foraging and commuting activity varied between climbed and unclimbed areas. We used radio-telemetry to track small-footed bats to day roosts and Anabat SD2 detectors to compare bat activity between climbed and unclimbed areas along climbed cliff faces, and between climbed and unclimbed cliffs. Four adult males were tracked to 9 day roosts. Three roosts were in large boulders on the shore of the river, 1 roost was in a barn, and 5 roosts were in cliff faces (3 on climbed and 2 on unclimbed faces). Foraging/commuting activity was high along climbed cliffs and did not differ between climbed and unclimbed areas. However, bat activity was significantly higher along climbed cliffs than unclimbed cliffs. Lower activity along unclimbed cliffs may have been related to lower cliff heights and more clutter along cliff faces. High bat activity along cliff faces suggests that additional study of bat activity in relation to climbing throughout the annual cycle will aid in the development of climbing management plans.

Networking with Farmers to Encourage Bat Activity on Farms

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We evaluated the use of 186 bat houses by bats on farms in California's Sacramento Valley, from 1997-2004. Location affected bat house occupancy more than house size, color, and height. Colonies of bats (mothers and young) preferred houses mounted on structures, such as barns, shaded or exposed only to morning sun, and within one-quarter mile of water. Individual bats (generally males) were less selective in where they roosted. The overall bat house use in our study was 48% for colonies and 28% for individual bats with most being occupied within the first 2 years. Mexican free-tailed and *Myotis* bats were the main species using the houses, with occasional sightings of pallid and big brown bats. In 2015, we conducted a survey of growers and landowners in the Sacramento Valley to determine how farmers perceive bats on their farms. Almost all respondents viewed bats as being beneficial for insect pest control and about half considered bats as good for crop yields. Few growers considered bats as a problem for food safety issues, but disease transmission to animals and people and guano in buildings was a concern. About half of the respondents wanted to attract more bats to their farms for pest control. To reach the grower community about the value of bats on farms, a range of networking is needed, including workshops, personal contact with agencies such as the Natural Resource Conservation Service, and information about bats distributed via printed and online materials.

A New Species of *Molossus* (Chiroptera, Molossidae) with Comments on Its Phylogenetic Relationship

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Molossus is one of most diverse genera within the family Molossidae and occurs from the southeastern United States to southern Argentina. Although monophyletic, species diversity within the genus is poorly understood. In preliminary examination of DNA barcodes (mtDNA CO1 gene sequences) we noticed unusually high levels of divergence among some samples of *Molossus* from Guyana and Ecuador, prompting a review of the systematic identity of these individuals. Generally, *Molossus* appears to be genetically conservative. Low intraspecific and interspecific variation within *Molossus* has been observed for CO1, with less than 1.8% divergence among samples within *M. molossus,* and less than 2.2% between the morphologically distinct *M. molossus* and *M. rufus.* We sequenced CO1 in 364 specimens of *Molossus* and 15 specimens of the nearest outliers *Promops* and *Eumops.* Concomitantly, to examine morphology, PCA and MANOVA were done on a correlation matrix for 11 morphological variables for 272 specimens representing four species of *Molossus*. In the molecular phylogeny the new species appears as a distinct clade that is the sister group to all other *Molossus,* marked by a divergence in CO1 of approximately 10%. Morphologically, the new species shows clear qualitative differences from other *Molossus,* such as small size and a well developed mesostyle in the second premolar. As a result, we propose a new species of the genus from Guyana and Ecuador.

Phylogenetic Analysis of Afrotropical Malaria Parasites Identifies Bats as Ancestral Hosts

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Haemosporidia (malaria) parasites of bats exhibit a high level of diversity and divergence relative to malaria parasites of other mammals, and have presented a phylogenetic quandary for systematists trying to resolve evolutionary relationships among major haemosporidian lineages. To expand knowledge of Afrotropical parasite diversity and to improve resolution of the haemosporidian phylogeny, we surveyed a broad range of bat species from Kenya, Malawi, Mozambique, Tanzania, and Uganda between 2009 and 2014, and analyzed DNA sequence data from mitochondrial, nuclear, and apicoplast genomes of the parasites. Sampling of avian parasites was conducted concurrently, and data from our surveys were combined with additional sequences from major parasite lineages of primates, rodents, bats, birds, and reptiles for phylogenetic analyses. This comprehensive taxon sampling approach, paired with a molecular clock rooting method, supports a chiropteran origin of malaria parasites, and suggests that bats have played an important role in the diversification and host switching of major parasite lineages. Contrary to results of prior phylogenetic analyses, our data support the monophyly of sauropsid parasites, as well as the reciprocal monophyly of mammalian *Plasmodium* and *Hepatocystis* parasites. Rigorous model tests validate our principal conclusion and reject several important alternatives, including both the placement of avian parasites as the outgroup to mammalian parasites and the monophyly of mammalian parasites. Despite this comprehensive approach, it is clear that improved taxon sampling alone will not resolve key basal nodes, and that such sampling must be paired with increased genetic information to elucidate deeper evolutionary relationships in the haemosporidian tree of life.

A Proposal for Pollination Services Provided by Fruit Bat Species to Baobab Trees in South Africa
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Throughout Africa, baobabs (*Adansonia digitata*) provide many economic benefits to local communities as food and medicine. Baobab flowers appear to be bat-pollinated, but studies confirming bats as the primary pollinators are lacking, yet urgently needed as hunting and persecution imperil populations of plant-visiting bats, and thereby baobabs, across Africa. I will demonstrate the role of bats in baobab pollination through a series of exclusion experiments, and will work with local communities who rely on baobabs as a source of income. Exclusion experiments with the flowers will have varying treatments to tease apart the pollinator-baobab relationship. Along three transects radiating out from a known roosting site, baobab trees will be picked based on pre-set distances. These trees will be used for the exclusion experiments and have camera traps set up to photograph potential pollinators. Camera traps will be used to identify bat species visiting the flowers, which could include *Rousettus aegyptiacus* and *Epomophorus* species. Additionally, pollen will be collected from the fur of captured bats. Outcomes will contribute to both bat and baobab conservation and secure local economies that depend on baobab vitality.

Do Hummingbird Feeders Affect Bat-Plant Interactions?
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Bats provide benefits to the plants they pollinate, and these plants have evolved various traits to attract them. However, when hummingbird feeders are available in an area, there exists the possibility that the large quantities of readily-available nectar could draw bats away from plants. We experimentally tested the effects of feeders on bat-plant interactions in an Ecuadorian cloud forest. We chose the species *Burmeistera glabrata* as focal taxa due to it is a common bat-resource in the area. We selected sites close to the feeders (within 15 m) and control areas further away (>500 m). Within these two areas we evaluated the effects of feeders on bat-plant interactions via three approaches: 1) quantifying seed production, 2) recording flowers using a camcorder with night vision to register the number of bat visits a flower receives per night (18:00 – 23:00 hrs) and 3) capturing bats to evaluate the frequency and abundance of pollen loads in bat's fur. We predicted less seeds per fruit, fewer visits and lower frequency and abundance of pollen in feeder areas. Preliminary results showed no significant difference in the number of seeds per fruit in feeder versus control areas (1129.5 vs. 990.9); the average number of visits to flowers was lower in feeder areas (1.76 visits/night) than in control areas (3.58 visits/night), the frequency of pollen was similar between areas but the abundance was lower in feeder areas. We concluded that feeders are drawing bats away from plants but this does not have an effect on plant fitness.

Survey and Conservation of Cave-dwelling Bats in Coastal Kenya
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Coastal Kenya has many coral caves hosting many different colonially-roosting bat species. The majorities of these caves are on private lands and face serious anthropogenic threats. I investigated threats to bats and their roosts, and annual changes in bat populations in four important caves in coastal Kenya. I also investigated local peoples' perceptions about bats. Population estimates were conducted via photography while direct observations, structured interviews and questionnaires were used to understand views of locals concerning bats and the threats they face. The first cave housed 7 species (*Hipposideros caffer*, *H. vittatus*, *Triaenops afer*, *Coleura afra*, *Taphozous hildegardeae*, *Miniopterus africanus*, *M. minor*) and the second cave had 6 species (above excluding *H. vittatus*) while the third and fourth caves contained a single species each: *Cardioderma cor* and *Rousettus aegyptiacus*, respectively. The caves were most affected by agricultural activities that involved burning. Bat populations were highest in November and gradually declined in the subsequent months. *Coleura afra* were the most abundant and *Miniopterus africanus* had the lowest numbers in general. Local people viewed bats negatively because they do not understand their importance especially in agriculture and instead persecute them whenever the occasion arises. Therefore, a robust public education and community outreach program is necessary to change peoples' perceptions and enhance bat conservation along the Kenyan coast.

Annual and Seasonal Fluctuations in Roost Use by *Tadarida brasiliensis* in a Highway Overpass, San Angelo, Texas

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Previous research has documented that populations of Brazilian free-tailed bats, *Tadarida brasiliensis,* use highway overpasses as day roosts in parts of central Texas, however no colonies in western Texas have been extensively studied. We surveyed a large population of *T. brasiliensis* roosting in a highway overpass in San Angelo, Tom Green County, Texas to determine roost use and seasonal patterns of occupancy. Further, we determined if rainfall was a variable that affected population trends, roosting, and emergence behaviors. Lastly, we compared occupancy patterns observed in 2014 to those observed when the site was last surveyed in 1995. Population counts and roost use were documented from February 2014 through February 2015. Bat populations ranged from 0 during some winter counts to an estimated high of 191,795 individuals in August. We noted that during times of extended rainfall, the bridge joint opening crevices filled with and heavily dripped rainwater, causing many roosting areas of the bridge to be wet and often not habitable. Because of this, many bats temporarily left the bridge during rainy weather conditions, and returned when bridge crevices dried. Comparison to a previous study conducted on the same roosting population in 1995 showed similar trends in occupancy, including temporary roost evacuation behaviors during rainfall. We conclude that despite rainfall events, the colony fluctuates predictably year-round and that current seasonal patterns of use are consistent with those reported in 1995.

***Chiro*Surveillance: the Use of Native Bats to Detect Invasive Agricultural Insect Pests**

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Invasive insects cost the agricultural industry billions of dollars annually in crop losses and associated management. Timely detection of these pests is critical because management efficiency decreases exponentially with time since detection. Innovative strategies that maximize sampling resolution across space and time may improve surveillance, and ultimately, control of invasive species. Using a new high-sensitivity molecular assay, we documented consistent seasonal predation of the invasive agricultural pest, brown marmorated stink bug (*Halyomorpha halys*; BMSB), by big brown bats (*Eptesicus fuscus*). Importantly, bats detected BMSB 3-4 weeks earlier than standard monitoring efforts across all sites. Our study highlights the previously unrecognized potential for bats to provide an additional ecosystem service by serving as agents of invasive species *chiro*surveillance. This work provides much-needed evidence for articulating the consequences of catastrophic declines of bats from white-nose syndrome and wind turbines and increasing public acceptance of bats as critical to human quality of life.

Echolocation in Bats and Porpoises Hunting Alone and in Pairs

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Approximately 1000 species of bat and 80 species of toothed whales are known to use echolocation to detect and track prey. While the basic function and phases of echolocation (search, approach and terminal buzz) are similar in both laryngeal echolocating bats and toothed whales, it is currently unclear whether similarities between Chiroptera and Cetacea extend to group situations. The influence of conspecifics on echolocation signals, for example, has been widely studied in bats, but is relatively lacking with respect to toothed whales, including porpoises. Using multi-microphone arrays and multi-hydrophone arrays, we recorded the calls/clicks produced by Daubenton's bats and harbour porpoises, respectively, while they hunted insects and fish either alone or with a conspecific. Some of the call/click parameters we measured included source level (dB re 1 µPa pp), peak frequency, +/- 10 dB bandwidth, signal duration and inter-click interval (or call period). Based on previous research, we expect that bats foraging in pairs will produce calls with shorter durations, longer call periods and more variable peak frequencies compared to foraging alone. Because porpoises are facing similar constraints and acoustic clutter when they forage in groups, we expect to see similar changes in echolocation click parameters in harbour porpoises.

Deviations from these patterns could provide information regarding the ability or likelihood of porpoises to engage in jamming avoidance responses when hunting with conspecifics.

Plasma Metabolite Analysis as a Tool for Studying the Nutritional Ecology and Energetics of Insectivorous Bats

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Bats experience rapid and dramatic changes in energy status. At times, bats consume large amounts of prey to either meet current energy demands, as in lactating females, or in preparation for future energy shortages, as in bats preparing for hibernation. At other times, foraging opportunities are limited, such as periods of inclement weather. Understanding the fueling rate provides important information on short term fluctuations in energy status, and provides perspective on broader ecological questions such as the effects of sex and age, reproductive status, habitat quality, seasonal variation, and variation among populations. The concentrations of certain metabolites (triglycerides, β-hydroxybutyrate) in blood plasma provide an indicator of the nutritional status of individual animals from a single capture. Over the past several years, with a number of collaborators, we have conducted several studies validating the use of plasma metabolite analysis for insectivorous bats, new technology for rapid analysis of plasma samples in the field, and applying the technique to examine demographic, seasonal, and population level differences in fueling rate of little brown bats, *Myotis lucifugus*, including populations in Ontario, Manitoba, and Alaska. With the recent development of a handheld, field portable device for measuring plasma concentration of a key metabolite (β-hydroxybutyrate), we anticipate plasma metabolite analysis will become an increasingly common tool for examining the nutritional ecology and energetics of insectivorous bats.

North American Bat Monitoring Pilot Surveys in Arizona

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Monitoring bat populations is challenging. The North American Bat Monitoring Program (NA Bat) is a multi-agency, multi-national effort designed to address the need for standardized monitoring and management of bat species across multiple taxa in North America. The goal of the NA Bat Initiative is to facilitate continent-wide monitoring of bats at local to range-wide scales. The national program has been designed with the best knowledge available, but is dependent upon pilot studies and state and local partner participation to refine the design. In 2014, Arizona obtained a multi-state State Wildlife Grant with partners CA, CO, ID, MT, TX, UT, WA and BCI, to build capacity for and begin conducting acoustic and roost monitoring, core components of the NA Bat Initiative. In 2015-2017, Arizona will conduct acoustic and roost monitoring using NA Bat Protocols to gather baseline data for bats in Arizona. In 2015, Arizona surveyed 35 fixed point locations with Wildlife Acoustic SM2 detectors for 1 – 4 nights and conducted 14 mobile acoustic surveys using AnaBat SD2 detectors. Information gained in this project will contribute to refinement of national protocols, state data needs, and strengthen regional and local partnerships.

Looking for Bats in All the Right Places: Spatial Patterns at Effigy Mounds National Monument

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We were asked to survey bats at Effigy Mounds National Monument in northeastern Iowa with special emphasis on detections of Federally Threatened northern long-eared bats (*Myotis septentrionalis*) and Federally Endangered Indiana bats (*M. sodalis*.) We sampled bats with acoustic detectors (Wildlife Acoustics SM3) and with mist-nets. Acoustic detectors were randomly deployed throughout the park and provided guidance on where to set mist-nets to enhance our capture success. Through Kaleidoscope Pro 3.0, acoustic files were initially identified to species. For myotine bat species, each file was examined to determine the correct bat species. Seven bat species were confirmed including northern long-eared bats. Our acoustic files strongly suggest that Indiana bats are present in the southern portion of the park. All captured bats were processed and DNA samples were obtained from the facial region using Isohelix® DNA swabs; these samples were used to test for the presence of *Pseudogymnoascus destructans*, the fungus that causes white-nose syndrome. In total, seven bat species were captured with northern long-eared bats being most common followed by little brown bats and big brown bats (*Eptesicus fuscus*). Some spatial patterns have emerged with northern long-eared bat captures occurring throughout the park and little brown bat captures only occurring in the northern sample sites. Silver-haired (*Lasionycteris noctivagans*) captures have occurred only in upland prairie-forest interface locations while captures for all other bat species were concentrated in lowland floodplain locations. At present, Effigy Mounds National Monument appears to be an important site for bats, especially northern long-eared bats.

Rabies in Bats of Illinois

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Every year thousands of bats in the United States are submitted for rabies testing. We have identified most of the bats submitted in Illinois since 2002. Although the number of bats submitted for testing in Illinois has varied widely, the percentage of submitted bats that test positive for rabies has remained relatively constant. The vast majority of the submitted bats are big brown bats (*Eptesicus fuscus*), which frequently use buildings for roosting in the summer and hibernating in the winter. However, the bats with the highest prevalence of rabies are bats that are not typically associated with humans (hoary bat [*Lasiurus cinereus*], eastern pipistrelle [*Perimyotis subflavus*], and eastern red bat [*Lasiurus borealis*]). We will continue to monitor and examine long term trends of bats submitted for rabies testing in Illinois.

Metabolic Rate, Colony Size and Latitude, but Not Phylogeny, Affect Rewarming Rates of Bats

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Torpor is an energy-saving adaptation that allows many endotherms to save energy by abandoning the energetic cost of maintaining elevated body temperatures. Although torpor reduces energy consumption, the metabolic heat production required to arouse from torpor is energetically expensive, and when endotherms rely solely on metabolic heat production to rewarm from torpor, rates of rewarming can impact the overall cost of torpor. Ecological and behavioural factors influencing the opportunity for passive rewarming could, therefore, influence the evolution of rewarming rates and overall energetic costs of arousal from torpor. We used a comparative analysis to examine the relationship between ecological, behavioural and physiological factors and rewarming rates of 45 bat species. We used basal metabolic rate (BMR) as an index of thermogenic capacity, local climate (i.e., latitude of geographic range) and maximum colony size as ecological and behavioural predictors of rewarming rate. After controlling for phylogeny, high BMR was associated with rapid rewarming rates, while species that live at higher absolute latitudes and that live in smaller colonies, rewarmed most rapidly. This suggests that some species rely on passive rewarming and social thermoregulation to reduce costs of rewarming, others have evolved more rapid warming rates, associated with higher BMR, as an alternative means to reduce energetic costs. Our results highlight species-specific traits associated with maintaining positive energy balance in a wide range of climates, while also providing insight into possible mechanisms underlying the evolution of heterothermy in endotherms.

Widespread Anti-bat Ultrasound Production in Moths

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For over 60 million years bats and moths have been engaged in a co-evolutionary arms race. Bats have evolved specialized echolocation strategies and, in turn, moths have developed bat-detecting ears and ultrasonic countermeasures to defend against their aerial predators. Previous work has shown ultrasound production can be an effective anti-bat strategy that can startle bats, jam sonar or warn of bad taste. Currently these acoustic defenses to bat attack are known in only a small fraction of moth diversity. Here we show that anti-bat ultrasound production is widespread across moths (Order: Lepidoptera). We tested hundreds of moth species from around the world by playing back bat echolocation attack sequences and describe the prevalence of this anti-bat strategy in a phylogenetic context.

Co-infection with White-nose Syndrome Fungus and Coronavirus May Exacerbate Fungal Pathology or Risk of Viral Spillover

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In recent years several viruses that appear to cause no obvious disease in bats have spilled over to humans and other species, frequently causing fatal disease. These spill-over events are extremely rare and are thought to be the result of a "perfect storm" of circumstances that lead to infection of other species followed by successful establishment and spread of virus. We hypothesized that co-infection of bats with a coronavirus and the white-nose syndrome (WNS) causing fungus (*Pseudogymnoascus destructans, Pd*), influences fungal pathology as well as increasing the rate of shedding of a persistently infecting virus. To test this hypothesis we examined hibernating little brown bats (*Myotis lucifugus*) experimentally either mock-infected or infected with *Pd*. Using nested PCR we amplified a segment of the coronavirus RNA polymerase from the ileum and gut contents of 18 of 54 bats. The difference in frequency of virus detection between *Pd*-infected and mock-infected bats was not significant. However the ileum of fungus-infected bats contained on an average 60 fold more viral RNA than mock-infected bats. The increase in viral RNA also correlated with WNS-related pathology and the ileum of *Pd*-infected bats contained higher levels of cytokines known to enhance coronavirus replication. Our results suggest that WNS leads to an increase in coronavirus gene expression and potentially to an increase in virus shedding or, as an alternate explanation, that viral co-infection affects the severity of WNS.

Creating Bat Assemblage and Temporal Activity Baselines in Arizona: Evaluating the Utilization of Stationary Acoustic Detectors

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We used the conservation management needs of land managers in Arizona as a basis for a long-term bat monitoring project. The recent decline in bat populations in the Eastern U.S. due to white nosed-syndrome (WNS) indicates that bat species assemblages and the temporal distribution of bat activity may be the first indicators of the disease on a landscape scale. In order to detect these changes in bat species assemblages and the temporal distribution of activity a comparison of bat activity across time is needed. We designed a study to establish a baseline index of bat activity that can be compared statistically across time. The combination of three ongoing studies with Grand Canyon National Park, Barry Goldwater Bombing Range and the Bureau of Reclamation allowed us to create a landscape scale sampling scheme. All three of these projects utilize elevated stationary acoustic bat detectors that are deployed year long. We used the data collected from these 14 stations to create a baseline bat assemblage and temporal activity pattern at each station. We then developed a statistical methodology to compare the stations across temporal periods to allow for the detection of significant change across time. Our methods will allow for the early detection of changes in bat species diversity and temporal use that may indicate population declines.

Geographic Variation in Contact Calls Emitted by a Leaf-roosting Bat Suggests Distinct Modes of Vocal Transmission

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Group behaviors, such as coordination and information exchange, are typically mediated by acoustic signals known as contact calls. Although these vocalizations are widespread, the mechanisms driving variation in acoustic features within and between populations remains poorly understood. Our study examines whether patterns of variation in two contact calls emitted by Spix's disc-winged bats, *Thyroptera tricolor,* are congruent with patterns of genetic distance among populations isolated by a geographic barrier. *T. tricolor* is a leaf roosting bat that forms stable social groups and exhibits all-offspring philopatry. To evaluate if vocal variation between groups is influenced by genetic distance, we studied the variation in microsatellite allele frequencies at multiple sites on the Caribbean and Pacific mountain slopes. We found that the geographic variation patterns differed between the two

types of calls studied, and we argue that this indicates distinct modes of vocal transmission. Our results suggest that one contact call is likely socially transmitted via vocal learning, while the congruence between patterns of genetic differentiation and acoustic variation for the second call type suggest this is an inherited trait. Further research is needed to better understand the role of vocal learning and genetic transmission of contact calls emitted by *T. tricolor.*

Monitoring Hawaiian Hoary Bat Activity and Prey Availability at Kaloko-Honōkohau National Historical Park

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The endangered Hawaiian Hoary bat (*Lasiurus cinereus semotus*) endemic to the Hawaiian archipelago is Hawai'i's only native terrestrial land mammal. We examined habitat use, foraging activity, and insect abundance in the 470 hectare Koloko-Honōkohau National Historical Park located in the coastal region of Kailua-Kona on Hawai'i Island. We compared two principal habitats: wooded shorelines beside brackish water fishponds and xeric lava fields dominated by invasive trees, *Leucaena leucocephala* (Mimosoideae) and fountain grass, *Cenchrus setaceus* (Poaceae). We recorded echolocation calls at seven stations using SongMeter SM2Bat+ units powered by solar panels that operated continuously from November 2013 through February 2015. Three UV light traps collected insects from dusk to dawn for three nights each in January, April, July and November 2014. We hypothesized that bat activity and insect biomass would be associated primarily with brackish water fishpond habitats and least with a grass and shrub xeric habitat. We found that insect biomass and numbers were much greater at the fishpond sites. Additionally, bat activity, including feeding buzzes were also much greater at the fishpond sites compared to the grass and shrub xeric habitat.

Genomic Inventories of Bat Antimicrobial Peptides: Implications for Resistance to White-nose Syndrome

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The first opportunity for the immune systems of bats to recognize invasion by the white-nose syndrome (WNS) pathogen is in skin tissues where the fungus invades. Understanding skin immune defenses across bat species exhibiting differential disease and mortality is of critical importance. We hypothesize that immune defense proteins, known as antimicrobial peptides (AMPs), confer resistance to WNS because AMPs: 1) are abundant in skin, 2) are constitutively expressed and likely to remain functional during hibernation when invasion occurs, and 3) can have strong, immediate anti-fungal activities. The diversity of AMP repertoires and their antimicrobial functions are, however, unknown in species affected by WNS. To discover bat AMP repertoires, we deployed hidden Markov models calibrated using known, annotated AMP sequences from non-bat mammals. We applied this method to six bat and 21 non-bat mammal genome assemblies. We found >130 previously undiscovered AMP genes in bat genomes. We then modeled AMP evolution across all mammalian species. We found little diversification in bat α-defensins. In contrast, bat cathelicidin and β-defensin diversity matches or exceeds diversity in other mammals. Additionally, AMP repertoires differed between two species variably impacted by WNS (*Myotis lucifugus* and *Eptesicus fuscus*). We hypothesize that differences in AMP diversity and function between bat species may explain differences in susceptibility to invasion and infection by the WNS pathogen and can lead to an effective control. We are currently exploring this question using proteomic analyses of skin tissues from five species variably impacted by WNS complemented by functional tests of bat AMP abilities.

Home Range and Habitat Use of Foraging *Myotis grisescens* from Five Maternity Sites in Northern Arkansas

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Gray bats (*Myotis grisescens*) were listed as endangered in 1976 because of declining populations resulting from cave disturbance. The Gray Bat Recovery Plan recommends further study on foraging habits and home range. Yet, little data exist partly because gray bats have large home ranges, making ground-based tracking methods problematic. Accordingly, our objective was to assess gray bats' foraging habits using aerial telemetry. In 2014-2015, five maternity sites in Arkansas were harp-trapped, and 112 adult lactating gray bats were radio-tracked from a Cessna 182 Skylane to gather 1,293 time-independent locations from June 15 - July 15. Fixed-kernel density with least square cross validation was used to determine home range (95% of locations) and core foraging area (50% of locations) of a sub-sample of 42 individuals with ≥15 independent locations. Minimum Convex Polygon (MCP) was also used for comparative purposes with past published studies. In 2014, mean 95% home range was 362.2 km^2 (SE= 24.9 km^2). For Newark (n=253 locations), home range was 349.3 km. At Bone cave, tracked later in the rearing period (n=310 locations), home range was larger at 1006.9 km^2. Each individual used 1-3 core foraging areas. Bats were often located over water, traveling by creek or river. With such large home ranges, management strategies for gray bats should go beyond protecting roost sites to include waterways and riparian areas for travel and foraging on sensitive aquatic insect species. Data for the three maternity sites tracked in 2015 are forthcoming pending data analysis, in addition to comparisons and habitat use.

***Myotis* Diverge, but with Migration**

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Growing evidence supports the idea that species can diverge with gene flow. However, most methods of phylogeny estimation and species delimitation do not consider this process, despite the fact that neglected gene flow can bias phylogenetic inference. Our goal in this work was to jointly estimate species relationships and rates of gene flow (if present) among the western long-eared bats, *Myotis evotis*, *M. thysanodes*, and *M. keenii*. We collected genomic data (808 loci of Ultra Conserved Elements) and used PHRAPL, a new tool for demographic model selection, to infer phylogeographic history. A large set of models that included isolation-only, migration-only, and isolation-with-migration scenarios was explored, and we found that one model (of 410) garnered most of the AIC model weight, with a model probability of ~0.98. This best model included two divergence events ((*evotis*, *thysanodes*), *keenii*) as well as a both tip migration (between *M. evotis* and *M. thysanodes*) and ancestral migration. We also quantified environmental niche overlap between pairs of species to explore whether past or current climatic conditions influenced gene exchange among western long-eared bats. Results showed that niche overlap and niche similarity in these bats have changed over geological time. Overall, our results suggest that both gene flow and environmental differentiation have influenced the evolution of western long-eared bats.

Roost Selection by *Desmodus rotundus* and Interspecific Interactions

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Roost selection has important implications for the development and survival of bats. Although roost selection is a complex interaction of biotic and abiotic factors, it is known that temperature is one of the most important aspects for roost selection. *Desmodus rotundus* occupies a wide variety of roosts; in Mexico it can be commonly found in caves that shares with numerous non-hematophagous species causing interspecific interactions. This study furthers the knowledge of roost ecology of the common vampire bat. We analyzed the differences of temperature between sites in caves occupied by *D. rotundus* and another non-hematophagous species. Additionally we tested the roost preference of both species and observed the interspecific interactions in an experimental set up with artificial roosts. We expected that inside the caves the average, maximum and minimum temperature would differ significantly between the sites occupied by *D. rotundus* and the non-hematophagous species. During the roost selection experiments we expected that both species would show preference for the roost with the temperature range closer to the thermoneutral zone when alone, and when interacting, *D. rotundus* presence would affect the non-hematophagous bat roost selection. We found significant differences in the temperature of the sites occupied by both species in caves and in the captivity tests we confirmed that the aggressive displays of *D. rotundus* changes the roost selection of the non-hematophagous bat. This information contributes to the better understanding of the roost ecology of bats and may aid the improvement of conservation strategies of endangered species.

Bat Conservation in PG&E Hydroelectric Project Facilities
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Pacific Gas and Electric Company (PG&E) operates 26 hydroelectric projects that are licensed by the Federal Energy Regulatory Commission. These projects span California watersheds from Siskiyou County to Kern County and include diverse bat roosting habitat in natural features and anthropogenic structures. Within these watersheds, there are opportunities for PG&E to contribute to overall bat conservation. PG&E activities that contribute to bat conservation include providing employee education and training, conducting project-wide surveys to determine bat presence in or near project facilities, and performing pre-activity surveys before construction commences. Mitigation can also contribute to bat conservation in the form of onsite building retention and enhancement, installation of bat houses, and temporary or permanent exclusion to facilitate construction and maintenance. This poster presents examples of these activities and mitigation opportunities.

Poop
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With the dramatic decline of bats from the effects of white-nose syndrome (WNS), what are the ecological consequences? Many advocates of bats promote their ability to consume large volumes of nocturnal insects, but who will eat these when the bats are gone? Our study was designed to determine if Big Brown Bats (*Eptesicus fuscus*) are succeeding to occupy the niche of bats removed by WNS, specifically Little Brown Myotis (*Myotis lucifugus*), and have changed their diet accordingly. We collected and analyzed >1200 detector-nights of acoustic echolocation data from 15 locations pre-WNS in Southern Ontario and Michigan, and >1200 detector-nights from the same 15 locations post-WNS in a pairwise, repeated measures comparison of the activity levels of bats over 6 years. To determine if there is a diet shift associated with competitive release we collected guano samples from nine roosts across southern Ontario and Michigan. These were processed through next-generation sequencing (NGS) on the CO1 gene in the Illumina MiSeq® system to determine insect prey species. Our acoustic data demonstrate the significant decline of activity of Little Brown Myotis, and a corresponding increase in activity of Big Brown Bat, which supports the hypothesis that interspecific competitive release is acting on these species. We processed 166 guano samples across four months for the nine roosts to quantify the relative proportions of prey items in the diet of Big Brown Bats. These proportions were compared to similar proportional estimates from before WNS and also compared to the proportional prey of Little Brown Myotis.

Roost-site Selection and Movements of the Townsend's Big-eared Bat
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We are studying year-round roost site selection and movements of the Townsend's big-eared bat (*Corynorhinus townsendii*; hereafter COTO) in the Inyo and White Mountains (Inyo and Mono counties), eastern California. Locating maternity roosts and hibernacula will provide land use and wildlife agencies the opportunity to actively manage these resources. We are using standard techniques to capture bats during the spring to fall activity period (early March to early November) to avoid disturbing hibernacula and maternity roosts. We implant each bat with a PIT tag for individual identification. We use both hand-held PIT recorders and activating readers to identify tagged individuals. Marking began in 2013 and continues to date. We have now marked >500 COTO that are associated with >15 maternity colonies and >100 hibernacula. To date, we have relocated 48 bats one time, 18 two times, and 6 three or more times. Preliminary results show that individuals in a maternity colony select multiple hibernacula, and members of different maternity colonies winter together. Distance moved between maternity and hibernacula range from 0 to 40 km, with an average movement of about 10 km. Site fidelity has been shown during both winter and summer. During 2014 we initiated tissue sampling for genetic analysis to supplement movement data and examine population structure, diversity, and dispersal; analyses are underway and preliminary results will also be presented.

Activity Patterns of the Hawaiian Hoary Bat at Pohakuloa Training Area

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Little is known about Hawaiian hoary bat (*Lasiurus cinereus semotus*) occupancy and seasonal activity patterns at Pohakuloa Training Area (PTA), a subalpine tropical dry forest on Hawaii Island. Due to the cryptic and mostly solitary nature of this bat, we used passive acoustic monitoring to study spatial and temporal movement patterns. We analyzed activity and weather data collected from 5 study regions, from July 2014-June 2015 and will model the relationship between bat presence and environmental covariates at 45 additional survey locations over the next three years. We installed a permanent weather station (Davis Instruments and EME Systems) and Anabat SD2 detector in 3 regions containing potential roosting habitat and 2 regions of open grasslands. Weather data recorded continuously while detectors recorded from sunset to sunrise. We indexed nightly bat activity as the number of 1-minute intervals containing bat calls as described by Miller (2001). We ran ANOVA and Tukey's SD post hoc tests and found that activity was significantly higher in the two grasslands throughout the year. Activity peaked in August during lactation season, and December-January, during mating/fledging season in these regions. Detectors in both grasslands are within 100m of a sparse row of Eucalyptus trees. From this year's data we conclude that bats may not prefer contiguous areas of tree roosting habitat at PTA. Rather, more open regions may provide roosting options while minimizing obstruction to foraging.

Bat Species Composition at Four National Parks in Southwestern Pennsylvania, Pre- and Post-White-nose Syndrome

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Knowing what species are present on the landscape is essential for managers to make informed decisions, especially with the changing status of many bat species in eastern North America due to the fungal disease white-nose syndrome. We inventoried bats at four national park properties from June through August 2015, including Allegheny Portage Railroad National Historic Site, Johnstown Flood National Memorial, Friendship Hill National Historic Site, and Fort Necessity National Battlefield. Using single-high and triple-high mist nets, we resampled sites that had originally been surveyed in 2005 and 2006. Data was standardized as captures per trapping hour. In the original surveys, five species were captured: *Myotis lucifugus* was the most common at 36.8 % of captures, followed by *M. septentrionalis* (29.2 %), *Eptesicus fuscus* (25.8 %), *Lasiurus borealis* (5.8 %), and *Perimyotis subflavus* (2.4 %). In 2015, during 27 nights of trapping, only three species were captured, including *E. fuscus* (88.6 % of captures), *L. borealis* (10.1 %) and a single *M. septentrionalis* (1.3 %). The very low captures of *Myotis* sp. are what one would expect to see in a post-white-nose syndrome region.

Statewide Acoustic Monitoring of Bats: Establishing the North American Bat Monitoring Program (NABat) in South Carolina

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Bat populations in North America are under stress from a number of threats including white-nose syndrome, habitat loss, and climate change. To better understand the impacts of these threats and allow managers to make well-informed decisions, large-scale bat population monitoring efforts are necessary. The recently released North American Bat Monitoring Program (NABat) plan provides guidelines for the implementation of continent-wide bat population monitoring using standardized methods performed by multiple agencies at local and regional scales. Our objective was to implement the NABat sampling design and protocols in South Carolina as the basis for a long-term monitoring program. During summer 2015, acoustic surveys were performed with Anabat SD2 detectors at 35 randomly selected, 100 km^2 cells across South Carolina. Mobile and stationary surveys were conducted in 14 cells while 15 cells received only mobile surveys and 6 cells received only stationary surveys. Call files were filtered for noise using AnalookW and then assigned a species or grouping using BCID 2.7c. The eastern red bat/Seminole bat group was the most frequently detected species on mobile surveys. Among cells with both survey types, there were 25 occurrences of a species being detected in a stationary survey but not in the corresponding mobile survey, and zero occurrences of the reverse. *Myotis* spp. and Rafinesque's big-eared bats were more likely to be detected in

stationary surveys. In conclusion, we suggest that when establishing NABat sampling protocols, conducting stationary surveys along with mobile surveys will likely increase the diversity of species detected.

Diurnal Activity in a Hoary Bat Maternity Roost in the Central Valley, Sutter County, California
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The Sutter Buttes are a unique geological formation in the Central Valley of California that supports maternity roosts for two Lasiurine bat species: hoary bats and Western red bats. Maternity roosts of hoary bats have been rarely observed and it is unknown if recordings from such roosts have been obtained. From July 15-30, 2014, a total of 72h 36m of dayroost video was recorded from a hoary bat maternity roost that contained a single adult female and two juveniles. Activity of the bats were determined from the videos and a range of behaviors were observed from simple waking and repositioning activity to complex grooming and social behaviors between the bats. Frequent arousals from sleep were observed and grooming, stretching, and yawning behaviors were commonly seen. Time spent in these activities during daylight hours was quantified.

***The Intracellular Entry Receptor Niemann-Pick C1 Controls Filovirus Susceptibility in African Pteropodid Bats**
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*** Melinda Ng** received the **Bat Conservation International Award**.

Ebola virus (EBOV) can infect a broad host range, however little is known about the biological factors that influence susceptibility. To determine if cell lines derived from African pteropodid bats are equally susceptible to EBOV infection, we performed infectivity assays and identified that cells from the African straw-colored fruit bat (*Eidolon helvum*) are resistant to infection, while cells from sympatric bat species are fully susceptible. The resistance in African straw-colored fruit bat cells can be explained by a single amino acid change in the endogenous NPC1, which greatly reduces EBOV affinity to the intracellular entry receptor Niemann-Pick C1 (NPC1), which was measured by ELISA. Genetic evolutionary analysis suggests that NPC1 is under positive selection at this exact residue that controls EBOV infection in these cells. Our work identifies NPC1 as the first known genetic determinant of filovirus susceptibility in bats, and suggests that this polymorphism in the African straw-colored fruit bat NPC1 may reflect a host adaptation to control replication of EBOV/EBOV-like filovirus. We also identified a single viral mutation that increases the EBOV-NPC1 affinity in *E. helvum*, revealing a possible avenue for a co-evolutionary arms race between the host and virus and the expansion of the EBOV host range in nature.

Investigating Bat Actinobacterial Microbiota and Natural Defenses against White-nose Syndrome
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Recent studies have shown that mammals, including humans, have a natural external microbial community that acts as a first line of defense against pathogens. We know little about this potential defense in bats and its effectiveness against *Pseudogymnoascus destructans*, the causative agent of white-nose syndrome (WNS). Our investigations of bat microbiota have revealed that Actinobacteria are found on many bat species in Arizona and New Mexico, especially on cave-caught bats. Actinobacteria are one of the most prolific producers of secondary metabolites, such as antifungals, and may represent a natural defense system by some bat species against *P. destructans*. To test this, we cultured external Actinobacteria from bats, subcultured 2500 isolates, most of which are Actinobacteria, and tested for the production of antifungals that are effective against *P. destructans* using a bi-layer method in the laboratory in which the Actinobacteria is grown on R2A media, followed by a second layer of fungal medium inoculated with a lawn of *P. destructans*. To date, eleven isolates inhibited *P. destructans,* ten of which were *Streptomyces* spp. and the 11th was *Rhodococcus rhodochrous.* Understanding the antifungal potential of the external microbiota on bats will help to identify potential WNS management tools. Also, investigations of microbiota, in particular actinobacteria, give us insight into what management strategies are likely to be successful. Testing of microbiota interactions will provide added insight into potential implications of different management strategies. USGS: This information is preliminary and is subject to revision.

Conservation Implications of Some Unusual Characteristics of the Endangered Florida Bonneted Bat
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The Florida bonneted bat (*Eumops floridanus*) is a poorly understood species endemic to south Florida. Although interest in the species has risen following federal listing in 2013, limited knowledge of these bats natural history precludes an understanding of their ecological requirements and subsequent development of effective conservation strategies. We investigated a population of Florida bonneted bats roosting in a group of 8 bat houses on a wildlife management area in SW Florida, attempting to capture and mark all bats from each house within a 4-day window once every four months for 1.5 years. Three facets of the species natural history set it apart from nearly all other species of bat in the US: morphology, social structure, and seasonality of reproductive activity. We discuss the conservation implications of sexual dimorphism, a harem social structure, and lack of a distinct seasonal birthing period.

Severe Declines in Bat Populations in Great Smoky Mountains National Park
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Great Smoky Mountains National Park (GRSM) is an ecologically rich and diverse protected area that hosts 12 bat species—at least 6 of which are susceptible to white-nose syndrome (WNS). The disease was confirmed in GRSM in early 2012; the park contains several important bat hibernacula, including one cave that is designated critical habitat for the largest known hibernating colony of endangered *Myotis sodalis* in Tennessee. We aimed to measure the impacts of WNS on bat populations across GRSM by assessing bat distribution and abundance 2–3 years after WNS was first confirmed in GRSM hibernacula. We compared captures per unit of effort (net area*hr) for summer mist-netting surveys conducted in 2009–2012 (10–15 nights/year) and 2014–2015 (34–40 nights/year). We detected significant and substantial post-WNS (2014–2015) declines in captures per unit of effort for *M. septentrionalis* (-94%), *M. sodalis* (-95%), *M. lucifugus* (-99%), and *Perimyotis subflavus* (-73%). Data were more promising for 2 other WNS-susceptible species—*Eptesicus fuscus* declined by only 14%, whereas *M. leibii* showed an overall increase by 24%. There have been no other obvious disturbances to the protected GRSM landscape during the study period and, thus, we conclude that these declines in summer captures are the result of WNS-induced mortality in wintering populations of bats. These data show that WNS has significantly impacted the bat community in this biologically important natural area.

Impact of Agriculture on Global Bat Assemblages

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Intensification in land use and farming practices has had largely negative effects on bats, leading to population declines and concomitant losses of ecosystem services. A growing body of research demonstrates that not only do some agricultural systems harbor high levels of biodiversity and provide a variety of ecosystem services, but that the characteristics of these agricultural systems may have profound effects upon remaining natural areas. We reviewed 68 studies that directly measured how agricultural management affects bat assemblage structure, behavior, and ecology in agricultural systems. Specifically, we reviewed studies that examined bat species richness, diversity, activity, or habitat selection in two or more agricultural systems differing in management intensity, or in studies that compared responses between forests and agricultural systems. Agricultural systems provide important habitat for global bat assemblages. However, bat responses are highly variable in different agricultural areas. Twenty-four studies (46%) demonstrated negative effects to agricultural conversion, ten (19%) showed little or no difference between agricultural and natural areas, while seven (13%) showed increased measures of bat richness, activity, or abundance in agricultural areas versus unmanaged habitat. Forty-five studies addressed some aspect of agricultural intensification, with far more concordance across studies: of these, 31 (71%) documented a negative effect of intensification on bats. Surprisingly, five studies (11%) documented increases in bat richness, abundance, or activity in more intensive systems. Given the importance of bats for global food production, future agricultural management should focus on 'wildlife-friendly' farming practices that conserve biodiversity and associated ecosystem services in the anthropogenic matrix.

Monitoring a Bat Population in Thailand Using Long-term Guano Harvest Records

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Reliable, long-term monitoring of bat population size is hampered by several factors, including the short-term nature of most funding and project cycles, physical and technological challenges to obtain accurate counts for large numbers of individuals, and personnel costs and time to implement longitudinal monitoring. Direct roost counts, evening emergence counts, mark-recapture, and thermal imaging, each have unique advantages and challenges to counting bats, but require standardization and application at the same site over many (>10) years to monitor long-term trends. We collected and analyzed a 15-year data set (1998-2013) of weekly bat guano harvest records from a cave at Khao Chong Phran Non-hunting Area in Ratchaburi, Thailand, to test if community guano harvesting may have value for long-term bat monitoring. Using time-series analyses, we found a 50% decline in estimated bat abundance over the time period after removing (decomposing) seasonal variation. We additionally analyzed environmental and weather data from Ratchaburi province and tested if fluctuations in guano volume were explained by environmental correlates. Mean monthly temperature was significantly and negatively correlated with guano volume across all data, but environmental factors did not explain the rapid inter-annual declines. Anthropogenic factors (mist-netting in agricultural fields, habitat loss) are likely responsible for the decreased abundance. *Chaerephon plicatus* (Wrinkle-lipped Free-tailed bat), the most abundant species at the site, is critical to controlling insects and providing guano for the surrounding agricultural community. Continued, sustainable guano harvesting practices combined with other conservation measures are urgently needed to conserve this species and the services it provides.

Explosive Metabolic Rates and Physiological Counter-strategies in Tent-making Bats

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The balance between energy intake, distribution and expenditure drives many aspects of animal ecology and evolution. However the relationship between the energetic cost of life and how it is maintained within an ecological context is not well understood for most animals. We take a multi-pronged approached to investigate how tent-making bats (*Uroderma bilobatum*) can maintain a high-energy lifestyle fueled primarily by fig juice. Instantaneous energetic expenditure (heart rate), metabolic incorporation rates (carbon dioxide isotopes of breath), and energy mobilization (glucocorticoids) all suggest that these bats suppress energetic expenditures at multiple physiological levels when at rest, but rapidly mobilize resources to fuel activity. *Uroderma* undergo cyclical depressions in heart rate during day roosting to less than 200 beats per minute (bpm) that counters heart rates of over 900 bpm during flight. They also use some of the fastest metabolic incorporation rates measured in flying vertebrates to support this explosive metabolic shift between rest and flight. Furthermore, *Uroderma* have low circulating glucocorticoid values that increase over 1000 times when stressed, which indicates rapid mobilization of glucose reserves as bats transition from rest to active states. While they use rapid metabolic rates when active, these bats employ multiple physiological strategies to compensate for these large energetic expenditure that complement their use of social information within the roost, and allows them to specialize on a widely distributed, but temporally unpredictable fruit resource.

A Different Kind of Black Gold: Molecular Characterization of Bat Guano Reveals Unique Pest Management Strategies

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Previous morphological and molecular studies have demonstrated that many bat species are voracious insectivores that exhibit a diverse arthropod diet. This insect consumption provides extensive ecosystem services including potential control of agricultural pests and carriers of vector-borne diseases. However, white-nose syndrome has dramatically reduced bat populations throughout the eastern United States; this sharp decline in primary insect consumers may have substantial impacts on these ecosystem services. We followed previously described next-generation molecular techniques to determine the composition of bat diets in New Hampshire each week throughout a single summer season. While previous research has demonstrated a change in community composition of bat prey between distinct seasons, our research provides resolution to assess the degree with which bat foraging reflects the dynamic and ephemeral nature of the insect community throughout the summer. In addition, our evidence suggests that monitoring bats in strategically defined geographic locations may provide a novel and effective monitoring strategy for the detection and management of forest pathogens and agricultural pests. The study provides a foundation for further research to measure potential impacts of decreased bat populations and correlated changes in insect community composition.

Occupancy Patterns of Western Yellow Bats in Palm Oases in the Lower Colorado Desert

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The western yellow bat, *Lasiurus xanthinus*, ranges throughout the lower Sonoran or Colorado Desert but otherwise very little is known regarding their specific occurrences in protected wildlands. In California, this bat is listed as a Species of Concern but has no official federal status. *L. xanthinus* is a tree roosting species that has a preference for roosting in palm trees, both native *Washingtonia filifera,* and non-native palms, where it roosts in the dead palm tree fronds that form a skirt on the palm. Even though the species is associated with palm trees, occupancy patterns across the Colorado Desert and what factors about the palm tree or a palm oasis are important to the western yellow bat for roost selection have remained unknown. Active, acoustical monitoring using an Anabat SD2 bat detector was used to conduct surveys at 41 palm oasis sites throughout the Colorado Desert and environmental variables were compiled for each oasis surveyed as a means to identify what attributes of a palm oasis facilitates or limits their use of these habitats. Western yellow bats were active at 33 sites and day roosts were confirmed at 19 sites. Compared to unoccupied sites, bats were found roosting in palm oases in higher elevations, new palm growth within the oasis, and oases with a full range of palm skirts lengths. Our findings have implications for managing palm oases for western yellow bats.

Water-borne Vibrations and Dynamically Inflating Vocal Sacs: a Multimodal Cocktail for Frog-eating Bats

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Across the animal world, elaborate courtship displays have evolved in response to sexual selection. Eavesdropping predators exert counter selection on male advertisement signals, exploiting them to detect, assess and localize potential prey. Investigating the interaction between calling túngara frogs and frog-eating bats, we assess costs and benefits associated with multimodal signaling in simple acoustic environments, in noise, and in echoacoustic clutter. We find that both female frogs (potential mates) and frog-eating bats (heterospecific eavesdroppers) prefer multimodal signals to unimodal ones, and that signal by-products, in the form of ripples on the water surface produced by the inflation and deflation of the male frog's vocal sac, significantly increase both rival male behavior and predator attacks. We investigate the role of background noise and echoacoustic clutter on bat preferences for uni- versus multimodal cues, and quantify bat localization behavior amidst heterospecific chorus noise, with and without the presence of a robotic túngara frog with a dynamically inflating vocal sac. Our studies illustrate the role of environmental complexity in mediating costs and benefits associated with multimodal signaling.

Use of an Urban Park by Big Brown Bats

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Some animal species show great capacity to adapt and succeed in highly urbanized landscapes, often making use of networks of green spaces. Big brown bats (*Eptesicus* fuscus) are one such species, known for their ability to use a range of landscapes, including urban areas. Here, we examined how big brown bats use space in High Park, a large urban green space in Toronto, Ontario. We hypothesized that High Park would provide ideal foraging and roosting habitat for maternity colonies of big brown bats given the large size (161 ha) of the park, presence of unmanaged forest, and the high degree of development in the surrounding area. Throughout June-August 2015, we captured bats in the park and radio-tracked individuals to determine foraging and roosting locations. We caught 54 big brown bats in the park, the majority of which were male (n=44, 86%). Of the 10 bats we radio-tagged, we located roosts for 5 bats, none of which were in High Park. Roosting locations included trees in residential areas (n=2 males, 1 female) and a residential building (n=2 females) that housed a maternity colony of roughly 42 bats. We trapped 14 adult females and 11 juveniles from this colony. Eight radio-tagged bats were heard foraging in the park. Females (n=2) foraged primarily over/near bodies of water, while males foraged throughout the park. Our results suggest that although High Park may be ideal for foraging, suitable roosting habitat, particularly maternity roosts, may be limited. Additionally, there may be sexual segregation of foraging areas.

Steps Toward *The Bats of Kenya*: Identification and Characterization of *Rhinolophus* (Chiroptera: Rhinolophidae)

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Rhinolophus is a diverse bat genus centered in the Old World tropics, and found across Africa, southern Europe, temperate and tropical Asia, and tropical portions of Australasia. Fourteen of the 74 species recognized by IUCN (2011) are thought to occur in East Africa. The genus occupies various localities and habitats throughout Kenya, where it is rare for more than two species to co-occur. To better understand their distributional limits, we evaluated

members *Rhinolophus* throughout Kenya using mitochondrial DNA (cyt-b), external measurements, and echolocation calls. To date, our preliminary analysis has identified 8 reciprocally monophyletic lineages, most of which are readily recognizable as species already known to occur there. However, three different lineages (in two geographic clusters) all key out to *Rhinolophus eloquens,* indicating the need for additional revisions to the systematics and taxonomy of this group.

Effects of Cave Disturbance on Multiple Health Parameters in a Least Concern Species, *Hipposideros diadema*

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Caves represent critical roosting sites for numerous bat species, yet cave disturbance is the leading cause of declines in cave-roosting bat populations. To prevent species loss it is essential to understand underlying mechanisms by which species respond to cave disturbance. Glucocorticoid (stress hormones) concentrations are effective for understanding physiological mechanisms by which species respond to human pressures, but blood must be sampled within 3 minutes of exposure to an acute stressor, such as capture or handling. Peripheral blood profiles allow for more lenient sampling constraints and represent baseline stress levels. Nonetheless, it can be difficult to assess physiological responses of threatened species to cave disturbance because of policy restrictions, small population sizes and restricted geographic distributions. Instead, least concern species may be more applicable than threatened species for early detection of potentially deleterious effects of cave disturbance. *Hipposideros diadema* (Diadem roundleaf bat) is a widespread, common bat species found throughout Southeast Asia. We compared physiological markers in peripheral blood, specifically differential and total white blood cell counts and neutrophil:lymphocyte ratios, ectoparasite prevalence and health condition of 765 individuals from 31 caves with differing levels of disturbance. Generalized linear mixed effect models are used to compare measured parameters with principal components representing 18 factors of cave disturbance. Results reveal the consequences of increasing cave disturbance on physiological health, which has the potential to impact population sizes of this least concern species.

Investigating Genetic Demography of the Common Vampire Bat at the Edge of Their Range

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Understanding demography of a species at the edge of its range can provide insight into factors influencing the distribution of a species. Obtaining information from DNA and applying a Bayesian statistical framework allows inferences about demography and evolutionary history. In a long term study from 2003-2010 we sampled common vampire bats (*Desmodus rotundus*) across the north-easternmost portion of their range in Mexico. We collected over 600 samples and obtained mitochondrial DNA sequences and nuclear DNA genotypes from 12 microsatellites. One goal was to test for population expansion as field work suggests vampire bats from this region are being found farther north and at higher elevations than expected. Another goal was to estimate a date for the beginning of population expansion to infer if expansion was potentially due to human and livestock availability or if it pre-dated the appearance of those resources. From the mitochondrial DNA sequences we generated haplotype networks, Bayesian skyline plots, and calculated mismatch distribution, Fu's F_s and Tajima's D to infer recent and historical demography. Further we used an approximate Bayesian computation with our total genetic data to test various models of demography. We find that vampire bat populations are expanding in this region and it may mean that monitoring and surveillance for vampire bats and their associated rabies virus in livestock and wildlife populations at the U.S./Mexico border region would be prudent.

Climate Change Modeling Reveals Major Shifts in Suitable Habitat Niches for Western North American Bats

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Climate change is affecting the distribution and abundance of numerous organisms, including bats. Species with narrow ecological niches may be more greatly affected than generalists, and while some bat species could benefit by increasing density or expanding ranges, others, especially those occupying cooler biogeographic and or more restricted ranges, may go extinct. We used presence only modeling to determine how future climate change scenarios may affect the distribution, community composition, and suitable climatic niches for 18 bat species with the centroid of their ranges in Western North America. We used 5,312 species occurrence records obtained from open-source, NatureServe, and Heritage databases, climactic data from Worldclim, and Maxent modeling algorithm to project changes in suitable habitat niches over the next 100 years at three different Green House Gas (GHG) emission scenarios, from moderate (RCP 2.6) to severe (RCP 8.5). Emissions scenarios were derived from the International Panel on Climate Change. There was a reduction in species diversity and suitable habitat area under increasing GHG emissions scenarios, especially at higher altitudes and latitudes. The average range shift for 16 of the 18 species was approximately 200 km northwest under the moderate emissions scenario and 400 km under the most severe scenario. While the range of some species such as *Corynorhinus townsendii* and *Leptonycteris* changed little or expanded slightly, others such as *Myotis thysanodes* contracted significantly. These results will be used to inform climate adaptation strategies and conservation actions to conserve the species most affected by climate change.

Effect of Phyllostomidae Bat Ingestion and the Use of Hypochlorite on Seed Germination

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Frugivorous bats may influence the germination of seeds by endozoochory. Hypochlorite is employed to combat seeds contamination with microorganisms. This study aimed to evaluate the efficiency of germination of three pioneer species after passage through the digestive tract of *Artibeus lituratus* (Olfers, 1818) and the effect of washing with hypochlorite on the germination and contamination of seeds with microorganisms. From August 2013 to August 2014, seven samples were examined, which were collected from four bats in two fragments of a seasonal semi-deciduous forest located in southern Brazil. The animals were placed in cages where each individual received half of a respective fruit (*Ficus adhatodifolia* Schott in Spreng, *F. guaranitica* Chodat and *F. luschnathiana* (Miq.) Miq.), and the other half was used as a control group. Four treatments were designed: Group Feces; Group Feces (hypochlorite); Group Fruits; and Group Fruits (hypochlorite). The percentage of germination (PG), the germination speed index (GSI), and the mean germination time (MGT) were calculated and compared by two-way ANOVA and Fisher test (95% probability). To compare treatments between the different plant species, a PERMANOVA (95% probability) was applied. *Ficus guaranitica* was the only species that showed significant differences between groups feces and fruits, indicating that *A. lituratus* is a good inducer of germination for this species. *Ficus adhatodifolia* and *F. luschnathiana* presented a significant difference for the hypochlorite, which delayed germination. Results varied depending on the plant species, demonstrating the importance of this type of study to increase knowledge about the quality of dispersion by *A. lituratus*.

Hemoparasites in Madagascar Fruit Bats

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Though bats have been acknowledged reservoirs for several families of intraerythrocytic protozoans (parasites which infect host red-blood cells, including species of the same *Plasmodium* genus as human malaria) for over a

century, in Madagascar, no published work confirms hemoparasite infection in any of three endemic fruit bats. Microscopy on blood smears collected by our team in 2013-2015 is suggestive of blood parasite (*Hepatocystis* spp.) infection in at least two species of Malagasy fruit bat (*Pteropus rufus* and *Eidolon dupreanum*). Life stage specific patterns in pathogen prevalence in both bat species mimic those observed for malaria pathogens in other mammals (including humans), with elevated prevalence in susceptible young. Higher prevalence in tree-roosting *P. rufus* versus cave-roosting *E. dupreanum* is suggestive of a mosquito vector mode of transmission, a hypothesis we test with theoretical models of vector-borne disease dynamics.

Born to Fly? Ontogeny Suggests Pterosaurs Could Fly Right Out of the Egg
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Among vertebrates, the extinct pterosaurs represent the first evolutionary experiment in powered flight. Birds, then bats, are the only other vertebrate groups ever to have evolved this means of locomotion. Bats, and most birds, cannot fly when they are born or hatch and most species take several weeks to attain powered, controlled flight. Having reached static size and dimensions, bats and birds also tend to occupy the same ecological niche over their lifetime. Deviating from both patterns, our results suggest that basal pterosaurs, first, like brush turkeys, hatched able to fly and, second, apparently moved through a time-ordered, age-dependent series of ontogenetic foraging niches, like crocodiles and some other reptile groups. In basal pterosaurs, these niches are reflected by absolute size differences, but not size-independent differences in body and wing design.

Gaps in our Understanding of African Bat Ecophysiology - Lessons from South Sudan
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Bats are known and suspected carriers of a variety of pathogens, including viruses. The ability of bats to host, maintain and transmit these pathogens is likely related to their health status, which itself likely varies by sex, age, reproductive condition and a variety of social factors, including the formation of multi-species assemblages. Currently lacking is a comprehensive metric of 'bat health' to inform these types of studies. Based upon our work in South Sudan, we will present data on our attempts to quantify health and immune status in a variety of bat species, with an emphasis on the Gambian epauletted fruit bat (*Epomophorus labiatus*). Metrics in our assessment of health status include: body mass index (BMI) and ectoparasite load (both of which are commonly used by bat biologists), blood parasite load (malarial parasites and trypanosomes), white blood cell counts (assessing immune status and stress), blood chemistry (informing acid-base balance, electrolytes, liver and kidney function, metabolism, and degree of anaemia), and the response to immune challenge. In the peridomestic *E. labiatus,* health status varied by sex and habitat disturbance level, but BMI did not differ by season and blood parasite levels were not related to stress (as indexed by the neutrophil/lymphocyte ratio). Studies such as these will inform our understanding of the nuances of disease spillover risk and inform conservation and education strategies.

Genus *Tadarida* (Rafinesque, 1814): from Sicily with Love!
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Tadarida (Rafinesque, 1814) is a genus of the bat family Molossidae. The derivatio nominis of this genus, described by Constantine Samuel Rafinesque (1783-1840), has been subject to various assumptions, sometimes quite imaginative. Rafinesque lived in Sicily (Italy) from 1805 to 1815 and he published in Palermo "Précis découvertes et des travaux somiologiques" (1814), with a description of a new species of bat, *Tadarida teniotis*. The word "tadarida", with different variations including taddarita, taddarida, tallarita, tallarida, taddrarita, is still frequently used in Calabria and Sicily to refer generically to "bat", regardless of the species. The first mention of the word "tallarita" dates back to a manuscript from 1348 (Angelo Senisio - Declarus). We also found these local names for "bat" in Sicilian beliefs, legends, and poems. Therefore Rafinesque did use a dialect word he had heard during his naturalistic excursions in Sicily. With good grounds the etymology of "tadarida" is from Greek: the feminine greek noun νυκτερίς (nykterís) = "bat" [genitive νυκτερίδος (nykterídos)] became "tadarida" in Southern Italy

(Sicily and Calabria) due to apheresis and dialect deformation. According to Vinci (1759) this term should instead have Hebrew origin: עטלף (atalleph') means "bat", hence "tadarida". Pasqualino (1790) reports this hypothesis without much conviction**.** Just to mention there is also a supposed (but unfounded, according to Ruffino, 1991) Arabic root *tayr al layl* .

***Seed Dispersal and Habitat Selection by Tent-roosting Bats in the Great Lacandona Ecosystem**
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*** Marina Rivero** received the **Bernardo Villa Award**.

Seed dispersal is essential for the maintenance of tropical forests. However, current defaunation caused by human factors, is producing a reduction in large-body frugivorous populations, which threatens the demographic recruitment of many of the tropical trees species. Therefore, it would be expected that the remaining fauna, composed mainly of small vertebrates, and especially fruit-eating bats, play a key role in the dispersal of large-seeded plants. Moreover, bat roosts are very important sites for mating, hibernation and raising the offspring. Therefore, environmental characteristics associated to the roots sites can be determining in the roost selection by bats. The general objective of this study was to determine the effect of seed dispersal by tent roosting bats and to describe the characteristics of the vegetation associated to the bat tents in two localities of the Great Lacandona Ecosystem (GLE). We found 4 different tent architectures, and a tent density of 9.4 tents / ha. We also found that tent roosting bats can disperse at least 54 seed species > 5mm. We extrapolate the deposition rate generated by the tent-roosting bats to know their effect over the seed dispersion in all the GLE. Finally, we found that tent-roosting bats show preference for certain vegetation characteristics to establish the tent. Our findings suggest that the tent roosting bats plays a very important role in the maintenance and regeneration of the tropical forest and they depend of certain characteristics of the forest to construct their tents.

Habitat Use of Bats on the UC Big Creek Reserve in Coastal California
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The University of California Natural Reserve System contains 39 protected sites spanning across California. Accurate species lists and understanding how species use reserve habitats help fulfill the education and research mission of the UC reserve system. The Landels-Hill Big Creek Reserve on the Big Sur Coast in California has an incomplete species list of bats and not much is known about habitat use and activity on the reserve. We examined bat community composition and habitat use in three dominant habitat types found on the reserve: grassland, chaparral, and redwood riparian during summer 2015. We sampled bat echolocation activity at three sites in each habitat type for 7 days each using acoustic bat detectors (Songmeter, Wildlife Acoustics). Echolocation data were analyzed and automatically classified to species using Kaleidoscope Pro software (Wildlife Acoustics). Our results show that overall bat activity was significantly higher in redwood riparian habitats ($p<0.005$) compared to either chaparral and grassland. Chaparral habitats had significantly more bat activity than grasslands ($p<0.005$). We acoustically detected a total of 14 bat species and species richness was similar across all three habitats. Habitat use varied among species and some species, such as *Lasiurus cinereus*, were only found in chaparral or grassland habitats. Our results indicate that bats are an important part of the faunal diversity on the UC Big Creek reserve and the redwood riparian and chaparral habitats support the highest activity of bats.

Using False-Positive Occupancy Models to Refine Distribution Models for Imperiled *Myotis* in Northeast Tennessee
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To develop effective management plans for the federally endangered *Myotis sodalis* and threatened *Myotis septentrionalis*, we must understand their distributions. Traditionally, mist-netting surveys were used to assess presence/probable absence of endangered bats. The distribution of *M. sodalis* encompasses the North Cherokee National Forest (CNF), but past mist-netting surveys have failed to document the species there. *M. septentrionalis*

once comprised the bulk of mist-net captures on North CNF. However, populations of both *Myotis* are in steep decline due to white-nose syndrome— first detected on the North CNF in 2009–10. Mist-net surveys are a challenge with dispersed, low density bat populations; acoustic surveys aid in detecting rare and cryptic animals, but we risk false positives. From May to August 2013–2015, we surveyed 37 road corridor sites on the North CNF for presence/probable absence of *M. sodalis* and *M. septentrionalis*, using both mist-net and acoustic (Anabat SD2s; analyzed using Bat Call ID v2.7c) methods. *M. sodalis* were not captured at any site, but represented 0.99–2.1% of acoustic files each year (recorded at 28 sites). *Myotis septentrionalis* were captured at 12 sites and represented 0.63–3.8% of acoustic files each year (recorded at 31 sites). We aim to assess the effects of survey-specific covariates, e.g., temperature and humidity, on detection probabilities for each survey method. For greater veracity, we chose false-positive multi-season occupancy models, which account for non-detection and misidentified detections. With decreasing populations and capture likelihoods, such probabilistic models lead to more reliable distribution models and, hence, management plans.

The Evolution of Hindwing Shape as an Anti-bat Strategy in Silkmoths

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Bats and moths have been engaged in acoustic warfare for more than 60 million years. Yet almost half of moth species lack bat-detecting ears and still face intense bat predation. We recently demonstrated that the long tails of one group of seemingly defenseless moths, silkmoths, are an anti-bat strategy designed to divert bat attacks. Here we present preliminary data testing the hypothesis that long hindwing tails evolved through several intermediate steps from lobed hindwings to short projections and finally to full tails that are under selection to continue lengthening. We hypothesize that each intermediate step provides a greater survival advantage by moving the location of bat attack further away from critical body parts. We are using a combined natural (species that naturally vary in hindwing lobe size and hindwing tail length) and experimental (glueing wing area from conspecifics to enlarge hindwing lobes or elongate hindwing tails) approach to test these hypotheses in a phylogenetic context.

Impact of Heavy Metal Pollution on Free-living Daubenton's Bats

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Because of their longevity and top position in the food web, bats can be vulnerable to the impact of chronic exposure to environmental toxins. In specific, due to their foraging ground specificity, Daubenton's bats *(Myotis daubentonii)* living in close proximity to industrial pollution sources may also be exposed to contaminants through diet. Such long-term toxicant exposure can cause sub-lethal effects affecting individual's health and fecundity. Both can eventually lead to a decline in population size. During May-August of 2014, ca. 60 Daubenton's bats inhabiting in the vicinity of a Cu-Ni Smelter in Finland were sampled. Morphometric measurements were obtained and fecal pellets were collected for the quantification of heavy metals (As, Cd, Cu, Ni, Pb) with ICP-MS. These toxic metals have been aerially deposited from the smelter for over 40 years, causing disruption in the vegetation composition and detrimental effects in the surrounding fauna and flora. Results show elevated concentrations of some metals including cadmium from the smelter bats in comparison to our reference sites. Additionally, a negative association between cadmium levels and haematocrit indicates adverse effects on exposed populations, which will be further investigated with oxidative stress biomarkers.

Using LiDAR Derived Three-dimensional Forest Metrics to Predict Bat Species Habitat Use in New England

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Bats are an important feature of ecological communities and provide a number of ecological and economic services such as pest control and pollination. Bat populations in New England are thought to have declined by upwards of 7 million since the discovery of white-nose syndrome, and up to 900,000 annually as a result of wind turbine development, in conjunction with other factors. As part of my Master's thesis, I have conducted 4 iterations of 6 acoustic transects in New England and classified over 800 bats across the region. I identified the echolocation calls using Kaleidoscope Pro and manual vetting and have paired bat locations with 3D forest structure and composition metrics obtained remotely via LiDAR technology and satellite imagery. Currently I am in the process of modeling bat forest structure and habitat preferences in New England forests using Software for Assisted Habitat Modeling (SAHM), which simultaneously executes 5 modeling frameworks. This model could be used to guide bat habitat conservation and management efforts to help mitigate the effects of disturbance and disease on bat populations throughout the region.

Two Tickets to Paradise: Multiple Dispersal Events in the Founding of Hoary Bat Populations in Hawai'i

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The Hawaiian Islands are an extremely isolated oceanic archipelago, and their fauna has long served as models of dispersal in island biogeography. While molecular data have recently been applied to investigate the timing and origin of dispersal events for several animal groups including birds, insects, and snails, these questions have been largely unaddressed in Hawai'i's only native terrestrial mammal, the Hawaiian hoary bat, *Lasiurus cinereus semotus*. Here, we use multilocus molecular data to test the hypotheses that (1) Hawaiian *L. c. semotus* originated via dispersal from North American populations of *L. c. cinereus* rather than from South American *L. c. villosissimus*, and (2) modern Hawaiian populations were founded from multiple dispersal events, and thus represent differentiated populations with distinct evolutionary histories. Mitochondrial data support a biogeographic history of multiple, relatively recent dispersals of hoary bats from North America to the Hawaiian Islands. Coalescent demographic analyses suggest that modern populations of Hawaiian hoary bats were founded no more than 10 kya. Our finding of multiple evolutionarily significant units in Hawai'i highlights a need to re-evaluate the conservation status of hoary bats in Hawai'i.

Energetic Costs of Social Communication

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Bats that form stable social groups but use ephemeral resources face the energetic challenge of maintaining contact with group members as they move about the landscape. Yet, although fitness and survival are determined by the way they use energy, bioenergetic approaches to the study of group living are rare. Spix's disc-winged bats are known to use acoustic communication for relocating group mates and finding ephemeral roosts. This species uses furled leaves as roosts that are only available for a day. Despite the ephemerality of roosts, Spix's disc-winged bats form stable social groups, making them an ideal system to disentangle the energetic costs associated with social communication and group cohesion. To do this, me measured individual CO_2 production inside a respirometry chamber in two different settings: 1) at rest, and 2) while producing social calls. To induce call production, we reproduced contact calls inside the chamber. Overall, we found higher levels of CO_2 production and activity during playback trials. At the individual level, bats produced more CO_2 when calling, compared to resting periods. However, calling time did not have an effect on CO_2 levels. These results provide real measurements of energy expenditure related to call production, as well as energy invested in maintaining constant communication with group members while foraging and during roost finding.

Go Big or Go Fish: Morphological Specializations in Carnivorous Bats

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In bats, the ability to consume vertebrate prey has evolved multiple times but is a relatively rare feeding habit. While morphological specializations for vertebrate consumption have been identified in other mammal groups, it is unclear if there are any traits that jointly characterize carnivorous bats. Previous studies suggest that carnivorous bats tend to be relatively large and have skull morphologies that could enable high bite forces, but recent work indicates that large body size is not a requirement for the consumption of vertebrate prey in bats. Here, I apply modern morphometric tools and a phylogenetic comparative framework to answer three long-standing questions regarding the evolution of carnivory in bats: are carnivorous bats larger versions of their insectivorous relatives? Do

distantly related carnivorous bats share functionally-relevant cranial traits? And, are these traits similar to those found in non-volant eutherian carnivores? To answer these questions, I analyze the influence of dietary specialization on body size and cranio-mandibular shape, and contrast patterns of morphological evolution across bat clades and in relation to carnivorous carnivorans. When compared to insectivores, bat species that regularly feed on terrestrial vertebrate prey are larger and exhibit positive allometry in skull and mandibular shape. While carnivorous bats still share many similarities with insectivorous species in the morphology of the feeding apparatus, piscivorous bats are remarkably different. The cranio-mandibular shapes of some insectivorous and carnivorous bats closely resemble those of carnivorous carnivorans, indicating potential convergence on functional aspects of their dietary ecology.

Hepatocystis of African Fruit Bats – Evidence for Continuous and Efficient Transmission Cycles

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Parasites of the genus *Hepatocystis* are the closest relatives of *Plasmodium,* the causative agent of malaria. Hallmarks of *Hepatocystis* infections in mammalian hosts are parasite replication only during liver infection and complete differentiation of first generation blood stages into sexual stages for subsequent vector transmission. Lack of intermittent erythrocytic replication cycles, the exclusive cause of malaria-related morbidity and mortality, suggests alternative parasite/host co-evolution. Here, we present a serial survey of *Hepatocystis* infections in sympatric fruit bats from five consecutive biodiversity surveys in remote areas of the Republic of South Sudan. A combination of microscopic and molecular methods revealed high prevalences of *Hepatocystis* infections in four pteropodid (fruit bat) genera. Infected individuals were recorded both in the dry and wet seasons. Parasitemia levels differed during the years and suggest a seasonal pattern. Preliminary data of histological investigations of the parasites´ tissue stages show that parasites are simultaneously present in the host blood and host tissue. Summarizing, these data indicate continuous and efficient transmission cycles of *Hepatocystis* parasites in African pteropodid bats.

Counting the Night's Watchmen

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Traditional methods for surveying hibernating bats include direct counts, estimation of large clusters, and digital photography for manual counting. These methods inherently have different advantages, disadvantages, and biases. Terrestrial light detection and ranging (T-LiDAR), technology is emerging as a potential tool for biological surveys in subterranean habitats. T-LiDAR has been used to count the number of horseshoe bats in a Malaysian cave (Azmy et al. 2012). Researchers were able to generate a 3D model of the cave and use a detection algorithm to automatically count all roosting bats. This approach was successful only because individuals roosted singly. Many North American bats roost in tight clusters, making use of the extraction function in T-LiDAR reading software impossible. Here, we developed a proof-of-concept for using T-LiDAR scans to automate estimation of gray bats (*Myotis grisescens*) hibernating in Long Cave, Mammoth Cave National Park, Kentucky, USA. We conducted two series of T-LiDAR scans: winter scans when hibernating bats were present and summer scans when bats were absent. We calculated the volumetric differences between scans at locations with bat clusters of determinable size, estimated an average volume for a single bat, and applied the result to clusters of unknown size. This method can be scaled-up to estimate the total number of hibernating gray bats in the cave. This unique model is the first time T-LiDAR has been used to automate counting of hibernating bats in North America. Refinement of this methodology should allow managers to quickly, quietly, and more accurately estimate hibernating bat populations.

Climbers for Bat Conservation: Citizen Science for Understanding Bat Use of Cracks and Crevices

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Some North American bat populations have been decimated by white-nose syndrome (WNS). Most of these population impacts have been in eastern North America, but WNS appears to be moving westward. The dramatic population declines at cave and mine hibernacula have made the severity of WNS clear, yet there are many regions of North America where bat roosts are more dispersed and less conspicuous, making it more challenging to document population-level impacts. It is possible that there are large colonies of bats in inconspicuous rock cracks and crevices. Finding such roosts would provide locations for monitoring bat population persistence in regions where cave and mine roosts are unknown. We developed a collaboration with the rock climbing community in northern Colorado to enroll rock climbers as information resources for bat roost locations. The project, called Climbers for Bat Conservation (http://climbersforbats.colostate.edu), brought bat biologists, land managers, and climbers together to discuss the pros and cons of collaborating and how best to develop the collaboration. Climbers for Bat Conservation has engaged the climbing community by hosting climbing nights at local gyms and conducting bat surveys with climbers. Climbers are submitting information via iNaturalist, postcards, and climber feedback on The Mountain Project (www.mountainproject.com). Most submissions have been of singular roosting bats, but several accounts have reported >100 bats in crevices. Future effort will use groups of climbers to target specific climbing routes where large numbers of bats are suspected.

Roost Tree Characteristics of the Southeastern *Myotis* and Rafinesque's Big-eared Bat in the Bottomlands of Arkansas

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Little is known about the roosting ecology of the southeastern myotis (*Myotis austroriparius*) and Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) on the Cache River National Wildlife Refuge, which is one of the largest continuous tracts of bottomland forest in the Mississippi Alluvial Plain. Accordingly, the objective of this study was to describe characteristics of roosts selected by the southeastern *Myotis* and Rafinesque's big-eared bat. We affixed transmitters to 23 *M. austroriparius* (13 males; 10 females) and 9 *C. rafinesquii* (5 males; 4 females). Bats were tracked daily to their roost trees for the life of the transmitter. We identified roosts used by 20 bats with some bats using multiple roosts. Twenty-nine roost trees were water tupelos (*Nyssa aquatica*), 4 were bald cypress (*Taxodium distichum*), but other trees included a black tupelo (*N. sylvatica*), red maple (*Acer rubrum*), American hornbeam (*Carpinus caroliniana*) and an American sweetgum (*Liquidambar styraciflua*). All roosts were in living trees. *M. austroriparius* roost trees (random trees) had a mean diameter at breast height (DBH), basal area, height and canopy coverage of 232.7 cm (134.04 cm), 146.49 ha (123.61 ha), 36.61 m (24.84 m), and 78.5% (75.97%), respectively. *C. rafinesquii* roost trees (random trees) had a mean DBH, basal area, height, and canopy coverage of 390.83 cm (139.09 cm), 190 ha (111 ha), 40.28 m (30.48 m), and 80.69% (72.22%), respectively. Roost trees for both species were in taller, larger trees with more canopy coverage and in thicker stands than trees selected at random.

Bat Activity Patterns in Philippine Rice Fields

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Rice fields cover over 35.8 million ha of land in Southeast Asia and serve as artificial wetlands and foraging habitat for bats. Despite the predominance of this habitat across the landscape, very few studies have attempted to describe bat assemblage structure or bats' response to spatially and temporally dynamic insect prey, many of which may be harmful crop pests (e.g., stem borers, plant hoppers) or vectors of human disease (e.g., mosquitoes). Here, we present a theoretical framework for investigating assemblage structure and predator-prey interactions in a rice field ecosystem, and results from passive acoustic monitoring over early and late vegetative rice stages at the International Rice Research Institute. Three bat guilds were present, each with different call structure and flight behavior. The majority of the bats detected were edge-space species with characteristic frequencies between 35-45 kHz. Overall, bats exhibited a bimodal nightly activity pattern, with a peak in the early evening and a more abrupt peak just before dawn. Moreover, bat activity was significantly higher over early than over late vegetative rice stages, but only during the first half of the night. We hypothesize that this activity difference was driven either by higher prey availability at the early vegetative stage, or that the persistent ultrasonic sounds produced by Orthopterans (especially katydids) in closed-canopy paddies discouraged bat foraging. These data provide evidence that bats are highly responsive to insect behavior over the course of the night, as well as at a relatively small spatial scale.

***Isotopic Insight into Foraging by Two Very Different Species of Bats**
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* **Sierra Sell** received the **Avinet Award.**

Information about foraging ecology of insectivorous bats is heavily based on visual identification of fecal contents. Stable isotope analysis (SIA) is a powerful way to assess ecologically meaningful patterns in foraging, but it has not been widely used to study diet in bats. We studied diet by measuring stable carbon (δ13C) and nitrogen (δ15N) isotopes in fur of 63 *Eptesicus fuscus* (big brown bat) and 72 *Myotis leibii* (eastern small-footed bat) in New Hampshire, Virginia, South Carolina, and Tennessee Results suggested both species had relatively large overlap in diet, for both isotopes, although small-footed bats had a significantly larger range for nitrogen values. Both species also showed similar effects of geography, with bats from New Hampshire having more diverse carbon and nitrogen signatures than bats from the Mid-Atlantic States. The results from this analysis are consistent with traditional diet literature, suggesting broad feeding habits that are influenced by broader ecological factors.

Winging It in the Islands: Bat Conservation in a Sea of Unknowns
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The Hawaiian hoary bat or ʻōpeʻapeʻa (*Lasiurus cinereus semotus*) is a federally and state-listed endangered subspecies. Due to the cryptic and solitary nature of the ʻōpeʻapeʻa, knowledge of its ecology and life history is limited. However, impacts to the species from wind energy development starting in 2006 have drawn attention to the fact that, although total population remains unknown, bats may be more widely distributed than originally thought, and are colliding with turbines at a much higher rate than expected. This presents significant challenges to regulators and project proponents tasked with evaluating and offsetting impacts to a species that we know relatively little about. Advancements in ecological research have improved our understanding of this species in recent years, but have also led to dramatic and frequent changes in management approaches in a relatively short period of time. The state Division of Forestry and Wildlife has made a concerted effort to create consistent guidelines for developers attempting to avoid, minimize, and mitigate for incidental bat take, and for wildlife managers overseeing and implementing conservation and recovery efforts. These guidelines have been developed based on current research, interagency consultation with the US Fish and Wildlife Service, and a two-day state Endangered Species Recovery Committee workshop that brought together government regulators, ecological researchers, consultants, industry personnel, and members of the public. This talk covers management challenges, our approach to reaching solutions, and next steps for ʻōpeʻapeʻa management on the Hawaiian Islands.

Bats Do Not Do Hula-Hoops
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Echolocating bats routinely fly through complicated natural scenes, such as vegetation, which present multiple sources of echoes. Obstacle-avoidance tests of flight guidance have sought to mimic the spatial complexity, density, extent, and local asymmetry of natural scenes while also offering better quantitative control of scene structure. Bats have proven able to negotiate even the most complex, cluttered experimental scenes while adapting their broadcasts to the requirements of prevailing echo sequences. The bat's primary challenge is to perceive whether the immediate path forward is safe, or whether maneuvering is necessary to pass. From acoustic considerations, we have identified a novel configuration of obstacles that severely challenges sonar guidance. Echoes reflected by open rings have unique characteristics that interfere with perceiving that the path forward through the center of the ring is unobstructed. We conducted flight tests with big brown bats in a 5.4 m long tunnel consisting of a long row of 36 hula-hoops 90 cm in diameter spaced at regular intervals of 15 cm. When first exposed to this scene, bats fly only part-way along the tunnel before abruptly swerving to exit between adjacent hoops. Bats with long experience in flight tests along rows of vertical plastic chains often adapt to the tunnel and are able to complete their flights. Naïve bats are flummoxed by the hoops and exit rapidly with violent flight maneuvers. Interpulse-interval patterns reveal that the bats consider the task to be very difficult with regard to perceptual ambiguity associated with scene density and spatial extent.

Bats!

Nancy Simmons and Andrea Cirranello
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The last comprehensive list of chiropteran species published in Mammal Species of the World in 2005 recognized 1116 bat species. Although this represented a significant increase over previous tallies, bat species diversity has continued to climb. In the subsequent decade, over 250 additional species have been documented (and a few sunk), and as of August 2015 we recognize 1349 valid bat species. The greatest increases in diversity come from newly discovered, newly-named species rather than the elevation of subspecies or other junior synonyms (previously named by earlier workers) to full species rank. New, critical data take many forms including morphometric and other morphological data, echolocation call structure and frequencies, and DNA sequence data. The majority of new species described recently come from diverse and poorly-known tropical faunas and/or regions where water barriers have made it difficult to interpret patterns of morphological variation. Not surprisingly, the largest increases in recognized species diversity have occurred in the larger families with broad tropical distributions (e.g., Phyllostomidae with >50 new species since 2005, and Vespertilionidae with >100 new species). The greatest hotspot for description of species entirely new to science (rather than those resurrected from synonymy) is South America, which has seen 43 completely new species named since 2005, the majority of these (>70%) within Phyllostomidae. In sum, the large numbers of new species documented in recent years indicates that we are in the midst of a new "Age of Discovery" for bat diversity. Clearly many more new species remain to be discovered.

Altitude- and Sex-specific Variation in Roosting Behavior and Thermoregulation of *Myotis lucifugus* in Yellowstone National Park

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Little brown bats are common summer inhabitants of Yellowstone National Park (YNP), living at elevations above 1,800 m. These high-elevation populations of little brown bats survive in energetically challenging environments. We examined roosting behaviors and thermoregulatory patterns of bats from four lower, high-altitude sites with elevations ranging from 1,890 – 1,981 m, and one higher, high-altitude site at an elevation of 2,377 m. We sampled 6 non-reproductive females, 15 pregnant females, 3 lactating females, 2 post-lactating females, and 5 non-reproductive males during the summers of 2013, 2014, and 2015. Reproductive females, and some non-reproductive females, formed maternity colonies in buildings and exhibited daytime bouts of torpor. Solitary males and some non-reproductive females inhabited natural roosts such as cliffs, talus slopes, and dead trees, and also remained torpid for most of the day. Pregnant females recorded in natural roosts, however, maintained higher body temperatures (mean 32.20 °C ± .19) than females in building roosts (mean 29.43°C ± .06) and did not appear to enter torpor as frequently. Roost switching among buildings was common among the reproductive females we sampled, suggesting the importance of roost networks in these bats. Our research suggests that buildings are critical to reproduction and summer survival in little brown bats in YNP by facilitating energy savings and maturation of neonates in this species. We encourage the development of a long-term plan to maintain and protect a sub-set of buildings in the Park for roosting by this species.

Singing to Maintain Foraging Territories in the African Heart-nosed Bat

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The diversity of song repertoires and functions of singing in mammals have been little investigated. In bats, singing in the roost to court and defend mates has been studied, however the concept of territorial behaviors and the role of singing outside of the roost is poorly understood. *Cardioderma cor*, the heart-nosed bat, was noted as early as

the 1970s as a singer due to their conspicuously loud, low-frequency songs. This East African species roosts in mixed sex and age groups in the hollows of baobab trees, but disperses to exclusive areas whereby they move about foraging and singing. We tested the overarching hypothesis that singing is used to create and defend foraging territories by mist-netting, pit-tagging, and tracking 12 singing individuals during which we recorded songs and collected movement and singing behavioral data. We conducted song playbacks to further test song function. Male *C. cor* individuals return to same foraging area nightly, which are often over 100m across, and favor perches whereby they sing back and forth with neighbors. Low-frequency, repetitive syllables are likely adapted for song transmission across the cluttered bush habitat. Songs vary within and across individuals both spectrally and temporally. Song playbacks elicited investigative and aggressive responses, confirming the territorial function of singing. Song variability supports the possibility of other functions of singing, such as discrimination of conspecifics or displays of motivational level.

The Origins and Evolution of Singing by Bats

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It is now known that several widely disparate bat species use singing in their territorial and courtship behaviors. Singing is widespread among birds but generally rare among mammals. Recent technical advances have revealed many new insights into the social behaviors of bats, one of which is that singing might be surprisingly diverse and widespread among bats. Here we first review evidence that sampling biases and technical constraints have produced a myopic view a bat singing behaviors, and that in fact singing may play an important role in the behavioral ecology of many bats. A little more than a decade ago low-cost, portable, USB-based high frequency recording and monitoring equipment spurred resurgence in field studies revealing an unforeseen diversity of bat courtship, territorial and communication behaviors. Singing has now been documented in almost two-dozen species, with many more to come. Secondly, we introduce the hypothesis that singing by bats is strongly associated with the same principle subset of ecological variables that shaped the evolution of singing in birds, especially territoriality, polygyny, metabolic constraints, powered flight and migratory behaviors. Combinations of variables that favor singing are known for many bat species for which limited or no acoustic field data is available, which leaves open the possibility that singing may yet be relatively common among certain groups of bats. We conclude with a discussion of which taxonomic groups are most likely to benefit from singing.

***Tadarida* Behavior at Wind Turbines**

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In the U.S., migratory tree bats compose the majority of bat fatalities at wind-energy facilities. Various hypotheses have been proposed to explain why these species are found more often as fatalities at turbines, most of which assume that bats are attracted to turbines. However, it is unknown how other species react to wind turbines, which may have implications for their effective mitigation. The Spring Valley Wind Energy Facility in Nevada is located near Rose Guano Cave, a stopover site used by migrating Mexican free-tailed bats (*Tadarida brasiliensis mexicana*; TABR) in the fall. TABR is an abundant species throughout much of the western U.S., and one of the most common bat fatalities at wind-energy facilities where they occur. To determine TABR behavior at turbines, three turbines were monitored using thermal cameras from August 2 to September 29, 2013. Six hundred and ten hours of video were manually reviewed, and 3,539 behaviors involving bats were identified. Interactive behaviors (e.g., chasing blades, landing on turbines) accounted for 775 behaviors, while 2,764 behaviors were considered non-interactive (e.g., straight-line flight). These results are very different from what has been reported at the Fowler Ridge Wind Farm, a facility in Indiana where migratory tree bats interacted with turbines in about two-thirds of video events. We hypothesize that TABR may not be attracted to turbines, and that TABR fatalities may simply be due to large numbers of this fast-flying, high-altitude species passing through the same airspace occupied by turbines, rather than to an inherent attraction to them.

Faster, Cheaper, and Easier Plasma Metabolite Analysis: β-hydroxybutyrate Analysis in the Field with a Handheld Meter

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The energetic demands of insectivorous bats vary greatly based on age, sex, season, and environmental conditions. Plasma metabolite analysis provides a method of understanding individual variation in fueling rates and the implications for maintaining energy balance. Plasma concentration of β-hydroxybutyrate (BUTY—a ketone) increases with feeding in insectivorous bats. BUTY has traditionally been quantified with a kinetic assay on a microplate spectrophotometer in a laboratory setting, which requires freezing and shipping samples from the field site. Additionally, assay conditions are highly sensitive to user error. These methods are time consuming, complicated, and costly, limiting the current application of plasma metabolite analysis. Recently, we tested a handheld meter that measures BUTY concentrations in plasma. We analyzed a set of samples (n= 19) with both the kinetic assay and handheld meter, and used linear regression to compare concentrations determined by each method. The handheld meter was highly accurate ($F_{1,19}$=764, p<0.001, slope not different from 1). We also conducted repeated analyses (n=10) of a single sample and found the handheld meter to be highly repeatable (coefficient of variation = 5.4%). Additionally, the handheld meter is compact, easy to transport and use, and reports values quickly—all ideal for field conditions. Considering shipping, storage, and logistical costs, analysis with the handheld meter is more cost effective than laboratory analysis. The use of this handheld meter makes plasma metabolite analysis more accessible to researchers in a variety of field conditions, and will allow further understanding of fueling rates and energetics of insectivorous bats.

Chromosomal Rearrangements as Promoters of Biodiversity in Phyllostomid Bats

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The Neotropical bat family Phyllostomidae is a remarkable assemblage to study the role of chromosomal changes in adaptation and generation of biodiversity in mammals. Herein, the chromosomal homologies of representatives of nine phyllostomid subfamilies were investigated using the technique of chromosome painting. Using three outgroups and the set of chromosome probes of *Macrotus californicus*, we were able to infer the ancestral karyotype for the family and trace chromosomal rearrangements throughout their evolutionary history. The minimal number of chromosome rearrangements required to form the ancestral karyotypes of nine of the eleven subfamilies of Phyllostomidae was determined and the rates of chromosomal evolution in all lineages were calculated using a dated molecular phylogeny as reference for time of divergence and relationship between taxa. We discuss the trends of breakage and reshuffling of chromosomal blocks in the karyotypic evolution of phyllostomids, reevaluate the concept of karyotypic megaevolution and propose that chromosomal rearrangements were one of the promoters of the creation of the high diversity in this group of bats.

***Myotis septentrionalis* is Found in Roosts Similar to Those Used by Closely Related Species**

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In April 2015, the northern long-eared bat (*Myotis septentrionalis*) was listed as threatened species under the U.S. Endangered Species Act following dramatic declines caused by white-nose syndrome (WNS). During the listing process, the U.S. Fish and Wildlife Service (USFWS) developed guidelines, including the use of radio-telemetry, that are used by consulting biologists to evaluate impacts of potential projects on northern long-eared bats. These recommendations have resulted in a hundreds of northern long-eared bats being radio-tagged and tracked to roost locations during the 15 May to 15 August 2014 and 2015. These data have resulted in documentation of many roosts throughout the range of the species including a number of roosts in unusual situations including in stumps, debris piles, and even under decks houses that border woodlands. Documentation of these roosts should come as no surprise because northern long-eared bats belong to a clade of long-eared bats including *Myotis keenii*, *Myotis auriculus*, and *Myotis evotis* whose propensity to use such roosts is well-documented in the literature. We encourage biologists to leverage studies of closely related studies when developing conservation measures aimed at managing poorly-known species.

***Dispersal of Bats in an Island System**
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*** Kelly Speer** received the **Karl F. Koopman Award**.

Bats are excellent examples of highly mobile mammals and are useful in understanding mammalian dispersal in changing climates and landscapes. Islands provide a unique system where dispersal can be evaluated in a relatively controlled setting compared to mainland communities. Previous work on island bats suggests that dispersal of bats between islands may occur less frequently than expected, given their mobility. In the West Indies, it has been hypothesized that distance is the most important factor in determining the connectivity of populations on separate islands. We examine the population connectivity of a widely distributed bat, *Tadarida brasiliensis*, and that of an island endemic, *Erophylla sezekorni*, in the Bahamas. In addition, we compare the population connectivity of the obligate ectoparasitic bat flies (Streblidae) of *E. sezekorni*, as an independent source of information on bat dispersal in the Bahamas. Preliminary data suggest that distance is correlated with a decrease in connectivity between populations of *E. sezekorni* and of associated bat flies, but is not correlated with population structure of *T. brasiliensis*. Population structuring of *T. brasiliensis* may be impacted by dispersal, and we are working to tease apart the effects of distance and colonization history on population connectivity. As landscapes become more fragmented due to loss of intervening habitat and climate change, understanding the processes that impact mammalian dispersal is important for conservation—especially on islands, where bats frequently represent the majority of the terrestrial mammalian diversity.

The Diverse Feet of Bats: Histology and Comparative Morphology of the Calcaneum-Calcar Joint
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The derived postcranial morphology of bats reflects their specialized ecology – flying mammals with an inverted roosting position. While adaptations of the bat forelimb have been researched extensively, fewer studies have explored the evolution of the bat hindlimb. In particular, the calcar-calcaneum joint has received little attention, even though the calcar is known to vary considerably among bat species and may be a novel skeletal feature in mammals. We address two major knowledge gaps regarding the evolution of the calcar-calcaneum joint and shed light on their functional significance. First, is the calcar a bone or a cartilaginous element with varying degrees of calcification? Second, does ecological specialization explain the morphological diversity of the calcar and calcaneum in bats? To answer these questions, we integrated analyses of comparative histology and 3D morphology across 21 bat species from 16 families. By comparing the tissue anatomy of calcars in a subset of these species, we found evidence of ossification in at least one bat species, *Noctilio leporinus*. This raises questions about the homology of the calcar among mammalian tarsals. Our comparisons of the 3D morphology of the calcanea revealed that their shape is influenced by both phylogeny and ecological specialization. For example, the calcaneum of *N. leporinus* has a uniquely broad calcaneal tuberosity that corresponds with the laminar shape of its calcar. *N. leporinus* is a fishing bat, and its stiff, bony calcar may be adapted to support the uropatagium as it skims the water surface.

A Review of Echolocation Detection
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Use of acoustic devices to detect echolocation calls is an important method for sampling bats. Technological improvements and analysis programs make it easier than ever to quickly collect large quantities of acoustic data and interpret it, often to species level. Our objective for this review was to compile, compare, and synthesize information from acoustic studies to better inform future projects. We conducted a literature search of peer-reviewed and gray literature. We assessed characteristics of each study such as its geographic location, type of detector used, season(s) of study, measure of bat activity, and microphone height. We identified 88 papers from 18 countries published from 1997 to 2015. Over half of the studies occurred in North America, 14% were conducted in Europe, and the remainder in Australia, Africa, and Asia. Most studies used a call rate (e.g., calls/hr) or presence/absence as a metric, but how bat activity was calculated varied among studies. Microphones were deployed from ground level to 108 m (mean ± SE: 10 ± 2 m). In temperate regions, 75% of the studies measured bat activity only during summer months.

Half of the studies compared activity among treatment types (e.g., forest management); the remainder monitored bats. This review of acoustic studies gives an idea of the variability in acoustic studies. We suggest a common methodology to measure bat activity will assist comparisons among acoustic studies as this field continues to grow.

Flying Under the LiDAR: Relating Forest Structure to Bat Community Diversity

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To develop strategies to manage landscapes to promote bat diversity, it is essential to understand the relationship between habitat structure and species diversity. Light detection and ranging (LiDAR) allows accurate quantification of forest landscape structure at broader spatial scales than previously possible. This study used airborne LiDAR to classify forest habitat/canopy structure at the Ordway-Swisher Biological Station (OSBS) in north central Florida. LiDAR data were acquired by the National Ecological Observatory Network (NEON) airborne observational platform in summer 2014. OSBS consists of open canopy pine savannas, closed-canopy hardwood hammocks, and seasonally wet prairies. Multiple habitat structural parameters (e.g., mean, maximum, and standard deviation of canopy height returns) were derived from 3-dimensional LiDAR point clouds. K-means clustering was used to segregate each 5x5 m raster across the 3765 ha OSBS area into six different clusters based on derived canopy metrics. To determine the relationships among landscape-canopy features and bat species diversity and abundances, AnaBat II detectors were deployed from May to September 2015 stratified by these distinct clusters. Bat calls were recorded from sunset to sunrise during each sampling period using ZCAIM units attached to the detectors. Calls were identified to species using Echoclass v3.1. A statistical regression model selection approach evaluated how combinations of habitat structural attributes such as understory clutter, open regions, open and closed canopy, etc. influence bat community assemblages. This methodology provides a deeper understanding of habitat species interactions that may lead to the development of management practices to ensure survival of these ecologically important species.

Hedgerow Vegetation Structure is Important for Bats at Increasing Distances from Woodlands

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In fragmented agricultural landscapes across Europe, bats use semi-natural linear habitat (hedgerows and treelines) for foraging and commuting to foraging sites. From June to August, 2012, we recorded bat echolocation calls using direct sampling bat detectors along 20 transects (on footpaths and minor roads) in south west England. The positions of recorded bats were mapped to ±10 m using GPS. To determine the importance of vegetation structure on the use of linear features, the habitat adjacent to each bat was classified as: hedgerow without trees, hedgerow with intermittent trees (< 200 m between trees), and hedgerows with continuous treelines (<20 m between trees), or open field. We used generalized estimated equations to investigate the relationship between the use of these features by bats and distance to core foraging sites: woodland and riparian habitat Total activity of the generalist *P. pipistrellus* declined at increasing distances from river and woodland, but increased on hedgerows without trees and with intermittent trees. In contrast, activity of the more specialist *P. pygmaeus* was highest in close proximity to woodland and river irrespective of hedgerow vegetation structure. Our findings highlight the importance of habitat connectivity in the landscape. Hedgerow structure becomes increasingly important as distance to core foraging habitat increases. Agri-environment schemes targeting more specialist bat species should consider improving the quality of hedgerow habitat at increasing distances from woodlands and rivers.

Does the Size and Tree Composition of Monterey Pine Habitat Affect Bat Activity and Diversity?

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The Monterey pine (*Pinus radiata*) habitat is both unique and rare. Although the species is found as a landscape tree in many parts of the world, its native range is quite small and localized. The Monterey pine habitat today occupies only about 1,400 acres, primarily in the communities of Monterey and Carmel on California's Central Coast. Native Monterey pines often occur in conjunction with coast live oaks (*Quercus agrifolia*), but the shade from the oaks inhibits the growth of seedling Monterey pines. The fires that would normally regulate the population of oaks are controlled due to their location near developed areas. Therefore, Monterey pine stands, now mixed with coast live oak trees, are likely to give way to oak woodland as the climax in a cycle of forest succession. We hypothesized that Monterey pine habitat with both pines and oaks had higher bat activity and higher species diversity than habitats with only pines or oaks. We also hypothesized that larger patches of Monterey pine habitat had higher bat activity and a higher diversity of bats than smaller patches of the same habitat. We used 10 bat detectors (Wildlife Acoustics SM2+) to measure bat activity and to determine the number of species occurring in each habitat patch. We deployed one bat detector in each of 5 small (0.5 – 1 acre) and 5 large (20 – 370 acres) habitat patches, and determined the percentage of pine trees versus oak trees with 100-ft. transects. We will present our findings and discuss the management implications.

Roosting Behavior of *Myotis septentrionalis* during Spring Emergence in Mammoth Cave National Park

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The spring emergence season is one of the most poorly studied periods of the seasonal cycle of North American cave-roosting bats, and is likely critical to the long-term survival of species in regions affected by white-nose syndrome (WNS). The northern long-eared bat has recently been listed as threatened by the U.S. Fish and Wildlife Service due to extensive loss of individuals to WNS during winter hibernation. This paper reports on the early stages of a study examining roost selection of northern long-eared bats during spring emergence and the early maternity season in Mammoth Cave National Park (MCNP), Kentucky. WNS reached cave-hibernating populations of bats in MCNP in 2013, with significant declines in several species of hibernating bats in the Park during the winter of 2014/2015. Nine females and one male were captured with mist nets in May and early June 2015 at various sites across MCNP. Each bat was fitted with a radio-transmitter and tracked daily to identify roosting sites and determine size of colonies inhabiting roost trees. The average number of bats emerging from roost trees (3.12 ± 0.61) was lower than estimates reported for the species in the literature for populations studied pre-WNS. Stepwise logistic regression analysis comparing habitat features of roosting habitat with random plots showed bats selected roosts based on decay stage class and total stand basal area, with bats roosting in trees that were live or in early stages of decay and in stands with greater volumes of basal area.

Gape, Habitat, and Foraging Strategy Predict Open Space Echolocation Call Peak Frequency in Vespertilionid Bats

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Small vespertilionid bats emit echolocation calls with higher peak frequencies than do larger vespertilionid bats. This negative relationship between peak frequency and body size has variously been explained by allometry, as a limitation of minimum detectable prey size, or as a means by which small bats achieve more directional sonar beams when flying in open space. Here, we use a combination of published and measured body and echolocation call parameters to test these two of these hypotheses, focusing on the third and most recent hypothesis. Based on these data, we also used the piston model to test whether these bats should be expected to have biosonar beams with identical shapes and volumes, as suggested by previous studies. We found that while gape and body measures both well explained the variation in peak frequency when all bats were considered as a whole, gape size became the better predictor when bats with different foraging habitats and strategies were considered separately. Beam convergence among these bats was also not apparent until bats with different tasks and habitats were analyzed independently. Our study suggests that while gape size and biosonar beam shape may be an overlooked driver of open space echolocation call peak frequency, accounting for species-specific foraging behaviours and preferred habitat type is also essential to understanding the bat's acoustic field of view.

Vulnerability of Bat Populations to White-nose Syndrome within a Karst Environment in the Southern Sierra

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Overwinter behavior of bats across much of western North America remains poorly understood. White-nose syndrome (WNS), caused by a fungal pathogen (*Pseudogymnoascus destructans*), has killed millions of bats in eastern North America and continues to spread westward. Improving baseline information regarding overwinter bat behavior in western North America is necessary to assess potential risk of impact of WNS on western bat species. During the winter of 2014-2015, we surveyed 60 caves in Sequoia-Kings Canyon (SEKI) National Park and recorded bat echolocation activity across an elevational gradient from 700-3100m to determine winter use of caves and winter bat activity. Less than 20% of caves (11/60) had bats from November-March and nearly half of these caves housed single individuals of Townsend's big-eared bat (*Corynorhinus townsendii*). The largest aggregation was less than 10 *C. townsendii* and the only other species found in caves was a solitary big brown bat (*Eptesicus fuscus*). The majority of caves had temperatures suitable for bat hibernation (0-14 C). However, acoustic surveys showed seventeen species were active from September-March. Our results suggest that while species richness and activity were high, the extensive cave habitats present were not used by large aggregations of bats for hibernation. Nor did we find evidence that western *Myotis* species used cave habitats in winter. Relatively high levels of winter activity, especially at lower elevations, suggest that foraging opportunities are likely present year round, potentially reducing the risk of impact by WNS.

Dispersal Spurs Diversification of *Pteropus* Flying Foxes across the Indo-Australian Archipelago

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Islands provide opportunities for isolation from sister populations, promoting speciation. Most of the landmasses in the Indo-Australian Archipelago (IAA) are oceanic in origin, and the ability of organisms to disperse to these islands can vary. For volant taxa in the IAA, dispersal and founder-event speciation should therefore be the dominant biogeographic forces instead of vicariance. To empirically test this hypothesis, the highly mobile genus *Pteropus*, commonly known as flying foxes, serves as a suitable model system since it has multiple widespread and endemic species on every landmass in the IAA. We implemented the DEC and DEC+J model in BioGeoBEARS to determine what biogeographic forces shaped the diversification of *Pteropus*. Wallacea was found to be the center of origin of the genus, with dispersal as the most common scenario through which lineages diverged. Founder-event speciation was similarly found to be the mechanism for expansion of *Pteropus* species into Micronesia and islands in the western Indian Ocean. The rate of dispersal for *Pteropus* is a magnitude higher than most other volant taxa, such as flycatchers and *Papilio* butterflies, again highlighting the importance of dispersal in the genus.

Germination and Seedling Survival of *Brosimum alicastrum* under Bat Tents in the Lacandona Forest, Chiapas

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Few studies have investigated the role of small frugivorous bats in large seed dispersal. It has been reported that small tent-roosting bats disperse many undigested large-seeded tree species such as *Brosimum alicastrum* to their tents, but the post-dispersal fate of seeds and seedlings in these sites has not been investigated. Small tent-roosting bats may play an important role as dispersers of large seeds by improving germination and seedling survival underneath tents. Germination and seedling survival of *Brosimum alicastrum* was quantified under tents, other dispersal sites without tents, parental trees and controls (randomly placed quadrats) within the Montes Azules Biosphere Reserve, Chiapas. Seeds were counted within quadrats and germination was monitored regularly for the first month. All seedlings within the quadrats were tagged. Seedling survival was monitored monthly from June of 2014 to March of 2015. Canopy cover and distance to the closest parental tree were also measured. The data shows dispersal has an effect on both germination and seedling survival influenced by distance to parental tree or seedling density. Germination rate is also affected by dispersal, possibly as a result of manipulation. It is important to

consider the role of small bats as dispersers of shade tolerant large-seeded trees typical of mature forests given their effect on germination and seedling survival. Their contribution to forest regeneration in late successional stages may be more significant than usually assumed, and they may become a critical part of the remnant fauna in forests where larger dispersers have disappeared.

Habitat Use and Feeding Ecology of Bats at Uranium Mines and Adjacent Lands of Grand Canyon

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Uranium mining is an alternative energy source that has gained attention with recent and ongoing efforts conducted near the Arizona Grand Canyon Strip. Concerns have been raised regarding the types of impacts to the natural resources surrounding these mines. In an effort to address these concerns, the U. S. Geological Survey has been conducting a variety of studies at these mines. Since 2013, I have been studying the habitat use and feeding ecology of bats at 3 mines and adjacent sites near the Grand Canyon. Habitats of special interest are detention ponds created by the mines. These detention ponds hold water from the mine itself as well as from rain and snow-melt but exclude most wildlife with a > 3m tall fence around the perimeter of the mine. Water in these ponds also has the potential to have contaminated soil and particulates in them that come directly or indirectly from the mine. Despite an exclusion fence, detention ponds are accessible to bats that can drink the water and feed on emerging aquatic insects. I used mist-nets and acoustic detectors to document the presence and habitat use of bats at the mines and adjacent lands. I collected fecal samples from netted bats for diet analyses. I also concurrently sampled insects from the surrounding habitat and later compared the insect communities to those found in the fecal samples. In addition, I collected samples of bats and insects for future chemical composition analyses. USGS: This information is preliminary and is subject to revision.

Influence of Tent-roosting Bats on Dispersal and Establishment of Large-seeded Plants in the Northwestern Costa Rica

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Throughout history, many of the studies on bat seed dispersal have focused on small-seeded plant. Nevertheless, scarce information has been generated about plant species with large seeds, which are an important component of the flora of mature forests. We investigated the role of two tent-roosting bats, *Dermanura phaeotis* and *Uroderma convexum* for dispersal and establishment of large seeds in two sites of the northwestern Costa Rica. We also report spatial information (core-use, foraging range and home range) for 5 radio-tagged *D. phaeotis*. At least 12 seed species > 8mm were registered. *Spondias radlkoferi* and *Anacardium excelsum* account for most of the seeds found beneath bat roosts. Seed survival was highly variable among study sites, however strong evidence of establishment in some bat roost, indicates that bats can be effective dispersers at some areas. Spatial movements of the bats were highly variable and ranged from short movements around roosting resources and large movements, probably, in pursuit of food or water. Bats disperse seeds in many localities in the forest, including tents and random sites in the vegetation. Foraging behavior of *D. phaeotis* seems to promote seed dispersal trough long distant movements and heterogenic deposition of the seeds in different microhabits. Notwithstanding that tent-roosting bats seems to play an important role in the life history dynamics of large-seeded plants in the Neotropics, especially in the most defaunated areas, long term studies are needed to really elucidate the dynamics of post-dispersal, seed survival and seed establishment under bat feeding roosts.

First Record of Seed Predation by *Centurio senex* (Chiroptera: Phyllostomidae)

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Complex animal-plant interactions are present in the Neotropical bat family Phyllostomidae. Many of these interactions are obscured, mainly due to the paucity of information available on the diet and habits of these species. The Wrinkle-faced Bat, *Centurio senex*, has been always an enigmatic species. However, emerging evidence has partially elucidated the feeding ecology of this bat, confirming adaptations to consume hard food items. In addition to this information, here we show evidence of the predation of the seeds of *Sideroxylon capiri* (Sapotaceae) by *C. senex*. Bats employed multiple bites, chews and used principally deep unilateral bites to process the seeds. Observations show that endocarp hardness has important implications on the ecological interaction between *C. senex* and *S. capiri*, due to the bats inability to puncture seeds with harder endocarps. Nutritional rewards could be related to the predatory behavior documented. However additional information is needed to clarify the seed predation and seed dispersal scenario that exists between the two species.

SIMMA: The Mexican National Bat Monitoring Protocol and Its Implementation

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Information on species distribution and abundance is an essential base for effective species and habitat conservation, which is particularly important in the context of increasing anthropogenic habitat conversions in tropical countries that ultimately lead to the loss of species and the associated ecosystem services. There are a number of techniques available to assess local bat diversity; however, aerial insectivorous bats are often missing from traditional inventory studies. This group of bats is best detected using acoustic monitoring techniques, which allow the identification of species based on the measurements of echolocation call parameters. For monitoring programs, design and standardization of survey methodology are crucial to assure comparability of data collected at large spatial and temporal scales. Our goal was the develop and implement in a pioneer project for Latin America a standardized acoustic monitoring protocol for aerial bats in the different biomes of Mexico. This standardized protocol is essential to achieve the comparability of data taken at different locations and by different workgroups throughout the highly diverse habitats of Mexico. Our protocol has been designed to account for spatial and seasonal differences across different sites, and the results will be extremely helpful in terms of designing and implementing new policy within the natural protected areas (NPAs). We have implemented the protocol in two NPAs in Mexico and our design has also been adapted by the Central American Bat Conservation Strategy and is currently been tested in five other Central American countries and in more than 15 different NPAs. In future years, this regional effort involving 6 countries will be crucial to determine bat distribution and relative abundance of bats across the Mesoamerican region and how can we as a region influence public policy to prevent bat population losses.

Bat Activity in the Sutter Buttes of California as Determined Through Long-term Acoustic Data

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The Sutter Buttes are a unique geological formation in the Central Valley of California that provides extensive contiguous natural habitat for many mammals including bats. Long-term acoustic monitoring using a solar-recharged Anabat detector occurred from October 2011-September 2012 (350 contiguous nights) in this small mountain range. Bat activity levels in 1-hr blocks after sunset were calculated for a period of 1-yr to determine peak activity levels on a monthly and yearly basis in the Sutter Buttes. As expected, peak activity levels were typically experienced for two hours after sunset and the hours immediately prior to sunrise with gradual peaks and declines throughout the night. Seasonal variability in abundance was evident from the data with the greatest abundance of data during non-winter months. Nearly 37,000 acoustic files containing bat sonograms were examined.

Range-wide Genetic Analysis of Little Brown Bat Populations: How Far West Could White-nose Syndrome Spread?

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Although historically the little brown bat (*Myotis lucifugus*) was one of the most numerous and widespread bat species in North America, white-nose syndrome (WNS) has led to severe population declines in the eastern part of its range. Long-distance transmission of the WNS fungus depends on the seasonal movements of the bats. Therefore, understanding the population genetic structure of little brown bats across their entire range is essential for effective long-term management and conservation of the species. However, this information is currently lacking.

Accordingly, we assessed levels of genetic variation and population differentiation across the range of the species by examining both nuclear microsatellites and mitochondrial DNA (mtDNA) in 637 little brown bats from 29 locations across North America. We included all currently recognized subspecific lineages, and we sampled from areas both affected by WNS and those currently unaffected. We found no evidence for any major barriers to nuclear gene flow. However, some populations were highly differentiated from others at the mtDNA level, particularly in the western and northwestern parts of the species range. Furthermore, in contrast to the eastern populations, western populations were characterized by isolation by distance. The lack of any major barriers to nuclear gene flow suggests that WNS will likely continue to spread west. However, the highly variable levels of mtDNA genetic differentiation may lead to considerable spatial variation in the pattern and risk of WNS transmission across the range of little brown bats.

Species from Feces: Reliably Identifying Global Bat Species with a DNA Mini-barcode Assay

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Three technologies have come of age that together enable species identity from guano: reliable DNA typing from feces, DNA barcoding (species-specific genetic identifiers), and bioinformatic analysis. Taking advantage of these advances, we used 1.6 million sequences to develop a DNA mini-barcode assay that targets a segment of mitochondrial gene Cytochrome c oxidase I that we have found to be highly discriminatory among Chiroptera globally, readily accommodates fecal DNA, selectively targets bat but not prey DNA, and is scalable to next generation sequencing formats. Our assay has high resolution (93%) for barcoded bat species; we have successfully validated it from feces of 25 bat species, with aged fecal pellets (up to 3 months old), and with individual and pooled guano pellets, such that questions can target individuals (using specific fecal pellets) or populations and communities (long-term roost sites). Other benefits of our Species from Feces tool is in confirming field identification via feces, buccal samples, and wing swabs. We have developed searchable website (http://nau.edu/batdna) that allows users to determine the discriminatory power of our markers for bat species that interest them. Our Species from Feces tool has immediate application in the U.S. southwest, where abandoned mines are plentiful and used by bats as roost sites, and in central and eastern U.S. and Canada, where bats are under threat from white-nose syndrome. It is also a potentially powerful application worldwide for assessing presence of bat species that are vulnerable or facing extinction.

A Scalable and Repeatable Acoustic Site Selection Framework for the Northern Long-eared Bat

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It can be challenging to survey a rare species at the edge of its range. To maximize efficiency and likelihood of detection, it is best to increase the number of sampling units and decrease the intensity. As a result, quality site selection within a sample unit is even more important. For a 2015 state-wide northern long-eared bat (*Myotis septentrionalis;* MYSE*)* survey, we designed a pre-survey framework to select sites within 10km x 10km grids that were drawn using the Generalized Random Tessellation Stratified (GRTS) sampling method. Our framework incorporates existing summer habitat knowledge into selection criteria that is simple to apply, scalable, repeatable, and maximizes sampling in areas where MYSE are thought to prefer. While our framework was specific to MYSE, it can easily be modified to fit the requirements of future surveys for other bat species.

Bat Research and Conservation in Kenya

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Kenya has a very rich bat fauna with >110 species, second in Africa only to the Democratic Republic of Congo. However, little is known concerning their taxonomy and distribution, and even identifying them is hindered by incomplete understanding of African bats generally. A number are known only from rapidly deteriorating habitats, and even less known is their responses to habitat loss and fragmentation. I present current efforts and some preliminary results from our attempts to unravel the distribution and taxonomy of two diverse genera of Kenyan bats, *Miniopterus* and *Rhinolophus*. I also present a case study, with preliminary results, on the effects of forest degradation and fragmentation on the relative abundance of bat species and community composition at Kakamega Forest in western Kenya. Finally, I discuss findings of a monitoring study on colonies of *Eidolon helvum* (straw-coloured fruit bats) in western Kenya. While these studies have helped to raise the level of understanding concerning Kenyan bats, much more needs to be done.

***Personality Affects Pathogen Dynamics in Bats**

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*** Quinn Webber** received the ***Bat Research News*** **Award**.

Host behavior can affect host-pathogen dynamics and theory predicts that certain individuals disproportionately infect conspecifics during an epidemic. Consistent individual differences in behavior, or personality, could influence this variation with the most exploratory or sociable individuals most likely to spread pathogens. We quantified personality of little brown bats (*Myotis lucifugus*) and manipulated pathogen dynamics to test two hypotheses. First, we tested whether the infection of more sociable or exploratory individuals would be more likely to transmit greater infection intensities. Second, we tested whether more sociable or exploratory individuals that were naïve to an invading pathogen would be more likely to acquire infections. During summer 2014, we captured 10 groups of 16 bats and held each group in an outdoor flight-cage equipped with roosting-boxes. We used novel-environment and Y-maze tests to quantify exploration and sociability. We then randomly selected one individual from each group for 'infection' with UV-fluorescent dust, which served as a harmless proxy for a contagious pathogen. All bats were then released into the flight-cage for 24-hours after which we photographed each individual under UV-light. We then digitized photographs and quantified infection intensity. As we predicted, the most exploratory and sociable individuals were most likely to lead to high intensities of infection in the rest of the roosting group. Interestingly, the most exploratory naïve females, but not males, were most likely to acquire high infection intensities. Our results highlight the importance of personality for pathogen transmission and acquisition in wildlife populations and have implications for conservation and public health.

The Impacts of Two Ubiquitous Invaders on the Pacific Sheath-tailed Bat

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Although many indirect consequences of biological invasions are plausible, few studies test hypotheses for management of threatened taxa. A case study of the endangered Pacific sheath-tailed bat (*Emballonura semicaudata rotensis*) illustrates the importance of investigating indirect effects of invasion on species of conservation concern. We hypothesized that two invaders, feral goats and *Lantana camara*, would indirectly affect the bat by decreasing availability of suitable resources. Specifically, bat prey composition and abundance where lantana is dense would differ from native forests, and preferential browsing by goats would structure forests to be less suitable for bats. Our results suggest that bats avoid lantana shrub, but that preferential goat browsing does not influence bat activity. Our research implies that the impact of lantana on the persistence of the bat has been underestimated and that it is unclear how goats alter bat habitat aside from reducing understory vegetation. Future managers should construct long-term goat exclusion plots to assess the role goat herbivory plays in the persistence and spread of lantana. We urge conservation scientists to evaluate indirect effects of invasive species and publish findings that elucidate the consequences for native populations.

Miniature GPS/Data Loggers Yield a Few Fantastic Observations Causing Re-evaluation of our Notions of Hoary Bat Migration

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Patterns in distributional records, stable isotope ratios, and an understanding of their thermal ecology have allowed us to develop hypothesis regarding basic migration patterns of hoary bats (*Lasiurus cinereus*). In western North America, we assume that hoary bats generally move northeast to southwest during their autumn migration to locations with favorable climates and prey bases during winter. However, the actual migration routes used by hoary bats and their behavior during migration and wintering are virtually unknown. We have begun to address these gaps using newly-developed miniature devices: GPS tags which log locations at specified times and data-logging tags which record light levels, temperature and bat activity. We used dissolvable sutures to attach 8 GPS tags and 6 data loggers to male hoary bats during autumn 2014. GPS tags revealed that some hoary bats regularly travel >50 km per night, but flight directions were highly variable. In one case, a hoary bat made a 1000 km trip over the course of a month with the last fix 130 km from its starting point. Data loggers accurately recorded light levels and ambient temperatures while attached to hoary bats. Activity data from the data loggers allows construction of nightly activity budgets for individual bats over weeks or months. By linking activity and temperature data from the data logger with local weather data we were able to determine that one hoary bat engaged in multi-week bouts of torpor during the winter. Expanded use of such technology promises to greatly enrich our understanding of bat behavior and ecology.

Genetic Diversity of the Major Histocompatibility Complex before and after White-nose Syndrome in Little Brown Myotis
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Following massive mortality from white-nose syndrome (WNS), declines in some populations in the northeastern US began to attenuate. Several hypotheses may explain the apparent stabilization of these remnant populations, including the possibility that they have evolved resistance to WNS. We tested for evidence of recent selection by examining temporal patterns of genetic diversity at major histocompatibility complex (MHC) loci in little brown myotis sampled through the epizootic. MHC proteins present antigens for recognition by the immune system, and are often implicated in disease resistance in vertebrate hosts. We targeted exons encoding the antigen binding site of the DR-alpha (DRA) and DR-beta (DRB) subunits of MHC class II genes for high throughput sequencing of ~350 individuals sampled from 12 hibernacula between 2008 and 2013. Our primers amplified at least 13 DRB loci encoding more than 5,000 distinct DRB alleles across the entire sample, which imply over 1,000 forms of the DR-beta subunit of the MHC molecule when translated to amino acid sequences. Three DRA loci encoded 96 alleles comprising 54 putatively functional variants across the sample. Preliminary analyses indicate remarkable consistency in the frequencies of DRA and DRB amino acid variants over time and space, revealing no evidence consistent with one or a few specific alleles conferring resistance to WNS. While we continue to evaluate more complex mechanisms underlying genetic resistance, our preliminary analyses suggest that despite high mortality, levels of neutral and functional genetic diversity at MHC loci, an important metric of population health, remain as of yet unchanged.

The Ecological Energetics of Hibernation in Temperate Bats
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Hibernation energetics can be considered in terms of three phases: a preparatory phase of positive energy balance before winter; a period of negative energy balance during hibernation proper throughout winter; and an emergence/recovery phase when positive energy balance is restored in spring. Most of what we know about all three phases is based on rodents (e.g., chipmunks, ground squirrels), which differ from bats in important ways. Rodent hibernators construct their own burrows, hibernate solitarily or in small groups, use nesting material for insulation and often store food. In recent years, our group has been studying little brown (*Myotis lucifugus*) and big brown bats (*Eptesicus fuscus*) to test the broad hypothesis that similar selection pressures influence all three phases of hibernation for rodents and bats despite dramatic differences in ecology and behavior. We have combined temperature telemetry, infrared video and passive transponders (PIT tags) to understand how individual or group characteristics (e.g., sex, personality), and environmental factors (e.g., weather, winter duration) affect hibernation energetics and phenology. Sex differences in the timing of reproductive investment have a pronounced influence on winter energy expenditure and the timing of spring emergence, while individual behavioral traits (i.e., personality) appear to influence pre-hibernation fattening and hibernation energetics. Local weather and interactions among individuals within the hibernaculum influence the timing of arousals from torpor but only during late hibernation. Our findings are important for understanding the ecology of temperate-zone bats in general and have implications for understanding and potentially mitigating white-nose syndrome.

Roost Tree Selection by Indiana Bats in an Agricultural Landscape
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Resource selection studies can identify critical resources for important life stages of endangered species. Availability of required resources, such as roost trees during the maternity season, is critical to the maintenance and survival of the endangered Indiana bat. Resource selection by Indiana bats may vary geographically because of its broad geographical range and the landscape matrix surrounding maternity colonies can vary widely (i.e., urban vs. rural and agriculture vs. forest). Our objective was to determine resource selection by Indiana bats for maternity roost trees in Northeast Missouri and to compare resources selection in Missouri to elsewhere in its range. We radio tracked 27 Indiana bats daily to 86 unique roost trees over three summers. We selected two available trees for each roost tree (n=173) and measured habitat covariates at used and available trees. We used discrete choice modeling in a Bayesian framework with uninformative priors to identify resource attributes selected by Indiana bats. Tree species, tree condition, aspect, and diameter at breast height were resources. Indiana bats chose large, dead, and Southwestern facing trees for roosts compared to available. Resource attributes selected in Missouri were similar to the important resources identified in previous studies across the Indiana bat's range. This study highlights the likelihood that Indiana bats select roost trees at a local scale compared to a broader landscape scale across its entire range.

Viral Diversity, Prey Preference, and *Bartonella* Prevalence in *Desmodus rotundus* in Guatemala
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Certain bat species serve as natural reservoirs for pathogens in several key viral families including henipa-, lyssa-, corona-, and filoviruses, which may pose serious threats to human health. The Common Vampire Bat (*Desmodus rotundus)*, due to its abundance, sanguivorous feeding habit involving humans and domestic animals, and highly social behavioral ecology, may have an unusually high potential for interspecies disease transmission. Previous studies have investigated rabies dynamics in *D. rotundus*, yet the diversity of other pathogens that these bats may carry remains largely unknown. We screened 396 blood, urine, saliva, and fecal samples from *D. rotundus* captured in Guatemala for 13 viral families and genera. Positive results were found for rhabdovirus, adenovirus, and herpes virus assays. We also screened these samples for *Bartonella* spp. and found 38% of individuals positive. To characterize potential for interspecies transmission associated with feeding behavior, we also analyzed cytochrome B sequences from fecal samples to identify prey species and found that domestic cattle (*Bos taurus*) made up the majority of blood meals. The results of this study suggest that the risk of pathogen spillover from *Desmodus rotundus* warrants further investigation of microbe diversity and foraging ecology in their populations.

Roosting and Foraging Ecology of Lasiurine Bats in the Northern Portion of the Central Valley, California
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In 2009, a study to examine roosting ecology of western red bats (*Lasiurus blossevillii*) was initiated by Drs. Pierson and Rainey in the Sutter Buttes area of northern California. Western red bats were captured and radio-transmitters affixed to the bats during 2009, 2011, and 2014. A total of five western red bats (*L. blossevillii*) and one hoary bat (*L. cinereus*) were radiotagged and tracked to their roost sites in Sutter, Butte, and Colusa Counties, California. In 2009 two female red bats were tracked to day roosts, in 2011 one female red bat to its maternity roost and one male red bat to its day and night roost, and in 2014 one female red bat and one female hoary bat were tracked to their maternity roosts. The two maternity roosts for the red bats were found in mature Valley oaks (*Quercus lobata*) and the maternity roost for the hoary bat was initially found in a blue oak (*Q. douglasii*) but moved to a Valley oak after the two young became volant. Other roost sites included willow (*Salix* sp.), poison oak (*Toxicodendron diversilobum*)/California pipevine (*Aristolochia californica*)/wild grape (*Vitis californica*) liana, and

English walnut (*Juglans regia*). Strong roost fidelity was observed for the day roosts and maternity roosts. Foraging areas were also determined over several nights during 2011 and extended as far as 9.5 km from roosts.

Wake Up and Smell the Piper: Olfactory Receptor Repertoires Reflect Specialization in *Carollia*

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Olfaction is a primary sense used for food detection in plant-visiting bats. Olfactory receptors are diverse family of genes that code for odorant detectors in mammals. However, the relationship between dietary specialization and olfactory receptor repertoires remains unknown. New World Leaf-nosed bats (Phyllostomidae) have evolved adaptations to exploit plant resources, and many lineages are plant specialists. Recent analyses suggest the primarily frugivorous subfamily Stenodermatinae has a distinct olfactory receptor repertoire compared to insectivorous species, but there is no work to date examining whether species that specialize on particular plant genera also have more specialized olfactory receptors. We sequenced the olfactory receptor repertoires of three species of *Carollia*, a bat genus that varies in its dietary specialization to the soft fruits of *Piper* plants. We compared the olfactory receptor repertoires and the function of orthologous receptors among *Carollia* species that vary in their degree of specialization on *Piper*. The most dedicated *Piper* specialist, *Carollia castanea,* had a unique set of olfactory receptors not shared by the two more generalist species. These unique receptors potentially enable *castanea* to detect its primary resource to an extent that the other species cannot. *Carollia perspicillata*, the species with the most generalist diet, had a larger diversity of functional receptors. Interestingly, some of these diverse receptors were pseudogenized in the specialized species. This suggests relaxed selection on receptors in species with more specialized diets, and purifying selection in more generalist species that would maintain the ability to detect a wide range of odorant molecules.

Habitat Fragmentation Effects on Ectoparasite Loads of Bats in a Tropical Costa Rican Premontane Forest

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Habitat fragmentation results in drastic and dramatic changes in the physical and biological environment where species evolve. Fragmentation has been linked to an increase in parasite infection, and this has a negative effect on the ecological services that bats provide. From May 2014 to February 2015 a survey of ectoparasites was carried out in Alberto Manuel Brenes Biological Reserve, Costa Rica and its surroundings in two types of forest, continuous and fragmented. The ectoparasitic mites were mounted in Hoyer's medium and streblids were preserved in 70% ethanol. We inspected 86 bats—*Carollia perspicillata* (n=48)*, C. castanea* (n=3) and *C. sowelli* (n=35) —and collected 1216 ectoparasites. The assemblage of ectoparasites was dominated by mites (n=1116) consisting of 6 families (Trombiculidae, Macronyssidae, Myobiidae, Spelaeorhynchiidae, Chirodiscidae and Sarcoptidae), and 3 species of Streblidae, *Speiseria ambigua* (n=18), *Strebla guajiro* (n=18) and *Trichobius joblingi* (n=56). Overall, prevalence varied significantly between the continuous forest and fragmented forest, 76.8% and 90.9%, respectively, and mean intensity was significantly lower in continuous forest (6.39±2.79) than in fragmented forest (25.13±11.59) (both p=0.0057, Fisher's exact test). When comparing host parasite specificity, generalist parasites had highly significant (p=0.008, Fisher's exact test) prevalence and weak mean intensity (p=0.05, Fisher's exact test) in fragmented forest, meaning that ectoparasite loads and intensity are higher where the forest conditions are altered, since fragmentation increases parasite infection. Bats and their parasites may play an important role in providing guidelines for conservation and a better understanding of the links between bats and forest degradation.

FROM THE EDITOR

Happy 2016! I have a few announcements to end 2015 and to start 2016. First, this is the last issue of the 2015 series, which means it is time to renew your subscription to *Bat Research News* for the 2016 series if you have not already done so. Many thanks to all of you who have renewed your subscriptions to *Bat Research News* already! We sincerely appreciate your continued support. And welcome to all of our new subscribers! I hope you enjoy our little journal/newsletter and find it both interesting and helpful.

My next announcement is bittersweet. Dr. Jodi Sedlock is stepping down as Editor for Recent Literature. When Jodi sent me her final Recent Literature section (which appears in this issue), she wrote, "Thank you for giving me the opportunity to serve the bat community in this way. I learned a lot from this and enjoyed staying abreast of the literature better than I ever have!" Please join me in wishing Jodi well in her future endeavors and also in thanking her for her service to *BRN* and to all of you, the subscribers to *BRN*.

I am very pleased to announce that Dr. Tom Griffiths is returning as Editor for Recent Literature beginning with the 2016 spring issue. After more than a decade of college administration, Tom has returned from "the Dark Side" and once again is focusing on undergraduate teaching and bat research. His contact information is listed on the *BRN* website on the inside front cover, and also at the beginning of the Recent Literature section of this issue. Please welcome Tom back as Editor for Recent Literature and be sure to send any recent bat-related publications to him for inclusion in the future issues of *BRN*. What better way to welcome him back than by sending work!

Please consider submitting some of your manuscripts to *BRN*. Original research and speculative review articles, short-to-moderate length, on a bat-related topic would be most welcomed. If you are interested, submit your manuscripts as .rtf documents to Al Kurta, Editor for Feature Articles. Notes and letters on bat-related topics also are welcome and should be sent to Al. Send news items, announcements, conservation or education items, cover art, and subscription information to me (Margaret). And remember to send reprints of your recent publications to Tom.

Best wishes for a successful 2016,

RECENT LITERATURE

Authors are requested to send reprints (PDF files) of their published papers to the Editor for Recent Literature, **Dr. Thomas A. Griffiths**, (e-mail: **thomas.alan.griffiths@gmail.com**) for inclusion in this section. Receipt of reprints is preferred, as it will facilitate complete and correct citation. However, if reprints and/or PDF files are unavailable, please send a complete citation (including complete name of journal and corresponding author mailing address) by e-mail. The Recent Literature section is based on several bibliographic sources and for obvious reasons can never be up-to-date. Any error or omission is inadvertent. Voluntary contributions for this section, especially from researchers outside the United States, are most welcome and appreciated. The following Recent Literature section was prepared by the outgoing Editor, Jodi Sedlock.

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ANNOUNCEMENTS

In Memoriam: Susan M. Barnard

Susan M. Barnard (Sue), Founder and Executive Director of Basically Bats Wildlife Conservation Society, and author of many scientific papers and books on bats, reptiles, and parasites, died at the age of 80 after a long battle with leukemia. Born Susan Muller in New York City on March 7, 1935, she passed away on October 5, 2015 at her home in the small town of Johnson, Florida. Sue leaves behind a daughter and son, Tamara and Brett Romaine.

A "late bloomer," Sue graduated with a Bachelor degree in liberal studies from the University of the State of New York in 1983. Sue's love for animals began as a youngster when making pets of rats and mice that scampered around her mother's apartment in Manhattan, NY. This ultimately evolved into a professional career at Zoo Atlanta, a career that spanned 28 years.

In 1982, Sue pioneered bat rehabilitation in the United States, which included being featured in the National Geographic special, "Keepers of the Wild," and culminated in the 4-volume set of *Bats in Captivity*. Anyone wishing to honor Sue may do so by making donations to Basically Bats Wildlife Conservation Society, Inc. (http://www.basicallybats.org).

Submitted by Tamara Romaine

In Memoriam: Peter Andrews

Sadly Peter died in 2011 but he is remembered at international conferences not only for the quality of his research on bat hearing and echolocation but the way in which he was able to explain his ideas. Charlie Liggett, Chair of the local bat group said, "Peter had the rare gift of being able to explain difficult concepts at all levels to all ages." Although he was an enthusiastic amateur bat worker since 1973, making his own bat detectors, his lasting contribution to bat research has been the installation of infrared beam array counters that he made for automatic monitoring of greater horseshoe bats (*Rhinolophus ferrumequinum*) in Wales, U.K. It is a tribute to his work that this electronic equipment has produced valuable information with the environmental monitors. Peter won the Pete Guest Award in 2011 and is sadly missed but his legacy lives on.

Submitted by Maggie Andrews

ANNOUNCEMENTS (cont.)

Reminder—Renewal Time!

Just a reminder that this is the last issue of the 2015 series of *Bat Research News*. That means some of you will be receiving renewal information in the inbox of your e-mail fairly soon. I hope you will continue to support *BRN* for the 2016 volume-year. Regardless, all of us at *Bat Research News* wish you a safe and happy 2016!

Request for News

Please consider submitting news from your lab group, your field work, or any bat-related news. Also please consider submitting short articles, notes, or letters on a bat-related topic (see below). Thank you in advance for considering us as a place for bat, bat worker, and bat lab news items.

Request for Manuscripts — *Bat Research News*

Original research/speculative review articles, short to moderate length, on a bat-related topic would be most welcomed. Please submit manuscripts as .rtf documents to Allen Kurta, Editor for Feature Articles (akurta@emich.edu). If you have questions, please contact Al. Thank you for considering submitting your work to *BRN*.

Change of Address Requested

Will you be moving in the near future? If so, please **send your new postal and e-mail addresses** to Margaret Griffiths (margaret.griffiths01@gmail.com), and include the date on which the change will become effective. Thank you in advance for helping us out!

FUTURE MEETINGS and EVENTS

2016

The 2016 NEBWG Meeting will be held in Baltimore, Maryland, January 11-13, 2016, at the Lord Baltimore Hotel. Please see http://www.nebwg.org/AnnualMeetings/2016/nebwg16.html for meeting details.

The 17th International Bat Research Conference will be held in Durban, South Africa, July 31–August 5th, 2016. Please see:
http://www.eurobats.org/bat_news/17th_international_bat_research_conference_2016
for more information.

The 46th Annual NASBR will be held October 12–15, 2016, in San Antonio, Texas. See the NASBR website for future updates — http://www.nasbr.org/.

2017

The 47th Annual NASBR will be held in Knoxville, Tennessee, dates to be determined. Check the NASBR website for future updates — http://www.nasbr.org/.