BAT RESEARCH NEWS

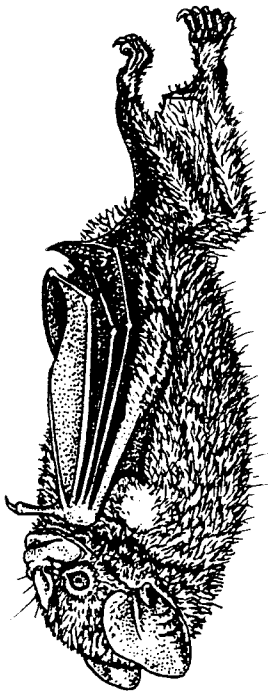

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Table of Contents for Volume 44, 2003

Volume 44: Number 1, Spring 2003

Table of Contents

Volume 44: Number 2, Summer 2003

Erratum

Unfortunately our printing contractor dropped page numbered 29 from some copies of the last issue of Bat Research News, Volume 44: No. 1, Spring 2003. Our apologies for not finding all of these before they were mailed. We have reprinted this page and it appears on page 82

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Publisher and Managing Editor: G. Roy Horst, Bat Research News, P. O. Box 5068, Potsdam, NY. 13676-5068 U.S.A., Tel. 315-267-2259 FAX 315-267-3170
e-mail: horstgr@potsdam.edu

Editor for Feature Articles: Allen Kurta, Dept. of Biology, Eastern Michigan University, Ypsilanti, MI. 48197. Tel.734-487-1174 FAX 734-487-9235
e-mail: bio_kurta@online.emich.edu

Editor for Recent Literature: Thomas A. Griffiths, Dept. of Biology, Illinois Wesleyan University, Bloomington, IL 61702 Tel. 309- 556-3697, FAX 309-556- 3864
e-mail: mgriff@illinoisalumni.org

Editor for Conservation/Education: Patricia Morton, Texas Parks and Wildlife, Suite 100, 3000 IH 35 South, Austin, TX 78704. Tel. 512-912-7020
e-mail: patricia.morton@tpwd.tx.us

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 which are reviewed by at least two scholars in that field. In addition Bat Research News includes a recent literature section which cites nearly all bat-related publications in English worldwide; the 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.

Communications concerning feature articles and "letters to the Editor" should be addressed to Kurta, recent literature items to Griffiths, conservation items to Morton, and all other correspondence to Horst.

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BAT RESEARCH NEWS

VOLUME 44: No. 1 **SPRING 2003**

Table of Contents

Editors' Comments

BRN now includes on its web site a portable data file (PDF) which will enable electronic viewers to see each issue exactly as it appears in the printed version. This will make it much easier to copy for your records and easier to cite articles by page number and issue number. Each new electronic issue will be added to the back issues section already included on the electronic site. We are making a very strong appeal to subscribers outside the United States (and those in the U.S. who choose) to convert to the electronic edition. This will help keep the cost of your subscription to Bat Research News affordable, hopefully at our current international rate of $15.00 per volume year worldwide, for several years in the future. If you have any comments or suggestions regarding this new arrangement please forward them to us, **and send us some news.** Thank you.

Roy Horst, Managing Editor and Publisher horstgr@potsdam.edu
Pat Morton, Editor, Conservation, Education patricia.morton@tpwd.tx.us
Tom and Margaret Griffiths, Editors, Recent Literature tgriff@titan.iwu.edu
Allen Kurta, Editor, Feature Articles & Letters bio_kurta@online.emich.edu

Front cover

The illustration of *Ametrida centurio* was generously provided by Fiona Reid and is taken from her book "A Field Guide to the Mammals of Central America and Southeast Mexico".

High-altitude Collision between an Airplane and a Hoary Bat, *Lasiurus cinereus*

Suzanne C. Peurach
U.S.G.S Patuxent Wildlife Research Center, Smithsonian Institution, P.O. Box 37012,
National Museum of Natural History, NHB 378, MRC 111, Washington, D.C. 20013-7012

On 9 October 2001, a U.S. Air Force T-37-B jet sustained a wildlife strike during a night flight (2030 hours) over Lawton, Oklahoma. The pilot and a student in the aircraft heard and felt the strike at an altitude of 2,438 meters (8,000 feet) above ground level and immediately recorded the time and location (U.S. Air Force strike number 50313). The strike occurred on the leading edge of the aircraft engine near the intake (B. S. Bowman, pers. comm.).

The remains of the animal were recovered from the outside of the aircraft upon landing and initially sent to the Smithsonian Institution, National Museum of Natural History, Division of Birds, for identification. The sample, which consisted of a large section of skin with attached fur, eventually was transferred to the U.S. Geological Survey, Patuxent Wildlife Research Center, Biological Survey Unit, Division of Mammals, for identification. The alternating banding pattern visible to the naked eye and the frosted tips of the hairs indicated that this bat was a species of *Lasiurus*, and most likely a hoary bat (*L. Cinereus.*

To identify the sample to the level of species, I prepared a slide of the hair according to techniques described for feathers by Laybourne and Dove (1994) and compared the hairs with a reference collection housed in the Division of Mammals, National Museum of Natural History. Samples were examined at low (100-x), medium (200-x) and high (400-x) power on a Zeiss comparison light microscope. Measurements were taken using an ocular micrometer. The sample was compared macroscopically, as well as microscopically, with samples from species of *Lasiurus* that occur in Oklahoma (Choate and Jones 1998), including the hoary bat, red bat (*L. borealis*), and Seminole bat (*L. seminolus*). Comparisons of unknown hair samples can be difficult when the region of the body that a sample came from is unknown. For bats, however, the form and scale pattern of hairs sampled from different regions of the body, as well as from different sexes, have no marked differences, although color and size of hairs do vary (Benedict, 1957).

Under the microscope, scale patterns on hairs from the strike formed a spiral pattern along portions of the shaft, as described for *Lasiurus* and some species of *Myotis* and *Eptesicus* (Nason, 1948). The hairs from the strike showed a banding pattern (dark at the base, followed by a pale band, and then dark distally) that was characteristic of *L. cinereus*, as described by Moore and Braun (1983). The imbricate crenate scale pattern found at the widest portion of the hair shaft of the unknown sample was a character used by Nason (1948) to distinguish *L. cinereus* from *L. borealis* and *L. seminolus*.

The diameter at the widest portion of the hair shaft was reported to be greater than 12.5 microns for *L. cinereus* and less than 12.5 microns for *L. borealis* (Moore and Braun, 1983). The diameter of the widest portion of one of the hair shafts found in the wildlife strike was 19 microns. Hairs from voucher specimens of *L. seminolus* were examined under the microscope and compared to hairs from the strike. The diameter at the widest portion of the hair shaft of *L. seminolus* was found to be no larger than 12 microns. Hence, the hair sample from the aircraft strike over Oklahoma best matched *L. cinereus*, according to microscopic characters, macroscopic examination, and geographic distribution.

High-altitude flights have been documented for Brazilian free-tailed bats (*Tadarida brasiliensis*), using visual triangulation (Davis et al. 1962) and radar with associated helicopter visualization to identify the bats (Williams et al.1973). The elevation of Lawton, Oklahoma, is approximately 462 meters and the highest altitude in the state is 1,516 meters at the peak of Black Mesa. Although no records for high-altitude flight were found in the literature for *L. cinereus*, this flight at 2,438 meters (8,000 feet) above ground level probably represents an altitudinal record for the species.

Acknowledgments

Special thanks go to Major B. S. Bowman, BASH Program Manager, Sheppard Air Force Base, for providing verification of the details of this strike. I would like to thank A. L. Gardner for permission to sample specimens from the U.S. National Museum for comparison. A. L. Gardner, C. J. Dove, D. E. Wilson, and L. Wolfe provided helpful comments on the manuscript. I also thank members of the U.S. Air Force HQ AFSC/SEFW BASH team, Kirtland Air Force Base, for their support and the opportunity to work on this event.

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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.

Recapture of a Banded Pocketed Free-tailed Bat (*Nyctinomops femorosaccus*) in Big Bend National Park, Texas

Nyctinomops femorosaccus, the pocketed free-tailed bat, is rare in the southwestern Unites States (D. J. Schmidly, 1991, Bats of Texas, Texas A&M University Press, College Station). It typically inhabits shrub-desert environments and utilizes high rock fissures (crevices) as roosts, in parts of southern California, New Mexico, Arizona, Nevada, and extreme west Texas. In Texas, *Nyctinomops femorosaccus* generally is considered to be a migratory species that is present from mid-to-late March to mid-to-late October or November, although recent evidence from Big Bend National Park suggests it may overwinter in Texas (Higginbotham and L. K. Ammerman, 2002, Special Publications, The Museum, Texas Tech University, 44:1-44). Information on the ecology of this species is greatly lacking.

In March 1996, we began surveying the bat population throughout the year in Big Bend National Park. During these surveys, a banding study was undertaken to evaluate population dynamics of free-tailed bats in the area. On 24 July 2000 at 0440 hours (Central Daylight Time), a banded, adult, male *Nyctinomops femorosaccus* was recaptured in a mist net strung across a spring-fed pool, along Tornillo Creek, Brewster Co., Texas (UTM: 684070E, 3252950N). The bat had been banded with a yellow, 2.8-mm, celluloid band (A.C. Hughes, Ltd., Hampton Hill, Middlesex, England) placed on the left forearm. The band was not imbedded in the wing membrane and was freely movable around the forearm, and there was no sign of infection or scar tissue around the periphery of the band. This male originally was banded at the same site on 27 November 1997, nearly 3 years earlier, and its recapture is the first record of seasonal site fidelity for *Nyctinomops femorosaccus*.

Submitted by Amanda K. Matthews and Loren K. Ammerman, Department of Biology, 2460 Dena, Angelo State University, San Angelo, Texas 76909

Please Note:

There are two sets of abstracts in this issue, Those from the meeting of the National Bat Trust(below), and those of the Southeastern Bat Diversity Network (following). Ed.

Abstracts of the Presentations to
The 17th Bat Conservation Trust National Bat Conference-United Kingdom
held at Reading University, Reading U.K.
6th - 8th September, 2002.

Bat Research News is grateful to Conor Kelleher for providing these abstracts.
The abstracts appear in alphabetical order by first author.

Bat diversity and conservation in Myanmar (Burma)

Paul J. J. Bates[1] and Khin Maung Swe[2]
[1]Bowerwood House, St Botolph's Road, Sevenoaks, Kent, TN13 3AQ, UK ;
[2]Zoology Department, Yangon University, Yangon, Myanmar.
e-mail: hzm@btinternet.com and: c/o goldenpearl@mptmail.net.mm

Although the study of bats in Myanmar began some 140 years ago, relatively few studies were conducted in the latter half of the 20th century. However, in 1999, a bat research programme was initiated by Yangon (Rangoon) University and the Harrison Institute. Today, following five field surveys to south-east, central, western and northern Myanmar, knowledge of the diversity and population status of the bat fauna has increased considerably. Recent records include five species new to the country, the most notable of which was the bumble-bee bat (*Craseonycteris thonglongyai*). This was discovered in south-east Myanmar in 2001 and increases the number of species known from country to 92 (about 9% of the world's bat species) and the number of families to 10. It shows the potential for well-focused bat research in Myanmar and emphasises the role that Myanmar can play in the conservation of globally rare and endangered bat taxa (Bates *et al*., 2000; Bates *et al*., 2001).

Following the recent award of a Darwin grant, a three-year programme focused on the bats of the extensive limestone karst regions of central, eastern and southern Myanmar is planned for 2002-2005. Activities and outputs will include bat surveys; the production of a bat identification guide; training Myanmar postgraduate students; establishing a national database of cave bats; identifying key sites for conservation; an education programme and strengthening links between the research and conservation community. It is hoped that such a programme will address some of the recommendations recently outlined in the Action Plan for Microchiropteran bats (Hutson *et al*., 2001).

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Diversity of Lyssaviruses in bats

Brookes, S.M., G. Parsons. D. Seldon, N. Johnson, L.M.McElhinney and A.R. Fooks
Rabies Research and Diagnostics Group, Veterinary Laboratories Agency – Weybridge, New Haw, Addlestone, Surrey, KT15 3NB, United Kingdom. WHO Collaborating Centre for The Characterisation of Rabies and Rabies-Related Viruses.

Rabies is a fatal encephalitic disease that occurs in most terrestrial mammals and is caused by members of the Lyssavirus genus. Within this genus are seven genotypes, classical rabies virus (genotype 1, RV), Lagos bat (G2), Mokola (G3), Duvenhage (G4), European bat lyssavirus types 1 and 2 (EBL, G5 and 6 respectively) and Australian bat lyssavirus (ABLV, G7). Lyssaviruses have been isolated from insectivorous, frugivorous and haematophagous bats and this diverse variety of bat species continue to play a role in the epidemiology of lyssaviruses throughout different parts of the world. In Europe, insectivorous bats are important reservoirs of sylvatic rabies (specifically genotypes 5 and 6). In the past 25 years, >600 cases of European bat lyssavirus infections in bats have been confirmed, including an EBL type 2 (genotype 6) that was reported from the UK in 1996. The incidence of rabies infection in humans following contact with a European species of bat however, is extremely low. Significantly, no 'at-risk' individual previously bitten by a bat in Europe and then administered with appropriate post-exposure treatment has been infected with rabies. There is little doubt however, that the legal protection of European bats has direct relevance on our lack of knowledge of the transmission mechanisms and pathogenesis of bat rabies in Europe. One important issue is the prospect of a 'spill-over' infection from a bat to a terrestrial mammal. In Europe on rare occasions, probable spillover infections of EBLs from bats to terrestrial mammals have been reported but there has been no evidence for host adaptation. In contrast, genotype 1 spillover infections from bats to mammals have been reported in North America. Disease caused by genotype 1 rabies (classical rabies) is preventable with the prior use of commercial vaccines. However, only fragmented data are available on the ability of these vaccines to cross-protect against challenge with non-genotype 1 viruses. In order to address this we have measured cross-neutralisation of viruses from G1 and genotypes 5-7 using sera raised against inactivated viruses using a modified fluorescent antibody virus neutralisation assay. In addition, the ability of a commercial vaccine to cross-protect against other genotypes (vaccine and wild G1 strains, and G5, 6 and 7) was measured following an intra-cerebral challenge in mice. Our data indicates evidence of medium to high levels of cross-neutralisation, but only partial cross-protection following challenge with non-vaccine strains in a murine model. The implications of these results will be discussed.

A search for barbastelle and Bechsteins bats in a Pembrokeshire woodland

Margaret Clarke, Lin Gander* and Tom McOwat
e-mail:mclarke@brynach.u-net.com
* Reserves Manager, Wildlife Trust of South and West Wales

Pengelli Forest National Nature Reserve, which lies between the Cardigan Bay coast and the Preseli hills, is owned and managed by the Wildlife Trust of South and West Wales. The reserve is the largest remaining area of ancient woodland in West Wales; it covers some 65 hectares and is set in an area of steep wooded valleys, small fields and narrow lanes with high hedgebanks. In 2000 it seemed a promising place for a project to look for woodland bats such as barbastelle (*Barbastella barbastellus*) and Bechstein=s (*Myotis bechsteinii*) which had rarely been recorded in Wales. As no conclusive bat work had previously been done in Pengelli another important objective of the work was to discover all the species of bats using the woods and to understand how their presence might influence the management of the reserve.

Several different methods have been used to search for the bats. The first and continuing programme consists of regular transects to monitor the presence of bats. Echolocation calls are recorded using time expansion detectors and the bat species identified. This programme bore fruit

immediately when the distinctive calls of barbastelle bats were found on the first recordings made. We now have a good picture of the areas used by the bat species which are recorded regularly, namely: 45kHz and 55kHz pipistrelles (*Pipistrellus pipistrellus and Pipistrellus pygmaeus*), barbastelles, brown long-ear bats (*Plecotus auritus*), noctules (*Nyctalus noctula*)and *Myotis* species. The majority of the detected *Myotis* calls are believed to be from Brandt=s (*Myotis brandtii*) and Natterer=s (*Myotis natteri*) bats, though other species may be present. Occasional records have been made of greater horseshoe bats (*Rhinolophus ferrumequinum*) and a few are thought to be of Leisler=s (*Nyctalus leisleri*) and serotine (*Eptesicus serotinus*). While time expansion recording of calls provides an easy means of detecting barbastelles, it is not effective in a hunt for Bechstein=s, as it is difficult to distinguish the calls from those of other *Myotis* bats and also because the Bechstein=s calls are relatively quiet and so could be under-recorded. As Bechstein's bats have been known to use bat boxes elsewhere (Dorset) the main strategy in the search for this species was a set of 60 bat boxes set out in five areas. The presence of droppings showed that 77% of the boxes had been used by bats during last year while 41 individual pipistrelles, 14 brown long-ear and 14 noctules were found in the boxes. This is an encouraging start but we expect that it may be some time before any Bechstein's that may be in the woods use the boxes.

Barbastelle, noctule and Natterer's roosts were located during a bat workshop in 2000. Teams of bat workers were able to track the evening flight paths of some bats and then to trace the bats back to roost sites in the early morning.

The methods described so far are all Apassive - we wait for the bats to turn up - and most of the work can be carried out by relatively inexperienced people without licences. By contrast a further study in the summer of 2001 carried out by Geoff Billington, involved the trapping and radio tracking of barbastelle bats. This study provided a wealth of interesting information about the roosts, flight paths and foraging areas of the Pengelli colony of barbastelles. The presence of Natterer=s and Brandt=s bats was confirmed in the initial trapping.

By the beginning of the summer 2002 we have learnt much about the first target of our search, the barbastelle bat, but we still do not know if Bechstein's are present. This is not so surprising as they are far harder to detect than most bat species and persistence and luck may be needed to find them. In the meantime the search for Bechstein's continues this summer with monitoring targeted at the areas where *Myotis* species are detected most often and in attempts to find *Myotis* roosts.

Acknowledgements:

Many others have taken part in the project, in particular Rupert Clarke, John Galvin and Rob Colley.

Funding for the project has been provided by The Beryl Thomas Animal Welfare Trust, The Vincent Wildlife Trust, The Countryside Council for Wales and the Forestry Commission.

The habitat requirements of *Pipistrellus pipistrellus* and *Pipistrellus pygmaeus* in lowland England studied by radio-telemetry

Ian Davidson-Watts, Ministry of Defence Conservation Officer
Conservation Office, Blandford House, Aldershot GU11 2HF
e-mail: ian.davidson-watts@de.mod.uk

Since the two species of pipistrelle bat, commonly referred to as the 45-kilohertz and 55 kilohertz pipistrelles bats (*Pipistrellus pipistrellus* and *Pipistrellus pygmaeus* respectively), were separated, bat detector and dropping analyses studies have indicated that there may be significant foraging habitat differences between the two species.

A desktop study of 14 breeding roosts of each species in Hampshire showed that *P. pygmaeus* selected roosts that contained a significant proportion of wetland habitats, such as river corridors, floodplains or large water bodies within 2km of the roost when compared with habitat surround-

ing random sites across Hampshire. There were no significant differences between hab-itat surrounding breeding roosts of *P. pipistrellus* and habitat surrounding random sites. This suggests that breeding colonies of *P.pygmaeus* may be more reliant on wetland habitats than *P. pipistrellus*.

Recent advances in technology have made radio-telemetry of bats more accessible than ever before. Radio-transmitters can weigh as little as 0.35g, light enough to permit the acceptable tagging of species such as pipistrelle bats. This study was the first to use radio-telemetry methods on pipistrelle bats in the UK.

The aim of this work was to identify the habitat preferences of pipistrelle breeding colonies. During the summers (May to August) of 2001 and 2002, 24 breeding female bats of *P. pygmaeus* and 12 breeding female bats of *P. pipistrellus* (total of 36 bats) were tagged and radio-tracked in two study areas in the Avon Valley of West Hampshire and South Wiltshire. Tracked bats were plotted using triangulation techniques or followed individually for an average of 2.5 nights each.

Initial results have indicated that *P. pygmaeus* spends a high percentage of its foraging time feeding over static or slow moving water adjacent to mature trees such poplars and willows. *P. pygmaeus* forages up to a maximum of 2.3 km from its roost and will use a number of foraging areas throughout the night. *P. pipistrellus* exhibits similar foraging behaviour but appears less dependent on wetland areas and will forage over grasslands adjacent to trees and within woodlands. These early results appear to support the view that breeding colonies of *P. pygmaeus* are dependent on wetland ecosystems and particular wetland areas with a high proportion of mature trees. *P.pipistrellus* appears to be more flexible in its foraging requirements; open areas adjacent to mature trees remain a constant element of its preferred foraging habitat however.

Another summer season is planned (2003) to complete this study, which is also investigating colony activity patterns and roosting requirements of the two species.

The Coggeshall Bunkers – a successful conversion

John Dobson, *no address given*

The 500 acres of woodland to the north of Coggeshall in Essex was first mentioned in the Domesday Book. Now the Marks Hall Estate, it is currently managed by a charitable trust together with Forest Enterprise and the areas of intensive coniferisation are being returned to broad-leaved woodland. During the Second World War, the site played host to the United States 9th Army Air Force who were responsible for the construction of protective bunkers in the grounds of the estate. Although many of the bunkers have been lost since the war, twelve have been converted into bat hibernacula.

Using a variety of potential roost sites, the number of hibernating bats has reached a total of 78 of three species, just seven years after the start of the project. The total of 53 Natterer's bats (*Myotis nattereri*) makes this site one of the most important in Britain for this species.

Surveying for Bechstein's bats

Frank Greenaway, *No address given*

General survey methods for bats have mostly been based around a combination of bat detector surveys, winter hibernation site searches, and incidental records. Whilst these methods can be productive for a range of species some pose particular problems. Bechstein's bats are difficult to survey because most methods that have worked for other species are largely ineffective for Bechstein's bats. Bechstein's bats echolocation calls are quiet and easily confused with other *Myotis* species calls. This particular species hibernates in trees, only very rarely uses underground sites and being a forest animal it is rarely encountered incidentally. In consequence its presence in many areas was entirely unsuspected. The interpretation of records can be extremely difficult when the original records have no details of the sex of the bat. All bat detector

records fall into this category. Males of even the rarest species can range over wide areas whilst the females are normally quite restricted in their travels. For conservation reasons records of males are therefore of little consequence as they provide little clue to the proximity of nursery roosts.

In order to overcome these problems alternative methods of survey have been tested. Combining methods such as examining old records and following up by mist netting in appropriate habitat worked with some difficult species. Bechstein's bats however still produced a very low capture rate, even when the presence of Bechstein's had previously been confirmed in the area. Because of these difficulties less conventional methods of survey were tried.

It has long been known that bats can be attracted to the calls of conspecifics. They can actually also be repelled by them. The effectiveness of this varies enormously with the particular call that is played. Generally ordinary echolocation has little effect. A vast range of other vocalisations produced by bats are called either social or distress calls but we have little idea of the true meaning to most bats. By electronically synthesising bat calls one has the ability to alter a call until it attracts the target species. After testing and modifying a range of calls, success with Bechstein's was finally achieved with a long quite loud FM sweep.

Having attracted bats to close range it is a much higher probability that they can be trapped. This is still actually very difficult. Infra red video shows that many more bats are attracted than actually caught. In spite of this it became possible to regularly trap Bechstein's bats in areas where they were known to exist. The same synthesised call attracts a long list of other species with varying degree's of success, in particular male Brown Long Eared bats. The Bechstein's bats trapped when using this method and this particular call were largely female but in the case of the other species they are almost invariably males. Seasonal differences occur however.

When tested on an extensive survey last May the method produced two well separated records of sites with pregnant female Bechstein's bats as well as a long list of other species. As female Bechstein's bats rarely travel more than three kilometres from their nursery roost it can be safely assumed that that these represent new colonies.

The method is fast, positive, and used properly very effective. Its does however require very experienced field workers. This is not a particular drawback considering the area that can be covered in a short period. It is indeed so effective that two or three different sample periods of two hours each seem sufficient to prove the presence or absence of Bechstein's bat within a 50 hectare woodland. With modified calls the system holds the promise of fast reliable surveys for many species.

CAUTION Since at present we have so little understanding of the meaning of these calls the indiscriminate use of the method could be disturbing especially close to roosts. It requires a specific license.

RoBat - bat echolocation and the future of robotics

John Hallam, Institute of Perception, Action & Behaviour, Edinburgh University

Bats possess one of the most versatile and effective systems for perception using ultrasonic signals; their discriminatory performance is the envy of engineers. One way to try to understand how the bat biosonar system works is to build working models, based on what is known from neuroethology, and study their performance in realistic tasks. One such model system is Edinburgh University's RoBat. This system has been used for a variety of investigations, for example into ear-movements used by rhinolophid bats during biosonar behaviour and the Doppler perception strategies they might employ. The key disadvantage of systems like RoBat, however, is their relatively large physical size. A new European Union funded research project, CIRCE, is attempting to engineer a realistic model of a bat head -- realistic in terms of physical size and mobility as well as acoustic emission and reception parameters -- with which to study bat biosonar. The goals and status of this project will be reviewed.

The Paston Great Barn barbastelle story

L Bruce Keith and John Goldsmith,
English Nature and Norfolk Bat Group

This is an account of how a colony of Barbastelle bats living in an Ancient Monument/Listed Building complex in North Norfolk are being protected in an imaginative, yet pragmatic, approach to the management of both the natural and built heritage.

The presence of the bats, an Annex II species, means that Paston Great Barn site is both an SSSI and a candidate Special Area of Conservation (SAC) under the EC Habitats Directive, which requires special controls over any development of the buildings. Measures to provide maintenance and repairs to the structures, therefore, require to be subject to special design criteria and agreed protocols for working.

English Nature has taken a long lease of the building from the owners, the North Norfolk Historic Buildings Trust and a Management Group, comprising a wide range a specialist conservation and local interests has been established to agree a Management Plan, to consider the repairs schedule and to conduct monitoring and research into the activities of the bat population.

Bat conservation and the work of the Heritage Council

Liam Lysaght, Wildlife Officer, The Heritage Council, Kilkenny. Ireland.

The Heritage Council of Ireland is an independent advisory council established under the Heritage Act (1995). The primary responsibility of the Council is to propose policies and priorities for Ireland's heritage, but it also has a function to raise awareness and co-ordinate the activities of other bodies that impact on heritage.

Some of the work of the Heritage Council has focussed directly on bat conservation. Perhaps the most significant involvement of the Council in bat conservation, was the purchase of a building in Co. Clare which supports one of the largest known nursery roost of lesser horse-shoe bats. Initial work was done to secure the building from casual trespass and to halt deterioration of the building fabric. With the assistance of the Vincent Wildlife Trust, a management plan has been drawn up for the site, and a research and monitoring programme is providing much needed additional information on the behaviour and ecology of the bats.Another facet of the work of the Council is the provision of grant assistance to carry out building works to architecturally significant buildings at risk. Each year, grants are provided to more than 60 buildings of architectural merit, with total expenditure reaching in excess of €2 million. Recognising the potential threat work of this nature poses to bats, and to follow good practice, the Council has established a panel of bat surveyors to visit buildings earmarked for grant aid by the Council, and assess the importance of the structures for bats as part of the planning phase. These pre-construction surveys have already yielded important results, as one building was found to support a previously unknown colony of almost 100 lesser-horseshoe bats. The conservation needs of the bats are now being incorporated into to building work to ensure the survival of the roost.

Other aspects of the work of the Council promote bat conservation. The Wildlife Grant Scheme, a scheme where applications are invited for survey work on all aspect of the natural heritage, provides opportunities to fund bat survey work. The Council has been very supportive of the Irish Bat Conference, and has been the principal sponsor of the event since its inception in 1998. The Heritage Council has also supported the establishment of Heritage Officers in the Local Authorities, and the network of Heritage Officers has produced a publication on how Local Authorities can assist in bat conservation.

The biology and ecology of critically endangered bats

Simon Mickleburgh, Senior Conservation Researcher,
Fauna & Flora International, Great Eastern House, Tenison Road, Cambridge, CB1 2TT, UK
e-mail: simon.mickleburgh@fauna-flora.org

There are at least 1001 species of bats worldwide and 28 of them have been categorised by IUCN as Critically Endangered, indicating that there is a high risk of extinction in the near future. What are the factors that have brought these species to the verge of extinction and are there common themes that can be identified as threats to all Critically Endangered bats? In many cases they are island endemics that are facing increasing pressure from human activities as well as the added threat from natural events such as cyclones. But there are also species that in large mainland countries such as Malaysia and Mexico. In this talk I look in detail at the biology and ecology of these highly threatened species. I look at the well documented history of decline, and in some cases partial recovery, amongst Critically Endangered species and ask if this provides us with invaluable information about future trends for other less threatened species. I also look at what the future holds for these species – are they doomed to become finally extinct or is there yet hope to reverse current trends? I look at some of the successful management programmes, such as in the Comores and on Rodrigues, that have led to significant increases in numbers of bats. I also look at the methods for assessing threat and ask if they truly reflect the current situation given the new information that is regularly appearing that might lead us to review their classification as Critically Endangered, looking particularly at recent research on *Latidens salimalii* and *Otomops wroughtoni*.

Habitat use by bats in a lowland agricultural landscape

Niall Moore[1] and Tony Hutson[2]
[1]Central Science Laboratory, Sand Hutton, York YO41 1LZ
[2]Winkfield, Station Road, Plumpton Green, E. Sussex BN7 3BU
Email: nmoore@csl.gov.uk

Since 1988 MAFF and now DEFRA have been encouraging farmers to take land out of active agricultural production using the incentives of the Farm Woodland Schemes. These schemes have resulted in the planting of over 100,000ha of mainly broad-leaved woodland since their commencement 14 years ago. Most of these woodlands are small (less than 2ha) and they are still immature. As part of the DEFRA aim to maximise the biodiversity value of these plantations to the agri-environment DEFRA has commissioned scientists at Central Science Laboratory (in association with BCT and Tony Hutson) to investigate the usage of farm woodlands by bats. The eventual aim is to produce recommendations on the design, siting and management of farm woodland to optimise the benefit for a range of species. Bats, with their current conservation status, and making up c. 30% of the UK's mammalian fauna as well as their use of whole landscapes, may strongly influence final recommendations. We here report on several year's research which has involved detector surveys, static recorders and radio-tracking of brown long-eared and whiskered bats.

Detector surveys of 123 woodlands in Suffolk and the Vale of York showed that there was widespread use of immature woodlands by many species of bats. In both areas the majority of bat passes were of pipistrelles (70% in Suffolk and 80% in Yorkshire). In Suffolk, bat usage was strongly related to vegetation density, basically weedier plantations having more bat activity. Older, larger plantations with taller trees were also more attractive to bats in Suffolk. In Yorkshire, these relationships were not so clearcut and some of the relationships were counter-intuitive. The strong relationship with weediness was not apparent in Yorkshire, possible due to

far less use of vegetation management in the Yorkshire plantations. Detector surveys in the Yorkshire plantations found higher bat usage in young plantations than in adjacent arable land, although this was only significant for pipistrelle usage. Static detectors also found higher bat usage over plantations than adjacent arable land.

Radio-tracking of brown long-eared and whiskered bats has also been carried out over several summers. To date, 27 radio tags have been deployed on brown long-eared and 14 on whiskered bats. The brown long eared bats were travelling up to 7.4km to forage in the course of a night (further than expected) while the whiskered's were foraging up to 3.5km from the roost. Adults tended to forage farther from the roost than juveniles. Foraging locations for both species were remarkably consistent over time for adults but juveniles seemed to do more exploring of the landscape, visiting different areas on subsequent nights. Commuting along hedgerows was frequent but brown long-eared's also commuted along deep land drains which were relatively un-vegetated. Brown long-eareds were foraging in all sizes of woodlands from individual trees in parkland and hedgerows up to woods of 30ha. Whiskered bats foraged preferentially in woodlands, hedgerows, small wetlands and farmyards. Both species appeared to actively avoid arable land. The potential implications of these findings for the Farm Woodlands Premium Scheme are considered.

Distribution and activity of *Myotis daubentonii* and *Myotis nattereri* during the swarming season.

Katie Parsons
Bat Ecology and Bioacoustics Lab., University of Bristol, Woodland Road, Bristol, England UK.
E-mail - Katie.Parsons@bristol.ac.uk

24 Daubenton's bats and 35 Natterer's bats (*Myotis daubentonii* and *M. nattereri*) were caught, radio-tagged and released from a major swarming site in south-west England between August and November in 2000 and 2001. Locating tagged bats after release was enhanced in 2001 by the use of aircraft searches, resulting in an overall relocation rate of 69% of all bats tagged. Furthest day roosts from the release site were 27km for *M. daubentonii* and 25km for *M. nattereri*. Catchment areas (100% MCP around day roosts) were 254km^2 for *M. daubentonii* and 497km^2 for *M. nattereri*. Day roost distributions for both species were non-random and non-uniform. *M. daubentonii* were concentrated in the south of the region, and *M. nattereri* in the south and east. There was no difference in distribution between males and females of each species. Compositional analysis of habitat surrounding roosts compared with that around random points will be discussed.

A variety of different day roosts were used, including trees and buildings. No two bats used the same day roost, however several were in close proximity perhaps indicating the location of colony groups. Bats of both species were faithful to small home ranges (from less than 1km^2 to nearly 10km^2) comprising one or more day roosts and compact foraging areas. Average home range size for *M. nattereri* was greater for females than for males for both species. Several home ranges of individuals of both species overlapped with one another on the periphery, however there was only one confirmed instance of two radio-tagged *M. daubentonii* interacting. Mean emergence times for the two species were not significantly different, however on average female *M. nattereri* emerged before males. *M. nattereri* remained active for on average 55% of the night. Activity normally comprised several foraging bouts interspersed with durations in night roosts or at the day roost. Time of return to the roost was variable both within and between individuals of both species. Variation was also seen in degree of visitation of the release site. One male *M. daubentonii* returned on each night of observation, but in general return for both species was low as suspected from mark-recapture studies. No bat was observed to visit another swarming site. Application of these results to the function of swarming and the conservation implications of the findings will be discussed.

Naturally Trust the National Trust?

Phil Richardson, Bat Conservation Officer
National Trust Estate Office, 33 Sheep Street, Cirencester, Gloucester. GL7 1RQ
e-mail: xeapxr@smtp.ntrust.org.uk

With a huge number of buildings, vast areas of land and numerous farms it is not surprising that a large amount of wildlife is associated with National Trust properties. The Act of Parliament that brought the Trust into being mentions that it is for preserving the animal and plant life as well as the historic buildings. Until 1995, however, very little bat work and protection had been carried out. A preliminary review in 1995 did highlight that the bat species found on Trust properties did not reflect the same proportions of bats as found elsewhere in Britain – the Trust had more of the rarer bats and fewer of the more commonly found species, a fact probably related to the type of structures involved.

In the ensuing 5 years or so the National Trust began to experience major conflicts between building repairs and bats in residence. Some major bat sites such as Stackpole and Fountains Abbey were suffering as work went ahead regardless of bats. It seemed a matter of time before prosecutions would occur.

In November 2001 the position of a Bat Conservation Officer was set up and I was the successful candidate. One aspect of the work has been to try to prevent damaging actions at bat roosting places. I have been involved in directing a number of property managers through the rather complex new rules involving DEFRA licensing, and ensuring that the right things were done for bats. This led to me giving direct advice to all building managers about bats in properties where repairs were to take place. Follow up information in internal newsletters and other routes continue to educate those involved.

One essential ingredient of the progress of bat conservation at the National Trust has been the direct involvement of local bat groups. Their expert knowledge has proved essential when it comes to surveys and their constant bat conservation promotions at the local properties have reaped rewards.

A recent major re-organisation of the National Trust has led to the setting up of Regional Nature Conservation Advisers around the country. I hope to make these the local bat contact for Trust properties in their areas and will be giving them support and training for this role.

A complex (and poorly understood) eco-ethological system in Daubenton'sbats, *Myotis daubentonii.*

Ingo Rieger
Fledermaus-Gruppe Rheinfall, Chratzhöfli 4, CH-8447 Dachsen, Switzerland

Although the Daubenton's bat is the most common bat species in middle Europe and it can be easily observed (at least when hunting over water), the eco-ethological system of this bat species is far from understood. More than ten years of studies of Daubenton's bats around Rhine Falls produces the following picture:

Hunting habitat over river Rhine: An individual Daubenton's bat always uses the same approximately 500 metres long section of the river Rhine as its hunting range. Several individuals might use almost exactly the same part of the river (even individuals radio marked in different years). Together with other observational methods, we have strong indications that groups of Daubenton's bats hunt together in a distinct section of the river and it looks as if these areas are defended against non-group members. We thus use the term "group hunting territory".

Hunting habitat in forests: In some parts of our study area, Daubenton's bats hunt within one night over water and in forest, in other parts, the bats stay over water during the whole night.

Flight paths: On their way from the daytime roosts in forests to the hunting areas above water, Daubenton's bats use linear landscape elements like forest edges, hedges, slopes, embankments, etc. when crossing open habitat. They usually fly only a few metres (3 to 5 m) high. Daubenton's bats prefer following such landscape elements even if they have to make comparatively long detours.

Daytime roosts: Daubenton's bats in our study area use tree holes as day-time roosts. All roosts are in living trees. From one up to nearly 100 individuals stay together in a such roosts. We have distinguished four different daytime roost types according to the pattern of use and the roost architecture. On average, Daubenton's bat females change daytime roosts every 3.7 day (range: 0 to 23 days), and males change every 1.78 days (range: 0 to 8 days).

The individuals living in tree holes in one forest (at least a quarter of a square kilometre in size) know each other from staying together in the same roost, we thus expect that individuals living in one forest have some social bonds. We never (with a few, most interesting exceptions) found individuals using tree hole roosts in different forests.

Other roosts: Beside the roosts in tree holes, we know of other locations where Daubenton's bats rest or walk / climb for short distances, like "hunting pause roosts", "shelter roosts" and a few that cannot be categorised.

- Hunting pause roosts are close to the river hunting habitat, often on trees immediately near the water. Individuals use these roosts usually only for one or two minutes, but up to three times per night. Most probably, these "roosts" are on tree stems facing the water. These could be defecation locations.

- In autumn, we often find Daubenton's bats in "shelter roosts". These are locations like open garages, bus stop shelters, recessed building entrances, covered balconies, etc. The common trait among these roosts can be described as "a man made cave". From our study area, we have no data concerning hibernation roosts of Daubenton's bats.

Social Organization: The Social Organization of Daubenton's bat is complex: During the active season, the adults separate into sex-specific summer ranges; the females are in "better" habitats than the males.

Within a female area, there are two parallel social systems, one can be called the forest system, the other the river system:

- Individuals in a Group Hunting Territory over the river Rhine come from different forests.
- Individuals using tree holes in one particular forest hunt in different Group Hunting Territories

Thus Daubenton's bat individuals are members of two different social systems, the daytime roost system and the night-time river hunting system. They daily switch from one system to the other.

In our study area around Rhine Falls, we do not know where the adult males live during the active season (excepting some anecdotal observations). The males appear in the female summer range by the end of July. They stay in the female summer range for around one or two weeks. We assume (but until now cannot prove it) that the males help the females/mothers with their young and may even come to guide the young males to the male summer ranges.

Social Segregation in Daubenton's bats in Wharfedale, or 'Where's your Daddy then?'

Paula Senior *(no address given)*

We have been studying Daubenton's bats in Wharfedale for several years. The bats roosting and foraging in the upper dale are exclusively male, whereas 15km downstream the population is predominantly female with a few adult males. This pattern of segregation is not exclusive to Daubenton's bats, it has been observed in several other bat species in upland sites in the Swiss Alps (Leuzinger & Brossard, 1994), Canadian Rockies (Barclay, 1991) and the Black Hills of South Dakota (Cryan et al, 2000). Barclay (1991) working in the Canadian Rockies suggested

that the energetic demands of pregnancy and lactation might prevent females living at higher elevations where insect densities are less reliable. Males can enter torpor to save energy if foraging conditions are marginal. However this hypothesis does not explain the segregation of the two male groups.

Radio-telemetry, foraging and morphology studies revealed that upper dale males forage longer and further than lower dale males or females and have lower body masses relative to skeletal size. These results may suggest that the downstream habitat is superior to that upstream and that the downstream males are in better condition and exclude upstream males from mating opportunities with the females. Alternatively upstream males may regulate body mass for more efficient flight and use torpor to enable them to exploit the more ephemeral resources in the upper dale. They may simply have a different strategy to ensure that they are in prime condition to exploit mating opportunities at swarming sites. Bats were caught from summer roost sites, both upstream and downstream, and at swarming and hibernation caves or mines. Small disks of wing membrane were taken for DNA analysis, using microsatellite markers, to assess parentage and to test whether mating success is skewed towards a particular group of males. Initial results suggest that the father of a Wharfedale juvenile is as likely to be an upstream bat as a downstream one, which means that the upstream males are not excluded from mating opportunities by downstream males and that they are as attractive to females as downstream males.

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Patterns of roost use and home range of Natterer's bat maternity colonies

Peter Smith, University of Aberdeen*

Thirty one adult female, four adult male, and six juvenile Natterer's bats from three maternity colonies and two further adult male bats were radio tagged in the Welsh borders during three summers from 1995. They were tracked for up to 11 nights with continuous recording of location and activity on nights tracked.

Of 48 roosts in the study area 15 were in buildings and 33 in trees. However, seven roosts, including 6 buildings, contained multiple roosts sites, giving 83 roost sites in all. Sixty percent of buildings were houses and 33% barns or outbuildings. The median age of buildings was 150 years and most were solid stone under a slate roof. Tree roosts were only found in trees of at least 20 cm diameter at breast height and entrances never exceeded 50 mm in width. The median height was 6.0 metres, though the lowest was 1.8 metres.

Colonies of about 35 adult females used 21 to 31 day roost sites each, distributed across 15 to 25 trees and buildings. Many were reused in successive years. Core roost areas had from 7 to 15 roosts per sq. km.. Bats often remained together through roost changes, and moved every 3 days on average. Up to six roosts per colony accounted for about 80% of bat occupancy days each summer. There was no evidence of individual exchange between neighbouring colonies.

The above colonies occupied home ranges of about 12 sq. km. with core foraging areas of at least 1.5 to 2.1 sq. km.. There were 2.9 adult females per sq. km. within the home range. About 10% of the home range supported about 90% of foraging activity. Overlap of core foraging areas was greatest within mature semi-natural broad-leaved woodland. Individuals typically used 2 or 3 discrete core areas per night, amounting to about 13 to 14 hectares. Use of core foraging areas was independent of their distance to the day roost. Day roosts, including the parturition roost, were not necessarily centrally located within the home range. However, most foraging occurred with about 3 km. of the parturition roost. Bats emerged 59 minutes (median) after sunset and returned in the morning 75 minutes before sunrise. They spent at least 80% of this time engaged

in foraging activity on the wing, from 7% to 11% of the time roosting and from 6%to 8% of the time commuting. It is recommended that a high priority should be given to protecting roosts where young are born and raised and those in heavily timbered old barns.

*PhD study completed September 2000, supervised by Professor Paul Racey. Sponsored by The Peoples Trust for Endangered Species, The Endangered British Mammals Fund, The Countryside Council for Wales and English Nature.]

The winter ecology of the lesser horseshoe bat

Williams, Carol, G. Jones & L. Salter
University of Bristol, Woodland Road, Bristol BS8 1UG. U.K.
E-mail: carol.bat@ukonline.co.uk

My research over the last four years has looked at several aspects of the winter ecology of *Rhinolophus hipposideros* including diet, hibernacula requirements, foraging range, night roost use and habitat needs. Amongst some of the findings to be discussed will be the finding that lesser horseshoes fed throughout the winter in Cornwall and also throughout Britain dependent on the ambient climatic temperature. They foraged on a reduced abundance and diversity of prey and fed selectively on lesser and yellow dung-flies where these were available. Both these flies are particularly associated with cattle dung. Grazed areas and damp woodland were important foraging areas. Bats travelled up to 2.1 km in winter to feed with a mean foraging range of 1.2 km. Humidity in Cornish hibernacula was in excess of 95% with the typical temperature range being 6 to 11ºC. Activity within the hibernacula was principally during the hours of darkness.

Abstracts of the 8TH Annual Meeting of the Southeastern Bat Diversity Network and the 13TH Colloquium on Conservation of Mammals in the Southeastern United States
Starkville, Mississippi February 20 and 21, 2003

These first four papers in order of presentation formed a panel discussion

Bat conservation and forest management: Information needs from habitat selection studies

Dan Taylor, Bat Conservation International, P.O. Box 162603, Austin, TX 78716;
e-mail: dat4@dana.ucc.nau.edu

To maintain viable bat populations, resource managers must have reliable information upon which to base management decisions. This includes information on how bats use forests, and how bat populations respond to natural and human-induced changes in forest structure, composition, and distribution. Over the last two decades, the advent of radiotelemetry and acoustic monitoring has greatly increased our knowledge of forest bat ecology. Roost sites and foraging habitat have received the majority of research efforts, and are thought to be key parameters limiting foliage and crevice-roosting bat populations. This research has provided useful information, such as the prevalence of roost-switching by maternity colonies, and a general preference for large snags. However, many additional questions must be answered before the consequences of management can be predicted accurately. Information is needed on the underlying causal mechanisms that influence roost site and foraging habitat selection, and how these ultimately effect fitness. Other basic questions include; how many roosts are needed, and how should they be distributed at both the stand and landscape level? What constitutes foraging habitat, how much is necessary, and how does foraging and roosting habitat interact to effect overall habitat quality? And, of course, how does forest management influence these parameters? Other aspects of forest bat ecology, such as the importance of forests as night roosts, migratory stopovers, and travel corridors, remain largely unknown. The difficulty in providing answers to these and other questions is compounded by many factors, including sampling issues, a lack of knowledge of forest bat behavior, and environmental variability. While we'll still need to make management recommendations with incomplete knowledge, a move is underway to address these and other key questions using innovative and rigorous new research strategies.

The need for scientific rigor in habitat studies of forest bats

Michael J. Lacki
Department of Forestry, University of Kentucky, Lexington, KY 40546-0073
e-mail: mlacki@uky.edu

Considerable advancement in knowledge and understanding of the biology and habitat requirements of forest bats has been achieved in the past two decades. However, most of the research associated with this information growth has been largely descriptive in nature, with authors often extrapolating management recommendations beyond the scale at which the data were collected. The result of this has been a growing uncertainty as to whether proposed management recommendations should be implemented or whether additional study is necessary before an appropriate management alternative can be selected. This presentation reviews a number of considerations that influence experimental design and interpretation of data in field studies of bats, highlighting a series of topics and issues where design flaws, or interpretations, might occur. Among the topics that will be considered are spatial scale, sampling intensity, replication, variability of the data, and randomness and independence of the data. Issues assoc-

iated with the current shift in study design toward Information-Theoretic approaches as well as meta-analysis will be discussed.

Design consideratons for radioteleletry studies

L. Wes Burger
Department of Wildlife and Fisheries, M.S. Univ., Mississippi State, MS 39762
e-mail: wburger@cfr.msstate.edu

Radiotelemetry provides a powerful tool for documenting many ecological processes. However, the full potential of radiotelemetry is often lost due to lack of attention to experimental design. Prior to implementation, purpose, goals, and objectives must be clearly defined. Is the study descriptive, an observational experiment, or a manipulative experiment? Is the study intended to estimate population parameters, movement patterns and/or rates, home range size, habitat use or selection? The answers to these questions will strongly influence appropriate experimental design. Of primary concern is "To what population will inference be made?" The spatial and temporal extent of this population will dictate the sampling frame from which animals will be drawn. If the study is an observational or manipulative experiment, what is the experimental unit to which treatments are "applied"; the landscape, stand, population, or individual? This will determine the appropriate experimental unit. The type of habitat or movement information desired will determine the temporal and spatial resolution at which sampling should be conducted. If space use or home range information are desired, number of animals marked, their temporal distribution through time, and frequency and temporal distribution of locations will strongly influence the validity of estimates. Will habitat use and selection be described as discrete categories such as cover type, or described as continuous variates measured at point locations? In addition to these questions, critical issues such as effect of radio-marking on behavior and survival, non-random sampling, truncated movement distributions, and independence of observations (individuals within a social group and among locations within an individual) all must be considered and satisfactorily addressed before the first radio is deployed.

Using Euclidean distances in habitat selections studies of bats

L. Mike Conner[1] and Darren A. Miller[2]
[1]Joseph W. Jones Ecological Research Center, Rt. 2, Box 2324, Newton, GA, 31770
[2]Weyerhaeuser Company, Box 2288, Columbus, MS 39704
e-mail: mconner@server.jonesctr.org

Understanding an animal's habitat needs is a basic requirement for managing any species. A variety of techniques have been used to document habitat selection by bats, including mist net and ultrasonic detector surveys, and increasingly, use of radiotelemetry. For decades, researchers have acknowledged the influence of telemetry accuracy on conclusions drawn from habitat selection studies. When telemetry accuracy (average size of error polygon or error ellipse) approaches or exceeds the smallest habitat patch, it is necessary to model telemetry error to remove potential biases. Because foraging bats are moving, there is likely to be some telemetry error associated with movement even when 'simultaneous' bearings are obtained. Moreover, it would be difficult if not impossible, to measure triangulation accuracy of locations obtained on foraging bats making it impossible to empirically model telemetry error. We suggest that using the Euclidean distance between foraging bats and habitat features provides a mechanism for assessing habitat selection in foraging bats. This technique does not assign estimated locations to habitat types but rather uses distances from estimated locations to all available habitat types. These distances are compared to a null model to determine if habitat selection is occurring and to rank habitats in order of preference. Additionally, habitat data are analyzed with multiple analysis of variance (MANOVA) , allowing for testing for difference in habitat selection among

main effects (e.g., sex, season, year). Because the analysis is based on distances as opposed to classification, there is no opportunity for misclassification bias. Although this approach goes far to remove bias associated with telemetry error, we caution users that increasing telemetry error will result in progressively less statistical power. Thus, researchers must strive to obtain accurate location estimates. We feel that this technique should provide more reliable information for bat habitat selection studies.

Solicitaed presentations: *listed in alphabetical order by first author*

Use of a portable radiotelemetry tower and vehicular system for radiotracking *Lasiuris borealis, Myotis septentrionalis* and *Myotis grisescens* in Missouri

Sybill K. Amelon, Frank R. Thompson, Kevin Heun and Joe Amelon,
all from USFS, North Central Research Station,
202 Natural Resources Bldg., UMC., Columbia, MO 65211

Quantitative natural history information is needed to clarify relationships between forest bats and forest habitat to develop conservation strategies for these species. Numerous factors operating at multiple scales potentially influence bat distribution, habitat selection and activity patterns. We initiated a long-term study in 2001 to (a) provide intensive information on foraging and roosting habitat use by *Lasiurus borealis*, *Myotis septentrionalis,* and *Myotis grisescens* and (b) to evaluate effect of landscape pattern, local habitat, and temporal factors on relative activity or occurrence of forest bat species in the Central Hardwood Region of Missouri. Due to small size, fast, and sometimes long distance, movements, foraging locations are difficult to determine accurately. To improve accuracy and consistency of triangulated foraging location estimates, we developed a portable tower and vehicular system using 8 and 11 element yagi antennas coupled with an electronic compass engine (KVH Industries, Inc.) for synchronous azimuth determination. We have used this system to radio track 26 *L. borealis*, 23 *M. septentrionalis* and 15 *M. griscesens* with a mean accuracy of locations of less than 2 hectares.

Evaluation of landscape-level habitat attributes of Indiana bat (Myotis sodalis) autumn home ranges in the Bankhead National Forest, AL

Ben Battle and Wes Stone
Center for Forestry & Ecology, Alabama A&M University, Normal, AL 35762
e-mail: wstone@aamu.edu

In mid-late October 2002, we descended into a known hibernacular cave on the Banhead National Forest, Alabama shortly before dusk on 5 occasions and captured 9 roosting Indiana bats (*Myotis sodalis*). We placed transmitters on these bats (3 males and 6 females) to collect data regarding their subsequent locations. All bats were tracked and located at 2 or more diurnal roost sites during the 3-week period following capture. A GPS unit was used at each roost location to record its latitude and longitude. We converted the roost locations to match the projection of a landscape image of the Bankhead National Forest that was derived from thematic mapper data and CISC forest inventory data. We then overlayed the locations on the landscape image. We connected the points to form a minimum convex polygon to represent each bat's home range area. The cover type composition, age class distribution, stream density, and an edge index (fractal dimension) were computed for each home range. Nine similar-sized polygons were clustered around a random, but representative, point in the forest. These polygons were clipped from the landscape image and their cover type compositions, age class distributions, stream densities, and edge indices were similarly determined. These data were analyzed using a series of t-tests to determine if any significant differences in landscape-level variables between occupied and unoccupied polygons existed. Although violation of sampling independence (common capture point)negates a rigorous statistical comparison,we found that occupied polygons had significantly

greater ($p < 0.05$) hardwood acreage and old-growth acreage (100+ years old) and significantly less conifer acreage and "stand type edge" (fractal dimension). The acreage of young to mature forest (0-70 years) and mature forest (71-100 years) were not significantly different. Stream mile density was higher in occupied polygons, but not significantly ($p = 0.20$).

Use of Mississippi limestone caves by bats

David C. Beckett and Austin W. Trousdale,
Dept. of Biological Sciences, Univ. of Southern Mississippi, Hattiesburg, MS 39406-5018

The caves of Mississippi (MS) have received little scientific attention, perhaps because MS has far fewer caves than neighboring states. Prior to our efforts, the only comprehensive survey of bats in MS caves was conducted by Middleton in 1973-74. He observed eastern pipistrelles (*Pipistrellus subflavus*) in several caves. From 1999 to the present, we have observed *P. subflavus* and southeastern myotis (*Myotis austroriparius*) in MS limestone caves. Numbers of *P. subflavus* inside the caves increase markedly during the winter when this species uses these sites as hibernacula. We have found *M. austroriparius* in 4 caves: Pitts (the largest known cave in MS), Triple H, Waddell, and Eucutta. Triple H Cave formerly supported a maternity colony of *M. austroriparius*, but was abandoned as such prior to 2000. Pitts Cave supported a maternity colony in the summers of 1999 and 2000 (numbering ca. 1000 individuals in July 2000) but has not been used as a maternity site since then. Waddell Cave is used by *M. austroriparius* as both a maternity and wintering site and, from a conservation viewpoint, is the most important known "bat cave" in MS at present.

Use of bridges as maternal roost sites by Rafinesque's big-eared bat (Coryorhinus rafinesquii) in South Carolina

Frances Bennett[1], Austin W. Trousdale[1], Susan Loeb[2], Mary Bunch[3] and William Bowerman[1]
[1]Department of Environmental Toxicology, P. O. Box 709, Clemson Univ., Pendleton SC 29670
[2]Southern Research Station, Department of Forest Resources, Clemson Univ., Clemson, SC 29634
[3]South Carolina Department of Natural Resources, 153 Hopewell Road, Pendleton SC 29670
e-mail: fbennet@clemson.edu

Rafinesque's big-eared bats (*Corynorhinus rafinesquii*) are known to use bridges as roosting sites throughout their range in the southeastern United States. The availability and use of bridges by maternal groups of *C. rafinesquii* is a poorly understood yet potentially important limiting factor in determining the status of this state endangered bat in South Carolina. Highway bridges were surveyed in South Carolina to determine: 1) which bridge characteristics influenced occupancy; 2) the distribution and abundance of *C.rafinesquii*; and 3) selection and use by maternal groups. From 22 May to 9 August 2002, 1134 bridges spanning permanent water bodies were surveyed in all 46 counties of South Carolina. Bridges were checked for occupancy by *C.rafinesquii* and grouped according to one of three structural designs: 1) T-beam; 2) multi-beam; and 3) slab. We also examined structural material, disturbance underneath each bridge and habitat. Both bridge type and material were significantly related to occupancy by *C.rafinesquii* ($p < 0.001$). Maternal and solitary roosts were found underneath 35 bridges, all within the Coastal Plain of South Carolina. Of these occupied bridges, 11 contained maternal roosts with an average number of 12 adults per roost. The largest recorded group of *C. rafinesquii* consisted of approximately 35 adults and 18 pups roosting under a concrete T-beam bridge. Identification of bridges used by *C. rafinesquii* as maternal roost sites in South Carolina is important to protect this endangered population and sustain populations of *C. rafinesquii* where natural roost sites are no longer available or in short supply.

Bat species activity in two forest habitats above and below the canopy

Justin G. Boyles, Matt N. Miller, and Lynn W. Robbins
Biology Department, Southwest Missouri State University, Springfield, MO 65804;
e-mail: lwr704f@smsu.edu

Bat species activity was examined using Anabat II bat detectors in upland and lowland deciduous forests, above and below the canopy. At the 2 upland localities, hi-mics were placed above the canopy adjacent to service roads where the ground-level detectors were placed. At the 2 lowland locations, hi-mics were placed above the canopy and the ground level detectors were placed at the edge of the forest-field boundary. Recordings were made on 2 consecutive nights during 3 different periods throughout the summer, approximately corresponding with pregnancy, lactation, and post-lactation. Species were identified quantitatively. Total species activity and individual species activity were compared between high and low detectors in each habitat throughout the night within and among sampling periods. Species richness was higher at ground level than above the canopy in both habitats, and fewer sequences were recorded and identified above the canopy. *Eptesicus fuscus, Lasiurus borealis,* and *Nycticeius humeralis* had higher activity indices than the other species above the canopy, with fewer *Myotis sodalis, M. lucifugus, Pipistrellus subflavus,* and no *M. septentrionalis*. Activity for all species increased above the canopy after June.

Long term spatial relationships of Indiana bats: A conceptual model?

Timothy Carter and Eric R. Britzke,
Department of Zoology, Southern Illinois University Carbondale, IL 62901-6501;
Department of Biology, Tennessee Technological University, Cookeville, TN 38505
e-mail: tcarter@siu.edu

Since the discovery of the first Indiana bat (*Myotis sodalis*) maternity colonies in the mid 1970's, research has focused on characteristics of the roost trees used. This research has determined that Indiana bats use dead or dying trees that are ephemeral roost sites, causing maternity colonies move from one roost tree to another. Despite this reliance on ephemeral resources, current thinking states that Indiana bats are found in certain locations and that they will remain in these areas for extended periods. With the location of numerous colonies throughout the species range, we can now start to address the long-term habitat use and distributions of these colonies. After examining Indiana bat colonies currently under study, historical records of colonies, and historical survey efforts, we hypothesize that Indiana bat colonies, in the long term, are nomadic. Colonies move across the landscape seeking out areas that have experienced catastrophic natural disasters (e.g. floods, wind storms, etc.) or human activities that create suitable habitat. During the relatively short time these areas remain suitable, Indiana bat colonies thrive. As the colony increases in size and/or as the habitat become less suitable, we suggest that smaller satellite colonies may leave the area in search of new sites to colonize. If this conceptual model is correct, long-term management and stability of a given colony becomes much more problematic.

Seasonal use of bridge roosts in Louisiana

Francesca J. Ferrara and Paul L. Leberg,
Department of Biology, University of Louisiana at Lafayette, Lafayette, LA 70506;
e-mail: fjferrara@juno.com

Little is known about seasonal use of bridges as roosting sites in the southeastern United States. My objective was to determine species composition and role of habitat characteristics associated with bridge roosting bats throughout the year. During January to December 2002, I surveyed bridges in the Winn Ranger district of Kisatchie National Forest located in north central

Louisiana. Three types of bridges were examined: wooden creosote bridges (n = 11), flat concrete bridge (n = 12) and double T concrete bridges (n = 52). Double T concrete bridges are distinguished by the presence of girders that create understructure. Preliminary surveys indicated that bats were observed under proportionally more double T bridges than is expected based on chance ($p < 0.004$). Subsequently, only double T bridges were monitored. Four species of bats have been observed roosting under bridges, including *Corynorhinus rafinesquii* , *Pipistrellus subflavus* , *Eptesicus fuscus* and *Myotis sp. C. rafinesquii* reached peak abundance during the summer months, while *P. subflavus* were more abundant during the winter. I will discuss light and temperature as possible microclimate factors that influence seasonality in selection of bridges as roost sites.

Hearing bat habitat: Anabat surveys on the Fernow Experimental Forest

W. Mark Ford[1], M. Alex Menzel[2], Jennifer M. Menzel[1] and Jane L. Rodrigue[1]
[1]USDA Forest Service, Northeastern Research Station, Box 404, Parsons, WV 26287;
[2]Division of Forestry, West Virginia University, Box 6125, Morgantown, WV 26506
e-mail: mford@fs.fed.us

We used Anabat II acoustical detectors linked to laptop computers to sample bat echolocation activity at 57 permanently located recording stations on the 1,800 ha Fernow Experimental Forest in the Allegheny Mountains of West Virginia. During the summers of 2001 and 2002, we detected *Myotis lucifugus, Myotis septentrionalis*, *Myotis sodalis*, *Eptesicus fuscus*, *Pipistrellus subflavus*, *Lasiurus borealis*, *Lasiurus cinereus*, and *Lasionycteris noctivigans*. Logistic regression analyses suggested that *Myotis septentrionalis* and *Myotis sodalis* activity was linked to small canopy gaps or closed forest conditions along small 2nd order streams whereas *Myotis lucifugus* and *Pipistrellus subflavus* activity was highest along larger 3rd to 4th order streams with discontinuous or open forest canopies. *Lasiurus borealis* and *Eptesicus fuscus* activity was greatest in medium-sized forest canopy gaps and linear openings along roads in upland conditions. *Lasiurus cinereus* activity was most noticeable within recently harvested forest stands, although its presence also was recorded above mature forest canopies and along forested riparian zones. Except for *Eptesicus fuscus* and *Pipistrellus subflavus*, logistic regression model performance linking individual species presence to habitat conditions was good with medium to high sensitivity and specificity measures. Multivariate ordinations of bat echolocation activity indicated some foraging habitat segregation based on morphology, echolocation characteristics and or feeding strategy that minimized inter-specific competition. Although roost habitat management for species such as *Myotis sodalis* remains the conservation priority on the Fernow, maintenance and management of foraging habitats that we identified also should be considered a critical task..

Roost partitioning of two common foliage roosting bats in the Piedmont

David W. Leput[1], Susan C. Loeb[2], and J. Drew Lanham[1]
[1]Dept. of Aquaculture, Fisheries, and Wildlife, G11 Lehotsky Hall, Clemson, SC 29634;
[2]Southern Research Station, U.S. F. S., Dept. of Forest Resources, Clemson, SC 29634
e-mail: dwleput@hotmail.com

Red bats (*Lasiurus borealis*) and eastern pipistrelles (*Pipistrellus subflavus*) are common bats in southern Piedmont forests. Both are foliage roosters but there is little information on resource partitioning between the species. The objective of this study was to document use and overlap of roost structures and habitats by red bats and pipistrelles during the maternity season. From June to August 2002, we radiotracked reproductively active female eastern red bats (n = 5) and eastern pipistrelles (n = 3) in upstate South Carolina. We determined the species, status, and size of each roost tree and measured characteristics of the surrounding habitat. T-tests were used to compare tree and habitat characteristics between bat species and with random plots. Fifteen roosts were

located (red bats, *n* =11; pipistrelles, *n* = 4). Both species roosted in live hardwood trees in mixed pine-hardwood and hardwood stands with red bats using a larger variety of tree species. Both species roosted in live foliage and clumps of dead leaves, but red bats primarily used live foliage. Roost trees were in areas with a taller midstory than other areas of the stand, but pipistrelles roosted in areas with a taller midstory and with a greater number of stems (0 – 2 cm DBH) than red bats. Distance to the next tallest tree was smaller for pipistrelles than for red bats and the DBH of the next tallest tree was greater than in random plots. This suggests that pipistrelles use areas of denser cover than red bats. These preliminary results suggest that female red bats and pipistrelles use similar structures but different habitats for summer roosting. Further, habitat management that maintains a diversity of hardwood trees in the mid-story and over-story would benefit both foliage roosting species, but practices that favor a denser mid-story may be more beneficial for pipistrelles.

Winter hibernacula survey for Indiana bats in Fern Cave

Robert F. Madej.
R.D. Zande and Associates, Inc. 1237 Dublin Road, Columbus, Ohio 43215;
e-mail: made2@zande.com

Fundamental to the recovery of Indiana bats is research that identifies the current population status and factors affecting the population. On the closing day of the March 2001 symposium on the biology and management of the Indiana bat, Dr. Merlin Tuttle commented that a large winter population of Indiana bats may exist in Fern Cave, Alabama. The statement was based on Dr. Tuttle's observation of Indiana bat urine stains on the ceiling of Fern Cave some years earlier. Fern Cave is a known hibernaculum of approximately 1 million gray bats and is protected on Wheeler National Wildlife Refuge. I proposed to the U.S. Fish and Wildlife Service to conduct a survey of Fern Cave to determine the possible presence and winter population of Indiana bats. The survey was approved and planned for the winter of 2002/2003. Over one mile of cave passage was investigated on 2 November 2002 in unrestricted portions of the cave. Additional passage was investigated on 18 January 2003, including the well-known Morgue area. The results of these investigations and their implications for conservation and management of Indiana bats will be discussed.

Searching for phyllostomid bats in the lower Florida Keys

Cynthia Marks,
Florida Bat Center, P. O. Box 496422, Port Charlotte, FL 33949
e-mail: FlaBats@aol.com

Recent publications list *Artibeus jamaicensis* as being resident in the Florida Keys, yet no evidence of a colony has been found. The purpose of this project was to look for evidence of colonization and to determine the potential for this species to survive on the food resources available in the Lower Keys. While reviewing past findings, it became evident that some identifications of *A. jamaicensis* were in dispute and others were inferences based on assumptions. Documented findings of other Phyllostomid species in the same region were also found. Because of this, the project was expanded to include the potential for other species of Phyllostomids to colonize in the Lower Keys. Flyers were circulated during 2001 in the Lower Keys requesting information on bat sightings. Interviews were conducted with Key West residents during 2001 an 2002 whose sightings were indicative of Phyllostomid bats. Flowering and fruiting plants were located in Key West and Stock Island, inspected during the day for signs of bat usage and visually observed at night. The review of past findings along with preliminary information from this on-

going study suggest that marginal populations of nectar feeding Phyllostomid species may be more likely than *A. jamaicensis*.

Fall surveys of microchiropteran bats at Murder Branch Cave, Daniel Boone Natioal Forest, Kentucky

Les E. Meade[1] and John R. MacGregor[2]
[1]Dept. of Biol. and Environmental Sciences, Morehead State Univ., Morehead, KY 40351
[1]Third Rock Consultants, Lexington, KY 40503
[2]1700 Bypass Road, U.S. Forest Service, Winchester, KY 40391
e-mail: l.meade@morehead-st.edu

This project included a survey of microchiropteran bat activity at Murder Branch Cave during early October, from 1995-2001. Murder Branch is in the Morehead District of the Daniel Boone National Forest. The primary goals of this project were to: (1) examine this cave for the federally endangered Indiana bat (*Myotis sodalis*) and Virginia big-eared bat (*Corynorhinus townsendii virginianus*); (2) to determine what additional bats were also using this cave; and (3) to examine and compare life history data for each species (including sex, weight, forearm length, reproductive condition, and age). Bats were collected in a 2.5 meter mist net set across the cave entrance and in an adjacent 12 meter net. Captured bats were examined, sexed, weighed, measured, banded and then released. Species collected in the Morehead District during this research project included *Myotis septentrionalis*, *M. lucifugus*, *Pipistrellus subflavus*, *Lasiurus borealis*, *Lasionycteris noctivagans*, *Eptesicus fuscus*, *Corynorhinus townsendii virginianus* and *C. rafinesquii*. Bat activity increased at the mouth of Murder Branch Cave from September to October, but winter surveys indicate that *C. rafinesquii*, *C. t. virginianus*, *L. borealis* and *L. noctivagans* do not normally frequent this cave during hibernation. However, 3 specimens of *C. t. virginianus* were found in this cave on 5 Febuary 1982 and one on 1 Febuary 1984. During recent field work, biologists with Kentucky Department of Fish and Wildlife Resources discovered banded specimens *of C. rafinesquii* and *C. t. viginianus* from Murder Branch during winter surveys at Donahue Cave (Morgan County) and Stillhouse Cave (Lee County), respectively.

Factors influencing bat activity patterns in the Southeastern United States

Michael A. Menzel[1], Jennifer M. Menzel[2], W. Mark Ford[2], John W. Edwards[1]and John C. Kilgo[3]
[1]Division of Forestry, West Virginia University, Morgantown, WV 26506;
[2]USDA Forest Service, Northeastern Research Station, Box 404, Parsons, WV 26287
[3]USDA Forest Service, Southern Research Station, New Ellenton, SC 29809, USA
e-mail: mamenzel@juno

Studies have examined effects of weather, forest structure, arthropod abundance, and landscape features on bat activity patterns. However, few studies have attempted to simultaneously monitor variables from each these classes to determine their relative impact on bat activity. The patchy distribution of bat activity in habitats with homogenous structure suggests inclusion of variables from all of these categories may be necessary to model bat activity patterns. We monitored bat activity at 437 locations and collected data on 86 variables including 9 weather variables (e.g., temperature, barometric pressure), 49 habitat structure variables (e.g., canopy density, basal area, stand age), 13 measures of arthropod abundance (e.g., number 2-15 mm coleopterans), and 15 landscape variables (e.g., distance to water). Our objectives were to determine which variables differed between sites with above and below average levels of bat activity and to create logistic regression models capable of predicting bat activity patterns. We detected 7 species including eastern red and Seminole bats (n=1491), eastern pipistrelles (n=474), evening bats (n=359), big brown bats (n=156), southeastern myotis (n=155), and hoary bats (n=110; total n=3251). Activity was related to commonly measured habitat characteristics including vegetational comm-

unity type and stand age. More importantly, site specific (habitat and landscape variables) and short-term transient variables (weather and arthropod abundance) differed between areas of high and low activity for all bat species. Despite detecting numerous differences between areas of high and low activity (e.g., 27 of 86 variables differed between areas of high and low total activity), we were unable to construct models capable of predicting areas of high bat activity. Our results suggest the high variance commonly associated with bat acoustical surveys may be caused by the inability to control or adequately account for variation in landscape or short-term transient variables.

Preliminary analysis of day-roost variability of evening bats *(Nycticeius humeralis)* in Southwest Georgia

Adam C. Miles[1], Steven B. Castleberry[1], Darren A. Miller[2] and L. Mike Conner[3],
[1]Warnell School of Forest Resources, University of Georgia, Athens, GA 30602
[2]Weyerhaeuser Company, P. O. Box 2288, Columbus, MS 39704
[3]Joseph W. Jones Ecological Research Center, Rt. 2, Box 2324, Newton, GA, 31770
e-mail: adamcmiles@yahoo.com

Natural longleaf pine (*Pinus palustris*) forests continue to decrease while intensively managed loblolly pine (*Pinus taeda*) plantations increase in the southeastern United States. The impact of this change in forest structure on bat roosting ecology has not been adequately investigated. Furthermore, few studies have investigated bat roosting ecology simultaneously in intensively managed and natural pine forests landscapes. Our objective was to characterize evening bat (*Nycticeius humeralis*) day-roosts in managed loblolly pine and natural longleaf pine landscapes. The study was conducted on 2 study sites in the Gulf Coastal Plain of Georgia. The Joseph W. Jones Ecological Research Center, Baker County, Georgia is a second growth mature longleaf pine ecological reserve managed with a 2 year fire rotation. The Aultman Tract, Worth County, Georgia is managed by Weyerhaeuser Company for loblolly pine sawtimber production with a 30 year clear-cut rotation. During summer 2002, we radiotracked 15 females and 15 males to 32 and 27 day-roosts on Jones, and 11 females and 11 males to 11 and 17 day-roosts on the Aultman Tract (n = 52 bats and 87 day-roosts). Bats used a variety of tree types, but pines were the most common roosts of both sexes (69% overall). Females used snags (38%) more than males (8%) on the Jones Center, but snags were used by females and males in similar proportions on the Aultman Tract (27% and 29%, respectively). Exit counts also were conducted when time permitted, and we found a large longleaf pine snag (dbh = 57.1 cm, approx. height = 23.2 m) on the Jones Center that contained approximately 490 individuals. Variability in roost tree characteristics within and between the study sites will be discussed.

A test of the sampling protocol for Indiana bats

Kevin L. Murray, Justin G. Boyles, John C. Timpone, Matt N. Miller and Lynn W. Robbins. Biology Department, Southwest Missouri State University, 901 S. National Ave., Springfield, MO 65804;
e-mail: lwr704f@smsu.edu

The purpose of this study was to test effectiveness of the accepted guidelines in determining presence or absence of Indiana bats in areas within one mile of known maternity colonies. In addition to the standard mist-net protocol, Anabat II detectors were used at the same localities for the same time periods. During the first year of the study, 2 locations in Missouri were sampled and all data were combined for analyses. Mist net effectiveness for this species was 19.6% and bat detector effectiveness was 42.7%. The probability of documenting presence of Indiana bats within one square mile using the protocol was 82.5% with nets alone and 98.0% when data from

the detectors were included. In the second year, data were collected during 3 separate reproductive time periods. Overall probability of capture and detection was higher in the second year, but the values varied greatly among time periods and between first and second nights of the survey. If these results are found to be consistent across the range of the species, the accepted guidelines may need to be modified in order to more accurately determine the presence or absence of this species. Data from sympatric species will be included and compared.

Characteristics of red bat (Lasiurus borealis) roosts
in the Ouachita Mountains in Arkansas

Roger W. Perry and Ronald E. Thill,
Southern Research Station, USDA Forest Service, P.O. Box1270, Hot Springs, AR 71902
Southern Research Station, USDA Forest Service, 506 Hayter St., Nacogdoches, TX 75965
e-mail: rperry03@fs.fed.us

Diurnal roosts are a critical life history requirement for bats and successful conservation programs depend on a thorough understanding of habitat requirements. Although red bats (*Lasiurus borealis*) are abundant throughout most of the southeastern United States, little research has been conducted on their ecology until recently. To provide information on roost attributes and to determine if roost site selection is influenced by structural differences among stand types, we characterized summer diurnal roosts of red bats in a diverse forested landscape of the Ouachita Mountains of central Arkansas. Using radiotelemetry, we tracked 10 male and 15 female red bats to 92 roost locations. Data were collected on roost attributes (e.g., tree species, roost height) and attributes of the sites surrounding roosts (e.g., overstory canopy height, canopy cover, basal area, aspect). Random trees and plots were also measured and compared with roosts and site attributes to determine selection. Red bats roosted primarily in white oaks (*Quercus alba*) and showed a preference for this species. Red bats preferred trees that were larger in diameter and taller than randomly selected trees. Roost plots contained more road cover than random plots because red bats tended to roost in close proximity to forest roads. Female maternity roosts were higher in trees, further from the edge of the crown, and in trees with higher crown bases than male roosts. Red bat roost sites were characterized as having a sparse understory and pine midstory and an abundance of large hardwoods. These conditions could be enhanced by overstory hardwood retention, mid-story thinning, and periodic prescribed burning.

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Roger W. Perry and Ronald E. Thill,
Southern Research Station, USDA Forest Service, P.O. Box1270, Hot Springs, AR 71902
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meter and taller than randomly selected trees. Roost plots contained more road cover than random plots because red bats tended to roost in close proximity to forest roads. Female maternity roosts were higher in trees, further from the edge of the crown, and in trees with higher crown bases than male roosts. Red bat roost sites were characterized as having a sparse understory and pine midstory and an abundance of large hardwoods. These conditions could be enhanced by overstory hardwood retention, mid-story thinning, and periodic prescribed burning.

The use of bat detectors to determine habitat use

Lynn W. Robbins
Biology Department, Southwest Missouri State University, Springfield, MO 65804
e-mail: lwr704f@smsu.edu

Since 1960 when Griffin and his colleagues determined that insectivorous bats used echolocation to capture insects, numerous investigators have used ultrasonic detectors to estimate habitat use, activity levels, and species composition of various habitats. As early as 1981, B. Fenton and colleagues determined that it is possible to recognize species of bats by characteristics of their calls, and subsequently, numerous researchers have attempted to identify species with varying degrees of success. However, it has been shown that if one acquires a large sample of search phase call sequences from each species within the study area, a high probability of identification is possible. My question is, based on information presented above, why are we still collecting data on "total bat activity" for studies dealing with the biology of bats or the conservation of habitat or endangered species? If we made conservation decisions based on "total rodent activity", we would conclude that barns and dumps were more important than old growth forests. If we made decisions on "total bird activity", areas with starlings and English sparrows would be allotted special protection, and if we were interested in ungulate activity, feed lots and pastures would be considered for protection. Moreover, because species of *Myotis* are difficult to distinguish, some studies have lumped these for analyses. Studies on *Peromyscus, Reithrodontomys*, or warblers would not be acceptable if species were not identified. Our understanding of bat biology and our management decisions for endangered species, if based on "total activity" or genus-level identifications, may be meaningless, or worse, misleading.

Status of the gray bat in the western portion of its range

Blake Sasse[1], Michael J. Harvey[2], Rick L. Clawson[3] and Steve L. Hensley[4],
[1]Arkansas Game and Fish Commission, #2 Natural Resources Drive, Little Rock, AR 72205;
[2]Department of Biology, Tennessee Technological University, Box 5063, Cookeville, TN 38505
[3]Missouri Department of Conservation, 1110 S. College Ave., Columbia, MO 65201
[4]U.S. Fish and Wildlife Service, 222 S. Houston, Suite A, Tulsa, OK 74127
e-mail: dbsasse@agfc.state.ar.us

The gray bat, *Myotis grisescens*, was listed as federally endangered in 1976 and known winter populations had declined by at least 50% when the species recovery plan was published in 1982. Based on banding studies performed in the 1960s and 1970s, it appears that the western portion of their range contains 3 sub-populations in: 1) northern Arkansas, northeastern Oklahoma, southeastern Kansas, and southwestern Missouri, 2) central and south-central Missouri, and 3) southeastern Missouri. Since these sub-populations were delineated, there have been changes in patterns of cave use such as the abandonment of a major hibernacula in Missouri and its apparent replacement by several new sites in Arkansas. Natural resource agencies have also undertaken significant efforts to protect important gray bat sites through signing, gating, and fencing. Surveys conducted at maternity caves from 1978-1989 and 1990-2001 indicate that minimum yearly population estimates in each period were unchanged or increased by more than 25% at 37 of 51 (73%) caves and decreased by more than 25% at 14 of 51 (27%) caves. Progress

towards implementation of recovery tasks and additional population trend information will be discussed.

Preliminary assessment of *Corynorhinus rafinesquii* roost characteristics at St. Catherine NWR

Alison R. Sherman and Chester O. Martin
Mississippi Museum of Natural Science, 2148 Riverside Dr., Jackson, MS 39202-135;
Environmental Laboratory, U.S. Army Engineer R and D Center (CEERD-EE-E),
3909 Halls Ferry Rd., Vicksburg, MS 39180-6199
e-mail: alison.sherman@mmns.state.ms.us

Roost sites of Rafinesque big-eared bats (*Corynorhinus rafinesquii*) were examined in abandoned buildings at St. Catherine Creek National Wildlife Refuge, Adams County, Mississippi, from April through August, 2002. These sites were also surveyed periodically during the fall and winter months. In 2002, 7 abandoned structures were documented to serve as roost sites on and immediately adjacent to the refuge. Only one site on the refuge was verified to be a maternity roost. This colony contained 36 adult females, recorded on July 23. Another structure on property adjoining the refuge contained 35 *C. rafinesquii* on September 16. Other structures supported from 0-9 individuals during the survey period. Twenty-five *C. rafinesquii* were hand netted in the roosts after pups were volant. Captured bats were weighed, sexed, measured and banded using split ring bands. Standard mist netting was conducted at 17 sites on the refuge from April through October. Eight *C. rafinesquii* were captured at 3 sites. This was the most frequently captured species, representing 38% of all captures. Other bat species netted during the survey period included the evening bat (*Nycticeius humeralis*; 29%), eastern red bat (*Lasiurus borealis*; 19%), southeastern myotis (*Myotis austroriparius*; 9%), and big brown bat (*Eptesicus fuscus*; 5%). A large colony (approximately 1500 individuals) of *M. austroriparius* was also discovered in a cistern on bluffs east of the refuge in November. Roost characteristics for *C. rafinesquii* were evaluated and data regarding internal temperature, humidity and light intensity were recorded. Roost dimensions, location of bats within the roost, and roosting substrate were also noted. Roost searches, mist netting and monitoring of roost characteristics will continue in 2003.

Description of tree-roosts of Rafinesque's bit-eared bat (*Corynorhinus rafinesquii*) in southern Mississippi

Austin W. Trousdale and David C. Beckett
Dept. of Biol. Sciences, University of Southern Mississippi, Hattiesburg, MS 39406-5018

Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) is a species of concern throughout its range. Most ecological studies of *C. rafinesquii* have been based on populations that primarily used caves or manmade structures (e.g., abandoned buildings) as roosts. However, this species also utilizes cavities of trees, which are thought to be the natural day-roosts of *C. rafinesquii* in the Gulf Coastal Plain, where caves are scarce. Previous studies suggest that tree cavities have a finite "lifespan" as suitable roosts and are often a limited resource for populations of bats dependent upon them. Knowledge of use of trees by *C. rafinesquii* is mostly anecdotal. Therefore, the goal of the study is to identify and describe tree-roosts of *C. rafinesquii* in DeSoto National Forest, Mississippi. Using radiotelemetry to locate trees used by bats that we have captured, we have thus far located 7 tree roosts. Five of these were *Nyssa sylvatica* and 2 were *Magnolia grandiflora*. Four of these trees were exceptionally large, 6 were alive, and all possessed "trunk hollows" rather than basal hollows. Four trees were located directly beside the main channel of streams with 2 others located $\leq$ 10 m of a stream. Three radiotagged individuals used the same tree. We will subsequently characterize roosts using both qualitative and quantitative variables specific to the individual tree and the surrounding habitat. We will also

monitor such trees using nighttime exit counts to determine if the roosts are used by solitary bats or by colonies.

The following abstracts were presented as posters

Dietary variation as determined by fecal analysis in Rafinesque's big-eared bat *Corynorhinus rafinesquii*, in coastal South Carolina

Heather A. Armbruster,
Department of Biological Sciences, 331 Funchess Hall, Auburn University, Alabama 36849;
e-mail: Hthomas98@aol.com

The largest known colony of Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) in South Carolina is located at Hampton Plantation State Park in an abandoned kitchen building. This colony of up to 80 individuals provided an opportunity to study the seasonal diet of *C. rafinesquii*. Fecal samples were collected from the roost from mid-March through late November. Insect samples were collected using aerial traps from various locations within the park on nights corresponding to fecal sample collections. Bats appeared in the roost in early March. The bats left for the winter at the beginning of December. Fecal samples were analyzed and compared to insect samples to determine diet preferences of *C. rafinesquii*. Rafinesque's big-eared bat preferentially ate Lepidoptera, but also consumed significant amounts of Coleoptera and Diptera. Blatteria and Neuroptera were important food items when they occurred.

Distribution of two bat species in Alabama

John L. Hunt, Troy L. Best, Lisa A. McWilliams, Paul R. Moosman,
M. Keith Hudson and W. B. Johnston,
Department of Biological Sciences, 331 Funchess Hall, Auburn University, AL 36849
e-mail: huntjoh@mallard.duc.auburn.edu

No comprehensive study of distribution records of bats in Alabama has been conducted since the 1950s. Records of occurrence were compiled from museum collections and publications, and from specimens submitted to the Alabama Department of Health for rabies testing. A distribution was plotted for each species using geographic information systems. Preliminary results for *Corynorhinus rafinesquii* and *Lasiurus borealis* are given.

Bats of the Mobile-Tensaw Delta, Alabama: Preliminary results

Charles H. Kilgore, Troy L. Best, John L. Hunt, Paul R. Moosman,
Lisa A. McWilliams, and Vickie A. Ashe
Department of Biological Sciences, 331 Funchess Hall, Auburn University, Al. 36849
e-mail: euderma@earthlink.net

Relatively little is known about most of the 15 species of bats in Alabama. Especially scarce are data on species occurring in southern Alabama, including the Mobile-Tensaw Delta region. Because there are significant recent acquisitions of tracts of land into the public trust within the Mobile-Tensaw Delta region in southern Alabama, it was especially desirable to obtain an accurate biological survey. Objectives were to conduct a field survey and to use radiotelemetry to determine characteristics of day roosts of the bat fauna. At each collection locality, habitat, species captured, date and time of capture, sex, age, and reproductive condition were recorded for each individual. Mist nets were used to capture bats, abandoned buildings were searched, and firearms were used to collect specimens at some sites. During 2002, 57 sites were surveyed. A total of 30 bats of 6 species was captured: 13 Seminole bats (*Lasiurus seminolus*), 6 eastern red bats (*Lasiurus borealis*), 4 Rafinesque's big-eared bats (*Corynorhinus rafinesquii*), 4 evening bats

(*Nycticeius humeralis*), 2 southeastern myotis (*Myotis austroriparius*), and 1 hoary bat (*Lasiurus cinereus*). Studies will continue in 2003.

Bat communities from two physiographic regions in Kentucky

Paul R. Moosman, Jr. and Charles Elliott
331 Funchess Hall, Auburn University, AL 36849
Dept. of Biol. Sciences, Eastern Kentucky University, Richmond, KY 40475
e-mail: prmoosman@hotmail.com

The distribution of most bat species throughout the U.S. is only partially known. Distribution records are often scattered throughout the scientific literature, and if compiled are usually presented using political boundaries. Records describing associations between bat species and physiographic regions in Kentucky were particularly hard to find. We attempted to identify differences in bat faunas between the Knobs and Bluegrass regions of Kentucky using mist nets. Nearby sites in both physiographic regions were divided into 1 ha plots with $\geq$ 25% forest cover and sampled using mist nets. Nets were erected over any suitable location within each plot (stream corridor, road corridor, or pond) and operated for 5 hours. Several faunal differences were observed, although not all were statistically significant at $\alpha = 0.05$. In general, capture success (bats/net-night) was less predictable in the Bluegrass than in the Knobs. Furthermore, bat communities in the Knobs were dominated by *Myotis septentrionalis* (84%), while those in the Bluegrass were dominated by *Lasiurus borealis* (44%), *Pipistrellus subflavus* (27%), and *Myotis lucifugus* (23%). One species, *Corynorhinus rafinesquii*, was only captured in the Knobs region. Bat communities were probably influenced by several factors, however characteristics related to the availability of roosts and the amount of forested land within each region seem particularly important.

Seasonal use of man-made structures by forest dwelling bats in west-central Mississippi

Monica S. Wolters and Chester O. Martin
Environmental Laboratory,U.S. Army Engineer Research & Development Vicksburg, MS 39180-6199

A survey of bridge-roosting bats was conducted from April 2000 through January 2002 in Claiborne County, west-central Mississippi. The study was initiated on 14 April 2000 when a maternal colony of 32 Rafinesque's big-eared bats (*Corynorhinus rafinesquii*) was found beneath a prestressed concrete girder bridge crossing a tributary of Bayou Pierre. In order to determine bat use of man-made structures in the area, 4 other concrete bridges and an abandoned cistern within the same watershed were monitored for seasonal use by bats. Sites were examined bimonthly March through August and monthly September through February. Data recorded included species and their compass orientation, notes on seasonal water levels beneath the bridges, temperature, humidity, light intensity within selected roost sites, and morphometric measurements. Five species of bats were found to utilize all 5 bridges. However, only *C. rafinesquii* formed a maternity colony beneath one bridge. Rafinesque's big-eared bats and big brown bats (*Eptesicus fuscus*) were documented under bridges throughout the year, southeastern bats (*Myotis austroriparius*) were encountered primarily from April through November, and eastern pipistrelles (*Pipistrellus subflavus*) were observed from November through April. Captured pipistrelles demonstrated a high male to female ratio (11:3). The cistern was used only by *C. rafinesquii* as a winter hibernaculum. The maternal colony began forming in April and parturition occurred from late May through early June. In 2000, the maternal colony consisted of 32 females and produced approximately 25 pups; 12 females produced 8 pups in 2001; and 26 females produced 15 pups in 2002.

Meeting organizers

Darren A. Miller, Weyerhaeuser Company
Bruce D. Leopold, Department of Wildlife and Fisheries, Mississipi State University
Chester Martin, U.S. Army

Notes

A long night of male fruit bats on the island of Príncipe, Gulf of Guinea

Tony King and Martin Dallimer
Projet Protection des Gorilles, BP 13977, Brazzaville, Republic of Congo. E-mail: ppg@uuplus.com;
Dept. Ecology & Evolutionary Biology, Tulane University, New Orleans, LA 70118, USA.
E-mail: dallimer@tulane.edu

Due to their small size and geographical isolation, the islands of São Tomé and Príncipe, located 220 km off the west coast of Africa in the Gulf of Guinea, support only a few species of bats. Ten species are known to occur on the islands, of which three are fruit bats (Megachiroptera: Pteropodidae) and seven are insectivorous (Microchiroptera; with four families represented) (Juste and Ibanez 1994). Nine of these species occur on São Tomé, while only four occur on Príncipe. Although species-richness is low, São Tomé boasts two endemic species and three endemic subspecies. A further species and sub-species are endemic to Príncipe (Juste and Ibanez 1994). Despite these high levels of endemism, and the conservation threats of habitat loss on such small islands, very little work has been done on the ecology of the bats of the Gulf of Guinea islands. Therefore, while conducting a mist-net survey of the birds of the islands from December 2001 to February 2002 (King and Dallimer, submitted), we took the opportunity to survey the bats.

After five weeks and over 300 net-hours of surveys at five different sites in São Tomé, we had yet to capture a single bat. We shifted our attention to the smaller island of Príncipe, where we took a motorised dug-out canoe in the open sea around the coast to a beautiful location in the south-west of the island. Beautiful, but still no bats. We walked for a day, crossing the island until we reached a small fishing camp at Praia da Nova (1°36'N 7°20'E). Finally, on 26 January 2002, we found a bat in one of the nets. An adult male *Rousettus egyptiacus princeps*, a subspecies endemic to the island, with two dipteran ectoparasites indicative of its cave-roosting habits. Encouraged, we set the nets again the following night, secretly hoping to capture one of the large, golden-furred *Eidolon helvum* from a near-by tree-roost (Dallimer *et al.*, submitted). After our standard evening meal of rice and fish, we checked the first net at 20h30, two and a half hours after dusk. No *E. helvum*, but no less than seven *R. egyptiacus*, all very tangled in the net. Four adult males and three juveniles, it took us over two hours to remove them, measure them, and refresh them with sugar-water from a teaspoon. Exhausted, we climbed the rocky hill to the other net, hoping for an empty net and the chance to sleep before midnight and the long walk almost the length of the island the following day. No such luck – four more *R. egyptiacus*, one juvenile, two adult males, and finally, the last bat of the night, an adult female. Until this point our very experienced local guide had insisted that there was only one species of fruit bat on the island, and that all the bats we had caught were simply babies from the *E. helvum* roost. We had shown him the impressive testicles of the males, hoping that would prove they were adults and therefore a different species, but he argued that all young boys had testicles so refused to believe us. The fully ossified joints of the wing digits were even less convincing. At just past midnight, fortunately under a full moon as our torch batteries were fading fast, we triumphantly presented him the swollen nipples of this last remaining bat, challenging him to finally admit this was indeed an adult animal, and therefore that it was not the same species as the much larger *E. helvum*. After nearly four hours of arguing over the males, he finally accepted that these nipples proved the existence of a second species of fruit bat on his island. Probably the most respected forest-goer on the island, surely this was grass-roots community education in action?

But why, out of 12 bats captured over the two evenings, was only one adult female captured compared to seven adult males and four juveniles? This endemic subspecies, *Rousettus egyptiacus princeps*, has already been demonstrated to be a dwarf compared to continental forms of the species (Juste and Ibanez 1993, 1994). Never-the-less, the adult males we captured appear to be even smaller than those of the same sub-species captured by other researchers. The mean fore-arm measurement of our males was just 87.3 mm (sd 3.17, range 82.9 to 91.0), compared to

a mean of 91.3 mm (sd 3.58) given by Juste and Ibanez (1993). In contrast, our single adult female had a fore-arm of 86.5 mm, a figure similar to that given by Juste and Ibanez (1993) for females. Therefore, it is unlikely that our sample was taken from a population of bats even smaller than elsewhere on the island, but probable that the males captured were small simply due to being young. Together with the high male:female ratio, and the relatively high juvenile:adult ratio, this may indicate the presence of a roost of juveniles and young, possibly non-breeding, males close to our survey site. The female may have come from a separate breeding roost slightly further away from the survey site. If so, could it be that the population is partitioned, by sex, age or breeding capacity, between several different cave roosts in the area? Unfortunately we did not have the time to locate any *R. egyptiacus* roosts, surveys of which would be necessary to test our hypothesis. However, the small size of Príncipe (approximately 128 km^2, Juste and Fa 1994) and the restrictions this places on the movements of bats, makes this a perfect site for investigating bat ecology. Along with the outstanding natural beauty, we recommend anyone to visit and to contribute to the very limited knowledge of the unique biodiversity of the island.

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Another Unique Way for Bats to Die

Virgil Brack, Jr. And R. Andrew King
Environmental Solutions and Innovations. LLC, 781 Neeb Road, Cincinnati, OH 45233
U.S. fish and wildlfe Service, 620 s. Walker St. Bloomington, IN 47403-212

Bats have been found dead in a variety of situations unique to a small flying mammal. For example, they have been found impaled on thorns of cacti, burdock burrs, tree thorns, and barbwire fences (Mohr 1976, Schwartz and Schwartz 1981), and along the Current River in Missouri, one of the authors (VB) once found a dead bat hanging from a fishing line and hook that had been left dangling from the branches of a tree. On 25 January 2003, near the entrance of a cave in Greene Co., Indiana, we found a dead little brown myotis (*Myotis lucifugus*) frozen to the surface of an icicle about 1 cm in diameter. The bat was attached to the icicle by the fur on its belly and was in a horizontal position, without either its feet or its thumbs touching the icicle. This species frequently collects moisture on the fur during periods of hibernation. Between periods of hibernation, bats are often active and fly about within and sometimes leave hibernacula. Apparently, this bat's fur was wet when its belly contacted the icicle during flight and the bat froze instantly to the icicle. When the bat was found, regional temperatures had been below freezing for 5 days, with lows reaching -18C. There are reports of bats entombed in icicles, presumably while hibernating (Schwartz and Schwartz 1981), but we believe this the first reported incident of bat mortality in this manner.

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Asociación Mexicana de Mastozoología

Titles and Authors of papers presented at their Meeting in Oaxaca, Mexico October 22-25, 2002

Titles are in alphabetical order by first author. e-mail of first author is given as: author@wherever.mx

Bats of the Sierra de Huatla Biosphere Reserve, Morelos, Mexico. Luis Gerardo Avila- Torres Agatón, , Antonio Guillén-Servent, Alejandro Palacios-Franco, Lorena Orozco-Lugo and David Valenzuela-Galván bigbat@eudoramail.com

Study of some aspects of the bat community at" Los Ortices Cave, Las Ortices, Colima, Mexico. Almanza Ortega F., León Galván M. and López-Wilchis R. fabi_hola64@hotmail.com

Early phases of embryonic deveolpment in *Diphylla ecaudata.* Cynthia Elizalde Arellano, Juan Carlos López Vidal, Hortensia Montellano Rosales, Rocío García, Esther Uría Galicia, Joaquin Arroyo Cabrales, Rodrigo A. Medellín Legorreta thiadeno@hotmail.com

The *Artibeus lituratus* complex in the state of Oaxaca, Mexico. Carlos R. Bonilla-Ruz

Observations of reproductive behavior in *Leptonycteris nivalis* at Tepoztlan, Morelos, Mexico. Luis Caballero and Rodrigo Medellín lcaballero@miranda.ecologia.unam.mx

The bat community in the town of Jolalpan, Puebla, Mexico. Miriam López Castro , Clara A. Rodríguez Mendoza, Jacquelíne Román Romano, Mayra Vega Benítez, Ma. Concepción López Téllez and Gonzalo Yanes Gómez csO01414@siu.buap.mx

Pollination interactons between nectarivorous bats and two species of columnar cactus in a disturbed deciduous forest on the southern coast of Jalisco, Mexico. Carlos Ibarra Cerdeña and Luis Ignacio lñiguez Dávalos h_frenatus@yahoo.com

Bat community structure and diversity in the Zamatan river watershed at the Oaxacan coast. Beatríz Rebeca Hernández Chávez and Miguel Briones-Salas ecs@prodigy.net.mx

Determination of the reproductive cycle of *Tadarida brasiliensis mexicana* in the Salitre cave, Metztitlan, Hidalgo, Mexico. Rocío Cruz, Hortensia Montellano, Juan Carlos López Vidal, Cynthia Elizalde rocio_cruzgarcia@hotmail.com

Incidence of vampire bat attacks on cattle in the Sierra de Manatlan (Zona Norte) Biosphere Reserve. Luis Ignacio lñiguez Dávalos and Juan Pablo Esparza Carlos liniguez@cucsur.udg.mx

Genetic variation and populations sizes of the fishing bat *Myotis vivesi* on Partida Island (Gulf of California). José Juan Flores-M, Chris H. Floyd, L. Gerardo Herrera and Bernie P. May josef@ibiologia.unam.mx

Ecomorphological structure and guild definition in an insectivorous bat community in La Sierra de Huautla. Alejandro Palacios Franco and Antonio Guillén Servent allfranco@hotmail.com

Spatial pattern causation in the frequency distribution of body size inChiroptera. Paloma C. de Grammont and Héctor Arita paloma@ate.oikos.unam.mx

Histological structure and morphogenesis of the placenta in the big eared bat *Corynorhinus mexicanus.* Sánchez Hernández María Guadalupe, María del Carmen Uribe Aranzábal and Ricardo López Wilchis rlw@xanum.mx

Spatial and seasonal distribution of bat communities in the Calakmul Biosphere Reserve, Mexico. Rafael Herrera-Herrera, Jorge Vargas-Contreras and Therese Donovan jrherrer@yahoo.com

Quantification of antioxident enzymes SOD, GPX and CAT in the male reproductive tract of *Corynorhinus mexicanus*: Their role in sperm survival. León-Galván M. A., López-Wilchis R., Arenas R. E., Hernández P.O., and Rosado G. A. leon@xanum.uam.mx

Incidence of endoparasites in the digestive tract of *Corynorhinus mexicanus*. López-Wilchis R., Aguilar Muñoz R. M. and Osorio Sarabia D. rlw@xanum.mx

***Corynorhinus mexicanus* and *Corynorhinus townsendii* in the mining region of Guanacevi, Durango, Mexico.** C. López-González , L. Torres-Morales, D. F. García-Mendoza, H. Name Z. celialg@prodigy.net.mx

Population aspects of a *Pteronotus davyi* colony in the Alto Balsas region in the state of Pueblo. Jaime López, Mary Carmen Ornelas, Cristóbal Galindo, Elsa González and José Ramírez. mary_claremx@yahoo.com

Microclimate characterization of "Los Laguitos" cave during the dry season in Chiapas. Matias Martinez-Coronel, Carlina Mudespacher Z., Salvador Gaona and Irma E. Lira marti17@hotmail.com

Chromosomatic description of *Artibeus jamaicensis* in Santo Domingo Huehuetlan el Grande Puelba, Mexico. Florentina Mejía R., Rosa María González M. and Jesús Martínez V. flor993@starmedia.com

Chromosomatic description of the fruit bat *Chiroderma salvinii* in Huehuetlan el Grande Puebla, Mexico. Paola Hernández C., Rosa María González M. and Jesús Martínez V. yoyas22@yahoo.com.mx

Enrichment of stable isotopes ^{15}N and ^{13}C in an omnivorous bat *Glossophaga soricina*. Leticia Mirón, L. Gerardo Herrera, Keith Hobson, Nicte Ramírez. lmm@ibiologia.unam.mx

Bats in the mesophyllic forest and shaded coffee plantations: Comparison of their diversity with that of other biological groups. Claudia E. Moreno , Eduardo O. Pineda-Arredondo and Federico Escobar S. pinedaed@ecologia.edu.mx

Contribution to the knowledge of the bat fauna at Huatulkco National Park. Edgar Negrete Nava and Catalina B. Chávez Tapia akuttus@yahoo.com

Description of echolocation calls from aerial insectivorous bats at Sierra de Huautla, Morelos, Mexico. Lorena Orozco-Lugo, Antonio Guillén-Servent, Luis G. Avila-Torresagatón, Alejandro Palacios-Franco, Fabiola Gutiérrez-Medina, Alejandra Kuri-Rojas and David Valenzuela-Galván zootz73@yahoo.com

Effect of habitat disturbance in an insdectivorous bat community in lowland deciduous forest. Lorena Orozco-Lugo, Antonio Guillén-Servent, David Valenzuela-Galván, and Héctor Arita Watanabe zootz73@yahoo.com

Characterization of microsatellites in *Artibeus jamaicensis* and interspecific amplification. J. Ortega, J. E. Maldonado, H. T. Arita, G. S. Wilkinson and R. C. Fleischer artibeus2@aol.com

Evolution of microsatellites in bats: Inferences based on repetition squences of di- and tri-nucleotides. J. Ortega y J. E. Maldonado artibeus2@aol.com

Study of some aspects of the resident bat community in :Los Ortices cave, Los Ortices, Colima, Mexico. Almanza Ortega F., León Galván M. and López-Wilchis R. fabi_hola64@hotmail.com

Bats of the San Felipe Bacalar Reserve, Quntana Roo, Mexico. Álvaro Ramírez and Enrique Escobedo

Solanaceas dispersed by bats: Seed germination and seedling survival. María Magdalena Ramírez-Martínez and Luis Ignacio lñiguez Dávalos centurio_senex@yahoo.com

Comparative study of aerial insectivorous bat activity in distinct seasons of the year in La Sierra de Huautla, Morelos, Mexico. Alejandra L. Kuri Rojas and Antonio Guillén Servent alejandrakuri@hotmail.com

Population dynamics of *Leptonycteris curasoae* in a central Mexico cave inhabited year round. A. Rojas-Martínez , O. García V. and K. Torres V. aerojas@uaeh.reduaeh.mx

Identification of columnar cactus fruits consumed by *Leptonycteris curasoae* using seeds defecated in a central Mexico cave. A. Rojas-Martínez , O. García V. and M. Salinas R. aerojas@uaeh.reduaeh.mx

Populaton dynamics of *Leptonycteris yerbabuenae* in Morelos, Mexico. N. Sánchez-Casas, J. Villalpando-R. and S. T. Álvarez-Castañeda nsanchez04@yahoo.com.mx

Molecular and biogeographic systematics of bats from the family Hipposiderae. Antonio Guillén Servent aguillen@buzon.uaem.mx

Morphological description of the male reproductive tract of *Desmodus rotundus.* Karina Lagunes Serrano, Cynthia Elizalde Arellano, Juan Carlos López Vidal. yingkarwa@hotmail.com

Morphological structure of the bat fauna of the Yucatan Peninsula. Leonor Solis and Héctor Arita lsolis@oikos.unam.mx

Bats of the mining region of Guanacevi, Durango, Mexico. L. Torres-Morales, C. López-González and H. Name arualtm@hotmail.com

Conservation status of two *Tadarida brasiliensis mexicana* roosts. Juan Carlos López Vidal, Cynthia Elizalde Arrellano, Rocío Cruz García, Joaquin Arroyo Cabrales and Rodrigo A. Medellín Legorreta iclvidal@hotmail.com

Resident populations of *Leptonycteris yerbabuenae* in central Mexico. J. Villalpando R., N. Sánchez-Casas and S. T. Alvarez-Castaneda villalpandoja@yahoo.com.mx

The Bat Community in the town of Huehuetlan el Chico, Puebla Daniel Espinoza Vizcarra , Ma. Concepción López Téllez and Gonzalo Yanes Gómez csO01414@siu.buap.mx

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Announcements

Indiana Bat Symposium Proceedings Available

The proceedings of the Indiana Bat Symposium, held in Lexington, Kentucky, in March 2001, were printed late in 2002. The title of the volume is *The Indiana Bat: Biology and Management of an Endangered Species*, with A. Kurta and J. Kennedy as editors. The 253-page book consists of 27 papers on various topics, including distribution and status, management of hibernacula, use of dayroosts and nightroosts, diet, parasites, and the effects of pesticides. The book is published by Bat Conservation International, but all sales will be handled by Speleobooks. Contact Speleobooks (speleobooks@speleobooks.com) for price and shipping information.

"BAT BLITZ"
Ouachita National Forest, Arkansas

When: 4,5,6 August 2003
Where: Camp Clearfork, Ouachita National Forest, Arkansas

The U.S. Forest Service will sponsor a Bat Blitz for three evenings during the month of August. Base of operations will be at Camp Clearfork located 17 miles west of Hot Springs on Hwy 270 West. Facilities will be available beginning at 1500 hours on Saturday August 2nd, and the premises vacated by 1500 hours, Thursday, August 7th. Meals will be provided beginning with breakfast Sunday morning. These facilities can comfortably accommodate 100 people. Facilities include 2 bathhouses, 6 bunkhouses, 3 cabins, a building that may be used as a lab, and a dining hall with complete kitchen. A swim site is located nearby in Charlton Recreation Area.

The Southeastern Bat Diversity Network **may** provide a one-day training session on field techniques, bat identification and Anabat on Monday (4th). More info on this later.

What the Forest Service will provide:

The Forest Service will provide all food and lodging on site, *actual* fuel expenses incurred to and from your home location and while participating in the Blitz, and minor items such as batteries for lights. Persons responsible for vehicles must keep fuel receipts for fuel expenditures. Reimbursement will be by check approximately two weeks after receipts are received. **Each individual must sign a Volunteer Agreement in order to participate. You must pre-register in order to participate**. Persons handling bats must have received preventative rabies vaccinations prior to participating in the Blitz and must so indicate on their Volunteer Agreement. We do not have unlimited funds and may need to set a cap on fuel reimbursement. Please carpool to help us hold down on costs.

IMPORTANT NOTE: You **must** send an email message to David Saugey to be placed on a mailing list for updates on the Blitz. If we do not have a sufficient number of participants to make the Blitz cost effective we will cancel and notify you by email (only).

What you provide:

You must participate in bat survey/capture activities for the three evenings (4-5-6 August) and provide all transportation and field equipment necessary to survey/capture bats. At least one person in your group should have field experience with bat capture and handling. Information on captured bats must be documented on data sheets provided to you. Data sheets must be turned in each day for photocopying with originals returned for your records. **Use of firearms is prohibited**.

Continued >>

Collection Activities:

Participants **will not** be required to obtain an Arkansas Scientific Collection Permit. They will be covered by a Ouachita NF permit or designated agents of the Arkansas Game and Fish Commission (we are still working that out). Voucher specimens may be retained for deposit in a recognized museum or university mammal collection.

General information:

The Blitz has been scheduled at a time when bats in the Ouachita Mountains are more readily sampled by conventional means (nets) and we are more likely to encounter migrants. Ponds, streams, ridgetop roads and the entrances to abandoned mines offer many survey opportunities. **Participants are forbidden to enter abandoned mines due to safety concerns and federal regulations.** Maps and assistance in locating sites on the ground will be provided for each crew of participants

Food:

Breakfast: cold cereal, pastries, fruit, coffee, juice, milk, hot tea.
Lunch: Sandwich items, fruit, chips, soft drinks and the above beverages.
Dinner: A good, hot meal.
Field Food: Snacks, sandwiches etc may be prepared to take with you.

FINAL DATE FOR REGISTRATION: 20 June 2003

For additional information and registration, contact:
David Saugey, U.S. Forest Service, P.O. Box 189, Jessieville, AR 71949-0189
Tel. 501-984-5313 (voice, Monday – Thursday) 501-984-6253 (fax)
e-mail: dsaugey@fs.fed.us

News from our readers

From Missouri

Submitted by Lynn Robbins, Southwest Missouri State University

We are in the process of finishing up the data analyses from our work in NE Missouri on the summer habitat of Indiana bats and other sympatric species. Two students, John Timpone and Matt Miller will be finishing their Master's theses this spring. John is working on characterizing summer roost trees during pregnancy, lactation, and post-lactation periods, and Matt is using the Anabat system to look at the activity patterns of three species of Myotis in different habitats, and above and below the canopy during these same three reproductive periods. Kevin Murray and I are finishing up our study testing the efficiency of the recommended netting protocol for determining the presence or absence of Indiana bats. We are also testing the use of the Anabat II system as a possible means of increasing the accuracy of the recommended protocol. We (Scott Kelly and I) are continuing our study of the use of artificial roosts (rocket boxes, vinyl and metal siding) as possible alternatives to exfoliating bark for Indiana bats. I have one new student, Justin Boyles, who will begin a study on summer ecology of Evening bats using radio telemetry and pit tags. We have been fortunate to receive funding from the Missouri office of the USFWS, Missouri Department of Conservation, and Bat Conservation International.

From New Mexico

Submitted by Daniel Abrams, New Mexico Bat Research Institute

Got blood? On November 11, 2002, a female White Winged Vampire Bat named Maria gave birth in captivity. This represents the first captive birth of this species in the United States. Ten

White Winged Vampire Bats were collected for the New Mexico Bat Research Institute of Tijeras, New Mexico from the Caribbean islands of Trinidad and Marguarita. Of the four females in the group, one arrived pregnant. After a typical gestation of over 210 days, Maria gave birth to a female pup. The pup was born with its eyes open and a fine soft fur covering her back. She immediately positioned herself against Maria's underside and began nursing. Four days later, the pup began exploring her surroundings on her own. On November 20, the Director and bat caretaker of the project, Daniel S. Abram examined and weighed the young pup. He found her active, inquisitive, and tipping the scales at an impressive 12 grams.

The purpose of collecting the bats was to establish a captive breeding colony for research, education, and the preservation of this rare and rapidly disappearing species. Little is known of the behavior, reproduction, and potential benefits to medicine of this rapidly disappearing bat. The US majority holds an unfortunate misconception about all bats, especially the vampire. Where there are an astounding 1004 species of bats in the world (Simmons, 2002), only three are sanguivorous (vampires, feeding on a diet of only blood). These species are restricted to Central America, South America and Mexico, as well as the islands of Trinidad and Marguarita. *Diaemus youngi*, the White Winged Vampire Bat, named for the distinctive white coloration on its wingtips and fingers, is one of two vampire species that feeds primarily on avian blood. The colony is the only captive breeding colony in the world. The animals in the colony were rescued from destruction. To sustain the project, over 100 chickens, past their laying prime and slated for destruction, were donated from a local Albuquerque egg farm. Each vampire bat must be provided with one live hen per night. When feeding, the bats elusively approach the hens and administer a small bite on the foot or comb. They carefully lap about 10 to 15 ml of blood before retiring. Usually the chickens do not even feel what is happening. The hens, after their evening with the bats, get a weekâs vacation of free range, sunshine, and plenty of protein rich food before another call to service. The New Mexico Bat Research Institute is a program of Basically Bats, a wildlife conservation society. The organization is holding a contest to name the newborn vampire pup. To make an entry send a check in the amount of $2.00 to NMBRI, Attention Daniel Abram, 55 Young Road, Tijeras, New Mexico, 87059. A decision will be made on January 15, 2002. The winning entry will receive a framed photograph of the newborn pup and an informational packet. Basically Bats/NMBRI is non-profit 501 (c) (3) organization. All contributions are tax deductible. Tel. 505-281-6317

Future Meetings and Events

August 4-6, 2003

There will be a **"BAT BLITZ"** (a three-night field trip) at Camp Clearfork, Ouachita National Forest, Arkansas.
For additional information and registration, see page 45 this issue or contact:
David Saugey, U.S. Forest Service, P.O. Box 189, Jessieville, AR 71949-0189
Tel. 501-984-5313 (voice, Monday – Thursday) 501-984-6253 (fax)
e-mail: dsaugey@fs.fed.us **FINAL DATE FOR REGISTRATION: 20 June 2003**

October 8 – 11, 2003

The **33rd Annual North American Symposium on Bat Research** will meet in Lincoln, Nebraska, October 8-11, 2003, hosted by Trish Freeman (University of Nebraska and Nebraska State Museum). All formal sessions of the 33rd Symposium will be held at the Cornhusker Hotel in downtown Lincoln, located within easy walking distance of the UNL campus, the state capital, and of a number of downtown restaurants, pubs, and other attractions. Room rates will be among the least expensive we have had in recent years, and other costs (including transportation) should be very reasonable.

See our website at: http://www.nasbr.org/ Watch this space for further details. >>

April , 2004

The next meeting of the **Australasian Bat Research Symposium** will be held in Toowoomba, near Brisbane, Australia just after Easter in 2004.

August 23-28, 2004

The **13th International Bat Research Conference** is planned to be organised in Poland from 23-28 August 2004. More information about the conference will be available in a few months at: http://www.miiz.waw.pl/IBRC also http://www.miiz.waw.pl/IBRC

October, 27-30, 2004

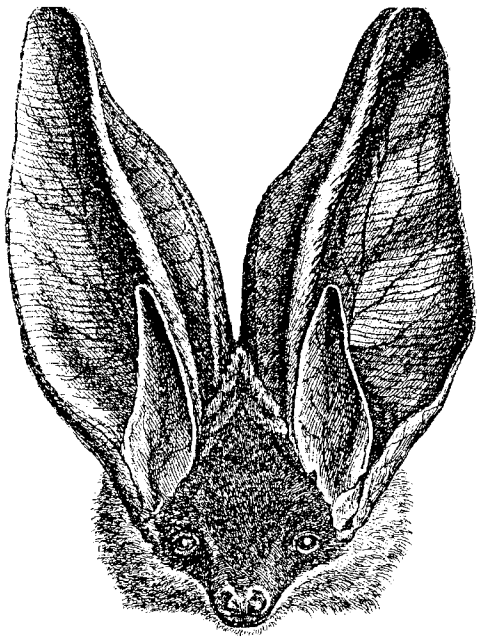
The **34th Annual North American Symposium on Bat Research,** will convene in Salt Lake City, Utah, October 27-30, 2004

August, 2005

The next **European Bat Research Symposium** will be held in Ireland in August 2005. More details will appear here as they become available.

If you know of other planned meetings, large or small, concerning any aspect of bat biology, please send details to Roy Horst for publication in the next issue.

BAT RESEARCH NEWS



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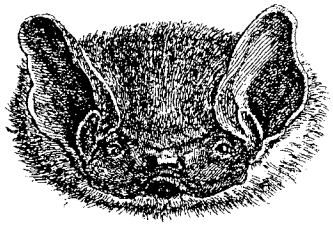

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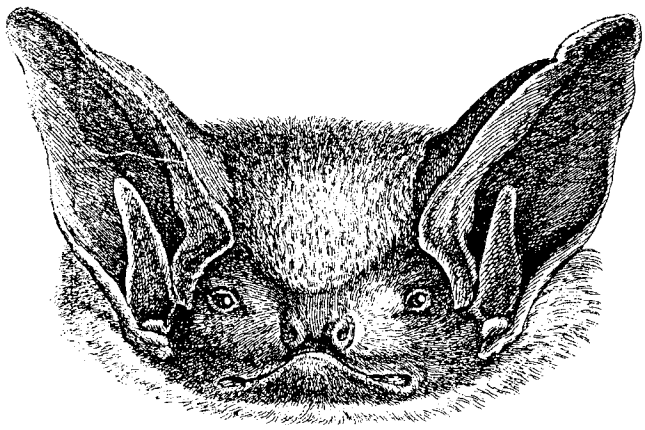

Fig. 1.

VOLUME 44: No. 2 **SUMMER 2003**

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e-mail: horstgr@potsdam.edu

Editor for Feature Articles: Allen Kurta, Dept. of Biology, Eastern Michigan University, Ypsilanti, MI. 48197. Tel.734-487-1174 FAX 734-487-9235
e-mail: bio_kurta@online.emich.edu

Editor for Recent Literature: Thomas A. Griffiths, Dept. of Biology, Illinois Wesleyan University, Bloomington, IL 61702 Tel. 309- 556-3697, FAX 309-556- 3864
e-mail: mgriff@illinoisalumni.org

Editor for Conservation/Education: Patricia Morton, Texas Parks and Wildlife, Suite 100, 3000 IH 35 South, Austin, TX 78704. Tel. 512-912-7020
e-mail: patricia.morton@tpwd.tx.us

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 which are reviewed by at least two scholars in that field. In addition Bat Research News includes a recent literature section which cites nearly all bat-related publications in English worldwide; the 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.

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BAT RESEARCH NEWS

VOLUME 44 **SUMMER 2003**

Table of Contents

Erratum

Unfortunately our printing contractor dropped page numbered 29 from some copies of the last issue of Bat Research News, Volume 44: No. 1, Spring 2003. Our apologies for not finding all of these before they were mailed. We have reprinted this page and it appears on page 82

COVER ILLUSTRATION

This is an illustration reproduced from Daubenton'a work, 'Mémoire sur les Chauves-souri' (1765)

Figure 1 represents *Myotis myotis*, fig. 2, *Plecotus auritus*, fig. 3. *Pipistrellus pipistrellus.*

Cursory Assessment of Bat Activity in State Parks of Coastal Southeast Florida

Jeffrey T. Hutchinson
Florida Park Service, 13798 S.E. Federal Highway, Hobe Sound, FL 33455.
Present Address: Archbold Biological Station, P.O. Box 2057, Lake Placid, FL 33862

Introduction

Coastal southeast Florida contains one of the highest human population densities in the United States and is expected to increase in population size at a rate greater than 28 of the 50 states by the year 2020 (Burchell et al., 1999). Near exponential increases in density of people within southeast Florida is resulting in greater demands on public lands for such activities as recreation, utility easements, edge encroachments, and other special interests. Forested sites, no matter how fragmented or small, may provide the last remnants of adequate roost sites for cavity and foliage roosting bats within high-density urban centers, such as southeast Florida. Natural areas, however, are limited and scattered along the coastal sections of this part of the state. Since only limited information exists on bats from state parks and other public lands in southeast Florida, I performed surveys in selected state parks along coastal southeast Florida to evaluate bat activity and document the presence or absence of various species.

Study Area and Methods

Surveys were conducted in the extreme southernmost counties of coastal southeast Florida, including Broward, Dade, and Monroe counties, from April 2000 to March 2001. Surveys (n = 11) were conducted in the following parks: Hugh Taylor Birch State Park (HTBSP) and John U. Lloyd State Park (JULSP), Broward County; Oleta River State Park (ORSP), The Barnacle State Historic Site (BSHS), and Cape Florida State Park (CFSP), Dade County; and Key Largo Hammock Botanical State Park (KLHBSP) and Lignumvitae Key Botanical State Park (LKBSP), Monroe County (Figure 1). All survey sites were located <1 km from the Atlantic Ocean and in or adjacent to tropical maritime forest or rockland hammock (Johnson and Barbour, 1990).

Dominant vegetation includes pigeon plum (*Coccoloba diversifolia*), strangler fig (*Ficus aurea*), poisonwood (*Metopium toxiferum*), mastic (*Mastichodendron foetidissimum*), gumbo limbo (*Bursera simaruba*), Jamaica dogwood (*Piscidia piscipula*), live oak (*Quercus virginiana*), cabbage palm (*Sabal palmetto*), paradise tree (*Simarouba glauca*), and exotic trees such as Australian pine (*Casuarina equisetifolia*) and Brazilian pepper (*Schinus terebinthifolius*). Adjacent to the hammocks was marine tidal swamp dominated by red mangroves (*Rhizophora mangle*) and black mangroves (*Avicennia germinans*). Climate of the area is subtropical, with annual maximum and minimum temperatures of 28.3°C and 20.6°C, respectively (Winsberg, 1990).

At each park, 4–8 mist nets (6, 9, or 12 m; single or double stacked) were set under the canopy, along flyways, in forest openings, or over water. Nets were opened at sunset and remained open for 1.75 to 4.50 h. During each survey, bat activity also was monitored acoustically using a Mini-2 Bat Detector (Ultra Sound Advice, London, United Kingdom). Although identification of individual species cannot be obtained using this type of detector, it can yield an index of overall activity. The detector was positioned in the general area where nets were placed and frequently rotated 360° to detect bats in all directions. Frequency was slowly switched back and forth covering a range between 10 and 50 kHz. Detectors also were used outside the survey period in areas within the parks that bats may utilize for foraging (e.g., street lights and open fields) and drinking (e.g., swimming pools and solution holes). In addition to netting and acoustic monitoring, all abandoned and old structures within each park were searched during daytime for roosting bats and signs of bats (e.g., culled moth wings, guano, etc.).

Results

A total of 150 h of mist netting, 49 h of acoustic detection, and 20 h of structural searches were preformed to gain preliminary data on bat activity. No bats were captured at the seven state

parks in which the survey was conducted. Acoustic detection of bats occurred in only three parks, though bats were detected elsewhere in each county. An average of 0.08 bat-passes/h was detected per night. Bats were detected at the following parks with number of detections and frequency of the sounds in parentheses: JULSP (2; 30 kHz), CFSP (1; 20 kHz), and KLHBSP (1; 20 kHz).

Searches of abandoned and old structures at HTBSP (concession stand, railway trestle, cabins), JULSP (shop complex), ORSP (water treatment plant), KLHBSP (army radar site and Port Bouganville), and LKSBS (shop complex) produced no roost or sign of bats. An unknown bat that appeared to be a northern yellow bat (*Lasiurus intermedius*) was observed at sunset in JULSP, flying along an estuarine tidal creek. Another unknown bat was observed in the headlights of a vehicle along County Road 905 that separates KLHBSP and Crocodile Lakes National Wildlife Refuge in north Key Largo. Park managers and other park personnel reported occasionally observing bats at HTBSP, JULSP, BSHS, and LKBSP.

Discussion

Jennings (1958) observed occasional bats flying among the tropical maritime hammocks, but he was unable to collect any bats from this region and concluded that all species of bat were uncommon in southeast Florida. Robson (1989) also found bats to be rare throughout the southern peninsula of Florida. Schwartz (1952) stated the most common bat in southern Florida, excluding the Florida Keys, was the Brazilian free–tailed bat (*Tadarida brasiliensis*). One of the rarest bats in the United States, Wagner's mastiff bat (*Eumops glaucinus*), is known almost exclusively from the Coral Gables section of Miami (Robson et al., 1989). More recent information indicates that two tropical species, the Jamaican fruit-eating bat (*Artibeus jamicensis*) and Pallas' mastiff bat (*Molossus molossus*) occur in the Lower Florida Keys, including the first documented colony of bats in the Lower Florida Keys (Frank, 1997a, 1997b).

Though bats occasionally utilize coastal communities of southeast Florida, results of this study concur with those of past researchers in showing that bats are rare in this part of the state (Jennings, 1958; Robson, 1989). The lack of captures and a detection rate of 0.08 bat-passes/h from this survey are low compared with data from more northern counties. For example, capture and detection rates of bats in Martin and St. Lucie counties are 0.18 captures/h and 9.5 bat-passes/h (J. Hutchinson, unpubl. data). The larger size of natural areas and greater abundance of freshwater sources may contribute to the greater bat activity in northern counties.

Although only limited records exist, the northern yellow bat may be the most wide-ranging bat in southern peninsular Florida (Moore, 1949; Jennings, 1958; Robson, 1989). Jennings (1958) reported that the breeding range of the northern yellow bat extends throughout the Florida peninsula into Dade County. Robson (1989) found that mostly northern yellow bats were reported from coastal areas in Dade County during a 1989 survey. On 21 September 21 2000 at JULSP, a large, tan-colored bat was observed at sunset flying rapidly over an estuarine tidal creek. Based on the large size, light coloration, and flight pattern of this bat, it was most likely a northern yellow bat. In KLHBSP, bats were observed and detected during autumn. Several other researchers document the presence of bats in southeast Florida during autumn (Moore, 1949; Taylor and Lehman, 1997), suggesting that bats may utilize the coast of southeast Florida during migration, seasonal forays, or stochastic events such as strong southwest or west winds that are typical during a cold front.

Foliage and cavity roosting bats are not as roost limited as bats that require caves or crevices for roosts (Findley, 1993); thus, foliage and cavity roosting species should be more widespread. Natural roosts (large trees, snags, cavities, etc.) and some manmade roosts (old, abandoned, or seldom used buildings) exist within all parks surveyed, indicating that roost sites are not limiting. All parks surveyed are insular in nature, because they are surrounded by residential communities, commercial developments, or marine waters. Connectivity or closeness to other natural areas is very limited. In addition, sources of freshwater are rare or absent in all parks surveyed and along the coastal section of southeast Florida in general. As suggested by Jennings (1958) and this

survey, it appears that habitat loss, natural area insularity, and lack of freshwater are the proximate causes for reduced species and densities of bats in southeast Florida.

Robson (1989) suggested that use of insecticides to control mosquito populations could have lead to a decline in bats in southeast Florida. Although mosquitoes typically contribute little (<1%) to the diet of insectivorous bats (Whitaker and Long, 1998), adulticides used for mosquito control wound or kill all insects, possibly decreasing other food available to bats or increasing the content of insecticides consumed; bioaccumulation of insecticides by bats ultimately could reduce reproduction, inhibiting the recovery of an impacted population (Clark, 1988). Nevertheless, bats actually appear more common in urban areas less than 1.5 km from the Atlantic Ocean in Martin and St. Lucie counties, where mosquito spraying is frequent from May to October (J. Hutchinson, pers. observ.). Furthermore, historical data on bats is limited for the survey area, making it impossible to state whether bat populations have declined or increased among different counties due to use of pesticides for mosquito control.

The results of this survey suggest limited bat activity along the coast of southeast Florida. Habitat loss, effective insularity, and lack of freshwater appear to limit establishment of bat populations throughout coastal southeast Florida (Jennings, 1958), even though natural roosts (large trees, cavities, snags, etc.) and anthropogenic roosts (abandoned or old structures) are common in most parks surveyed. Although no aerial or ground spraying for mosquitoes is allowed in most state parks, intensive use of insecticides in areas adjacent to parks may reduce food availability over large areas and increase the chance of bats consuming insects exposed to insecticides. Surveys over freshwater canals and other freshwater sources in interior portions of south Florida would provide more insight into activity and density patterns of bats in south Florida.

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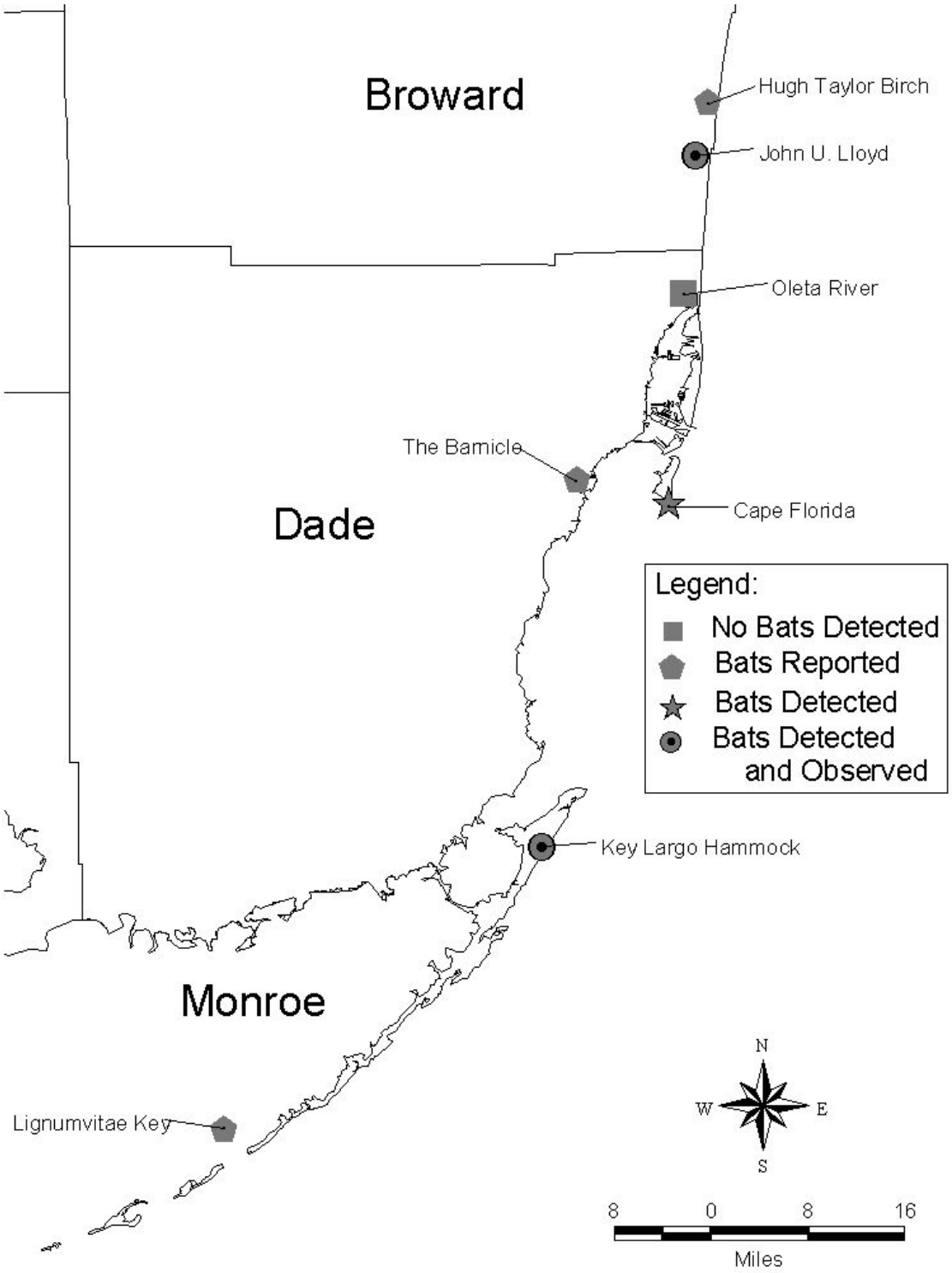

Figure 1. Location of survey sites in Broward, Dade, and Monroe Counties, Southeast Florida.

Light-tagging Observations of Microhabitat Use and Flight Behavior by Lesser Short-tailed Bats (*Mystacina tuberculata*)

Jennifer E. Christie. Dept. of Zoology, University of Otago, Dunedin, New Zealand
Present address: Science & Research Unit, Department of Conservation, Christchurch, New Zealand
E-mail: jchristie@doc.govt.nz

Introduction

Bats are small, nocturnal, and difficult to observe, so behavioral studies in the field rarely rely on extended observations of individuals. Light-tagging, which involves attaching small, luminescent tags to nocturnal animals, provides an inexpensive and safe method for tracking individuals (Buchler, 1976). This technique has been used to observe the behavior of a number of bat species (e.g., Aldridge and Rautenbach, 1987; Brigham et al., 1992; Buchler, 1976, 1980; Lumsden et al., 1994; McDonald et al., 1990). It potentially allows a more precise understanding of where and how bats fly at night, compared with radiotelemetry or bat detectors.

The New Zealand lesser short-tailed bat (*Mystacina tuberculata*; Mystacinidae) is a small (12–22 g) microchiropteran associated with mature stands of indigenous forest (O'Donnell et al., 1999). They appear to be gleaners, catching prey on or near surfaces (Jones et al., 1999; Parsons, 1997; O'Donnell et al., 1999), and they feed mainly on invertebrates, although pollen and plant matter also are consumed (Arkins et al., 1999; Daniel, 1976, 1979). Predictions of terrestrial foraging based on morphology and dietary analysis (e.g., Arkins et al., 1999; Daniel, 1976, 1979; Lloyd, 2001) are supported by laboratory observations of *M. tuberculata* burrowing for prey (McCartney, 1994; Jones et al., 1999), although there are few published observations of *M. tuberculata* foraging terrestrially in the wild.

Research indicates *M. tuberculata* is a bat of the forest interior. Predictions based on the structure of echolocation calls are consistent with *M. tuberculata* navigating within confined spaces (Parsons, 1997). Although wing morphology and an ability to fly at speeds of up to 60 km/h (O'Donnell et al., 1999) indicates a compromise between "fast, direct commuting flight and slow, maneuverable foraging flight" (Webb et al., 1998:465) and, this morphology suggests that *M. tuberculata* utilizes gaps within the forest interior.

The aim of this study was to investigate the usefulness of light-tagging as a technique to determine the microhabitat use and flight behavior of *M. tuberculata*. No previous published studies of *M. tuberculata* have used light-tagging.

Methods

The Eglinton Valley is a U-shaped glaciated valley with steep sides and a flat floor and contains an active riverbed; the valley is 0.5–2 km wide and is at an altitude of 250–550 m above sea level. Large pockets of modified tussock grassland, dominated by *Festuca rubra* and *Anthoxanthum odoratum*, cover much of the valley floor and are surrounded by mature mixed-beech forest dominated by red beech (*Nothofagus fusca*) and silver beech (*Nothofagus menzesii*). Forest composition varies, with stands of silver beech along the forest margins, and red beech becoming dominant further into the forest interior. The forest understory is predominantly beech saplings, mountain toatoa (*Phyllocladus aspleniifolius* var. *alpinus*), broadleaf (*Griselinia littoralis*), and small-leafed coprosmas (*Coprosma* spp.—O'Donnell et al., 1999).

On 4 nights between 1 January and 3 March 1998, bats were captured using mist-netting rigs (Dilks et al., 1995), set near occupied communal roosts. Sex and age of each bat were recorded. Juveniles were distinguished from adults by their lack of ossification of the metacarpal-phalangeal joint on the third digit (Racey, 1974).

Small (2.9 by 24 mm) plastic capsules filled with a fluorescent chemical (Cyalume, Omniglow Corporation, U.S.A.) were used. Capsules weighed 0.1 g, or less than 0.8% of the bats' mass, so I assumed the tags did not to affect maneuverability (Aldridge and Rautenbach, 1987). Light-tags were attached to the bat's dorsal surface between the scapulae, using a latex-based contact adhesive (F2, Ados Chemical Co., New Zealand). The fur was not trimmed, which allowed the tag to fall off after ca 24 h.

Attachment to the dorsal surface provided the best view of the light-tag when the bat was active.

Bats were released at their point of capture on the night they were caught. Capture generally took place in the first 3 h after sunset, and release occurred 3–6 h after sunset. Observations began as soon as the bat was released, and bats were monitored for as long as they remained visible. However, bats often were visible only intermittently during the total monitoring period. After release, the bat's location was recorded, using instantaneous sampling techniques (Altmann, 1974) at 10-sec intervals, which was sufficient for bats to move between different microhabitats (e.g., from ground to canopy). Using handheld tape recorders (Sony, TCM-82V), teams of 2–5 observers noted which microhabitat the bat was in, the bat's flight behavior, and the type of substrate if landing took place. Six microhabitats were identified based on vertical structure of the forest interior, and each contained varying degrees of clutter (Table 1). Patterns of behavior were classified as stationary, scrambling on substrate, slow zigzag flight, and fast directional flight.

Results

Nine bats were released with light capsules attached, and bat activity was monitored for over 54 min, or a total of 3,280 sec (Table 2). During this time, 89 observations of bats were recorded, accounting for 27% (n = 890 sec) of total time. Furthermore, 51% of observations were recorded within the first minute after release, and 65% of observations came from only three bats. Bats with light-tags attached appeared unaffected by the procedure in the short-term, as indicated by infrared-video observations of tagged bats returning to a communal roost 24 h after attachment (n = 3).

Due to the small sample size, data from individual bats were combined, and the number of observations in each microhabitat or behavioral category was calculated as a percentage of the total observation period. Combined results showed 83% of the 89 observations were in the upper understory, 14% were in the lower understory, and 3% were in the canopy. No bats were observed on the ground, within the undergrowth, or above the canopy. In 33% of behavioral observations, light-tagged bats were stationary, 27% were using fast directional flight, 25% displayed slow zigzag flight, and 16% were scrambling on a substrate. All landings (n = 43) occurred on tree trunks; bats never landed on ferns, foliage, or branches.

Discussion

My results suggest that *M. tuberculata* flies predominantly within the relatively uncluttered space of the upper understory within the forest interior. This is consistent with predictions that *M. tuberculata* will utilize gaps within the forest interior because they are highly mobile (O'Donnell et al., 1999) and have intermediate values of wing loading (Jones et al., 1999; Webb et al., 1998). Their use of both slow zigzag and fast directional flight is consistent with the recent suggestion by Webb et al. (1998) that wing morphology and, hence, maneuverability are a compromise between the demands of fast direct commuting flight and slow maneuverable flight. This indicates that previous predictions of flight behavior as slow and clumsy (Daniel, 1979; Norberg and Rayner, 1987; Stead, 1936) are incorrect. In addition, observed usage of substrates, such as tree trunks, by *M. tuberculata* confirms observations in captivity (McCartney, 1994; Jones et al., 1999) and predictions based on dietary analysis and morphology (e.g., Daniel, 1976; 1979; Arkins et al., 1999).

Mystacina tuberculata was not restricted to flight in the upper understory but also flew in the more cluttered lower understory and canopy. *M. tuberculata* should be able to vary the characteristics of its echolocation calls to suit a particular foraging situation or habitat (Parsons, 1997). This is consistent with predictions by Aldridge and Rautenbach (1987) that opportunistic species, such as *M. tuberculata* (Arkins et al., 1999), will not be restricted to foraging in the habitat to which they seem most adapted.

Light-tags were of limited use for observing habitat use and behavior by *M. tuberculata* within the forest interior. First, bats disappeared from sight frequently, so observations were biased to more open areas of the forest and to the first few minutes after release. Second, there was no way of deter-

mining how light-tag attachment influenced flight behavior. Third, observer error likely was associated with categorizing the height at which a bat was flying.

The limited number of bats tagged and the limited time that they could be observed made it necessary to obtain multiple data points from each individual to describe habitat use. Observations recorded in the first few minutes after release may have been influenced by attachment of the light-tag. Whereas 10-sec intervals were deemed sufficient for bats to move between microhabitats, it was still possible that bat position in one observation may influence the values of subsequent observations. Under these circumstances, making valid conclusions is difficult because assumptions about independence and over-reliance on samples from a few individuals can invalidate statistical tests (Machalis et al., 1985).

We encountered a number of other difficulties in using this technique. Varying visibility within the forest, for example, was a major problem because it was difficult to ensure that observing bat activity was unbiased in all microhabitat categories. Our ability to make accurate observations and distinguish among categories depended on a number of factors including bat orientation in relation to the observer, distance from observer, and amount of moonlight. Bats were easier to observe in the upper and lower understory than on the ground or in or above the canopy. In addition, high mobility meant bats soon disappeared from view, and it was difficult for us to follow them in the forest at night. Bright moonlight allowed for more accurate observations of bat position in relation to the surrounding vegetation, whereas reduced visibility of stars resulted in easier identification of the light-tagged bat. Torches were not used as they compromised our night vision and may have affected bat behavior.

Numerous other light-tagging studies fail to acknowledge how they overcame problems such as varying visibility between habitats (e.g., Aldridge and Rautenbach, 1987; Lumsden et al., 1994; McDonald et al., 1990), tracking bats within the forest (Buchler, 1980), continuous sampling, over-reliance on observations from few individuals (e.g., Aldridge and Rautenbach, 1987; Lumsden et al., 1994), and over-reliance on samples from the first few minutes after release (Aldridge and Rautenbach, 1987; Brigham et al., 1992; Buchler, 1980; Lumsden et al., 1994). Light-tagging initially was developed as a means of deriving time budgets where continuous sampling and varying visibility between habitats is less problematic (Buchler, 1976, 1980). Although more open types of forest may result in less varying visibility and easier tracking of light-tagged bats in some of these studies, this is not explicitly stated.

Light-tagging has limited value as a means of describing microhabitat use for *M. tuberculata* or other bats of the forest interior because of the problems associated with varying visibility and tracking. This technique may be more useful for bats that fly in open habitats and for describing individual time budgets. Increased sample size, larger and longer sampling intervals, and removing the biases associated with release would solve a number of the problems associated with this trial. Use of infrared night-vision equipment for better navigation by observers may also help.

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Table 1. Description of microhabitats in Eglinton beech forest (based on O'donnell and Dilks, 1988)

Microhabitat	Height (m)	Description
Above canopy	>30	Open space
Canopy	16 – 3	Red beech canopy, High clutter, few spaces
Upper understory	5 – 15	Occasional tall sapplings, Relatively open space
Lower understory	1 – 5	Shrubs and sapplings, Moderate clutter
Undergrowth	5 – 0	Fernery, high clutter
Ground	1 – 0	Leaf-litter substrate

Table 2. Light-tagging effort for a sample of *Mystacina tuberculata* in the Eglinton Valley (n=9 bats)

Bat	Date caught	Age	Sex	Time observed min:sec	Number of observations
1	12 Jan.	Adult	Male	00:20	2
2	12 Jan.	Adult	Female	20:00	19
3	28 Jan.	Adult	Male	01:30	2
4	28 Jan.	Adult	Male	09:30	19
5	03 Feb.	Juvenile	Female	14:00	20
6	10 Feb.	Adult	Female	06:20	10
7	10 Feb.	Adult	Female	00:20	2
8	10 Feb.	Adult	Female	01:50	10
9	02 Mar.	Adult	Male	00:50	5

Late-winter Observations of Red Bats, *Lasiurus borealis*, and Evening Bats, *Nycticeius humeralis*, in Missouri

Justin G. Boyles, John C. Timpone, and Lynn W. Robbins
Department of Biology, Southwest Missouri State University, Springfield, Missouri 65804.

Introduction

Red bats (*Lasiurus borealis*), which generally are considered a migratory species, winter as far north as Illinois, Indiana, and Missouri (Davis and Lidicker, 1956; Whitaker and Hamilton, 1998), but their winter roosting ecology is virtually unstudied. In Arkansas, Saugey et al. (1998) report radiotracking a female red bat in December to a short-leaf pine (*Pinus echinata*) and a small shrub, before the bat moved into leaf litter for the remainder of the transmitter's life. Other biologists describe *L. borealis* emerging from leaf litter during winter in response to approaching prescribed burns (Moorman et al., 1999; Rodrigue et al., 2001), but most of this information is anecdotal. In addition to roosting observations, Whitaker et al. (1997) note that the majority of red bats feed during winter in North Carolina and Virginia.

Even less is known concerning the winter whereabouts of evening bats (*Nycticeius humeralis*), which also are considered migratory. Bat-rehabilitation specialists have reported evening bats roosting in and around man-made structures during winter in Texas and Oklahoma (French and Bunyard, 2002; B. French, pers. comm.). Although dayroosts of *N. humeralis* have been studied in summer (Bowles et al., 1996; Hutchinson, 2001; Menzel et al., 1999; Menzel et al. 2001), no evening bats have been radiotracked in winter.

Our initial project focused on the summer roosting ecology of evening bats, but given the paucity of information concerning the winter ecology of various species of bat, we began netting in our study area in late winter—weeks earlier than we normally would have for a summer study. This paper reports the findings of this early netting endeavor.

Study Area and Methods

The study area was the Bull Shoals Field Station (BSFS) of Southwest Missouri State University, located on the Drury/Mincy Wildlife Area in Taney County, Missouri. Drury/Mincy is a 2,300-ha area that consists of upland oak/hickory forest with interspersed riparian areas and glades. The area, which is actively managed by the Missouri Department of Conservation, is within the Ozark Mountains and borders Bull Shoals Lake.

We captured bats using mist nets of varying lengths (6–12 m) and heights (4–6m) that we placed across roads where the entire flyway could be blocked. We netted on nights when the daytime air temperature was greater than 16°C and removed the nets when the temperature dropped below 10°C. Weather data were obtained from the National Weather Service in Springfield, Missouri (Table 1), approximately 55 km NW of the study site. We identified each bat and recorded sex and age. Select individuals were fitted with 0.51-g radiotransmitters (Holohil Systems Ltd., Carp, Ontario, Canada) between the scapulae, using a surgical adhesive (Skin Bond, Smith and Nephew United, Inc., Largo, Florida). All other bats that were captured were marked with a black marking pen (Sharpie, Sanford, Bellwood, Illinois) on the ventral surface of each wing to determine if they were recaptured on the same or successive nights.

Results

On 8 March 2003, we captured two male *L. borealis*, one female *N. humeralis*, and one male eastern pipistrelle (*Pipistrellus subflavus*). Air temperatures during the day reached ca. 20°C, and at sunset (1813 hours CST), air temperature was ca. 10°C. Bats tentatively identified as *L. borealis* or big brown bats (*Eptesicus fuscus*) were observed foraging above service roads about 45 min before sunset. All bats were netted between 1845 and 1900 hours. On 15 March, one adult male *L. borealis* and one adult female *E. fuscus* were captured, and on 26 March, three additional *L. borealis* adult males were taken. On 27 March, one female *L. borealis* was captured, as well as two adult female and two adult male *N. humeralis* and one adult male *E. fuscus*.

We attached transmitters to one *L. borealis* and the *N. humeralis* captured on 8 March, and the bats were located every day thereafter (4 days for the *L. borealis* and 7 days for the *N. humeralis*). On 9 March, the red bat was found buried under ca. 2–3 cm of leaf litter, on the top of a ridge in a location that received full sunlight. Several cool days followed (Table 1), and the bat remained in the same location until 12 March, when it was observed emerging from the litter, presumably to begin foraging. After that day, the bat could not be located.

The evening bat was tracked to a dead white oak (*Quercus alba*) on 9 March and remained there until 12 March, when it was observed leaving at 1825 hours from a small hole, which presumably was the entrance to an old woodpecker cavity. The following day, it was tracked to a live white oak, ca. 100 meters from the first, where it remained until the transmitter was shed.

Discussion

Most biologists believe that *L. borealis* and *N. humeralis* migrate south during the winter months. However, to our knowledge, there are no data indicating from how far north, nor are there any data on how far south these bats may go. Previous studies indicate that all red bats captured during winter were males (Davis and Lidicker, 1956; Saugey, 1989), with the exception of Padgett and Rose (1991), who collected one female in March. We captured one female at BSFS and found another on the ground, on the campus of Southwest Missouri State University, on 25 March.

The winter of 2002–2003 in southwest Missouri was one of the harshest on record, and very few days before we began netting were warm enough for bats to forage (Table 1). This weather pattern, combined with the fact that both bats fitted with transmitters remained in the area for at least 4 days, suggests that the bats that we captured were residents of the area for the entire winter and were not recent migratory arrivals from wintering areas farther south. Interestingly, the several days following our first captures again had nighttime temperatures that were below freezing, and the day after we captured the female *L. borealis*, 1.74 cm of snow was recorded (Table 1). Further field work during winter will be necessary to determine the roosting ecology of these species and to ascertain whether red and evening bats that overwinter in southern Missouri remain as year-round residents or spend the summer farther north. In addition, *L. borealis* has now been documented roosting in leaf litter during winter in at least four states, suggesting that this is a common overwintering behavior, and resource agencies may need to reevaluate the timing of prescribed burns to avoid impacting this species.

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Table 1. Daily weather records for March 2003, from the National Weather Service in Springfield, Missouri.

Day in March 2003	*Maximum Air Temperature (ºC)*	*Minimum Air Temperature (ºC)*	*Air Temperature at Sunset (ºC)*	*Precipitation (cm)*
1	2	1	2	Trace[a]
2	4	-6	1	
3	13	-7	10	
4	15	-2	13	
5	-2	-7	-4	Trace[a]
6	9	-7	7	
7	17	-2	14	
8	23	-2	10	
9	3	-8	-4	
10	3	-7	3	
11	14	-3	13	
12	24	6	19	0.71
13	12	6	8	0.74
14	14	4	13	
15	21	5	18	
16	22	8	18	
17	22	9	19	Trace[a]
18	21	11	17	0.03
19	14	9	10	2.74
20	14	7	8	0.46
21	13	2	8	Trace
22	17	1	12	
23	21	3	13	
24	25	8	19	
25	16	1	8	0.41
26	18	-2	11	
27	23	8	18	
28	11	1	4	1.74[a]
29	6	-3	2	
30	9	-4	3	
31	21	-1	17	

[a]Indicates snow or ice.

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.

Advantages of Infrared Thermometers for Recording Tempeπratures in Caves

In addition to counting bats, roost temperatures often are recorded during surveys of hibernacula. We have been using "point-and-shoot" infrared (IR) thermometers in this capacity since 1992. However, some colleagues and other researchers have voiced disapproval of this method of data collection. The purpose of this letter is to discuss applications and shortcomings of various types of thermometers in typical field situations. Although we mention specific instruments, we are using them solely for illustrative purposes and are not endorsing any particular product. Alternate products are available, and specifications vary among brands and models.

Between 1977 and 1987, we recorded temperatures with a standard mercury thermometer, specifically a quick-recording thermometer (Schultheis), calibrated in increments of 0.2°C. Despite its name, this mercury thermometer was slow to stabilize, limiting the number of data points that could be collected. In some situations, incorrect environmental temperatures may have been measured, reflecting the addition of body heat from the researcher, and the slow response also meant that more time was spent near hibernating bats, increasing the probability and magnitude of disturbance. Temperatures below 0°C had to be interpolated, and those below -2°C could not be discerned. Other drawbacks were that these glass thermometers sometimes broke, and most importantly, temperatures could be collected only from sites that were within the reach of the researcher.

From 1988 to 1991, we used a thermocouple thermometer (Digi-Sense, Model 8528-30) with a general-purpose probe(Model 8116-40; Type J) that had a range of -190–1000°C, a resolution of 0.1°C, and an accuracy of ±0.25%. This thermometer, like most electronic thermometers we have observed, suffered many of the shortcomings of the mercury thermometer, including the fact that temperatures could not be measured unless bats hibernated within the researcher's reach. As a group, advantages of electronic thermometers are that they are durable, have a great range of temperatures, and are easy to read (digital models). In addition, some models may be able to store data, and discrete rock and air temperatures can be measured. However, electronic models generally are not waterproof.

Since 1992, we have used non-contact infrared thermometers. In particular, we used three styles of infrared thermometers made by Raytek: ST2, with a range of -18 to 400°C, an accuracy of ±2%, and a display to the nearest 1°C; Raynger MiniTemp MT4, with a range of -18 to 260ºC, an accuracy of ±2%, and a display to the nearest 0.5°C; and Raynger ST20, with a range of -32 to 400ºC, an accuracy of ±1%, and a display to the nearest 0.2°C. Clearly, the range of temperatures sensed by these thermometers is suitable for use in hibernacula, and their ambient operating range (0–50°C) also is within the range of temperatures found in most hibernacula. In colder areas, we carry the thermometer in our hand, against the body, inside a layer of clothing, or in an insulated carry case to keep it within its operating range.

Infrared thermometers measure temperatures in seconds, allowing collection of more data than other types of thermometer, while minimizing time spent near hibernating bats. Further, the rapid response reduces the likelihood that measured temperatures are influenced by body heat of the researcher, and most importantly, temperatures can be obtained from areas beyond the reach of the researcher. Temperatures, however, can be taken only of surfaces, such as the wall or ceiling; air temperature cannot be measured. Although both surface and air temperatures may be

desired, clearly, a rock temperature is preferable to no reading of temperature, and in many circumstances, rock temperature may be closer to the body temperature of a bat than the surrounding air, making rock temperature a reliable indicator of the microenvironment used by the bat.

Many infrared thermometers retain multiple data points in memory, which eases the process of acquiring data and allows on-the-spot comparisons among entries. Infrared thermometers measure the temperature of a surface, and the size (area) of that surface increases with distance from the target. A typical ratio of the distance from a surface to the area that is being measured (D:A) is 12:1, although thermometers with a D:A ratio of 50:1 are available. Regardless, an average temperature of a small area may be a better indicator of habitat used by hibernating bats than measuring the temperature of an irregularity in one precise location, adjacent to but not precisely where a bat or cluster of bats is located. Many different readings of temperatures can be taken quickly using infrared instruments, and such thermometers can be used to scan an area for thermal irregularities.

Perhaps the greatest disadvantage of infrared thermometers is cost, which ranges from $200 to nearly $500, depending on the D:A. However, many thermocouple thermometers and probes, like those noted above, cost about $200, and although Schultheis quick-recording thermometers cost only $50, the additional cost, inconvenience, and potential for pollution resulting from breakage must be considered. Infrared thermometers are similar to electronic models in that they typically are not waterproof.

In summary, although point-and-shoot infrared thermometers cannot record air temperatures, they can be used in many situations where conventional thermometers cannot, dramatically increasing the amount of data that can be obtained. Because of their speed, they are less influenced by heat from the researcher, and they help reduce disturbance to bats. They can be used to scan large areas to determine whether bats are hibernating in a thermally anomalous site. We believe that advantages of using non-contact infrared thermometers far outweigh disadvantages.

Submitted by Virgil Brack, Jr., Environmental Solutions & Innovations, LLC, 781 Neeb Road, Cincinnati, OH 45233; R. Keith Dunlap, Indiana Karst Conservancy, P.O. Box 2401, Indianapolis, IN 46206; and Scott A. Johnson, Indiana Department of Natural Resources, 553 East Miller Drive, Bloomington, IN 47401

Electrocution of Indian Flying Foxes, *Pteropus giganteus giganteus*, in Jodhpur, India

The Indian flying fox, *Pteropus giganteus giganteus,* is the only species of megachiropteran reported from Jodhpur (26°17'59N, 73°02'02E) of the Great Indian Desert (Purohit and Senaha, 2002, Journal of Nature Conservation, 14:251-262). Herein, we report the death of a number of *Pteropus giganteus* due to electrocution. In Jodhpur, *Pteropus giganteus* feeds predominantly on fruits and foliage of *Ficus religiosa*, a common tree that is present along both the sides of roads, throughout the city. Also lining the roads are naked (uninsulated) electrical wires that frequently occur at multiple levels, with one wire slightly above another. Apparently the bats attempt to use the wires as roosting sites when foraging; their hind feet grab an upper wire, and the front of their body occasionally contacts a lower wire, thus completing a circuit and electrocuting the bats. In the past year, we counted 20 remnants of electrocuted bats from different locations in Jodhpur. Out of these 20, eighteen (90%) were hanging on wires very close to trees of *Ficus religiosa*. The electrocuted bat typically does not fall to the ground, due the tight grip of its hind feet on the wires. As a result, their dead body remains on the electrical wires apparently for a period of more than 5–6 months, until it dries and is broken into pieces by the wind. Although electrocution of *Pteropus giganteus* has already been reported in other parts of the world, such a large number of electrocuted bats from this city is alarming to bat conservationists, because the total population of these bats from this area has been estimated as

less than 1,000 individuals and birth rate is also very low (Purohit and Senacha, 2002). Thus, this situation needs immediate attention from conservationists to seek a remedy for the problem.

Submitted by Ashok Purohit and K. R. Senacha, Department of Zoology, JNV University, Jodhpur 342001, India. E-mail: purohit1411@yahoo.com

News

from Rodrigues Island, Indian Ocean

On March 11-13,2003 a severe cyclone hit Rodrigues Island (the worst storm the island has experienced since the 1960's). Fortunately, no one was injured but the island sustained severe damage. Almost all agriculture was destroyed, many fishing boats and homes were damaged, and electricity was not restored to the entire island until just last week. Mary Jane Raboude is fine but has been very busy, along with everyone else on Rodrigues, cleaning up after the storm.

Mary Jane and Vicki Powell (British Ph.D. candidate on Rodrigues studying the wild population of bats) report that a few bats were killed outright by the storm or suffered broken wings and subsequently died but that the majority of the population, currently estimated at 5,000 bats, appeared to weather the storm well. Vicki will be closely monitoring the bats to document their response to the inevitable post-cyclone food shortage caused by the defoliation of most of the trees on the island. I will share more information as I hear it from Vicki and Mary Jane.

Mary Jane will actually be away from Rodrigues for the next month. She's been chosen to travel with an U.S. State Department-sponsored initiative on the environment and sustainable development. Below is a description of the program, in her own words:

> " I am traveling with the US Regional International Visitor program administered by the Office of International Visitors in the Bureau of Educational and Cultural Affairs of the US Department of State. The program that I am on is a regional project, so I will be traveling with African delegates. Delegates are from, Burkina Faso, Congo, Cameroon, Chad, Democratic Republic of Congo, Swaziland, Tanzania, Zambia, Paris and Rodrigues (Mauritius). Every year, there is a regional program running and this year the theme of the program is Environment and Sustainable Development. It will run from April 7 - 26, 2003. The project goals are to promote greater understanding and cooperation between the United States and African Countries on Environment, health and economic development. We also to build upon the momentum of the Johannesburg world summit on sustainable development by offering expanded opportunities for the exchange of ideas and information among leaders of private sectors, and civil society groups
> and to observe public private partnerships, environmental education and public awareness programs in sustainable economic development and protection of the environment. So, I am arriving in Washington DC on Saturday April 5 and leaving on Saturday April 26 from Oregon. I will be visiting these areas and meeting up with people leading environmental projects: Washington DC 7 - 11 April; Knoxville, Tennessee 11 - 16 April; Tucson Arizona, 16 - 20 April; and Portland Oregon 21 - 25 April."

Mary Jane continues to grow the Rodrigues Environmental Educator Project (REEP) and recognition of her excellence continues to spread. Thanks to all of you who support this project for making it all possible. With your help, we've been funding REEP for five years now!

Submitted by Kim Whitman, Philadelphia Zoo.

Notes

Distribution and Fishing Habits of *Myotis ricketti* in China

Ricket's big-footed bat, *Myotis ricketti* Thomas, once was thought to occur only in southeast China (e.g., Nowak, Walker's mammals of the world, The Johns Hopkins University Press, Baltimore, Maryland, 1991). However, several authors recently reported this species in other

Asian countries, including Laos (Robinson and Webber, Bat Research News, 39:26-27, 1998), Vietnam (Bates et al., Acta Chiropterologica, 1:47-74, 1999) and India (Thabah and Jones, unpublished).

From 2000 to 2002, we performed a systematic survey to investigate the distribution and status of this bat in China. We found the species in Beijing municipality, Chongqing municipality, Guangdong Province, Guizhou Province, and Sichuan Province, which are some of the areas in China reported by Hill (Pp. 54-161 *in* Corbet and Hill, Mammals of Indomalayan Region: a systematic review, Oxford University Press, London, United Kingdom, 1992). We, however, do not agree with Hill on the distribution of the bat in northeastern China, because our surveys in that area did not result in collection of the species.

Myotis ricketti is larger than most species in the genus *Myotis*. Body mass of 30 specimens from China was 22.5 ± 3.5 (Mean ± *SD*) g. Length of the forearm was 55.0 ± 1.0 mm (n = 30), and length of the hind foot was 18.6 ± 1.9 mm (n = 30). We also examined echolocation calls of 50 bats from Beijing that were recorded with a time-expansion (10x) ultrasonic detector (Pettersson D240x) and a digital recorder (Sony TCD-D100). Calls of the big-footed bat were narrowband and frequency modulated, with the dominant frequency (most energy) at 38.2 ± 1.2 kHz; individual calls swept from 67.4 to 23.6 kHz and had a short duration of about 4 ms. The frequency of ultrasonic signals used by *M. ricketti* was somewhat low, and its calls might be best suited for detecting prey in open environments.

The outstanding physical characteristic of this species was the enormous feet and sharply recurved claws, suggesting fish-eating habits. From August to October 2002, we obtained 43 fecal samples from big-footed bats as they returned to their roost in a cave. Examination of the pellets indicated that the freshwater minnow *Zacco platypus* (Cypriniformes) was the most common prey (>40%). This species of fish was common in a reservoir near the cave, and they frequently jumped out of water, presumably allowing them to be more easily captured by the big-footed bat. Other fish that were consumed were small goldfish, *Carassius auratus* (6.3%), and downstream fat-minnows, *Phoxinus lagowskii* (3.1%). In addition, at least six orders insects (Homoptera, Coleoptera, Diptera, Hemiptera, Ephemeroptera, and Odonata) were present.

This work was financed by the National Natural Science Foundation of China (Grants 30025007, 30170250, 30070108 and 30270169), Special Prophase Project on Basic Research of the National Department of Science and Technology (No. 2100CCA00700), the Innovative Program KSCX2-1-03 of the Chinese Academy of Sciences, and a grant from the Royal Society and the Chinese Academy of Sciences. We thank F. Huang for identifying the insect specimens and S. Li and C. Zhang for identifying the fish. M. Holderied and S. Parsons assisted with the capture and recording of bats in Guilin. We thank J. Chen, T. Wu, G. Jia, and G. Sun for their kind and generous support during our field studies.

Submitted by Ma Jie, Institute of Zoology, Chinese Academy of Sciences, Beijing 100080, China; Gareth Jones, School of Biological Sciences, University of Bristol, United Kingdom; Zhang Li-Biao, College of Life Sciences, Guangxi Normal University, Guilin 541004, China; Liang Bing, Institute of Zoology, Chinese Academy of Sciences, Beijing 100080, China; Shen Jun-Xian, Laboratory for Visual Information Processing, Institute of Biophysics, Chinese Academy of Sciences, Beijing 100101, China; and Zhang Shu-Yi, Institute of Zoology, Chinese Academy of Sciences, Beijing 100080, China. Corresponding authors: Zheng Shu-yi or Shen Jun-xian: zhangsy@a-1.net.cn or shenjx@sun5.ibp.ac.cn.

Fruit Bats from Pakistan

Brenda Bhatti recently completed her master's thesis on bats at Antioch New England Graduate School, Antioch University. This project was a baseline study of the population status and general knowledge of Old World fruit bats (Pteropodidae) in and near Karachi, Pakistan. A field investigation was conducted in March 2000, aimed at locating any of the four species of fruit bats that have been recorded in the Karachi area: *Cynopterus sphinx*, *Pteropus giganteus*,

Rousettus aegyptiacus, and *Rousettus leschenaulti*. A variety of methods were employed to determine historic and current distribution. A total of twenty sites were visited in and near Karachi (Sindh Province) to search for potential roost and forage sites. Eleven individuals, identified as *Rousettus leschenaulti* based on the length of the second phalanx of the third digit, were captured in Karachi, Malir, and Thatta. Many factors were identified that may impact fruit bats in this region. A theory that an apparent increase in house crows (*Corvus splendens*) and black kites (*Milvus migrans*), along with the ability of these birds to disturb and compete with fruit bats or directly prey upon them, was explored. An apparent increase in lighting structures allows the normally diurnal kites to fly at dusk when they would not otherwise do so. While this light pollution may be beneficial for insectivorous bats, it may have a detrimental impact on the fruit bat population. The complete title of the thesis (2001) was: *Status of Fruit Bats and Factors Affecting Their Presence in and near Karachi, Pakistan*. Submitted by Brenda Bhatti

Announcements and Notices

The Lubee Foundation is pleased to announce that Dr. Allyson Walsh has assumed the position of Director as of May 1, 2003. Dr. Walsh is a field ecologist and she has spent more than thirteen years developing and managing large scale bat conservation projects in partnership with scientists and educators worldwide.

Prior to joining Lubee, Allyson was program manager for The Bat Conservation Trust in London developing a national monitoring program to assess population trends in UK bats. This successful program is still in place today. Allyson comes to the Lubee Foundation from Bat Conservation International (BCI), where she was Conservation Science Director.

Allyson has an honors degree in biology (Southampton University, UK) and completed her doctorate in conservation biology at the University of Bristol in 1995 (UK). She is an active member of the IUCN Chiroptera Specialist Group and has applied research interests in foraging ecology, population monitoring, global conservation priority setting and conservation management of endangered species.

Allyson recently organized a Global Bat Biodiversity Initiative meeting in Washington DC, where experts from international conservation organizations discussed a global biodiversity vision for bats. She is working with scientists to help lend a science based direction to the future of fruit bat conservation and to integrate fruit bat conservation priorities within initiatives led by the broader conservation community.

The Lubee Foundation is looking forward to continued growth as a leading research, conservation and education institution for threatened plant-visiting bats. Please feel free to contact Dr. Walsh concerning collaborative research interests, conservation and education projects in the future. Allyson Walsh : awalsh@lubee.org

Rabid Bat in Great Smokey Mountains

The following item appeared in The Courier-Journal (Knoxville, TN) on Sunday May 25, 2003. " a silver haired bat found crawling across a road near the Great Smokey Mountains National Park headquarters tested positive for rabies, officials said Thursday. It is only the second confirmed case of rabies in the national park: the other bat was found in 1989. Experts said the bat's discovery May 13 is no indication that rabies is on the rise, but is prompting park officials to review their protocols for informing visitors about risks in the woods.

Submitted by Kunwar Bhatnagar, University of Louisville, Louisville, KY: bhatnagar@louisville.edu

Groundwater Contamination Study

The Environmental Protection Agency in its study of groundwater contamination near Meramec Caverns near Sullivan Missouri has detected trace amounts of Tetrachlorethelyne (TCE) in the groundwater and interior cave air. We wish to determine any ecological effects that

might result on the bat population residing in or visiting the cave. Any one with information or literature sources which would assist us in making this determination should contact Steve Kinser via e-mail at kinser.steven@epa.gov; via telephone at 913-551-7728 or by mail at USEPA Region 7, SUPR/MOKS, 901 N. 5th Street, Kansas City, Kansas, attn: Steve Kinser. The information developed in our study will determine the clean up levels and actions taken at the near by hazardous waste Superfund Site.

Bat Biologist Field Assistant Wanted

Field assistant for bat research in Oregon required June 14 - August 31, 2003. Applicant will assist a graduate student from Portland State University in a study of bats throughout the state of Oregon. In an attempt to capture bats across the state, the team will work at a new site each night. Duties include mist netting, capturing bats in nets under bridges, recording echolocation calls, handling and processing bats, and collecting wing biopsies for genetic analysis. Previous experience with mist netting and bat identification required. A completed degree in biological sciences, ecology, wildlife or closely related field is preferred. Applicant must have strong interpersonal skills, be in good physical condition, and have a strong work ethic. Position requires traveling in remote locations and long hours in varied environmental conditions. Applicant must have a valid driver's license and experience with 4WD. Transportation in the field will be provided. Applicant must provide his or her own waders, headlamp, food and camping gear. The team will come and go out of Portland, returning for a couple of days after each 2-3 week session in the field. During the short breaks in Portland, applicant must provide his or her own housing and transportation. Reimbursement funds are available for applicant to receive complete rabies vaccine. Wage dependent on experience.

Apply by sending a statement of interest, resume, and a list of 3 references (name, phone, and e-mail address) to: shonenes@pdx.edu or Shonene Scott, c/o Dr. Debbie Duffield, Biology Department, Portland State University, P.O. Box 751, Portland OR 97207-0751.

Equipment Grants

Sandpiper Technologies specializes in wildlife research equipment and video surveillance systems. Sandpiper is keen to assist students with their field research projects and has issued an Equipment Grant of a *TreeTop Peeper Elevated Nest Surveillance Systems* to David Leput of Clemson University for use in the spring/summer 2003 field season in his study of "Habitat Use of Piedmont Bats in relation to forest structure and composition: Influences for forest management."

Sandpiper Technologies has loaned its rental fleet to U.S. and Canadian university students since 1998 and recently added the AquaPeep Underwater Surveillance System to the roster of available equipment. December 1 is the deadline for applying for the Equipment Grant Program for the 2004 spring/summer field season. Students applying for grants during the off-season can apply at any time. For more information about this program go to: http://sandpipertech.com Ann Christensen, Sandpiper Technologies, Inc., 535 W. Yosemite Ave., Manteca CA 95337 Tel. 209-239-7460

RECENT LITERATURE

Authors are requested to send reprints of their papers to the Editors (Margaret and Tom Griffiths, Dept. of Biology, Illinois Wesleyan Univ., Bloomington, IL 61702-2900, U.S.A.) for inclusion in this section. If reprints are scarce, please send a complete citation (including complete name of journal and author mailing address) to **mgriff@illinoisalumni.org** by e-mail. Receipt of reprints is preferred as it will facilitate complete and correct citation. Our 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.

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Future Meetings and Events

August 2. 2003

The Organization for Bat Conservation at Cranbrook Institute of Science in Bloomfield Hills, Michigan, is hosting **The Great Lakes Bat Festival** on Saturday August 7, 2003 with presentations from 10:00 AM to 5:00 PM and an additional presentation at 8:00 PM until 10:00 PM. The program includes live bat presentations, conservation programs, bat house information, and mist-netting in the evening session. For additional information call the **Cranbrook Institute of Science** at 800-276-7074 or contact: http://www.batroost.com

August 4-6, 2003

There will be a **"BAT BLITZ"** (a three night field trip) at Camp Clearfork, Ouachita National Forest, Arkansas.
For additional information and registration, see page this issue or contact:
David Saugey, U.S. Forest Service, P.O. Box 189, Jessieville, AR 71949-0189
Tel. 501-984-5313 (voice, Monday – Thursday) 501-984-6253 (fax)
e-mail: dsaugey@fs.fed.us

October 8 – 11, 2003

The **33rd Annual North American Symposium on Bat Research** will meet in Lincoln, Nebraska, October 8-11, 2003, hosted by Trish Freeman (University of Nebraska and Nebraska State Museum). All formal sessions of the 33rd Symposium will be held at the Cornhusker Hotel in downtown Lincoln, located within easy walking distance of the UNL campus, the state capital, and of a number of downtown restaurants, pubs, and other attractions. Room rates will be among the least expensive we have had in recent years, and other costs (including transportation) should be very reasonable.

See our website at: http://www.nasbr.org/ Watch this space for further details.

April 14-16, 2004

The 11th meeting of the Australasian Bat Research Symposium will be held The University of Southern Queensland in Toowoomba, near Brisbane, Australia just after Easter in 2004. For additional information contact Greg Ford at: fordg@powerup.com.au

August 23-28, 2004

The **13th International Bat Research Conference** is planned to be organised in Poland from 23-28 August 2004. More information about the conference will be available in a few months at: http://www.miiz.waw.pl/IBRC also http://www.miiz.waw.pl/IBRC

October, 27-30, 2004

The **34th Annual North American Symposium on Bat Research,** will convene in Salt Lake City, Utah, October 27-30, 2004

August, 2005

The next **European Bat Research Symposium** will be held in Ireland in August 2005. More details will appear here as they become available.

If you know of other planned meetings, large or small, concerning any aspect of bat biology, please send details to Roy Horst for publication in the next issue.

Erratum: Page 29 was omitted from several copies of Volume 44: No.1, Spring, 2003. We include it here with our apologies. GRH

monitor such trees using nighttime exit counts to determine if the roosts are used by solitary bats or by colonies.

The following abstracts were presented as posters

Dietary variation as determined by fecal analysis in Rafinesque's big-eared bat *Corynorhinus rafinesquii*, in coastal South Carolina

Heather A. Armbruster,
Department of Biological Sciences, 331 Funchess Hall, Auburn University, Alabama 36849;
e-mail: Hthomas98@aol.com

The largest known colony of Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) in South Carolina is located at Hampton Plantation State Park in an abandoned kitchen building. This colony of up to 80 individuals provided an opportunity to study the seasonal diet of *C. rafinesquii*. Fecal samples were collected from the roost from mid-March through late November. Insect samples were collected using aerial traps from various locations within the park on nights corresponding to fecal sample collections. Bats appeared in the roost in early March. The bats left for the winter at the beginning of December. Fecal samples were analyzed and compared to insect samples to determine diet preferences of *C. rafinesquii*. Rafinesque's big-eared bat preferentially ate Lepidoptera, but also consumed significant amounts of Coleoptera and Diptera. Blatteria and Neuroptera were important food items when they occurred.

Distribution of two bat species in Alabama

John L. Hunt, Troy L. Best, Lisa A. McWilliams, Paul R. Moosman,
M. Keith Hudson and W. B. Johnston,
Department of Biological Sciences, 331 Funchess Hall, Auburn University, AL 36849
e-mail: huntjoh@mallard.duc.auburn.edu

No comprehensive study of distribution records of bats in Alabama has been conducted since the 1950s. Records of occurrence were compiled from museum collections and publications, and from specimens submitted to the Alabama Department of Health for rabies testing. A distribution was plotted for each species using geographic information systems. Preliminary results for *Corynorhinus rafinesquii* and *Lasiurus borealis* are given.

Bats of the Mobile-Tensaw Delta, Alabama: Preliminary results

Charles H. Kilgore, Troy L. Best, John L. Hunt, Paul R. Moosman,
Lisa A. McWilliams, and Vickie A. Ashe
Department of Biological Sciences, 331 Funchess Hall, Auburn University, Al. 36849
e-mail: euderma@earthlink.net

Relatively little is known about most of the 15 species of bats in Alabama. Especially scarce are data on species occurring in southern Alabama, including the Mobile-Tensaw Delta region. Because there are significant recent acquisitions of tracts of land into the public trust within the Mobile-Tensaw Delta region in southern Alabama, it was especially desirable to obtain an accurate biological survey. Objectives were to conduct a field survey and to use radiotelemetry to determine characteristics of day roosts of the bat fauna. At each collection locality, habitat, species captured, date and time of capture, sex, age, and reproductive condition were recorded for each individual. Mist nets were used to capture bats, abandoned buildings were searched, and firearms were used to collect specimens at some sites. During 2002, 57 sites were surveyed. A total of 30 bats of 6 species was captured: 13 Seminole bats (*Lasiurus seminolus*), 6 eastern red bats (*Lasiurus borealis*), 4 Rafinesque's big-eared bats (*Corynorhinus rafinesquii*), 4 evening bats

BAT RESEARCH NEWS

VOLUME 44: No. 3 FALL 2003

BAT RESEARCH NEWS

VOLUME 44: No. 3 **Fall 2003**

Table of Contents

We have not received any offers of a photo or drawing for our cover illustration for this issue. If you have a good black and white photo of your favorite bat or a drawing you would like to submit please send it to Roy Horst. If we use your illustration, we will reward you with a free one-year renewal of Bat Research News

Design and Construction of a Triple-bank Harp Trap

Rob Gration
Ecological Consulting Services, 80 Hobson Street, Newport, Melbourne, Australia 3015
e-mail: rgration@yahoo.com.au

Introduction

The original single-bank harp trap designed by Constantine (1958) has been one of the major tools used to capture bats since its inception in the late 1950s. Later, Tuttle (1974) introduced a second bank of lines to improve capture rates. Tidemann and Woodside (1978) eventually made further improvements to the design of Tuttle (1974), and Francis (1988) researched the effectiveness of three and four banks of lines. Surprisingly, even though the results indicated an improvement in capture rates with increasing banks of line, the double-bank system is still the primary design. In the last 15 years, there have been only minor changes to the double-bank design (Bat Conservation and Management, 2003; Lumsden, 1999), and three- and four-bank traps are still not readily available.

In recent times, my interest has focused on redesigning the harp trap. Although I tried a number of designs (Gration, 1999) in the years preceding the current design, they failed to meet the desired objectives. In addition, Dobson et al. (2002) recorded low capture rates (2.6%) in relation to the number of approaches, and this further encouraged me to push on with redesigning the trap. My fieldwork and research indicated the design process should focus on two key areas—features that will improve capture rates and those that will make a trap more user-friendly for a single operator.

Improving Capture Rates

The first area I researched was a bat's response to an obstacle in the form of monofilament line. I put a series of questions to Tony Messina (2001), from Nevada Bat Technology, on the echolocation ability of bats. Tony indicated that the angle of attack (both vertically and horizontally) when approaching a harp trap would dictate the strength of the echo. The monofilament lines are more acoustically visible on the vertical plane when approached at 90°, and they are more acoustically visible on the horizontal plane when approached from any angle less or greater than 90°. This is due to the perceived reduction in the gaps between lines; the lines are seen (acoustically) as a larger object, thus providing a greater reflecting area. Tony provided the example of looking at a mistnet. If you look at the mistnet while facing the net, it is difficult to see, but as you move to either side of 90°, it becomes more visible.

Griffin's (1986) research indicated that by decreasing the diameter (<0.20 mm) of a vertically strung steel line, a bat's ability to avoid obstacles decreased. This led me to investigate the properties of monofilament line and the relationship between breaking strain and diameter. While researching this topic, I also looked for information on the effects of weather conditions on line tension, because I have experienced a relaxation of tension during a night of trapping, particularly on warm nights. Research into the manufacture of monofilament line indicated that the quality of the line has an influence on the breaking strain-diameter relationship, line relaxation, and plastic memory (Bray, 1987).

Would increasing the number of banks of lines improve capture rates? Francis (1989) designed and built three- and four-bank harp traps, and his results indicated an improvement in capture rates with increasing banks of line. Petit et al. (1995) also found that a harp trap with three banks increased capture rates for lesser long-nosed bats (*Leptonycteris curasoae*) from 0 to 60%.

I also was concerned about bats escaping at the ends of the capture bag. I had observed that bats did not always fall to the bottom of the capture bag. In addition, scat was found on the plastic at the top of the capture area, but there was no evidence of bats in the bottom of the bag. I noticed too that if the capture bag was tied off too tight it reduced the angle of the capture zone to an almost flat surface, and I suspect this allowed a bat to crawl to the end or top of the capture bag and fly off.

Finally, I undertook research to find if there was any correlation between the size of the capture area and number of captures. Mike O'Farrell's (pers. comm.) work with infrared cameras indicated that the height of the capture area could play a role in the escape of some bats. Mike

observed bats hitting the top section of the trap and spreading their wings between the lines, which brought them to a halt; they then manipulated themselves through the lines and flew off. Thomson (pers comm.) observed instances of bats escaping when they failed to be caught within the confines of the two banks at the top of the trap. This led me to believe that taller traps could lead to more escapes; hence, a larger capture area does not necessarily mean more captures.

Based on my research, a number of changes were proposed. To increase capture rates, the trap would consist of 3-banks. To minimize echolocation potential of the monofilament line, 2.72-kg line that was 0.20 mm in diameter would be used. Furthermore, the line configuration would consist of 50-mm spacings on the outside banks and 25-mm spacing on the inside bank; the inside bank would also have more tension applied. The construction of spring-loaded vertical uprights and use of high-quality monofilament line were seen as the solution to the line-relaxation problem. To decrease concern over escapes from the capture bag, the bag ends would rise above the line-carrier fixing point, and the taper on the capture bag ends would be increased; these changes also would allow for removal of the internal plastic baffle.

Making a Harp Trap More Single-operator Friendly

The design also needed to enable a single operator to erect or dismantle the trap with ease, while minimizing entanglement of lines. Reducing the width of the trap would make the process of rolling and unrolling the line carriers easier for a single operator; however, I was not keen to alter the width, and in fact, I actually would have liked to increase the width. Although a reduction in the height of traps apparently was possible without affecting capture rates, a reduction in height would not make the process of erecting a trap any easier.

The current design of the hips is inadequate because they require dismantling when transporting between sites. I have had experiences when the hips had been forgotten or separated from the trap, and a folding hip that fits into the carry bag would overcome the likelihood of this scenario. Not only did the hips need to be redesigned for transporting purposes, they also needed to accommodate the proposed new line-carrier fittings.

I believed the solutions to improve the single-operator friendliness would come in the form of elbow fittings for both the line carriers and capture bag. Furthermore, the hips would be designed to accommodate the elbow fittings and be folded into a compact unit for transporting.

Construction and Evaluation of a Prototype

The design and construction phase were undertaken in the reverse steps of how a manufacturing project normally would be undertaken. I had the design ideas but was unsure as to the availability of materials needed to build a prototype. There was a need for the construction material to be cheap, easy to work with and readily available, so the decision to use PVC electrical conduit with aluminium inserts was deemed best. The prototype was one-third the size of a full-size trap. The changes to the capture bag ends and the one-piece folding hips were not included at this stage.

The prototype's ease of operation and capture rates was assessed over a 12-month period. The general response from those who used or saw the trap in action was positive. Personally, I found it very easy to erect and dismantle, but this is to be expected, given that I had designed it to meet my needs and it was not yet a full-scale version.

Whether or not there was an improvement in capture rates is uncertain, because there was no statistical comparison between types of harp traps. However, anecdotal evidence suggested capture rates of the prototypes were equal to traditional harp traps when they were used on the same night in a survey area. If capture rates were similar, why bother continuing with the redesign? The answer is that, even though the prototype had a smaller capture area, it did not appear to come at the expense of captures.

Construction of and Response to the Full-scale Version

Buoyed by the apparent success of the previous 12 months of testing, I proceeded to source the materials and sub-contractors needed to construct the full-sized model. Materials used in construction of the full trap were structural grade aluminium tubing, 90º copper elbows and 12-oz mold-proof canvas. I also incorporated the features that were not included with the prototype—increased height of capture-bag ends, collapsible one-piece hips, and a refined spring

system. The refining of the spring system involved inserting the spring within the vertical uprights, not externally as on the prototype; this was done for aesthetic reasons rather than any functional purpose.

There currently are 12 of these traps located throughout Australia and one in Central America, but to date, I have not received feedback from all users. One owner is convinced the triple-bank design is capturing more bats than his other traps (P. Webb, pers comm.), but at present, there is no scientific evidence to support this statement. However, I can state that the triple-bank trap has been successful in catching a suite of bats ranging from fast flyers to gleaners. In terms of its ease of erecting, there have been varying responses, Peter Homan (pers comm.) found it very easy to erect and also was pleased with the capture rates. Another user had some teething problems when erecting, but these problems were a case of operator error due to the inadequate instruction manual.

I used my wildlife survey students as guinea pigs for assessing how user-friendly the new design was; they were an ideal study group, because they had not previously erected any kind of harp trap. I had them use a triple-bank trap and two commercially available traps in the field over a three-day period. They thought that the design features aimed at improving user-friendliness were useful, and perhaps coincidentally, the triple-bank also caught the majority of bats. In terms of the positive response I received from this group, I cannot exclude the possibility that they believed their responses would be beneficial to their grades.

The design is a work in progress, and subtle improvements are constantly being implemented to improve all facets of the trap. One such improvement is the option of a capture-bag made of a PVC mesh for areas where dehydration of bats may be of concern. The author would welcome any suggestions or comments on his modifications.

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An Improved, Beaded, Polymer Necklace for Marking Bats

S. Isaac[1], J. Balasingh[1], P.T. Nathan[1], D. P. Doss[1], M.R. Sudhakaran[1], and T.H. Kunz[2]

[1] Research Department of Zoology, St. John's College, Palayamkottai 672 002, India

[2] Center for Ecology and Conservation Biology, Boston University, Boston, MA 02215, U.S.A.

Several tagging methods and devices have been used for marking bats (Kunz, *in press*). These include numbered, metal, lipped bands, metal butt-end (bird) bands, plastic split rings, ball-chain necklaces, ear tags, tattoos, punch marks, and passive integrated transponders (PITs). Each marking device has its advantages and disadvantages, and some may be more appropriate for certain species than others. Ultimately, the marking method used will depend on the research objectives, species being studied, and availability of materials.

In this paper, we describe an improved beaded necklace that has been used successfully on three species of megachiropterans *(Cynopterus sphinx, C. brachyotis* and *Rousettus leschenaulti*) in South India. A prototype of this necklace was described by Balasingh et al. (1992), but their later observations revealed that this necklace, which used an elastic band, deteriorated with time and, thus, could not be used for long-term monitoring. We have improved this necklace by replacing the elastic band with polymer tubing. Advantages of polymer tubing are its high tensile strength, durability, and persistence under a range of environmental conditions.

Beaded polymer necklaces are fabricated using clear polymer tubing (1.1-mm diameter) through which a nylon thread (0.4-mm diameter) can be strung to add color. Polymer tubing also may be available in different colors, and thus, different colored threads may not be necessary. In both situations, 1–10 plastic beads are strung onto a 70-mm length of tubing, and one overhand knot is tied adjacent to the beads at each end to hold the beads together. The fabricated necklace is then placed around the neck of the bat being marked (Fig. 1a). A spring-like coil is made using copper wire (0.7-mm diameter) that is wound around a rod (3-mm diameter). The coiled wire is then removed from the rod and cut into small pieces, each with 4–5 turns. Each end of the tubing is then threaded through the spring-like coil to form a complete necklace. Once the polymer necklace is placed around a bat's neck, the size of the necklace is adjusted by pulling on the ends of the tubing (Fig. 1b). The ends of the tubing are firmly attached by crimping the copper coil with needle-nosed pliers (Fig. 1c), and then, the free ends of the tubing can be trimmed with scissors (Fig. 1d).

To establish a unique numbering system, beads (4.3-mm diameter) of 10 different colors are each assigned digits from zero to nine. Using 10 beads of three different colors, it is possible to assign 999 different numerical combinations. Numbers assigned to a beaded polymer necklace also can be increased by using different colors of nylon thread, with specific colors used for different sets of 999. For example, a beaded polymer necklaces made with clear polymer, and threaded with red or green thread, would be designated with prefixes of "R" and "G," respectively.

The combination of beads (and associated numbers) can be read easily if the beads are rotated to the back of the neck and their color and position recorded from right to left (Fig. 1e). A beaded polymer necklace with three beads weighs ca. 0.53 g, representing ca. 1% of the mean body mass of *C. sphinx* (49.5 g), and 10 beads weigh less than 1 g. Marking devices that weigh less than 5% of an animal's body mass are considered appropriate for birds and bats (Cochran, 1980; Aldridge and Brigham, 1988).

Polymer beaded necklaces offer an alternative to other types of necklaces, such as ball-chains (Handley et al. 1991; Kunz, 1996) and cable ties (Gannon, 1993), onto which numbered bands are strung for individual identification. Different positions and colors of plastic beads make it possible to identify individuals without using numbered bands although, as with other types of marking devices, recaptures are necessary to confirm the identity of

the individual. Polymer beaded necklaces offer several advantages. They weigh less than 1 g, are flexible, durable, and can be fitted easily onto bats. As with other necklaces, they may not be suitable for crevice-dwelling species. Moreover, necklaces of any type should not be used on growing animals or on species that have large sternal or gular glands (Barclay and Bell, 1988; Kunz, *in press*). Beads are available in different colors and sizes, and large sizes are more suitable for making observations of individuals in captivity. As with other marking devices (Kunz, *in press*), one must properly fit polymer beaded necklaces to bats. The length of polymer necklaces should be determined empirically for each species and for each individual bat, especially for sexually dimorphic species. A beaded polymer necklace should fit tightly enough around a bat's neck so that it does not slip over the head, but loose enough that it does not choke the bat, irritate the underlying skin, or interfere with feeding.

Although the persistence of beaded polymer necklaces has not been established firmly, out of 1,583 *C. sphinx* individuals that were marked between 1996 and 2002, one juvenile female was recaptured 2,346 days (6.4 years) after it was marked. Recapture data, based on intensive mist netting between October 2001 and April 2002, indicate that 10 individuals were captured at intervals ranging from 100 to 894 days; 18 individuals were captured at intervals ranging from 1,046 and 2,246 days. The thumbs of large megachiropterans can be marked successfully with butt-end bands, but the thumb pads of smaller species are not large enough to use this method (Kunz, *in press*). Small species of megachiropterans, such as *C. sphinx* can be marked successfully with lipped and split-ring wing bands (Storz et al., 2000), but because this and similar species have a large propatagium, this membrane must be slit for appropriate attachment of these bands (Kunz, 1996). The general availability of materials for fabricating beaded polymer necklaces and the recapture data for *C. sphinx* in South India suggest that these necklaces provide an alternative method for marking small plant-visiting megachiropterans. This type of necklace also may be suitable for some microchiropteran species. Use of larger colored beads on polymer necklaces may also facilitate recognition of different individuals in behavioral experiments on captive individuals.

Acknowledgments

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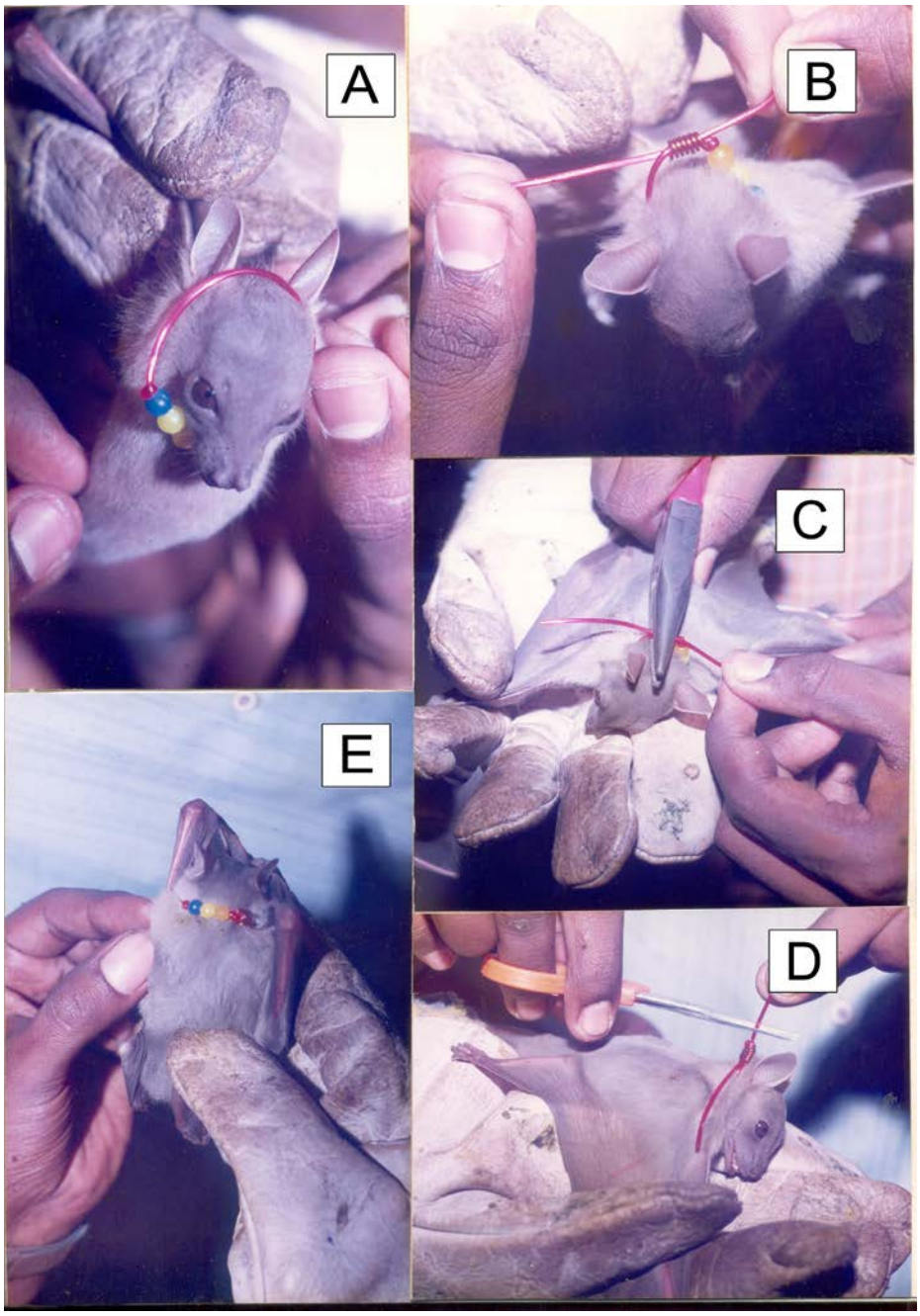

Figure 1. Step-by-step procedure for marking bats with a beaded polymer necklace: a) a loosely fitted necklace is placed around a bat's head, b) the necklace is adjusted to the size of the bat's neck, c) the copper coil is crimped using long-nosed pliers, d) excess length of polymer tubing is cut at both ends, and e) completed necklace, with beads rotated into position for determining number by reading color from right to left (in this example, yellow, white, and blue = bat number 379).

Automated Log-ratio Analysis of Compositional Data: Software Suited to Analysis of Habitat Preference from Radiotracking Data

Peter G. Smith, peter@ smithecology.com
Smith Ecology, 1, Bettws Cottage, Bettws, Abergavenny NP7 7LG, Wales, United Kingdom

Radiotelemetry increasingly is used to investigate habitat use by foraging bats. The technique enables data to be obtained on proportionate habitat use by individual bats over several nights of tracking, and this can be compared with the proportions of habitats available. Standard multivariate analysis designed for unconstrained multivariate data is entirely inappropriate for the statistical analysis of such compositional data (Aitchison et al., 2002). This is because the data are constrained by the fact that the proportions describing habitat use or availability sum to one over all habitat types, an issue known as the constant-sum or unit-sum problem. Compositional data can, however, be assessed by log-ratio analysis (Aitchison, 1986), which also is known as compositional analysis (Aebischer et al., 1993). This technique can be used to assess habitat preference with sample size being the number of tagged animals and the radiolocations providing a subsample of each individual's habitat use.

Compositional analysis is described and demonstrated by Aebischer et al. (1993) using two data sets, including methods of treating missing values representing zero use or availability of habitats for some individuals. The method first determines whether overall use differs from random and, if so, ranks habitats according to relative use and locates significant between-rank differences. Randomization tests are used to determine probability values to overcome problems when assumptions for parametric statistics do not hold.

The manipulation of data and calculations required when carrying out a compositional analysis are laborious and present many opportunities to introduce errors. To assist with such analyses, I have written an add-in program for use with Microsoft Excel that implements fully the method for compositional analysis as described by Aebischer et al. (1993) and presents the final results automatically. The user is required only to provide the observed data as tables of percentage use and availability for the set of animals sampled. Default values are offered for parameters that may be set by the user. Testing for effects is not included in the program but can be achieved by entering log-ratio differences output as intermediate data into a standard MANOVA. My program is called "Compos Analysis" v5.0. Further information can be found on the internet by visiting http://www.smithecology.com/software.htm, which also explains how you can obtain a copy.

Acknowledgments

The development of "Compos Analysis" has benefited especially from the helpful comments and suggestions of N. J. Aebischer, Game Conservancy, Fordingbridge, United Kingdom, and also from the feedback of various users.

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First Record of *Lasiurus intermedius* H. Allen (Vespertilionidae) from Costa Rica

Bernal Rodríguez-H[1], Willy Pineda[2], Marcela Fernández[2] and Richard K. LaVal[3]
[1]Historia Natural, Museo Nacional de Costa Rica, 749-1000 San José, Costa Rica; [2]Escuela de Biología, Universidad de Costa Rica, [3]Monteverde, 24-5655 Puntarenas, Costa Rica
E-mail: bernalr@racsa.co.cr

The northern yellow bat (*Lasiurus intermedius)* is known from the southeastern United States, from the Atlantic west to Texas. The range of this species continues south through Mexico (both coasts) to Honduras and El Salvador, and it also is found on Cuba. (Webster et al., 1980). According to Reid (1997) the species is restricted to elevations lower than 1600 m. Beginning in 2000, we recorded numerous call sequences, using ultrasound detectors (Anabat II), at four localities in Costa Rica, which, on direct comparison with confirmed files of this species from Belize (supplied by B. Miller), appeared to be made by *Lasiurus intermedius.* The first three localities included Poco Sol, Bosque Eterno de los Niños, 800 m; Monteverde, 1,350 m; and Las Alturas de Cotón, San Vito, 1,500 m. At the Poco Sol locality, the bat was observed foraging around a light while recordings were being made, and it appeared to be a relatively large and yellowish vespertilionid.

On 26 February 2003, at about 1900 h, we collected an adult male *Lasiurus intermedius* in a mist net set among trees and shrubs on the grounds of a hotel at San Gerardo de Dota (9º56'41'' N, 83º51'49'' W; 2,500 m). The specimen is preserved as a skin and skull and deposited in the collection of the Museo Nacional de Costa Rica (MNCR #1362). It has the following measurements (mm): total length, 134; tail, 61; right hindfoot, 11; ear, 19; tragus, 9; and forearm, 54. The animal weighed 20 g. The only similar species of bat in Costa Rica is the southern yellow bat, *Lasiurus ega.* These two species are distinguished by the larger size of *L. intermedius* in the following measurements (Hall and Jones, 1961): total length greater than 119 mm (MNCR #1362 = 134 mm), condylocanine length greater than 16.5 mm (18.04 mm), and length of maxillary toothrow greater than 6 mm (7.17 mm). The forearm of our specimen is larger than that of any reported for *L. ega* (Hall, 1981; Kurta and Lehr, 1995).

The specimen was collected on the grounds of the Hotel de Montaña Savegre Lodge, in an open park-like setting, with numerous small cabins along a small mountain stream. The area contained a few mature trees about 30-m tall, including exotic conifers, as well as a number of small trees and many ornamental shrubs. Feces collected from the bat contained only the remains of Coleoptera.

Capture of this specimen increases the known bat fauna of Costa Rica from 108 (LaVal and Rodríguez-H 2002) to 109 species and extends the distributional range of *L. intermedius* from southeastern Honduras (Hall, 1981) to southwestern Costa Rica, a distance of ca. 600 km. Our specimen was collected at a much higher elevation than previously recorded for the species, and all Costa Rican localities where Anabat II recordings were made of this species were 800 m or higher. Because we have recorded extensively in the lowlands of Costa Rica, as well as at elevations as high as 3,400m, it appears likely that, here, at the southern extremity of the species' range, *L. intermedius* occurs only at middle elevations and is relatively rare.

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Emergence Patterns of Cave Myotis (*Myotis velifer*) on Fort Hood, in Central Texas

Tarisha Smith Land, Thomas E. Lacher, Jr., and Donald R. Clark, Jr.
[1]Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, TX 77843 and
[2]Columbia Environmental Research Center, US Geological Survey, Brazos Field Station, Department of Wildlife and Fisheries Sciences, College Station, TX 77843
[2]Present address of TEL: Center for Applied Biodiversity Science, Conservation International, 1919 M St., Suite 600, Washington, D.C. 20036 [1]E-mail: t.lacher@conservation.org

The cave myotis, *Myotis velifer*, is a cave-roosting specialist, whereas most species of *Myotis* roost in trees (Brigham et al., 1997; Grindal, 1998; Foster and Kurta, 1999). Cave myotis are colonial and abundant in the Edwards Plateau of Texas, where they are active during spring and summer but hibernate in winter (Davis and Schmidly, 1994). They are strong flyers and opportunistic insectivores, with small moths making up a large part of their diet (Davis and Schmidly, 1994). Although Kunz (1974) conducted a detailed study of emergence, foraging, and dispersal for several populations of the cave myotis in south-central Kansas and northwestern Oklahoma, this species is poorly studied in Texas. In the present paper, we document patterns of emergence by cave myotis at Shell Mountain Cave; this cave is located on Ft. Hood, a facility of the United States Army, near Killeen, Coryell Co., Texas (31.21870N 97.84200W).

Of seven bat species potentially living on Ft. Hood, cave myotis (*M. velifer*), eastern pipistrelles (*Pipistrellus subflavus*), big brown bats (*Eptesicus fuscus*), and Brazilian free-tailed bats (*Tadarida brasiliensis*) commonly roost in caves (Schmidly, 1991). Shell Mountain Cave, located in training area 45B, historically has been occupied by unidentified species of bats. About 10 years ago, bats were seen exiting the cave steadily for ca. 45 min beginning after sunset (J. Cornelius, pers. comm.). No gate was present at that time, and the colony may have consisted of Brazilian free-tailed bats. Warton and Associates subsequently surveyed the cave twice and recommended censusing and monitoring of the bats (Reddell, 1997). Though not in the live-fire area, Shell Mountain was often subject to noise from helicopters.

Cave myotis currently occupy the cave, roosting in a large room directly below the major opening. A pyramid-shaped gate, designed to allow bats access to the cave, now covers this opening. There are small east-west tunnels through the cave, but these are not accessible by humans; these tunnels might open into larger rooms where bats may hibernate. The mapped portion of the cave is 166 m long and 11 m deep.

Exiting bats were counted at Shell Mountain Cave, during an 80-min period, 1 night each month, for 13 consecutive months, July 1999 through July 2000. Kunz (1974) reported that cave myotis males and females spend considerable time foraging before returning to the roost. Males returned only 1-2 h before sunrise, and females returned as early as 2-3 hours after departure when nursing. Thus, it is likely that we counted few, if any, returning bats during our 80-min observations. Counts were obtained by recording each emergence on a zero-lux, digital, video recorder (Sony, DCRTRV10). The camera was mounted on a tripod and placed ca. 10 m east of the cave entrance. The zero-lux tool on the camcorder minimized disturbance to the bats, and the night vision feature was turned on as available light declined. This technique retained as natural an atmosphere as possible and did not appear to alter normal patterns of emergence. The entrance of the cave was small enough that the entire aperture could be captured on the video frame. Each tape was reviewed, and every individual on the screen was counted in a 1-second sample, collected once for each minute of the emergence.

Relative abundance estimates for this colony are provided from July 1999 through July 2000 (Table 1). Population size and emergence times at Shell Mountain Cave varied by season and month. Time of first emergence, relative to sunset, was variable, occurring 1–89 min after sunset, but bats always began leaving the cave as darkness set in, ca.10 min after dusk. Kunz (1974) observed the same behavior in cave myotis in Kansas and Oklahoma. Absolute time of emergence was later in the evening during summer, presumably due to the later occurrence of sunset (Table 1). The July emergence in both 1999 and 2000 began exactly at 2103 h (CST), and

emergence times were earlier in all months preceding and following July. No bats emerged during the months of November through February. Davis and Schmidly (1994) reported this pattern previously for *M. velifer* in Texas. As the colony size increased over summer, bats apparently emerged in pulses, although this behavior was not analyzed statistically; this pattern was most pronounced during July.

We developed an estimate of peak colony size first by taking the average of the two July indices (i.e., the total number of bats counted in all 1-second/minute intervals during the entire emergence), or 1,396 bats. Kunz (1974) reported that *M. velifer* emerged in small groups of 4-15 bats, but that the pause between groups was quite short so as to appear continuous. From watching the video, we observed that the movement of bats from the cave resulted in a complete turnover of bats on the video ca. every 5 seconds ($1/12^{th}$ min). Thus, our estimate for the total population is 16,752 (1,396 x 12) bats.

Schmidly (1991) reported colonies of cave myotis with up to 15,000 individuals. Each adult female gives birth to a single young. Lactating females on the Edwards Plateau have been captured between mid-May and early June. The young are capable of flight about 5 weeks after birth (Schmidly, 1991), and this results in peak colony size during June and July. With the knowledge that this cave houses a nursery colony, it is essential that the area continue to be protected. We recommend that the current gate be maintained to ensure the continued protection of the colony. If the colony remains healthy, it will continue the nutrient input and flow into the cave that will benefit the native and endemic cave-dwelling invertebrate species.

Table 1. Emergence counts of bats (number represents the number of bats counted in a 1-second interval every minute), time of emergence (CST), duration of emergence, and time of sunset at Shell Mountain Cave, Texas.

Date	Time of sunset (h)	Time of emergence (h)	Duration of emergence (min)	Total number of bats counted
16 July1999	1937	2103 – 2201	58	1387
20 Aug. 1999	1910	2035 – 2134	59	1029
17 Sept. 1999	1837	2006 – 2103	57	580
15 Oct. 1999	1801	1921 – 1941	20	49
19 Nov. 1999		No emergence		0
17 Dec. 1999		No emergence		0
14 Jan. 2000		No emergence		0
18 Feb. 2000		No emergence		0
17 Mar. 2000	1841	1842 – 1902	20	64
14 Apr. 2000	1859	1959 – 2105	66	580
19 May 2000	1923	2029 – 2132	63	980
16 June 2000	1937	2044 – 2148	64	1083
17 July 2000	1936	2103 – 2204	61	1405

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The Indiana Bat: Biology and Management of an Endangered Species, Edited by Allen Kurta and Jim Kennedy. 253 pp. Published by Bat Conservation International, 2002.

If you have any interest at all in the Indiana bat or manage resources for conservation organizations or private, state or federal entities that occur within or adjacent to this bat's range, put down Bat Research News, go to the computer or phone and order a copy of this proceedings. I'll wait.

I had the pleasure of attending the symposium from which this volume is derived and was very pleased with its recent publication because for many U.S. Forest Service biologists such as myself, the Indiana bat and its known habitat needs are a major consideration when making land management decisions. Having this wealth of information at my fingertips has made life easier. Kurta and Kennedy have done a good job of organizing a wide variety of subject matter into a very user-friendly format that I have found extremely useful on a day-to-day basis.

In the Preface the editors note "one of the greatest difficulties in managing the Indiana bat is that most studies conducted by graduate students, consultants or government employees are not published, and hence, information gleaned by those researchers is largely unavailable and/or unknown to others." They also state "our goal in assembling this volume is to make such valuable information accessible to all who are involved in the conservation of this endangered mammal." I think they achieved their goal and established a model on which future symposia devoted to single species can be based.

This volume contains 27 papers organized into six topic areas. These areas and the number of papers in each are Status, Distribution and Policy (7); Winter Habitat and Management (5); Selection of Dayroosts and Daily Movements (4); Summer Habitat at Broad Scales (3); Further Studies of Ecology and Behavior (6); and Effects of Environmental Contaminants (2). Some of these papers contain only preliminary information; others are detailed reviews of the literature, while the majority are comprehensive analyses of previously unpublished data.

Maps depicting distribution (2001), migratory routes, and summer/winter ranges will be especially useful to land managers. The Literature Cited section following each paper is a virtual gold mine of Indiana bat research both recent and dated, published and unpublished. To further facilitate communication between the authors and their audience, a list of contributors with detailed contact information is included – something I have found useful and have used frequently. The publisher has also provided the volume on CD as a bonus.

This volume should be in the library of every biologist charged with the management of the Indiana bat and its habitats.

Submitted by David Saugey, U.S. Forest Service, P.O. Box 189, Jessieville, AR 71949
dsaugey@fs.fed.us

NEWS

Bat Research News has received the following news release from the Office of Public Relations of Boston University (*marked "released on September 9, 2003"*)

"BU RESEARCHER WEDS ECOLOGY, COMPUTER VISION FOR $2.4 MILLION STUDY ON ROLE OF BATS IN ECOSYSTEMS"

Ecologist Thomas Kunz leads novel, multidisciplinary study of merits of winged mammal

— If corn farmers in south-central Texas go batty in their efforts to prevent corn ear-worm larvae from eating their crops, Thomas Kunz will be thrilled. He will be equally happy to hear the same about cotton farmers.

Kunz, a professor of biology at Boston University, knows that bats, like the thousands of Brazilian free-tailed bats found in caves throughout this region, can help farmers control a catalog of crop-destroying pests. And he wants farmers to know bats are a cost-free, environmentally friendly, pest-control resource just waiting to be of service.

Supported by a $2.4 million grant from the National Science Foundation, Kunz is about to take his search for data on the "services" of Brazilian free-tailed bats to a new level, one that involves computer vision and economic modeling. In October, Kunz and his multidisciplinary research team will begin a five-year study of the ecologic and economic importance of these creatures to Texas communities and farmers who depend on corn, cotton, and other income crops. Kunz believes it may be the first such study to use computer vision to analyze ecologic data.

Scientists today increasingly talk about 'ecosystem services' when describing the contributions that animals, plants, and microbes make to human environments," says Kunz. "Bats are natural predators of insects that destroy economically important crops. This is a service with great economic value and makes a strong case for conserving bats in our environment."

Each day, one Brazilian free-tailed bat — a visitor that migrates annually to Texas and other areas of the southeastern United States — eats up to two-thirds its body weight in corn earworm, cotton bollworm, and tobacco budworm adult insects. Fewer adult insects means fewer insect larvae. It also means a reduction in the use of pesticides, which, to an ecologist and conservation biologist like Kunz, is good news.

Kunz knows that pesticide use, destruction of habitats, and eradication efforts are undermining bat populations throughout the U.S. As an authority on winged mammals and an ecologist dedicated to conserving the diversity of its many species, he has spent his academic career gathering evidence of the integral role this misunderstood creature plays in our world.

"As the ways of doing science have evolved to ever more sophisticated levels," says University Provost Dennis Berkey, "Tom Kunz has been a consistent innovator and leader, nationally and internationally, in conservation biology research, and especially, research on bat species. This significant award to Kunz and his associates underscores the type of collaboration across disciplines and among institutions that is necessary to attack many important but complex questions in the natural world."

The research effort is unusual because it brings such a range of scientific expertise to bear on what is essentially a conservation biology study. The multidisciplinary study brings together biologists, computer scientists, ecological economists, ecologists, mathematicians, and meteorologists. Using infrared thermal imaging cameras, Doppler radar, computer-vision software, ultrasonic recording devices, and DNA analysis, this diverse group of researchers will track bat flight patterns, locate caves that house bat colonies, census the region's Brazilian free-

tailed bats using custom-developed computer algorithms for motion tracking, record bat feeding calls, and identify and quantify the insects that bats eat by analyzing the DNA of insect parts found in bat guano.

These data will be analyzed with data mined from state records of crop types, crop yields, pesticides used, and other relevant economic information to build what these researchers expect will be a complete picture of the Brazilian free-tailed bat's role in the natural ecology and the agroecology of south-central Texas. "Having an accurate census of these bats is critical to this study," says Kunz. "Because we're using infrared thermal imaging cameras, we don't need light sources to record video images of bats as they leave their caves for nightly feeding. Our use of computer-vision software to count thermal signatures of individuals in these clouds of thousands of bats brings a new dimension to this research and to computer vision itself, improving it as a tool for counting anything that moves, whether for conservation biology or homeland security."

Joining Kunz as co-principal investigators on this study are **Margrit Betke**, assistant professor of computer science at Boston University; **Gary F. McCracken**, professor of ecology and evolutionary biology at the University of Tennessee in Knoxville; **John K. Westbrook**, research leader and meteorologist with USDA/Agricultural Research Service in College Station, Texas; and **Patricia Morton**, program leader for education in the Wildlife Diversity Branch of Texas Parks and Wildlife. Other scientists who will work on the study as senior research collaborators are Boston University's **Cutler J. Cleveland**, director of the Center for Energy and Environmental Studies, and **Stan Sclaroff**, associate professor of computer science; and **Thomas G. Hallam**, professor of ecology and evolutionary biology at the University of Tennessee. Boston University, with an enrollment of more than 29,000 in its 17 schools and colleges, is the fourth-largest independent university in the United States.

Note: Pictures of Brazilian free-tailed bats and thermal images of them in flight are available at http://www.bu.edu/news/releases/2003/09/bat.images.pdf

EQUIPMENT GRANTS

Sandpiper Technologies has extended availability of its rental/grant equipment to include off-season research. The company has issued Equipment Grants to U.S. and Canadian students since 1998, and now makes the equipment available during the fall and winter months. Although there is no deadline for applications during the off-season, students must follow the requirements detailed on the website: http://peeperpeople.com. **The deadline for the Equipment Grant Program during the 2004 spring/summer field season is December 1, 2003.**

Available Rental/Grant equipment:

TreeTop Peeper 1 (IR or monochrome cavity camera and 16-foot pole)
TreeTop Peeper 2 (Monochrome cavity camera and either a 35- or 50-foot pole. Please specify the height of the nests you hope to survey.)
Peeper Video Probe (2.3-inch diameter, 3 meter gooseneck probe with head mounted video display)
Peeper-A-Roo Video Probe (1.0-inch diameter, 3 meter gooseneck probe with head mounted video display)
Basic Sentinel System 1 (AutoColor camera with VCR and 25-meter camera cable. Batteries are not included.)
AquaPeeper Video Probe (16-foot pole with waterproof color camera and head mounted video display)

For more information about the Sandpiper Equipment Grant Program:
http://peeperpeople.com Ann Christensen, Sandpiper Technologies, Inc.
535 W. Yosemite Ave. Manteca CA 95337 (209) 239-7460

Abstracts of Presentations at the 1st Biennual Western Working Group Conference for the Management and Conservation of Bats

Doubletree Hotel, Durango, CO, January 29- February 1, 2003

The conference was sponsored by the following organizations

Western Bat Working Group	Colorado Bat Society
Colorado Division of Wildlife	Colorado Chapter of the Wildlife Society
Bureau of Land Management	Arizona Game and Fish Department
California Department of Fish and Game	Denver Museum of Nature and Science
Idaho Department of Fish and Game	U. S. Forest Service

U.S. Geological Survey

The conference was organized by
Michael Herder, Kirk Navo, Laura Ellison and Lyle Lewis

ABSTRACTS

(Abstracts appear in alphabetical order by first authors)

Water resource use by the bats in Boulder County

Rick Adams
University of Northern Colorado, Greeley, CO, 80639 and Colorado Bat Society,Boulder,CO.

A seven-year study of Boulder County bats has shown compelling patterns surrounding the use of water resources in xeric environments. 1) There are significant differences among species in mean visitation times to water holes, 2) Reproductive females and juveniles compose a higher percentage of captures at water holes containing the highest levels of dissolved calcium, 3) Precise dominant drinking pathways are established among individuals of species visiting high-use water holes, apparently lessening the chance of collisions (or the energetic expense of collision avoidance). Beyond theoretical considerations of competition, cooperation, and assemblage dynamics, these data suggest that an understanding of how water resources are used has importance to the conservation of bats in the West.

Bat use of gates installed in culvert-stabilized mine openings: Empirical evidence

J. Scott Altenbach and Richard E. Sherwin
Department of Biology, University of New Mexico, Albuquerque, NM.

Abandoned mine portals and collars in brecciated or loose material require stabilization to prevent natural closure of the opening. The use of steel culverts provides a solution to this problem and provides a stable foundation for attachment of a secure gate closure in unstable ground. However, a suggestion that bats, particularly Townsend's big-eared bat, cannot or does not accept steel culvert closures has seeped into the thinking of many private and public managers. In New Mexico, the use of exposed steel culverts has been common practice and they have been used repeatedly, as they have in Colorado and elsewhere. Post closure surveys demonstrate that these closures are readily accepted. Several sites in New Mexico are used by significant maternity colonies of Townsend's big-eared bats as well. Preliminary data from an experimental evaluation of culvert use by Townsend's big-eared bats confirms the acceptability of culvert closures and is presented.

Movement patterns of radio-tagged big brown bats (*Eptesicus fuscus*) in Fort Collins, Colorado

Melissa D. Andre, Thomas J. O'Shea, Daniel J. Neubaum, and Justin K. LaPlante. Colorado State University, Fort Collins, and U. S. Geological Survey, Fort Collins Science Center, Fort Collins, CO.

A five-year field study of the common big brown bat (*Eptesicus fuscus*) in Fort Collins, CO was initiated in 2001 to determine the relationship between the ecology of this species in a rapidly urbanizing environment and the potential for disease transmission (particularly rabies) among bat colonies in buildings. One ecological aspect of disease transfer is the movement of bats between roosts. Although much of the movement data in this study is anticipated to come from PIT tag records, an early phase of the study involved capture, radio-tagging, and release of big brown bats caught in open spaces and city parks of Fort Collins. This allowed for the subsequent location of roosting colonies and short-term observations on movements between roosts. In 2001, we attached radio-transmitters to a total of 91 adult female big brown bats and one volant juvenile male big brown bat (61 were captured in natural areas from 21 May to 28 June, the remainder were captured at roosts). In 2002 we attached radio-transmitters to 30 bats (22 of these were adult females captured at natural areas from 17 to 31 May). Big brown bats moved an average of 2.24 ± 2.16 km (range of 0.16-7.48 km) between the areas where first captured and their initial roosting sites. Roosts of 5 of the 83 bats captured in natural areas were never located. All of the roosts where the remaining 78 bats led us were in buildings. In 2001, 20 of the 92 radio-tagged bats were known to have more than one roost. Ten of 31 pregnant (32.26%), three of 29 lactating (10.35%), four of 17 post-lactating (23.53%), and two of 12 nonreproductive (16.67%) radio-tagged bats were known to have greater than one roost. Movements between roosts in separate buildings averaged 0.56 ± 0.66 km (range of 0.02-2.54 km). In addition, bats were captured and radio tagged in Fort Collins during the later part of the season (29 August and 3 September 2001; 16 September and 20 September 2002) in order to ascertain location of winter hibernacula of local bats. In 2001, radio tagged bats were not successfully tracked to hibernacula but appeared to have left the urban area. In 2002, five individual bats were radio-tracked to seven different hibernacula in rock cracks, as far as 64 km up the Poudre River Canyon and at elevations ranging from 322 m to 953 m above the city.

The use of abandoned mines by bats in Colorado

Kirk W. Navo, Lea R. Bonewell, Antoinette J. Piaggio, Nancy A. LaMantia-Olson, Carole E. Wilkey, Amy L. Bullington, Kate O. Schletz, and Thomas E. Ingersoll. Colorado Division of Wildlife, Denver, CO and University of Colorado Museum, Boulder, CO.

The Colorado Division of Wildlife initiated the Bats/Inactive Mines Project in 1991 to evaluate the use of abandoned mines by bats before closure. The goals of the project are to identify important roosts for bats, protect these roosts with bat gates, obtain more information on the status and distribution of bats, and educate the public and resource managers about bat conservation in the state. This project represents a cooperative effort between the BLM, USFS, Division of Minerals and Geology, Division of Wildlife, Great Outdoors Colorado, the National Fish and Wildlife Foundation, and volunteers from the general public. Trained volunteers conduct surveys outside designated mine entrances using bat detectors and document bat activity at mine sites. Mines with bat activity are then surveyed by trained biologists to determine species and roost types. During 12 years, 5,162 surveys have been conducted, and volunteers have compiled nearly 44,000 hours. The project has evaluated 3,442 mines to date. Results show that 31% of the mines surveyed have bats associated with the site. Of these, approximately 15% are determined to provide significant roosts for bats based on follow up surveys. Over twelve years 2,683 bats representing 11 species have been documented roosting in mines. Four species make up 85% of

the total bats captured at mines, *Corynorhinus townsendii, Myotis volans, Myotis evotis,* and *Myotis ciliolabrum*. The surveyed mines ranged in elevation from 4,960 to 12,842 feet, and averaged 8,289 feet. Bats were documented using mines as roosts at elevations ranging from 5,800 to 12,160 feet. The average elevation of mines used as roosts was 7,411 feet. Maternity roosts were documented at elevations up to 9,100 feet for *Myotis volans* and use by reproductively active females was documented at up to 10,580 feet. Bat gates have been installed or are pending installation at 523 mines. Gate monitoring indicates that all species documented using abandoned mines before gating, continue to use the gated mines. The status of Townsend's Big-Eared Bat is discussed, and future needs for bat conservation are addressed.

Foraging activity of adult female pale big-eared bats (Corynorhinus townsendii pallescens) in east central Nevada

Peter V. Bradley. Nevada Division of Wildlife, 60Youth Center Road, Elko, NV.

Fifteen female *Corynorhinus* were fitted with 0.67-gram radio transmitters and followed through a two-week period in mid-August, 1995, to discern foraging habitat, home range, roost habits and foraging strategies. Two to three biologists equipped with radio-receivers, compasses and two-way radios collected synchronized location data from dusk to dawn nightly throughout the life of transmitters. Thirteen of 15 bats yielded location data. *Corynorhinus* foraged almost exclusively in forested habitats [singleleaf pinyon pine (*Pinus monophylla*)/ mountain big sagebrush (*Artemisia tridentata vaseyana*) mix (60%), (*P. monophylla*)/ Utah juniper (*Juniperus osteosperma*) mix (21%), *P. monophylla* pure stand (3%), curlleaf mountain mahogany (*Cercocarpus ledifolius)*/ (*P. monophylla*) mix (1%), white fir (*Abies concolor*) pure stand (1%), riparian woodland - narrowleaf cottonwood (*Populus angustifolia*)/ quaking aspen (*P. tremuloides*)/ willow (*Salix* spp)/ water birch (*Betula occidentalis*) mix (1%)]. Only 2% of the locations occurred in a dominant shrub type [black sage (*Artemisia nova*)/ Wyoming big sagebrush (*A. t. wyomingensis*) mix]. Of over 500 total locations, none were found in the dominant valley habitat types of the area; the salt desert scrub or the wetland/hay meadow types. *Corynorhinus* displayed a high fidelity for one and sometimes two specific foraging territories and reappeared at these sights on numerous consecutive nights. Foraging territories were from 0.8 to 6.4 km from maternity roosts. Emergence from maternity roosts was generally between 20:00 and 20:30 hr and return was between 03:00 and 05:00 hr PST. Feeding bouts lasted all night for most individuals and appeared to be shortened only when winds increased or air temperatures decreased suddenly. *Corynorhinus* showed great fidelity for their maternity roosts. However, some individuals displayed a working knowledge of alternate roost site locations, using caves sometimes 5.6 km away from their maternity roosts as temporary night roosts.

Long-term monitoring of bats in abandoned mines: Before, during and after renewed mining

Patricia E. Brown and Robert D. Berry.
Dept. of Physiological Sciences, UCLA and Brown-Berry Biological Consulting
134 Wilkes Crest Road, Bishop, CA.

Since 1978, we have conducted bat surveys in mines in the Cargo Muchacho Mountains in the southeastern California desert. Two mines were selected for long-term monitoring and banding of California leaf-nosed bats (*Macrotus californicus*). A new open pit and underground mining operation was carried out between 1989 and 1996, which removed some of the historic mines while creating new underground workings. Prime foraging habitat (as determined by radio-telemetry studies) was lost when mine dumps and heap leech piles were located in the desert washes where the majority of the desert vegetation grows. The combination of roost disturbance and loss of foraging habitat contributed to population declines. Semi-annual exit counts have been conducted in at least seven workings during active mining, and in most years

since mine closure. The two new-gated underground mines are also being watched for bat colonization.

Observations of resource use by bats along a Sonoran desert riparian corridor

Debbie C. Buecher.
University of Arizona, Renewable Natural Resources, Wildlife Ecology Program, Tucson, AZ.

Preliminary report of resource use by bats along a Sonoran Desert riparian corridor near Tucson, Arizona. I am evaluating community structure of bats in Sabino Canyon Recreational Area, Coronado National Forest, (U.S.D.A). Bats are netted on a monthly basis over semi-permanent pools in a mixed riparian and Sonoran Desert environment. Reproductive assessment and standard measurements of captive bats are recorded. Bats are held in individual cloth bags before release to collect guano for later analysis. Guano analysis will provide important information regarding diet choice by different species of bats in a Sonoran Desert setting. I am also recording echolocation calls from released bats for development of a call library and conducting an acoustic assessment of free-flying bats along the riparian corridor. To date, 16 bat species have been captured and this study will continue throughout the year to evaluate both winter and summer use of water holes by bats in the Sonoran Desert.

Endangered species act considerations for *Leptonyteris* ssp in southwest New Mexico

Carrie Chalcraft and Lyle Lewis. U.S. Fish and Wildlife Service, Albuquerque, NM.

Two bat species in the southwestern United States are federally protected by the Endangered Species Act, the greater long-nosed bat (*Leptonycteris nivalis*), and lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*). Federal agencies are required to "consult" with the U.S. Fish and Wildlife Service (Service) if any actions they are proposing may affect these two species. Informal consultation occurs when an action is not likely to adversely affect the species and formal consultation occurs when there are likely to be adverse effects. If the Service analyzes the impacts of an action to the species and determines there will be an adverse effect, we provide measures to minimize impacts to the species. Consultation between the Bureau of Land Management and the Service on grazing activities has resulted in increased research, surveys, and monitoring of these and other bat species in southwest New Mexico.

Problems with night vision technology and a proposed solution

David C. Dalton. 9572 E. Banbridge St., Tucson, AZ.

The need to make wildlife observations at night without altering the subject animals' natural behavior has led to the widespread use of night vision technology. However, unless researchers understand how this technology for seeing in the dark actually works, they are likely to overestimate the capabilities of their equipment and the quality of their data. Night vision devices feature two modes of operation. The first is to amplify existing ambient light levels, and the second is to convert a wavelength of light undetectable by the observer (and the subject animals) into a wavelength we can see. Image intensifiers, the devices used in night vision goggles, incorporate both techniques. Solid-state cameras, as found in today's camcorders, incorporate only the second. The first method, light amplification, has some serious drawbacks that are not readily apparent. Varying nighttime ambient light, caused by clouds or movement of the moon, produces extremes in lighting conditions, which are difficult for night vision devices to resolve. Moonless or overcast conditions produce insufficient illumination for the device to properly amplify, resulting in a grainy image with poor contrast. Conversely, full moonlight is too bright for the device, forcing it to reduce its amplification factor to the point where all visual information in shadowed areas is lost. Because an image can still be perceived with the device, the untrained observer is unaware of how much information is actually lost. These limitations of

night vision devices make it preferable to use them as wavelength converters rather than as light amplifiers. Providing supplemental infrared illumination of an appropriate wavelength not only eliminates the variability of available ambient light, but also allows the researcher to illuminate the specific areas of interest. Supplemental illumination can be positioned to eliminate shadows and enhance contrast, and if placed in the same manner for each field observation, improves repeatability. Although supplemental infrared lighting improves the quality of night vision images, its main value is that it allows the use of solid-state cameras, which have several advantages over night vision devices. Camcorders possess a higher spatial resolution than night vision goggles as well as a means to permanently record the viewed images. They are readily available and less expensive than good-quality night vision goggles. In summary, camcorders with the Night Shot feature, augmented with adequate infrared illumination, can produce superior results in all applications where night vision goggles are currently used.

Relationships among North American long-eared *Myotis* and the question of species boundaries

Tanya A. Dewey, University of Michigan, Ann Arbor, MI.

The most fundamental assumption of research on ecological features of species, and of conservation and management planning, is that we understand the identity and limits of particular species and populations. It is therefore vitally important to consider careful testing of these assumptions as an important first step in all such efforts. North American long-eared *Myotis* species, including *M. auriculus*, *M. evotis*, *M. keenii*, *M. milleri*, *M. septentrionalis*, and *M. thysanodes*, have been the subject of some taxonomic controversy and have long been considered closely related. These bat species are ecologically and morphologically similar, tending to occupy mixed coniferous forest habitats. All of these species are considered state sensitive throughout parts of their ranges and two, *M. keenii* and *M. milleri*, are endangered species in Canada and Mexico, respectively.

Although *M. thysanodes* is largely sympatric with both *M. evotis* and *M. auriculus*, several other of these species share limited areas of sympatry. In these areas there is some difficulty in distinguishing among long-eared *Myotis* species. This is particularly true in the Pacific Northwest, where *M. evotis*, *M. keenii*, and *M. septentrionalis* co-occur. In order to most effectively address the conservation and management needs of these species it is critical to better understand the limits of species boundaries in this group and to test for the presence of population structure that might influence conservation decision-making.

In order to address these issues, the research presented here uses mitochondrial DNA sequence data to discover the pattern of evolutionary relationships among these species and test for evidence of population structure. A phylogenetic analysis was conducted using 748 bp of cytochrome b for 128 taxa. Parsimony methods were used to determine patterns of relationship among a diverse set of *Myotis* species, including multiple old and new world species and many western North American species. Analysis using multiple outgroups and dense within-species sampling yields robust conclusions regarding evolutionary relationships among these taxa. The results suggest that our current understanding of species boundaries in this group may be inadequate and also raise several interesting questions regarding species boundaries and distributions of *M. lucifugus* and *M. occultus*.

Bat use of box-style bridges on highway systems in Beaver, Iron and Washington Counties of southwestern Utah

Gabrielle F. Diamond and Joel M. Diamond. Southern Utah University, Cedar City, UT.

Bridges have shown great potential for providing roosting habitat to bats. A national study by Bat Conservation International has shown that bridges and culverts in the western United States may provide critical habitat for 24 of the United State's 45 bat species (Keely and

Tuttle 2000). In Utah for instance, of 58 highway structures surveyed 44 were used by bats (Keeley and Tuttle 2000). Bridge surveys are critical for assessing bat use of highway structures in southern Utah due to isolated reports. A box-style bridge is constructed of concrete floor, walls and a roof that supports the roadway. Some of these bridges contain a seam between cement slabs that may provide suitable roosting habitat for crevice roosting bat species. This style of bridge is widely used in highway construction, especially in rural areas. We surveyed 23 bridges in Beaver County, 42 bridges in Iron County and 40 bridges in Washington County for bat use. Surveys consisted of a single visit to the bridge looking for the presence of guano, roosting bats, and/or insect parts. Bats used 80 percent of box-style bridges in Washington County and only 26 to 40 percent in Beaver and Iron Counties. There may be elevation differences in bat use of these bridges. We found maternity colony roosts in bridges with suitable seams while other roosts appeared to be independent of seam presence. A total of four maternity colonies were found in one hundred and five bridges surveyed. Analysis suggests that bridge length, elevation and the presence of a suitable open seam are important factors in bat occupation of a bridge. Bridge surveys are vital to the maintenance and understanding of many bat populations and should be utilized as an efficient tool for bat management.

Use of PIT readers to estimate survival and movement patterns of big brown bats (*Eptesicus fuscus*) in Fort Collins, Colorado

Laura E. Ellison, Thomas J. O'Shea, Richard A. Bowen, and Daniel J. Neubaum.
Colorado State University, Fort Collins, CO and U. S. Geological Survey, Fort Collins Science Center, Fort Collins, CO.

We used passive integrated transponders (PIT tags) and PIT readers to examine the short-term survival, over winter return rates, and movement patterns of big brown bats (*Eptesicus fuscus*) that roosted in maternity colonies in Fort Collins, Colorado. This effort is part of an ongoing research project investigating rabies transmission in commensal bat colonies in an urban setting. We PIT tagged and released 2,073 individuals in 2001 and 2002 and monitored their presence at up to 14 different buildings using PIT readers. We also captured individuals by hand at these roosts to gather individual measurements and sample blood for the rabies virus (under anesthesia). We specifically addressed the following questions: 1) Is there an affect of bleeding and anesthesia on short-term survival of adult and juvenile big brown bats?; 2) How do apparent survival and capture probabilities differ between hand capture events and PIT reader encounters?; 3) What are the over winter return rates for marked individuals?; and, 4) What is the frequency of movement within roosts and among roosts? We used Program MARK to estimate short-term survival and capture probabilities by roost, age class, and bleeding history. We found no difference in short-term survival over 14 days post-bleeding for individuals anesthetized and bled compared to those individuals not sampled for blood. Capture probabilities varied by roost and were substantially lower for hand capture events than for PIT reader encounters. Return rates from 2001 were high. The 2002 return rates for bats that were captured, anesthetized and bled at the largest colony in 2001 were nearly 90% for adult females and 77% for juvenile females. Hand captures in 2002 failed to detect 57.4% (253 of 441) of the bats marked in 2001 that were registered by PIT readers in 2002. Seven bats captured and marked at roosts during summer 2001 switched to different roosts in 2002. Thirty-nine individuals moved between 2 roosts during 2002 and one bat moved among 3 roosts.

Assessing species for protection under the endangered species act

Eileen Everett and Lyle Lewis. New Mexico Ecological Services Field Office, U.S. Fish and Wildlife Service, Albuquerque, NM.

The Endangered Species Act of 1973 provides a means whereby the ecosystems upon which

endangered and threatened species depend may be conserved. As the most far-reaching environmental law in the nation, the Endangered Species Act (ESA) provides many protections for listed species. The process for a species becoming listed is poorly understood. Species listing can be initiated either by a petition from a private entity or individual or through the candidate species assessment. A candidate species assessment identifies and evaluates threats to the species. These threats are categorized under habitat destruction, overutilization, disease, the inadequacy of existing regulations, and other factors affecting its continued existence. This information is used to make a decision on whether or not listing is warranted. Recently, the western red bat (*Lasiurus blossevillii*) underwent a status review by the U.S. Fish and Wildlife Service. Although there is information on a possible decline in *Lasiurus blossevillii* populations, substantial biological information on the species was not available to support designation of the species as a candidate. More information on *Lasiurus blossevillii* habitat; particularly, information linking population declines to habitat destruction; is needed to support a candidate designation.

Video recordings and discussion of Townsend's big-eared bat *(Corynorhinus townsendii pallescens*) behavior in a maternity colony inside an old log cabin in eastern Washington

Howard L. Ferguson and Theresa Mathis. Washington Department of Fish and Wildlife, Spokane, WA; Eastern Washington University, Cheney, WA.

Since the western big-eared bat (*C.t. pallescens*)does not tolerate human activity (Clark,et al. 1996). A maternity colony in eastern Washington was outfitted with a remote controlled video camera and IR source. A motorized track was also installed that allows the camera to move the length of the cabin. The camera was attached to a pan and tilt mount, which provided a broas range of motion and allowed us to video the entire cabin. This presentation will present short video clips from a maternity colony of Townsend's big-eard bats will be shown covering the following behaviors: 1) allogrooming(49 sec); 2) bats at play (31 sec); 3) birthing (120 sec); 4) confrontation (17 sec); 5) emerging (9 sec); 6) grooming (97sec); 7) juvenile with adult (107 sec); 9) mother and young interaction (98 sec); 10) nursing (126 sec): 11)roosting (99 sec); and 12) slow motion flight (10 sec). Camera and remote monitoring equipment that was used will also be shown and discussed as well.

The effect of moon phase on bat activity within two mines located at Silver Reef, Utah

Kate W. Grandison, Jason Beck, and John R. Taylor
Department of Biology, Southern Utah University, Cedar City, UT.

Two mines located in the Silver Reef mining district near Leeds, Utah were monitored from February until October 2002 using Trail Master infrared data loggers installed internally. To test the effect moon phase on bat activity within the two mines a linear model was created with Trail Master events as the response and moon phase in percent as a predictor. The two mines exhibited nearly inverse patterns of use when compared to each other. WH-180, a known maternity roost for Townsend Big-eared bats (*Corynorhinus townsendii*), had the majority of Trail Master events recorded in May and late August and September. WH-48, in contrast, showed the greatest amount of use in June and July. Daily patterns of use throughout the year suggest that both mines are used primarily for day roosting with a large peak of activity of emergence at sundown, and nearly no activity until sunrise. When Trail Master events were regressed to moon phase, neither mine showed a significant correlation ($p > 0.05$; WH-48 R-sq (adj) > .8%; WH-180 R-sq (adj) > 3.2%). The slightly higher R-sq (adj) value of 180 suggests

that it possibly may be slightly more subject to changes in moon phase than WH-48. It is reasoned that this subtle difference may be due to the varying patterns of use by bats within these mines.

Monitoring and evaluating results of bat protection efforts

Kate W. Grandison, Stephanie Leslie, Jason Beck, John Anderson, Carolina Allende, John R. Taylor and M.R. Mesch. Southern Utah University and Utah Division of Oil, Gas, and Mining.

Many states are authorized to close abandoned mines to protect the public from potential hazards. In Utah, abandoned mines are surveyed prior to closure to evaluate their potential as bat habitat. Those mines providing suitable habitat may be sealed with bat-compatible gates that allow bats continued ingress and egress. However, a few studies suggest that for some population sizes and certain species of bats, bat gates may actually decrease bat use of mine openings; few post-gate monitoring studies exist to document long-term effects of this technique for conserving bat populations. In two areas we are monitoring and evaluating the effectiveness of gated mines on existing, known bat populations. Objectives include: evaluating and ranking the effectiveness of techniques [e.g., night vision devices, infrared event counters (Trailmaster 500M), infrared video, ultrasonic detection equipment (Anabat) and mist nets or harp traps] to monitor bat use; using this information to develop a protocol for using the most reliable of these techniques; and establishing long-term monitoring sites. Evaluation criteria include purchase and operating costs, security concerns, equipment reliability and ease of operation, number of personnel necessary to gather and evaluate the data, the ease of analyzing the data, and type of information needed. Results indicate that a combination of monitoring techniques is necessary to meet long-term objectives. Infrared event counters are well suited to record relative bat activity inside mines over long periods of time with minimum observer disturbance and cost, but cannot be used to reliably gather information on bat behavior through gated entrances, or absolute numbers and species identification of bats. Ultrasonic detection equipment and mist net/harp traps are necessary techniques to reliably determine bat species composition. Infrared video cameras provide an accurate, permanent monitoring record of bat numbers and behavior. Protocols specific to each mine may be necessary to minimize observer and equipment effect on bat behavior. Efficient low cost monitoring can be accomplished using minimal equipment and personnel. Preliminary analysis suggests that bat behaviors do differ in gated and un-gated mine openings.

Assessment of bat faunal composition and roosting habitat preferences for the hoary bat (*Lasiurus cinereus*) near a wind power facility in southeastern Wyoming

Jeffery C. Gruver. Wyoming Natural Diversity Database, Laramie, WY.

Large industrial wind turbines have caused mortality of bats, primarily lasiurines, at several locations in North America. At a wind power facility in southeastern Wyoming, the hoary bat (*Lasiurus cinereus*) was the most commonly found bat during searches for carcasses, but it was unclear if mortality occurred in proportion to relative abundance. The goals of my study were twofold: to examine the faunal composition of bats and to quantify roosting habitat for the hoary bat proximate to the wind power facility in south-eastern Wyoming. Faunal composition data were used to determine if bat deaths occurred in proportion to relative abundance. A better understanding of roosting ecology of the hoary bat can inform mitigation strategies at wind farms. Bats were surveyed with mist-nets and ultrasonic detectors in 2000 and 2001. *Myotis volans* (99 captures) and *M. lucifugus* (87 captures) were the most commonly encountered species. The hoary bat was the fourth most abundant species (17 captures), but may have been transient in the study area. Timing of hoary bat deaths, combined with only a handful of captures and short residence times of instrumented animals suggest that most dead hoary bats were probably migrants. The number of hoary bat fatalities was about four times as great as the number captured indicating that turbine strikes befell this species relatively more frequently than other

species of bats in the study area. Day roosts for hoary bats were located nearly 7 km on average from the wind farm and most were in lodgepole pine (*Pinus contorta*) trees. Bats preferred trees that were taller and had greater canopy cover, and those that were located nearer to an edge and nearer to water than randomly selected trees.

Pre- and post-gate biological monitoring

Michael Herder. BLM Arizona Strip Field Office, St. George, UT.

Abandoned underground mine workings pose serious threats to human safety. Numerous wildlife species use these artificially created habitats including bats, mice, woodrats, skunks, ringtail cats, mountain lions, and a variety of bird and reptile species. Permanent mine closure methods aimed at protecting the public have resulted in destruction of habitat and direct mortality of animals, particularly bats. Many agencies have installed wildlife-passable gates at mine openings in an effort to mitigate these losses. Long-term monitoring studies have been initiated to determine if gates affect population numbers or alter behavior of animals using mines.

Designing an effective monitoring program requires identification of the questions to be addressed, the scale, and the strengths and limitations of the methodologies used. Where possible external surveys are preferable due to the inherent dangers associated with entering abandoned mines and the potential for compromising the integrity of the closure. However, external surveys are limited by the inability to determine if all of the animals have exited. Pre-closure surveys should be conducted for at least one year, including both warm and cold season checks, to establish baseline use levels. Commonly used methodologies for biological monitoring include: exit counts, alone or enhanced using lights or night vision equipment; infrared event counters; video imaging; and acoustic detectors. Other methodologies being tested include thermal infrared video imaging, radar, and electronic transponders. Care should be taken to select a method with minimal disturbance to the animals being monitored.

Exit counts can be among the most cost effective means for biological monitoring, particularly if volunteers are available. However, underestimates may occur when animals are not observed or counted due to inadequate visibility, rapid exit of large numbers of animals, or observer fatigue. Under estimates may also result when observer presence disturbs exiting animals and/or causes a change of behavior. Even when the number of animals exiting is precisely counted, observers have no way of verifying the accuracy of counts, of knowing if all animals present exited the site, or of determining which species were present.

Battery-powered infrared event counters are effective for counting animals entering and exiting mines. However, event counters may underestimate numbers when multiple animals trigger the device before it has time to reset or when individuals avoided the beam entirely. Conversely, event counters may overestimate numbers when a single individual repeatedly triggers the device, such as when bats circle the infrared beam. Remote devices are subject to vandalism, do not distinguish between ingress and egress, and do not distinguish one species from another.

Infrared video cameras may be used to verify the accuracy of event counters and monitor animal behavior at the site. In some cases in may be possible to permanently mount infrared cameras within the mine to monitor roosts. Limitations of video systems include short tape and battery life and low resolution. Visual data stored on video tape serves as a permanent record, which may be retrieved, analyzed, and edited at any time. However, reviewing video data can be very time-intensive without the use of costly electronic video editing tools. As with event counters, equipment left at the site may be subject to vandalism.

The Arizona Bat Conservation Strategic Plan: Use of a statewide plan to direct conservation activities

Katharine E. Hinman and Tim K. Snow.
Arizona Game and Fish Department, Phoenix, AZ and Tucson, AZ.

The Arizona Game and Fish Department (AGFD) has been working with members of the Arizona Bat Resource Group to develop a statewide conservation plan for Arizona's 28 bat species. While originally based on the framework of the North American Bat Conservation Partnership's Strategic Plan, the AGFD plan has developed into a comprehensive document that includes not only goals and objectives for research, inventory and monitoring, management, and education activities, but also background on the species of bats found in Arizona, the resources of most importance to these species, threats to these species and their resources, and specific goals and objectives to address these issues in the different habitat types found throughout the state. This plan will be used by the AGFD as well as by other state and federal agencies that have management responsibilities over bats, and by researchers seeking to integrate their work with conservation and management efforts. A workshop hosted by AGFD will allow signatories to the plan, as well as others interested in bat conservation, to discuss implementation of the plan and prioritization of activities.

Seasonal radon microclimatology at big-eared hibernacula

Thomas E. Ingersoll. University of Colorado Museum, Boulder, CO.

We examined seasonal changes in microclimate at big-eared bat hibernacula in uranium mines of western Colorado. Naturally occurring radon gas can provide a valuable tool for modeling air movement within confined underground spaces such as mines or caves. We used radon gas measurements, taken in summer and winter, to demonstrate changes in air movement at hibernacula, in response to periods of warm and cold above ground temperatures. These measurements were then compared to measurements of airflow amplitude and direction, and substrate temperatures within the hibernaculum. A mechanism for buffering temperatures towards coolness at late winter roosts is described. Additionally, bats appear to move from warmer roosts of low thermal stability in early winter, towards cooler roosts of high thermal stability in late winter.

Monitoring populations of the Yuma myotis (*Myotis yumanensis*) as an indicator of species healthy streams

Dave Johnston, Laura Curtis, Matthew Pyrch, and Katie Reich.
Santa Clara University, Santa Clara, CA.

Although alarming declines of bat populations are increasingly documented, in fact, quantitative information on the population status of bat species in the San Francisco Bay Area is lamentably scarce. Because the Yuma myotis (*Myotis yumanensis*) is a widespread species in western North America, it is relatively long-lived, and it forages over aquatic habitats, we suggest this species is a good candidate for monitoring long-term population trends and could be used as an indicator of intact riparian habitats. Our first goal was to establish a database for bats foraging on the Guadalupe River watercourse. To survey bats, we captured them with mist nets along the river and its tributaries and conducted acoustic surveys using an ANAbat 5 program and Titley Electronics hardware. Because the results of aquatic macroinvertebrate surveys have been used as indicators of polluted and disturbed watercourses, our second goal was to determine if the Yuma myotis could be used as an indicator species of healthy (undisturbed) streams. Although we do not have enough data to warrant statistical analysis, trends indicate that in undeveloped areas, the amount of foraging by Yuma myotis is correlated with the abundance of macroinvertebrates. In the upper watershed we recorded a mean of 259.8 passes/hr and 262.2

invertebrates/unit and in the lower watershed a mean of 9.1 passes/hr and 9.2 invertebrates/unit. In the middle portion of the watershed, downtown San Jose, we recorded a mean of 2.3 passes/hr and 65.1 invertebrates/unit suggesting no correlation. In order to help establish a long-term monitoring program of Yuma myotis along the Guadalupe River, an educational program to schools adjacent to the river was started in the fall of 2002 to train interested teachers and their students to help with acoustic surveys.

We also started monitoring prey taken by Yuma myotis. We collected 40 fecal pellets from 8 captured bats and analyzed the guano with a dissecting microscope. Using pooled data, 4 bats ate 34% Trichoptera, 16% Diptera, 4% Coleoptera, 16% Hemiptera, and 30% Ephemeroptera in a white alder (*Alnus rhombifolia*) – willow (*Salix lasiolepis and S. laevigata*) dominated riparian habitat in the upper watershed. In the lower watershed, 4 bats ate 32% Diptera, 1% Lepidoptera, and 67% Hemiptera in an alkali bulrush (*Scirpus robustus*) dominated saltwater marsh. Based on the % volume of the remains of the reticulated water boatman (*Trichocorixa reticulata*) found in guano, we hypothesize that the Yuma myotis also forages on evaporation salt ponds in addition to saltmarshes and sloughs where we observed this myotis foraging.

Updates on four bat research projects in southern Arizon

Karen Krebbs. The Arizona-Sonora Desert Museum, Tucson, AZ.

The lesser long-nosed bat (*Leptonycteris curasoae)* is federally listed (endangered) in both the United States and Mexico. Thousands of female *L. curasoae* migrate into southern Arizona each spring to establish maternity roosts and give birth to their young. The migratory routes follow the paths of blooming columnar cacti (on the northward migration) and agaves (on the southward migration). In late summer after young bats have learned to fly and additional nectar food sources are available in other areas, the mothers and young abandon their maternity roosts. Transient roosts in southeastern Arizona have a high number of *L. curasoae* in late summer. The Air Force is seeking information on the distribution of *L. curasoae,* habitat use, and effects of military overflights along Military Training Routes in seven mountain ranges in southeastern Arizona. Night-vision devices were used to observe *L. curasoae* foraging activity at agaves *(Agave palmeri)* in these mountain ranges.

The Bureau of Land Management is seeking information on the presence of *L. curasoae* in the Ironwood Forest National Monument (IFNM) in southern Arizona. Thirteen trips were made to the IFNM between December 2001 and August 2002 in search of evidence of *L. curasoae* roosts and foraging activity. Saguaros *(Carnegiea gigantea)* were monitored in the IFNM with night-vision devices for foraging bats and mountain ranges were checked for roosts. The Chricahua Mountains in southeastern Arizona has a large diversity of bat species. An inventory and monitoring project has been carried out at the Chiricahua National Monument for the past three years for the National Park Service. Little is known about bat house occupancy in the desert southwest. At the Arizona-Sonora Desert Museum (ASDM) 32 bat houses were installed at various sites on ASDM grounds between February and March 2002. Each bat house was equipped with a datalogger to record temperature and humidity. The bat houses vary in shape, size, and color. Twenty-three houses were installed on walls and the sides of buildings, eight houses were installed on poles, and one house is being used as an interpretive educational tool for the public. Two months after the bat house installations bats moved into one of the houses. All four of these bat research projects are ongoing and updates on each will be discussed.

Practical and technical considerations for the use of remote transducers with Anabat detectors

Tony Messina and Michael J. O'Farrell. Nevada Bat Technology, Las Vegas, NV and O'Farrell Biological Consulting, Las Vegas, NV.

The need to integrate bat detector equipment into configurations that are durable enough for long

term field monitoring may benefit from being able to mount the transducer remotely from the rest of the acoustic monitoring system.. We address several practical and technical aspects of achieving remote transducer configurations with the Anabat bat detector. Aspects such as physical housing against the weather, the use of sound reflectors, consideration of transducer types, and the effect of various cable lengths on bat call signals are examined.

Bat gates at abandoned mines in Colorado

Kirk W. Navo and Paul Krabacher. Colorado Division of Wildlife, Monte Vista, CO and Colorado Division of Minerals and Geology, Grand Junction, CO.

The availability of adequate roost sites is an important factor in the distribution and viability of most Nearctic bat populations. Abandoned mines serve as surrogates for caves in many circumstances, and more recently have gained attention in bat conservation efforts. Townsend's big-eared bat (*Corynorhinus townsendii*) is a species found in Colorado and is highly dependent on underground habitat for summer and winter roosting. One tool available to resource managers for the protection of abandoned mines is the bat gate, which restricts access and eliminates disturbance to roosting bats. Current designs are successfully used at some caves and mines that harbor large colonies of bats (gray bats, Indiana bats), but can be expensive and difficult to justify with smaller colonies or species not known to be endangered or declining. Resource managers, with limited funds and many pressing issues, need alternative designs to allow more opportunities and flexibility for the conservation of bat roosts in abandoned mines. However, it is important to include a monitoring program with any new gate design effort to evaluate the effectiveness of the design, and resultant success of the conservation action. In an effort to reduce the costs of gates, and increase the number of mines potentially protected, modifications of the basic gate designs were developed and installed during mine reclamation activity from 1991-2002. We report the results of eleven years of post gate monitoring on these gate designs, and the implications for conservation of bat roosts in abandoned mines.

Effects of radiotransmitters on the fate of big brown bats (*Eptesicus fuscus*) one year after tagging

Daniel J. Neubaum, Melissa D. Andre, and Thomas J. O'Shea. Colorado State University, Fort Collins, CO and U. S. Geological Survey, Fort Collins Science Center, Fort Collins, CO.

Little is known about the effects of radiotransmitters on bats after the lifespan of the radio has passed. Most studies presume that the movement of tagged bats verifies the animal's short-term survival. However, less consideration has been given to understanding whether or not the carrying of a radio results in reduced future survival, perhaps due to reduced feeding efficiency or fat storage during the period the radio was attached. During the summer of 2001, 92 radiotransmitters were placed on big brown bats (*Eptesicus fuscus*) as part of a larger study of disease transmission within an urban population in Fort Collins, Colorado. Radiotransmitters ranged from 0.52 to 0.95 grams, following the standard < 5% body mass rule. The mean ± SE proportion of body weight at tagging for all radiotagged bats was 3.74 ± 0.76 % (2.20 - 5.43). Bats were also implanted with a passive integrated transponder (PIT tag) to give them a unique identification number. Extensive tracking efforts in 2001 identified 58 roost sites, 14 of which were equipped with AVID PIT tag readers in 2002. The 2002 PIT tag reader data were searched for the presence of the 2001 radiotagged bats that had been known to use these monitored roosts in the year of their capture. A total of 34 out of 40 (85%) previously radio-tagged bats expected at monitored roosts were recorded by the readers, thus verifying their presence one year later. In addition, 2 of the 6 bats that were not recorded were re-captured during netting in 2002 for a total of 90% known to survive. This percentage compares favorably with the literature on big brown bat life history, and with the return rate at our largest maternity colony, where 86% (112 of 130)

of the adult females that were PIT tagged in 2001 returned in 2002. All previously radiotagged adult females recaptured by hand one year later (n = 21) were reproductive and exhibited normal body masses the second summer. Based on this evidence, we conclude that adult female big brown bats handle the stress of carrying a transmitter within the 5% rule well.

SW regional gap analysis project: Mapping the ranges and habitats of bats in the Southwest

Lee E. O'Brien, Tammy L. Hamer, and Donald L. Schrupp
Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO; Colorado Division of Wildlife, Denver, CO

The Southwest Regional Gap Analysis Project (SW ReGAP) is an update of the Gap Analysis Program's mapping and assessment of biodiversity for the five-state region encompassing Arizona, Colorado, Nevada, New Mexico and Utah. It is a multi-institutional cooperative effort coordinated by the U.S. Geological Survey Gap Analysis Program. The primary objective of the update is to use a coordinated mapping approach to create detailed, seamless GIS maps of land cover, native terrestrial vertebrate species habitats, and land stewardship and management status with improved resolution, detail and accuracy. This information will be analyzed to identify biotic elements that are under-represented on lands managed for long-term conservation, or have "gaps" in their protection. The project is creating an updated, 30m resolution, seamless, regional land cover map for the 5 state areas, using new satellite imagery and ground data. We will also produce a land stewardship map for the region that indicates individual management units of public land and private conservation lands, when voluntarily provided. The land cover map will be compared to the stewardship map to reveal land cover types that are under-represented in protective management, and the land cover map will be used to model wildlife habitat distribution. We are mapping predicted suitable habitat for all terrestrial vertebrates that breed or use habitat in the region for an important part of their life history. The habitat models will be constrained by range limits derived from probable and possible occurrences and expert opinion. In Colorado, we have completed the step of gathering all occurrence data available and creating preliminary range maps for all species that occur here, including bats. The next step is to have species experts review and refine these range maps. We will then model species habitats within these range limits based upon species habitat associations, and ask species experts to review and refine the habitat models. We encourage anyone with expertise on bat species' ranges or habitats to assist in this effort. Accurate range and habitat maps will be valuable in any bat (and wildlife in general) conservation efforts.

A CONTINUOUSLY OPERATING ACOUSTIC MONITORING STATION AT THE MOAPA NATIONAL WILDLIFE REFUGE, CLARK COUNTY, NEVADA

A continuously operating acoustic monitoring station at the Moapa National Wildlife Refuge, Clark County, Nevada

Michael J. O'Farrell, Jason A. Williams, and Tony Messina.
O'Farrell Biological Consulting, Las Vegas, Nevada Division of Wildlife, Las Vegas, NV, Nevada Bat Technology, Las Vegas, NV.

We placed a prototype acoustic monitoring station to operate continuously at the Moapa National Wildlife Refuge in January 2002. The station consisted of an Anabat detector and zero-crossings module connected to desktop computer within a structure with access to AC power. An auxiliary data logger was placed in February to record temperature and light levels. We present a progress report of an ongoing study. The system has performed well with only a few days lost

due to unanticipated filling of the hard drive. Both activity and species composition varied with weather changes. However, activity varied dramatically on a nightly basis during periods of relatively constant weather conditions. Seasonal trends in activity were apparent. Trends in species composition were also observed. The value of continuously operating acoustic monitoring stations is discussed.

Where is Waldo? Searching for hibernacula in the Pacific Noerthwest

Patricia C. Ormsbee, Aimee Hart, and Lee Templeman.
U.S. Forest Service, Eugene, OR.

Sixteen species of bats are known to inhabit Oregon and Washington. For most species, surveys of summer roosts or water sites result in detecting a few to several hundred individuals. Conversely, numbers of bats documented at hibernacula are typically small and do not approach the numbers found at some summer roosts and water sites. Locating hibernacula is a priority for the study and conservation of bats in the Pacific Northwest. Cave and mine sites that may provide hibernacula conditions are often inaccessible during winter. To locate additional hibernacula, we have begun collecting temperature, humidity, and activity data at caves and mines during winter. Hobo temperature and humidity recorders and Trailmaster motion sensors and recorders are used. The sensors and recorders are installed at caves and mines in fall before bats arrive to hibernate and before the sites become inaccessible from snow. Recorded data are retrieved in spring once the site is accessible and after bats are likely to have migrated to other locations. Simultaneously, we are collecting similar data sets at known hibernacula for analysis and comparison. New sites with temperatures that could support hibernating bats and/or with motion detections indicating bats are identified for further investigation.

Methods for inventorying and monitoring bats with an emphasis on genetic sampling

Patricia C. Ormsbee, Jan Zinck, Rebekah Hull, and Shonene Scott.
U.S. Forest Service, Eugene, OR and Portland State University, Portland OR.

Selecting locations for data collection on bats is often arbitrary – we go where we know or suspect bats will be found and return to locations where we successfully find them. This type of data collection can lack the breadth of information needed to establish reference data for species identification covering an area large enough that within and between species variation can be described. We have developed a cell grid across the state of Oregon and have begun systematically sampling genetic, acoustic, and morphological data for bat species in each cell. This data will serve as a baseline for describing within and between species variability across the State. At a finer scale, we are developing a survey protocol for bats that includes morphologic, acoustic, and genetic sampling. For this presentation we focus on the genetic sampling methods used to identify species by using DNA extracted from the bulk guano.

The Fort Collins bats and rabies study: Overview and progress report

Thomas J. O'Shea, Richard A. Bowen, Laura E. Ellison, Charles E. Rupprecht, Vidya Shankar, and Jeffrey H. Wimsatt.
U. S. Geological Survey and Colorado State University, Fort Collins CO; Centers for Disease Control and Prevention, Atlanta, GA; University of Virginia, Charlottesville, VA.

We are conducting a case study of the dynamics of rabies transmission in an urban population of big brown bats (*Eptesicus fuscus*) in Fort Collins, Colorado. Objectives of this 5-year cooperative project include characterization of roosts of urban big brown bats, determination of aspects of movements and population dynamics of bats in these colonies, establishing longitudinal histories of exposure to rabies virus by repeat serological sampling of individuals,

and assessment of prevalence of rabies in free-flying bats by sampling of saliva for rabies virus isolation and detection of viral nucleic acid by RT-PCR. We also characterize rabies virus variants circulating among bats in Colorado, and are measuring covariates to test competing models of the influence of key ecological factors on movements and survival in bat colonies. Our ultimate goal is to model potential disease transmission dynamics among urban bat colonies based on empirical data about spatial and physical characteristics of roosts, and movements, infection rates, and population dynamics of bats. We located 138 buildings used as roosts by radio tracking 114 big brown bats, most captured while foraging in city parks and green spaces, and through local knowledge. Fifty-four of the buildings were occupied by colonies of > 20 bats. No bat colonies occupied natural roosts. We PIT tagged and released 2,073 bats and monitored daily presence and movements at up to 14 colony sites throughout the city using PIT tag readers, augmented with hand captures at these and other roosts. Bats were brought to the laboratory for intensive sampling of blood (under anesthesia), saliva, and other variables, then released at colony sites on the same night. Saliva samples were analyzed for rabies virus via isolation and viral RNA using RT-PCR, and blood samples were analyzed for rabies virus-neutralizing antibodies using the rapid fluorescent focus-inhibition test. Although this is work in progress, preliminary highlights include a low proportion of individuals with evidence of rabies virus in saliva, but a high seroprevalence in most colonies (about 15-20 % of adults in each colony, ranging from < 5 % to 34 %). We are currently interpreting seropositive bats to be individuals with antibodies who survived past exposure to the rabies virus, not as actively infected or carrier individuals. PIT tag records document survival and reproduction of seropositive bats through the first full year of study. Serological findings suggest that bats may acquire immunity to rabies, a hypothesis we plan to test.

Foraging ecology of spotted bat (*Euderma maculatum*) on the Kaibab Plateau

Mikele. L. Painter, Carol L. Chambers, and Melissa S. Siders. Northern Arizona University, Flagstaff, AZ; USDA Forest Service, Fredonia, AZ.

Necessary spotted bat (*Euderma maculatum*) habitat components include tall roosting cliffs and relatively open foraging areas. How spotted bats use their habitat is poorly understood throughout this species' range. During the summer on the Kaibab Plateau in northern Arizona, lactating female spotted bats forage in subalpine meadows 1900 m above and 43 km from their known maternity roosts in the Grand Canyon. From 2001 to 2002, we investigated our hypothesis that prey availability influences spotted bat foraging activity on the Kaibab Plateau. We measured changes in relative insect abundance and species composition from May to August in meadows where spotted bats forage, and compared insect abundance and species composition to prey insects visually identified in guano collected from spotted bats during the same period. We also analyzed $\delta^{13}C$ and $\delta^{15}N$ stable isotope signatures of the bats and the available prey. The insect order Lepidoptera visually accounted for 95 to 100% of spotted bat guano contents. Female spotted bats were present on the plateau when sphingid moths were the most abundant lepidopteran family. Forest encroachment on the Kaibab Plateau may result in permanent loss of meadows, which would negatively affect available foraging areas and prey for the spotted bat.

Preliminary observation of ectoparasites of the big brown bat (*Eptesicus fuscus*), in Fort Collins, Colorado

Roger D. Pearce and Thomas J. O'Shea. Colorado State University, Fort Collins, CO and U. S. Geological Survey, Fort Collins Science Center, Fort Collins, CO.

A five-year study of population ecology and dynamics of rabies transmission in urban big brown bats(*Eptesicus fuscus*), was initiated in 2001 in Fort Collins, Colorado. Ectoparasites of bats have been hypothesized to influence daily movements, may affect body condition and surv-

-ival, and have been speculated to play a role in disease transmission. During 2002 we began systematically surveying the ectoparasites of big brown bats in conjunction with the larger study as a step towards understanding relationships between ectoparasitism and some of these factors. During the 2002 summer field season, ectoparasites of *E. fuscus* were systematically counted on over 1100 individuals (adult females, volant juvenile females, and volant juvenile males), including samples from 17 roosts. Thus far, we have found three orders of insect (Diptera, Hemiptera, and Siphonaptera) and two or more families of Acari (Spinturnicidae and Trombiculidae), with others still being identified. Ectoparasite diversity and numbers on individual bats varied with each roost surveyed in 2002.

Corynorhinus phylogeny and conservation implications: Do molecules match morphology?

Antoinette J. Piaggio. University of Colorado, Boulder, CO.

The genus *Corynorhinus* is a group of North American long-eared bats that are considered rare across their range. Based on morphological characters, it has been proposed that there are three species within this genus that represent independent divergences from an ancestral lineage (Handley 1959). This hypothesis is the working taxonomy of this group of bats. Conservation efforts to protect the disjunct and isolated populations of these bats are underway. For management projects to be successful they must be aimed at assemblages within this taxon that represent the evolutionary potential of these bats. I have inferred a molecular phylogeny from approximately 2000 base pairs of mitochondrial DNA from the control region and cytochrome *b* sequences. This phylogeny has been used to test Handley's hypothesis of evolutionary relationships within the genus *Corynorhinus*. The phylogeny has also been used to identify monophyletic clades within the genus. These monophyletic groups represent genetic entities that contain the evolutionary history and future potential of these bats. Preliminary data rejected Handley's (1959) hypothesis and inferred alternative evolutionary relationships within this genus, including evidence of cryptic species within *C. townsendii*. The conservation implications of these findings will be discussed.

Bats as ecological indicators: A pilot study on the Sacramento River

William E. Rainey, Elizabeth D. Pierson, Chris J. Corben, S. B. Khandwala, C. M. Champe, B. K. Orr, and M.E. Power. University of California, Berkeley, Department of Integrative Biology, Berkeley, CA; 2556 Hilgard, Berkeley, CA; and, Stillwater Sciences, Berkeley, CA.

Bats account for a significant fraction of the native mammal diversity in the alluvial floor of the Sacramento Valley. All species are insectivorous and many species concentrate foraging activity near streams, rivers, and riparian forests. Bats may be useful ecological indicators for monitoring change in river-riparian systems because they likely respond to habitat alterations occurring over broader spatial scales than less mobile animals. Although research has elucidated relationships between vegetative structure and bird communities, little is known about the species composition of bat assemblages or the habitat relationships of these species in the Central Valley of California. Current riparian and aquatic habitat restoration efforts in the Sacramento River valley, combined with new techniques for monitoring bats, offer opportunities to investigate responses of bats to habitat change in this region. Some lines of inquiry we are exploring include: Do museum records accurately represent bat species richness in Sacramento River riparian forests? Is the activity of tree-roosting species (such as the western red bat) or bat species diversity greater in mature riparian forests than in orchards? Do bat foraging patterns differ between riparian forest and orchard, or between mainstem river reaches and backwater areas? This pilot study is testing solar powered passive ultrasound systems for long-term monitoring of bat activity, species composition, and migratory patterns. Results will be used to evaluate bat

communities as biological indicators of river ecosystem health, as well as for guiding restoration efforts in the region.

Habitat use and roost selection by pallid bats (*Antrozous pallidus*) in British Columbia

Daniela A. Rambaldini. University of Regina, Regina, SK, Canada.

Pallid Bats reach the northern limit of their range in British Columbia, where they are restricted to the semi-arid steppe highlands of the Okanagan Valley. Pallid Bats are Red-Listed in B.C. and are federally classified as Threatened. Despite this, there is a paucity of data regarding their ecology in Canada. Suitable foraging habitat and roost sites may be limiting resources determining the extent of this species' range. Data were collected from May to August 2002 near Oliver, B.C. Based on a sample of 5 radio-tagged individuals, Pallid Bats exhibited fidelity to roosts in inaccessible rock crevices that were located $\leq$ 0.5 – 1 km from foraging areas and that maintained high stable temperatures. Maternity colonies were located near or within roosts used by adult males. Pallid Bats foraged in areas of native vegetation (dry sandy soils vegetated by mature antelope bitterbrush, sagebrush, and Ponderosa pine) but preliminary data is insufficient to assess whether orchards and vineyards were also used as foraging areas. Based on a sample of 34 faecal pellets, bats ate solely beetles including Scarabidae and Carabidae (*Calosoma* spp.). Previous studies in the Okanagan Valley showed that Pallid Bats foraged in open, sparsely vegetated grasslands and night roosted in Ponderosa pines after a single foraging bout. However, I found that Pallid Bats foraged in areas dominated by mature antelope bitterbrush, showed a bimodal foraging pattern, and used day roosts between foraging bouts. In 2003, I will explore thermoregulation by Pallid Bats.

EFFECTS OF HABITAT FRAGMENTATION ON BAT DIVERSITY AND DISTRIBUTION IN ORANGE COUNTY, CALIFORNIA

Stephanie Remington. 36766 Highway 78, Julian, CA.

Orange County, California is more than 60% urbanized. Acoustic and mist-netting surveys were conducted in each of three habitat size classes to determine activity levels and species diversity at 12 sites in 1997, and at six of those sites in 1998. Orange County Public Health Agency records of bat-human encounters from 1977-1999 were used as a baseline representative of species diversity within the county, and to examine patterns of change in relative abundance and distribution from the 1980s to the 1990s. The smallest sites had the lowest diversity and the highest activity levels (dominated by *Myotis yumanensis* and *Tadarida brasiliensis*). The percentages of these two species increased substantially in Public Health records during the last decade, and both appear to adapt well to the urban environment. *Eptesicus fuscus* declined by 50% in Public Health records during the last decade, but was, by far, the most commonly captured bat at the largest sites. *Antrozous pallidus* and *Lasiurus cinereus* also declined in occurrence in public health records. Both appear to be intolerant of urban environments and have lost foraging and roosting habitat as a result of urbanization. Large expanses of undeveloped habitat appear to provide the best support of a diverse bat fauna.

Identification and distribution of *Myotis yumanensis* in Oregon

Shonene A. Scott, Patricia C. Ormsbee, Jan M. Zinck, Deborah A. Duffield, and Luis A. Ruedas. Portland State University, Portland, OR and USDA Forest Service, Eugene, OR.

The Yuma myotis, *Myotis yumanensis*, is listed as a "species of concern" by the US Fish and Wildlife Service; recent efforts to capture the species in Oregon indicate it may not be as common

therein as previously believed. In general, *M. yumanensis* can be distinguished from other bats using a set of external morphological characteristics. However, in Oregon and other northern portions of its range, the features of *M. yumanensis* converge with those of the little brown bat, *Myotis lucifugus*, making species identification difficult and inconsistent. Genetic analysis of the 16S rRNA region of mitochondrial DNA has been shown to be an accurate method of distinguishing between these two species. The purpose of the present project is to examine the distribution of *M. yumanensis* within Oregon using this mitochondrial DNA marker to confirm species identification. Bats were captured across the state of Oregon using a spatially distributed sampling scheme. The geographic area of the state was divided into cells, and bats captured within each cell. Sites were selected within each cell using a database of historic capture data and discussion with local biologists. Once captured, bats were handled and measured using standard protocols; a 3-mm wing biopsy was taken to obtain DNA samples for genetic analysis. In the laboratory, standard protocols are followed for RFLP analysis to unequivocally identify each bat to species. At the completion of the project, an error matrix will be developed to show the accuracy of using morphological features for distinguishing between *M. yumanensis* and *M. lucifugus* in the field, as compared to species identification using genetic analysis in the laboratory. A revised species distribution map for *M. yumanensis* will be developed using location data and the results of the genetic analyses.

Population size of *Leptonyctris curasoae*, the lessor long-nosed bat, increased dramatically with cave protection at Fort Huachuca, Arizona

Ronnie Sidner. Ecological Consulting, Tucson, AZ.

Prior to federal listing in 1988 as an endangered species, the lesser long-nosed bat, *Leptonycteris curasoae*, was known from two cave roosts, Pyeatt and Manila, on Fort Huachuca (FH). Collection reports from the 1950s-1970s listed no more than 20 *L. curasoae* at these sites on FH, and nothing else was recorded regarding population numbers. Following the endangered listing, the Army assessed the status of the species and their potential food plants, Palmer agaves, *Agave palmeri*, on FH. Surveys were conducted in 1990, and *L.* curasoae was found at only one site, Manila, where 50 bats were observed. From the beginning, low disturbance methods were used at potential roosts. A monitoring program was initiated on FH with the intent of inventorying and monitoring all bat species at all possible cave roost sites. Counts of individual bats of any species during evening emergence flights provided population estimates of various bat species at cave roosts. Skeletal material of *L. curasoae* was found at Pyeatt, a popular recreational cave that showed conspicuous damage, but only one live *L. curasoae* was observed there during the first six years of monitoring. Before 1991, protective actions were initiated by the Army. Actions included temporary closure of potential cave roost sites, removal of gates and other obstructions at cave entryways, posted closure signs, fenced closure of caves and roads leading to caves, and prescriptions to prevent damage to fields of agaves during military operations. Following these actions, there was an immediate increase in population numbers of cave Myotis, *Myotis velifer*, insect-feeding bats that share the roosts of *L. curasoae*. In 1997, *L. curasoae* began to recolonize the old Pyeatt roost. The maximum annual numbers of *L. curasoae* on FH increased from 50 bats in 1990 before protective actions to over 3000 bats in 1999 through 2001. With protection of roost sites during the past 12 years at FH, population numbers of both nectar-feeding and insect-feeding bats at roosts have increased dramatically.

A survey of Colorado's caves for bats

Jeremy L. Siemers, Steve K. Carroll, Sarah Lant, Stephanie J. Smith, and Carole E. Wilkey.
Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

More than 700 caves are thought to exist in Colorado, and most have not been surveyed for use by bats. At least 12 of Colorado's bat species use caves seasonally or throughout the year. For example, *Corynorhinus townsendii* (Townsend's big-eared bat) requires caves and the environmental stability they provide for hibernation and maternity roosting. During August 2001 through July 2002, we used internal and external cave surveys to assess 99 caves in 11 counties for use by bats. Nineteen of the 99 caves supported one or more types of use by 8 different bat species. Twelve of these 19 caves were used by *C. townsendii*, which was the most frequently encountered species of bat. The next most frequently encountered bat species, *Myotis ciliolabrum* (western small-footed myotis), was found at 8 caves. The relatively high frequency with which *C. townsendii* was observed in our study reinforces the need for effective protection and management of caves for this bat species.

Idaho Panhandle bat surveys 1997 – 2002

Jenny C. Taylor. Idaho Panhandle National Forests, Coeur d'Alene, ID.

Since 1996, bat surveys have been conducted at over 70 abandoned mines in the Idaho Panhandle. Prior to 1996, Townsend's big-eared bat (*Corynorhinus townsendii*) was known from only two sites in North Idaho. Recent surveys have located 4 Townsend's big-eared bat hibernacula, a maternity roost and 10 additional mines used by this species. Four other bat species have been mist netted at North Idaho mines, including California myotis (*Myotis californicus*) and western long-eared bat (*Myotis evotis*), which were not previously known from the Idaho Panhandle. Thirty-six Idaho Panhandle mines have been closed with bat gates. Bats used 12 of 16 mines, which were monitored after the gate was installed. Twenty-two mines have been closed with a gate inside a culvert. Bats used 9 of 17 mines, which were monitored after culvert installation. 2003 surveys will focus on additional hibernaculum searches, and monitoring known Townsend's big-eared bat sites and mines that have not had a bat survey after installation of a bat gate and/or culvert.

Anabat: Friend or foe? Dichotomous keys as a way to make Anabat more useful and calls easier to classify

John R. Taylor. Department of Integrative Biology, Brigham Young University, Provo, UT.

Valuable use of bat call identification to species is a sort of Holy Grail in bat research. Reliable classification is necessary before bat call identification can be used for analysis of bat population characteristics. While it is true that researchers who have spent a lot of time classifying bat calls easily separate most of the bats in their area to species, there is still uncertainty in distinguishing some similar species. An additional problem is the impracticality of spending months training someone to classify bat calls. We created dichotomous keys specific to the bats in the areas that we study. Criteria for classifying bat calls was obtained from analysis of verified Anabat calls – those being calls from captured bats that had been visually identified and hand released. Most of our verified calls came from hand-released bats in the specific area, but in some cases, our data was supplemented with data from other sources. The dichotomous keys were given to undergraduate students to use for identification of Anabat files that had been collected during our field studies. Criteria for separating many species was obvious due to unique characteristics, while other species required analysis of a number of verified calls before a reliable distinction could be made. Some bats included on the keys due to theoretical range were not detected in any Anabat files from this field season, these were primarily the calls that had criteria determined from other sources. In one study area, *Corynorhinus townsendii* are frequently caught, but seldom

detected by Anabat. *Corynorhinus townsendii* were determined to have very short, infrequent call patterns, so adjustments were made to more liberally classify short duration calls as that species, which in turn yielded population characteristics very similar to that of capture by mist netting. Classification of bat calls to species should be used as at least supplemental data to other means of determining bat population characteristics. Inclusion or exclusion of rare bat species from keys should be determined by personal preference, as definitive classification of most of these species should come to the attention of primary researchers and generally requires a second opinion. Classification of Anabat calls may be the only means of establishing population dynamics in areas lacking suitable capture landscaping.

Use and function of a bat night roost within an abandoned mine in central Utah

John R. Taylor[1], Michael J. Herder[2], K.W. Grandison[3], M. Mesch.[4]
[1] Department of Integrative Biology, Brigham Young University, Provo, UT; [2] Bureau of Land Management, Arizona Strip Field Office, St. George, UT; [3] Department of Biology, Southern Utah University, Cedar City UT; and, [4] Utah Division of Oil, Gas, and Mining.

Video monitoring of an exclusively used bat night roost was conducted throughout the summer of 2001 at an abandoned mine in the Wasatch Mountain Range near Santaquin, Utah. Digital camcorders recorded twelve 8-hour sample periods in May, June and July for the purpose of evaluating the mine as a place for bats to process prey, to rest between foraging bouts, and as a location for social interactions. Results were then compared to behaviors found in several previous studies of bat night roosting behavior. The results differed significantly from the expected uses and function. Only 0.01% of the 456 total recorded events resulted in two or more bats present within the mine simultaneously, suggesting very little social interaction between bats. Only one percent of the roosting episodes lasted longer than 1000 seconds. Also, 91% of all roosting episodes lasted less than 200 seconds, with 61% lasting less than 20 seconds. These results suggest resting was not the primary purpose for roosting. Bats also switched roosting locations within the mine an average of 9.7 times (2 SE±3.0) per night, and a maximum of 68 location changes. Furthermore, 48% of all recorded events resulted in bats utilizing the mine for flight only. A linear mixed model was used with date and location within the mine as fixed effects and event as a random effect. Roosting duration changed as the sample periods got closer to late July. Furthermore, roosting duration was dependent on the location within the mine. The short duration of roosting bouts, frequent roost switching events, and numerous periods of extended flight suggest-this mine is primarily used for foraging and prey processing, particularly during the early summer. Use of the mine also shifts more toward resting behavior as the summer progresses.

Monitoring and management of the endangered lesser long-nosed bat (*Leptonycteris curasoae*), at Organ Pipe National Monument, Arizona

Timothy J. Tibbitts and Ami C. Pate, Organ Pipe Cactus National Monument, Ajo, AZ.

The lesser long-nosed bat (*Leptonycteris curasoae*) is a migratory species whose summer range extends into southern Arizona and southwestern New Mexico. Its primary foods in the United States are the flowers and fruits of saguaro and organ pipe cactus, and flowers of several species of agave. This bat was classified as endangered in 1988. The largest maternity colony known in the United States is located in an abandoned mine in Organ Pipe Cactus National Monument (OPCNM), in southwestern Arizona. Adult females begin arriving in the roost in April, and give birth somewhat asynchronously through June. The colony reaches its largest size in late June, when large numbers of volant juveniles are present. The colony then declines in size from July into September, as bats disperse to unknown regions. This maternity colony increased substantially in recent years, from approximately 10,000 to 15,000 adult females in the mid-1990s

to approximately 22,000 to 25,000 adult females in 2000-2002. The National Park Service monitors this site with regular inspections and exit counts. The roost is protected by fencing, signage, and location. Potential threats are present in the form of barn owl predation, and disturbance by illegal immigrants and drug smugglers. Additional protection (e.g. gating) is being evaluated. The NPS also monitors *Leptonycteris curasoae* as part of a general bat monitoring program; the species has been found essentially throughout the Monument, even where its normal nectar and fruit resources are rare. Short-term night roosts are ubiquitous in the Monument, ranging from natural caves and rock overhangs to the eaves of occupied buildings. Additional mine features and natural caves may provide day roost habitat. Additional survey work is needed to determine use (current and/or potential) of these features. Some mine features require modification to provide bats access.

Determining foraging and roosting areas for Underwood's mastiff bat (*Eumops underwoodi*) using radiotelemetry at Organ Pipe Cactus National Monument, Arizona

Timothy J. Tibbitts, Ami C. Pate, Brian J. Barns, and Yar Petryszyn.
Organ Pipe Cactus National Monument, 10 Organ Pipe Drive, Ajo AZ and Department of Ecology and Evolutionary Biology, The University of Arizona, Tucson, AZ.

Underwood's mastiff bat (*Eumops underwoodi*) is a large, little-understood tropical species, reaching its northern distribution limit in extreme southern Arizona. One of the few locales where it occurs is Quitobaquito Pond in Organ Pipe Cactus National Monument. Quitobaquito is located on the U.S. - Mexico border next to a busy highway, and is subject to various threats. Further, the adjacent Mexican border lands are undergoing changes due to increasing human population, tourism, construction, and changes in land use. Quitobaquito and the border area are clearly important to this bat for foraging, roosting, and accessing water in an arid landscape. To expand our knowledge of this bat's life history and to identify potential management issues, we sought to determine foraging and roosting areas using radiotelemetry. *E. underwoodi* were found to forage widely across and along the international border area. Foraging habitat ranged from rugged wilderness topography to agricultural and semi-urban areas. Unexpectedly, they were found to be roosting in woodpecker cavities in saguaro cacti (*Carnegia gigantea*) on Mexican ranch lands. This is the first documentation of this species roosting in cactus cavities, and a rare documentation of any bat species doing so.

What's new with the occult myotis (*Myotis occultus*)?

Ernie W. Valdez. U. S. Geological Survey, Museum of Southwestern Biology, Albuquerque, NM.

In light of recent analyses, the occult myotis (*Myotis occultus*) is now recognized as a distinct species. Because *M. occultus* was once considered a synonym of *M. lucifugus*, its ecology was also assumed to be the same. Despite many similarities between these two species, there are notable differences between them. An update on the distribution of *M. occultus*, with emphasis on Colorado, New Mexico, and Utah, will be given, as well as insight into the unique biogeography of this species. Key characters needed for distinguishing *M. occultus* from other related *Myotis* species (e.g., *M. lucifugus*) will be presented and information needs regarding *M. occultus* will be discussed.

Designing regional-scale monitoring for free-flying bats: Incorporation of detectability estimates

Theodore J. Weller, Patricia N. Manley, James A. Baldwin, and Michelle M. McKenzie.
Pacific Southwest Research Station, USDA Forest Service, Arcata, CA.

The documentation of bat species occurrence and distribution by monitoring at regional scales is an effective means to identify concerns and prioritize conservation efforts for bats. Challenges inherent in large-scale monitoring efforts, such as spatial and temporal variability, geographic extent, and survey cost, necessitate a solid statistical foundation that allows maximum inference from data collected. Estimates of detectability can serve as one element of this foundation; they enable estimates of actual (as opposed to observed) occupancy rates, evaluation of sample size requirements, and exploration of sample design efficiencies. We conducted a pilot study in forests of the central Sierra Nevada, California to evaluate designs for a regional-scale bat monitoring program. A total of 36 sites in three elevation bands were surveyed multiple times. We then applied a maximum likelihood estimation procedure to data collected during these 178 surveys to estimate detection probabilities for 11 bat species detected in the study area. Summation of detection probabilities allowed us to estimate the number of species detected per unit effort and evaluate survey completeness. It further allowed us to determine efficient combinations of spatial and temporal replication required to achieve reliable results. We outline the statistical approach, present specific results, and expand upon the wider applicability of such an approach, particularly as it applies to designing regional-scale monitoring.

Habitat distribution of bats in a riparian corridor in the Mohave Desert of southern Nevada

Jason A. Williams, Michael J. O'Farrell, and Brett R. Riddle.
Nevada Division of Wildlife, Ely, NV,; O'Farrell Biological Consulting, Las Vegas, NV;
Department of Biological Sciences, University of Nevada, Las Vegas, NV.

We examined bat species richness and habitat preference among four types of riparian communities (riparian woodland, riparian marsh, mesquite bosque, and riparian shrubland) in the upper Muddy River drainage, southern Nevada. Bat activity was examined using a stratified, replicated sampling design, and sampling techniques included active and passive acoustic monitoring, harp traps and mist nets. Multiple Anabat acoustic detection units sampled replicates of each of the four habitat types simultaneously throughout an entire night for 3-5 successive nights each sampling session. One to 4 sampling sessions were conducted each month over the course of one year. Sixteen of Nevada's 22 known species of bats were identified from the study area. Approximately 67,000 bat passes were recorded from a total of more then 2,800 hours of acoustic recording. Collectively, 540 bats were captured with a total 278.75 hours of trapping/netting effort from 30 nights. A substantial species-specific difference in habitat use was observed. While species classified as gleaners (e.g. *Lasiurus blossevillii*, *Lasiurus xanthinus*, *Macrotus californicus*) were more abundant in riparian woodlands and mesquite bosques, other species classified as aerial hawkers (e.g. *Euderma maculatum*, *Nyctinomops macrotis*) were found more frequently over riparian marshes and riparian shrublands. Our sampling design enabled the detection of seasonal changes in activity levels among habitat. These changes may reflect seasonal changes in the distribution and abundance of prey, as well as seasonal changes in species composition of the local bat assemblage.

Future Meetings and Events

October 8 – 11, 2003

The **33rd Annual North American Symposium on Bat Research** will meet in Lincoln, Nebraska, October 8-11, 2003, hosted by Trish Freeman (University of Nebraska and Nebraska State Museum). All formal sessions of the 33rd Symposium will be held at the Cornhusker Hotel in downtown Lincoln, located within easy walking distance of the UNL campus, the state capital, and of a number of downtown restaurants, pubs, and other attractions. Room rates will be among the least expensive we have had in recent years, and other costs (including transportation) should be very reasonable.

See our website at: http://www.nasbr.org/ Watch this space for further details.

March 9 – 12, 2004

The Second Bats and Forests Meeting will be held in Hot Springs, Arkansas. Please see the official call for papers and registration instructions on page 120 (over) .

April 14 - 16, 2004

The 11th meeting of the Australasian Bat Research Symposium will be held The University of Southern Queensland in Toowoomba, near Brisbane, Australia just after Easter in 2004. For additional information contact Greg Ford at: fordg@powerup.com.au

August 23 - 28, 2004

The **13th International Bat Research Conference** is planned to be organised in Poland from 23-28 August 2004. More information about the conference will be available in a few months at: http://www.miiz.waw.pl/IBRC also http://www.miiz.waw.pl/IBRC

October, 27 - 30, 2004

The **34th Annual North American Symposium on Bat Research,** will convene in Salt Lake City, Utah, October 27-30, 2004

August, 2005

The next **European Bat Research Symposium** will be held in Ireland in August 2005. More details will appear here as they become available.

If you know of other planned meetings, large or small, concerning any aspect of bat biology, please send details to Roy Horst horstgr@potsdam.edu for publication in the next issue.

CALL FOR PAPERS

and

REGISTRATION INFORMATION

2nd Bat and Forests Symposium and Workshop

9-12 March 2004 -- Hot Springs, Arkansas

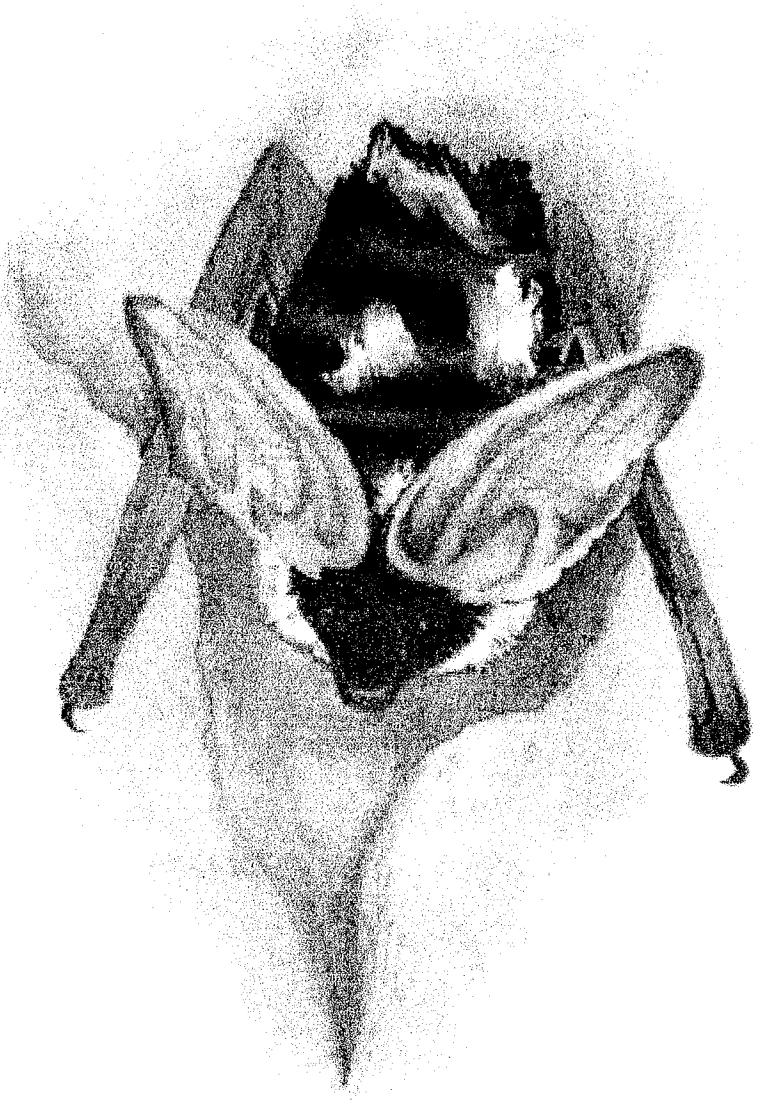
This is the official CALL FOR PAPERS for the 2nd Bats & Forests Symposium and Workshop. Complete information is available at the Bat Conservation International web site: http://www.batcon.org/ and click on the 2nd Bats & Forests Symposium link under *What's New*.

Please pass on this information to other interested parties. The 2nd Bats and Forests Symposium and Workshop is open to anyone interested in bat conservation, ecology, and forest management. *Abstracts for Contributed Papers and Posters will be due November 17, 2003.*

Thank you.

Daniel Taylor, Bat Conservation International

BAT RESEARCH NEWS



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BAT RESEARCH NEWS

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e-mail: horstgr@potsdam.edu

Editor for Feature Articles: Allen Kurta, Dept. of Biology, Eastern Michigan University, Ypsilanti, MI. 48197. Tel.734-487-1174 FAX 734-487-9235
e-mail: bio_kurta@online.emich.edu

Editor for Recent Literature: Margaret A. Griffiths, Dept. of Biology, Illinois Wesleyan University, Bloomington, IL 61702 Tel. 309- 556-3697, FAX 309-556- 3864
e-mail: mgriff@illinoisalumni.org

Editor for Conservation/Education: Patricia Morton, Texas Parks and Wildlife, Suite 100, 3000 IH 35 South, Austin, TX 78704. Tel. 512-912-7020
e-mail: patricia.morton@tpwd.tx.us

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 which are reviewed by at least two scholars in that field. In addition Bat Research News includes a recent literature section which cites nearly all bat-related publications in English worldwide; the 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.

Communications concerning feature articles and "letters to the Editor" should be addressed to Kurta, recent literature items to Griffiths, conservation items to Morton, and all other correspondence to Horst.

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BAT RESEARCH NEWS

VOLUME 44: No. 4 **WINTER 2003**

Table of Contents

Front Cover Illustration

Our cover illustration is a portrait of *Euderma maculatum* and was created by Lucas Navo, who is the 16 year old son of Kurt Navo. This portrait was also the cover illustration for the meetings in Durango. Thanks, Lucas for sharing your work with us.

From the Editor

Dear Subscribers to Bat Research News,

I have decided to discontinue as Managing Editor and Publisher of Bat Research News. When I assumed this responsibility in 1977 it was to be for a term of five years, this was extended to 'five more years", and so it went for twenty-five years until now. I feel it is time to pass this honor on to younger and more enthusiastic hands. I am happy to inform you that Dr. Margaret Griffiths of Illinois Wesleyan University has agreed to assume this responsibility. She will be the Managing Editor and Publisher of Bat Research News beginning with Volume 45: # 2, (Summer 2004).

Dr. Griffiths is currently serving as Editor of the Recent Literature section of Bat Research News and is thoroughly familiar with our editorial policies and operations. I am sure she will bring many fresh and creative ideas to Bat Research News.

The electronic edition has had its start-up problems but these seem to be working out. I have had neither the facilities nor the skills to design and set up a pay-for-view website so have had to rely on professional services provided by our university staff. Since I am no longer employed by the university, I needed to contract this portion of our operation to a private provider, Cybertrail Outfitters operated by Debbie Thacker. She has been most helpful and any difficulties you may have experienced with passwords, user addresses, or logging on are due mostly to my own ineptitude and unfamiliarity with the mysteries of "the net". Marge is highly competent in computer networking so the electronic edition can only become more efficient and easier for you.

The printed edition seems to be in good health even though its production costs seem to be ever on the increase due to constantly rising costs of printing and postage. We have attempted to keep our subscription rates as low as possible but it seems inevitable that they will continue to creep upward. We are contemplating an increase in the price of those subscriptions to addresses outside the United States as foreign postage is becoming prohibitive. Perhaps these subscribers can in future switch to the electronic edition, where costs are much less and easier to maintain.

I have agreed to serve as "treasurer" for just a few more months until all current subscriptions are paid up to date, that is for Volume 45:2004 (and any previous outstanding dues). So until you are all paid up to date, you will be hearing from me one more time.

I have enjoyed serving our little journal-newsletter, especially the opportunity it afforded me to remain in contact with so many of you. I will miss that quarterly frantic effort to get it all together and into the mail (but not very much). Happily my contact with you will continue as I read the future issues of Bat Research News. It has been especially rewarding to attend Our Annual Symposium and see so many of my old friends, some of you have been with the symposium from the beginning and with Bat Research News for even more years. Sadly too many are no longer part of this great family except as treasured memories. Their places are taken by a host of new faces with new ideas and a bright future.

Thank you for allowing me this opportunity to be involved with you and your interesting work with bats and their biology. Good luck to all of you and especially to you Marge!

All the best,

G. Roy Horst, Managing Editor and Publisher

Abstracts of Papers Presented at the 33rd Annual North American Symposium on Bat Research

Held 8-11 October 2003 in Lincoln, Nebraska

The abstracts are listed in alphabetical order by first author.
* designates student award-winning papers.

Preliminary Data for the Effects of Forest Thinning on Bat Foraging Patterns in Boulder County, Colorado

Adams, Rick A., and Lauren Golten
University of Northern Colorado, Greeley, CO; University of Colorado-Boulder, Boulder, CO

Protecting critical foraging habitats for bats is of paramount importance because loss of critical foraging habitat can affect the stability and survivorship of bat populations, and several critical factors need to be balanced. Human impacts to foraging habitats usually come in the form of forest cutting and various other degradations. Studies in the West indicate that bats, with the exception of open-aerial specialists, tend to avoid large open habitats when possible. Thus, bat activity is low where clear-cutting has occurred. Conversely, the less-severe practice of forest thinning may enhance bat foraging areas. In 2003, we chose at random two 0.25 hectare plots for each of recently-thinned (2002) forested areas, unthinned forested areas, and open montane meadow located in proximity to the thinned and unthinned treatments. Pettersson 240X ultrasonic detectors attached to Panasonic RQ-L51 cassette recorders were positioned on tripods at a height of 1m and tilted upward at a 300 angle to the ground. To accommodate for differences in vegetative density and its effect on detector functioning, we placed three detector units at 12.5m intervals in our unthinned plots with detectors positioned at the corners angled at 450 towards the center of the plot. A detector placed in-line with and centered between the corner detectors faced straight into the plot. In the thinned and meadow treatments, two detectors were placed at the corners of the plots 25m apart and pointing 450 towards center. Detectors were positioned along one side of the 0.25 hectare grids for two nights and reversed across each grid for two nights equaling four nights per plot and a total of 60 detector nights across plots. Detectors were started at sunset and turned off three hours past sunset on each night. Results indicated that highest foraging activity (number of passes) and species diversity (number of species) occurred in thinned plots, second highest in montane meadow, and least in unthinned forest. These data are preliminary, but suggest that forest thinning practices are having a positive effect in our study area by increasing preferred foraging habitat.

Monitoring and Evaluating the Results of Bat Protection Efforts

Allende, Carolina, Jason Beck, Nick Ervin, John Taylor, and Kathryn Grandison
Southern Utah University, Salt Lake City, UT

Populations of many bat species are believed to be declining due to a decrease in historical habitat. Recent studies have shown that abandoned mines are being used by numerous bat species. The Utah Department of Natural Resources, Division of Oil, Gas and Mining Abandoned Mine Reclamation Program is currently authorized to close abandoned mines to protect the public from potential hazards. Abandoned mines are surveyed prior to closure and those providing suitable habitat are sealed with bat-compatible gates. Few post-gate monitoring studies exist to document long-term effects of the techniques for conserving bat populations. This study was designed to document the effects of techniques used in Utah. Long-term objectives include determining daily and seasonal use of mines by bats, and evaluating species composition. Two mine areas were chosen in southwestern Utah for this study. Within these two areas, three gated

mines in the Silver Reef/East Reef area and three ungated mines in the Tushar Mountains have been monitored since 2000. The Tushar mine adits were gated in November after the 2002 field season. Eleven of Utah's 18 bat species have been netted or acoustically recorded at these mine entrances. *Myotis* spp. and Townsend's big-eared bats, *Corynorhinus townsendii pallescens*, were found in highest numbers in the Silver Reef and East Reef. The long-legged myotis, *M. volans*, was the dominant species in the Tushars. Bat activity was highest in gated Silver Reef Mines. A combination of monitoring techniques (infrared digital video recorders, night vision goggles, and Trail Master's event recorders) was used to collect bat behavior data; mist netting and Anabat' acoustic detection were used to determine species identification. Bats circled 6-10X more frequently at gated than at un-gated mines. This behavior difference has been noted at all gated mines, and does not appear to be restricted to any one species of bat. However, circling frequency changes seasonally, which correlates with changes in species and age structure of bats. Use of a culvert for gating one of the Tushar mines significantly decreased bat use of that mine. Preliminary analysis indicates that humidity and microclimate fluctuations may contribute to variability in daily activity. External climate does not appear to play a consistent role in bat activity patterns. There is no consistent correlation between observer presence and levels of bat activity.

The Effect of Moon Phase on Bat Activity

Allende, Carolina M., Nick Ervin, Kate Grandison, and John Taylor
Southern Utah University, Cedar City, UT

Two mines located in the Silver Reef mining district near Leeds, Utah were monitored from February 2002 until August 2003 using Trail Master infrared data loggers installed internally. To test the effect moon phase on bat activity within the two mines, a linear model was created with Trail Master events as the response and moon phase in percent as a predictor. The two mines exhibited nearly inverse patterns of use when compared to each other. WH-180, a known maternity roost for Townsend's big-eared bats (*Corynorhinus townsendii*), had the majority of Trail Master events recorded in May and late August and September. WH-48, in contrast, showed the greatest amount of use in June and July. Daily patterns of use throughout the year suggest that both mines are used primarily for day roosting with a large peak of activity of emergence at sundown, and nearly no activity until sunrise. When Trail Master events were regressed to moon phase, neither mine showed a significant correlation ($p > 0.05$; WH-48 R-sq (adj) > 0.8%; WH-180 R-sq (adj) > 3.2%). The slightly higher R-sq (adj) value of 180 suggests that it possibly may be slightly more subject to changes in moon phase than WH-48. It is reasoned that this subtle difference may be due to the varying patterns of use by bats within these mines.

Use of a Portable Radiotelemetry Tower and Vehicular System for Habitat Use Analysis of Forest Bats in Missouri

Amelon, Sybill K., and Frank R. Thompson, III, North Central Research Station, USFS, Columbia, MO

Numerous factors operating at multiple scales potentially influence bat distribution, habitat selection and activity patterns. We initiated a long-term study in 2001 to (a) provide intensive information on foraging and roosting habitat use by *Lasiurus borealis*, *Myotis septentrionalis*, and *Myotis grisescens* and (b) to evaluate effect of landscape pattern, local habitat, and temporal factors on relative activity or occurrence of forest bat species in the Central Hardwood Region of Missouri. Due to small size, fast and sometimes long distance movements, foraging locations are difficult to determine accurately. To improve accuracy and consistency of triangulated foraging location estimates, we developed a portable tower and vehicular system using 8 to 14 element yagi antennas coupled with an electronic compass engine (KVH Industries, Inc.) for synchronous azimuth determination. We have used this system to radio track 35 *L. borealis*, 29 *M. Septentrionalis* and 18 *M. Grisescens* with a mean accuracy of location less than 2 hectares. All

observed species utilized a relatively small geographic area for roosting (1.3-17.4 hectares). Roost sites of *L. borealis* were dominantly over story oak and hickory species and *M. Septentrionalis* were dominantly understory small diameter dead trees within the same landscape. Foraging locations ranged to 20 kilometers for *L. borealis*, and 10 kilometers for *M. septentrionalis*. Foraging areas and distances were highly variable for *M. grisescens*. Quantitative natural history information is currently being used to clarify relationships between forest bats and forest habitat to develop conservation strategies for these species.

Influence of Landscape Characteristics on Presence and Relative Abundance of Bats in Managed Forests in Western Oregon

Arnett, Edward B., and John P. Hayes, Oregon State University, Corvallis, OR

We studied the presence, relative abundance, and richness of bats in managed forests in the western Oregon Cascades from 1999 to 2001. Our objective was to evaluate the relationships between landscape-scale variables and probability of detecting bats by mist netting in landscapes with varying availability of snags. Landscapes were defined as a 4.8 km radius circular area (3,663 ha) centered on a capture site (small ponds offering available drinking water to bats). Landscapes were stratified for sampling based on estimated availability of snags and categorized as having low, medium, and high snag density. A total of 36 sites were randomly selected for sampling in each snag density category (n = 12/category). Bats were captured during 4 hr surveys with mist nets placed over small ponds. Surveys were conducted simultaneously at 3 sites/capture event representing a low, medium, and high snag density site. Between six and nine mist net surveys were completed for each landscape during the study. We used Poisson regression to model the probability of detecting a species of bat in a landscape as a function of elevation at the capture site and estimated density of snags, percent riparian habitat, and composition and configuration of stand types in the landscape. We also modeled species richness and the probability of detecting male and female bats in relation to these landscape variables. A total of 1,385 bats of nine species were captured during simultaneous mist net surveys between 1999 and 2001. Landscapes with the lowest snag density had the lowest number of captures and species richness, but results were variable. Male and female bat distribution appeared to be influenced by elevation at the capture site, as females were more readily captured at lower elevation sites. Elevation and snag density appear to be confounded by the fact that many sites with older forest, where snag densities are high, occurred at higher elevations. We discuss the biases and limitations of our models in relation to landscape-scale inferences and the conservation implications of our findings.

Intrageneric Speciation and Diversification in Genera of Phyllostomid Bats

Baker, R. J., F. G. Hoffmann, and A. D. Brown, Texas Tech University, Lubbock, TX

The family Phyllostomidae comprises about 55 genera and 150 species. It has the greatest amount of morphological variation present in any bat family. Members are adapted to feeding strategies for insects, blood, nectar, fruit, carnivory, and omnivory. The family represents a major component of neotropical biodiversity. Its geographic distribution ranges from extreme Southwestern United States to Chile and Argentina. In this study we are using genetic distance in the mitochondrial *cytochrome-b* gene and we are assuming that there is a temporal value that is associated with genetic distance (Aborgast and Slowinsky). We do not have an accurately calibrated clock, but we suspect that there will be variation in rates of change over time. We use two extreme figures ranging from 2% per million years to 5.5% per million years. Within phyllostomid genera, speciation appears to be spread over several million years. There is not a common speciation event across all genera. Speciation appears to be recent in some genera (*Uroderma*). The single genus *Rhinophylla* that has the highest distance values (19%) may have

an accelerated rate of molecular evolution rather than being the oldest genus in the sample. Within most genera there is an older species (for example *Carollia castanea*) with deep nodes that we interpret as indicating a longer history of diversification than is present in other species within the same genus (for example *C. brevicauda*, *C. perspicillata*) that have only shallower nodes and may be a product of a more recent speciation event.

Sound or Silence: When Do Tiger Moths Answer Bats?

Barber, Jesse R., and William E. Conner, Wake Forest University, Winston-Salem, NC

In the aerial combat of bats and moths one group of moths answers the bisonar attack sequence of bats with its own crescendo of ultrasonic clicks. We know very little of the diversity of sounds produced by the over 11,000 species of these tiger moths. The cloud forests of Ecuador contain perhaps the greatest diversity of tiger moths on the planet. We surveyed this population for sound production in response to varying levels of tactile stimulation and in response to a recorded bat echolocation attack sequence. Three main hypotheses exist for the functions of these moth clicks: momentary startle, jamming of the bat's echolocation system, and warning of the moth's poisonous nature. Each proposed function assumes particular conditions under which moths should emit their sounds and also what kind of sounds they should emit. For example, if a moth is attempting to jam a bat's biosonar, it need not respond to tactile stimulation, its call should be complex (to occupy as much acoustic space as possible), and its call should be locked to the terminal phase of the bat's echolocation sequence. However, if the moth is warning the bat of the distasteful chemicals it has sequestered earlier in life, it should respond readily to tactile stimulation and should respond early in the bat's attack sequence to give the animals time to recognize the warning of unpalatability. Over 140 species of tiger moths were assayed. Eighty of these produced sound in response to either tactile or ultrasonic stimulation.

Determining Bat Species Composition Using Call Analysis

Beck, Jason, and Cordell Peterson,
Southern Utah University, Cedar City, UT; Utah Division of Wildlife Resources, Cedar City, UT

Anabat files have been collected during field seasons for seven years in conjunction with the Bats and Gated Mines Project in southern Utah. The vast majority of the collected calls had not been analyzed due to three key problems: classification to species was inconsistent, large numbers of calls had been collected, and there was a general lack of confidence in Anabat data. Consistent classification was addressed by creating dichotomous keys to Anabat calls, with only bats known to occur in the area included. Criteria were obtained from a number of sources, including summaries from the Anabat manual, characteristics from hand-released calls in the immediate area and characteristics from USBats hand release calls. Bats were captured monthly at mine entrances to obtain verified calls and for baseline data of species composition. Captured bat call files were then used to compare accuracy of species composition as determined through Anabat call analysis. Much larger data sets were obtained and analyzed than in any previous year. Anabat had detected all species of captured bats in the area prior to capture; however, nearly three times as many species were detected with Anabat than netting at mine entrances. Sample size was much larger for Anabat than for capture (n=1150, n=15 at WH-48). Trends in species composition for *Corynorhinus townsendii*, a mine obligate, were similar for both survey methods. Call analysis has been a valuable tool for detecting species in our study areas and for determining relative species composition. The use of the dichotomous key has increased the effectiveness of using Anabat for our bat surveys. In this study, detection of species and determination of species composition using Anabat has been more effective than mist netting and other capture techniques, providing larger sample size over a larger survey area.

The Five W's of Colour Patterns in Bats: Who, What, Where, Why and When

Blasko, Jen, York University North York ON

Bats show considerable variation in appearance with respect to pattern and colour of pelage. Using specimens in the collections of the Royal Ontario Museum (Toronto), I described, quantified and categorized the pelage of approximately 600 species of bats, noting the presence and details of patterns. The first step was to determine what exactly constitutes a pattern. For example, patterns most commonly occur as white or yellowish stripes or spots on a darker brown to black background. However, there are other patterns, such as epaulettes and neck ruffs. Then I determined which species showed pelage patterns and the variation in patterns according to gender and location. Using a Minolta LS 110 luminance meter, I measured the refraction of light (in cd/m^2) from the dark and light portions of the bat's pelts to establish a quantitative measure for examining contrast levels associated with various pattern types. I then used these values to look for consistencies and differences between individuals of a species and between species as a whole. I will discuss the nature and variety of patterns and their distribution across species from both ecological and behavioural as well as phylogenetic perspectives. My data suggest that pelage patterns in bats are much more variable between species and location then they are within a given species or geographic area. Roosting behaviours appear to be more closely correlated with the occurrence and type of patterns than phylogenetic relationships.

Home Range and Feeding Behavior of *Carollia castanea* and *C. perspicillata* (Phyllostomidae) in Amazonian Rainforest: Exploitative Competition

Bonaccorso, Frank J., John R. Winkelmann, Thomas H. Kunz, Caroline I. Agrawal, Nadia Aslami, Andrea Hsu, Phoebe E. Jekielek, Allison K. Knox, Stephen J. Kopack, Tara D. Jennings, Jesse R. Lasky, Sarah A. Menesale, Jeannine H. Richards, Jessica A. Rutland, Anna K. Sessa, Danny Shin, and Luba Zhaurova
Boston University, Boston, MA; Gettysburg College, Gettysburg, PA

Chestnut short-tailed bats, *Carollia castanea*, and Seba's short-tailed bats, *C. perspicillata* (Phyllostomidae), were monitored by radio-telemetry in lowland rainforest over 25 days at the Estacion de Biodiversidad Tiputini, Yasuni National Park, Orellana Province, Ecuador. Based on 1,100 radio-telemetry and netting positions, mean home range for seven individuals of *C. castanea* was 7.6 ± 2.1 ha and mean core-use area was 2.1 ± 0.9 ha. The mean long axis of home range for *C. castanea* was 438.9 ± 100.6 m. Activity was associated with clumps of fruiting *Piper hispidum*, *Cecropia sciadophylla*, and *Miconia* spp. During the day, groups of ≤ 3 *C. castanea* roosted under soil ledges among root masses of undercut riverbanks along the Tiputini River, and showed fidelity to day-roost sites. *Carollia perspicillata* used tree hollows and buildings as day-roosts. For *C. perspicillata* 243 telemetry and netting positions on four individuals were obtained; mean home range was 6.2 ± 1.9 ha, mean core-use area was 1.8 ± 0.8 ha, and mean long axis across home range was 463.5 ± 108.6 m. Core-use areas of all individual *C. perspicillata* contained at least one clump of fruiting *Piper hispidum*. Overlap in home ranges within and between species of *Carollia* occurred primarily in clearings and young regrowth forest where dense clumps of *Piper hispidum* and *Cecropia sciadophylla* occurred. Both *P. hispidum* and *C. sciadophylla* were highly clumped in distribution. *C. perspicillata* handles piper fruits significantly faster than *C. castanea*, however *C. castanea* emerges earlier in the evening to commence foraging before *C. perspicillata* leave the day-roost. Ninety-seven percent of the available ripe fruits of *P. hispidum* were harvested by bats between a single sunset and sunrise (n = 58 marked fruits) indicating that exploitative competition for piper fruits is intense. *Piper hispidum*, the most abundant of the Piperaceae at Tiputini, produces a few ripe infructescences per night per plant and the population of *P. hispidum* continues to produce ripe fruits from at least late October to mid-January. Because *P. hispidum* represents a steady-state and nutritive food resource, individual *C. castanea* and *C. perspicillata* have stable core-use areas within their home ranges over periods of at least several months.

Late-winter and Summer Roosting Habits of the Evening Bat (*Nycticeius humeralis*)

Boyles, Justin G., and Lynn W. Robbins, Southwest Missouri State University, Springfield, MO

Evening bats (*Nycticeius humeralis*) are a relatively common bat in the eastern United States, but very few studies have focused on habitat selection in the species. In order to determine summer and winter roosting preferences of evening bats, we conducted a radiotelemetric study on the Drury/Mincy Conservation Area in southwest Missouri. This presentation discusses the work from March until August—covering both late winter and summer work. Captures in early March suggest that *N. humeralis* is a year around resident at the study site, and field work will continue during the upcoming winter to evaluate this claim. We captured 123 evening bats from March through August and banded or PIT tagged 82 of them. Ten adult females were fitted with radiotransmitters and used a total of 24 different trees. Exit counts at maternity roosts ranged from 18 to 102. The data suggest that pregnant female *N. humeralis* prefer to form maternity colonies in dead oak trees (*Quercus* sp.), but they utilize live and dead trees almost equally during other times of the summer. Five adult and two juvenile males were radiotransmittered and used a total of 13 different trees. Adult males were found almost exclusively in live trees of various species, while juveniles used both live and dead trees. Roost trees were found to be within 250m of a forest opening more often than randomly selected trees, and canopy cover was lower on roost trees than random trees.

Inter- and Intra-specific Variation in the Roosting and Foraging Ecology of *Myotis septentrionalis* and *M. lucifugus*

Broders, Hugh G., and Graham J. Forbes
University of New Brunswick, Fredericton, NB, Canada

In the Greater Fundy National Park Ecosystem only two species of bats are common: the northern long-eared bat (*Myotis septentrionalis*) and little brown bat (*M. lucifugus*). From 1999-2001 we studied spatial aspects of the roosting and foraging ecology of these species to determine the variability in behaviour within and among species. Despite the presence of only two species there were actually four ecologically distinct groups in terms of roosting and foraging. Using radio telemetry we determined that male *Myotis septentrionalis* roosted alone, and switched among a suite of diurnal roosts that occurred in an area <2 ha. They foraged in the forest interior in an area that overlapped roosting areas. Female *M. septentrionalis* roosted at communal sites with other females, and also switched between roost sites regularly, but they moved further between successive trees than conspecific males (their roosting area was on average 8.6 ha). Unlike males, females used foraging areas that were spatially separated from their roosting areas suggesting that suitable roost sites did not occur within suitable foraging areas. Male *M. lucifugus*, like male *M. septentrionalis*, roosted alone in a suite of roost trees in a 4 ha area. Like female *M. septentrionalis*, male *M. lucifugus* foraged at sites spatially separated from their roosting areas. They foraged in a variety of habitats, but were selective of water sites and hardwood forest stands. Female *M. lucifugus* roosted in buildings outside the core of the study area and were rarely captured in the forested landscape where the efforts for this study were directed. The best predictors of the magnitude of *M. lucifugus* activity, as measured by ultrasonic detectors, at a site on a particular night were temperature and site-type. The only landscape metric of any importance in explaining this activity was the amount of softwood surrounding the sampling site, probably indicating the quantity of roosting habitat. Of the three forest-dwelling bat-groups, female *M. septentrionalis* used the largest landscape area and foraged the longest suggesting that they were under greater energetic constraints.

Baseline Surveys and the Developing of Monitoring Protocol for Lower Colorado River Bats

Brown, Patricia E., and Robert D. Berry,
U.C.L.A. Los Angeles, CA; Brown-Berry Biological Consulting, Bishop CA

We have been studying bats along the Lower Colorado River (LCR) for 35 years. Since 2001, we have been involved in the LCR Multi-species Conservation Program (MSCP) with the following goals: to provide a better understanding of the past versus current bat assemblage along the LCR; to establish a long-term monitoring protocol for bats utilizing current acoustic technology; to identify potential species-specific threats to bats; and to assist in the protection of critical roosts. European man has drastically changed the natural habitat of the Colorado River over the past 150 years. The miners of the 1860s were followed by ranching and agriculture, and more recently by urban and recreational developers. Steamboats have been replaced by jet skis. Dams (for power, flood control and water export), bank stabilization, and channelization have altered the flow and flood patterns, salinity and plant communities of the LCR. The decline of the native vegetation, most notably the cottonwood/willow riparian, and its replacement by exotics, especially salt cedar, continues unabated. This vegetative change has affected the faunal composition, with bird species being the best documented. Historically, the LCR sustained a diverse bat assemblage of at least 14 species. Over the past 50 years, declines have been documented in some bat species, such as the cave myotis (*Myotis velifer*) and Townsend's big-eared bat (*Corynorhinus townsendii*), that were at one time relatively abundant along the LCR. Large deposits of the distinctive guano of these colonial species are found in abandoned mines that border the River, although the bats are now absent or present in very small numbers. Only four maternity colonies of cave myotis are now known along the LCR. The Arizona myotis (*Myotis occultus*) appears to have disappeared from the LCR, with the last museum specimen collected in 1945. The type locality for this species was Ft. Mojave north of Needles. One hypothesis for the decline of some bat species is the removal and replacement of native floodplain vegetation that supported the insect diets of these bats. Another is the heavy pesticide spraying in agricultural areas (conducted principally at night) that directly reduces the preybase and indirectly poisons the bats. A third is the disturbance of roosts by the increased resident and recreational human population along the Colorado River.

Chiropteran Community Composition along a Sonoran Desert Riparian Corridor

Buecher, Debbie C., University of Arizona, Tucson, AZ

Sabino Canyon is a Forest Service managed recreational area adjacent to Tucson, Arizona. Such close proximity to a large metropolitan area ensures heavy visitation (> 1.4 million visitors/year) to this popular Sonoran Desert riparian oasis. In addition, two consecutive years of major forest fires (Bullock Fire 2002 and Aspen Fire 2003) in the upper watershed of this rugged canyon environment has provided additional pressure on a resource already impacted by recent years of drought. Evaluation of the chiropteran community structure along this Sonoran Desert riparian corridor suggests the resource is critical for many species. Year-round mist netting over semi-permanent pools in a mixed riparian and arid southwestern desert habitat indicates that 17 species of bat will use a 3-mile reach of canyon to obtain water and/or forage for insects. Both winter and summer use of water holes by bats indicates the importance of these temporally variable pools in an arid environment. Partitioning of water resources can play an important role in community structure, and ongoing work includes evaluation of water hole parameters to determine possible dynamics contributing to species preference. Besides evaluation of population and community structure, this study includes development of a call-library through hand-releases to aid in long-term monitoring of the community. Given the many pressures on this unique environment, this study will provide forest service personnel with information on how bats use

the riparian habitat, which will be useful when making long-term management decisions regarding recreational use of this desert resource.

Evolution of the Bare-backed Fruit Bats, *Dobsonia* (Pteropodidae)

Byrnes, Deanna G. P., University of Wisconsin, Madison, WI

The genus *Dobsonia* comprises approximately 13 species ranging from the central Philippine to the Solomon Islands. Each species has a fairly restricted geographic distribution, though most occur sympatrically with another *Dobsonia* on at least some islands in their range. From what has been published about *Dobsonia*, it appears that sympatric pairs differ in size and primary roosting preferences - one being a more solitary foliage rooster, and the other a colonial cave rooster. Each of the species making up a sympatric pair also represents a different 'natural group' as described by Knud Anderson (1909, 1912) based on the morphology of the premolars and molars. I am currently constructing a complete molecular phylogeny for *Dobsonia*, which will be overlaid with the pattern of single and paired island endemics and their behavioral and morphological differences, and which will provide a framework to help us understand the process of diversification and speciation. Using a preliminary phylogeny based on partial sequences of *cytochrome-b*, and results from my and others' recent morphological studies, I show that Anderson's 'natural groups' do obtain, and will discuss scenarios for the evolution of the genus in light of the geographic history of this region.

Effects of Prescribed Fire on Cave Environment and Bat Inhabitants

Caviness, Michelle, University of Arkansas / USDA Forest Service, Grants, NM

Fire has always been an important ecological force around the world. Before indigenous peoples and subsequent immigrants, nature (lightening-induced fire) shaped the landscape. Today fire is used as an important ecological tool by foresters and wildlife managers to reduce fuel accumulations, to prepare sites, and to maintain diversity of forests. To date, the effects of fire on cave fauna have not been investigated. Areas surrounding various caves in the Boston Mountain Ranger District of the Ozark National Forest were included in a scheduled prescribed burn for the winter of 2003, several of which are inhabited by hibernating bats including the endangered Ozark big eared bat (*Plecotus townsendii ingens*) and the more common Eastern Pipistrelle (*Pipistrellus subflavus*). In an effort to address concerns about the effects of fire, four caves located in the Whitzen Hollow watershed included in the prescribed burn provided an opportunity to assess the influence of fire on these cave environments as well as their associated organisms. These caves were visited before, during and after the prescribed fire. Fuel levels around the caves were noted and recorded. Data loggers recording temperature and relative humidity in 15 minute intervals were placed in both the twilight and dark zones of each cave a month prior to the burn and were left two weeks after. Bat counts were made during each visit. On the day of the fire air quality measurements (carbon dioxide, methane, hydrogen sulfide, and oxygen) were made before, during and after the event in a selected cave. There was no notable influence on bat behavior or measurable effects on the hibernating bats. All bats present in caves at the beginning of the burn were still present when the burn was completed. Bat numbers in the caves were actually found to have increased several days after the burn. There were minute changes in relative humidity and temperature during the burn. Elevated short-term levels of some contaminants were noted (carbon dioxide, hydrogen sulfide). Toxic levels for hibernating bats have not been identified. All bats that were hibernating prior to the burn were still in full hibernation after the burn. Further research is recommended in order to establish toxic smoke level standards for bats and to determine impacts of firing activities around cave entrances.

Mummified Remains of Spotted Bats (*Euderma maculatum*) Indicating Historic Roosting Habitat in Eastern Grand Canyon, Arizona

Chambers, Carol L., David G. Mikesic, Mikele L. Painter, Tad Theimer, William O. Noble, Jim I. Mead, and Michael J. Herder,
Northern Arizona University, Flagstaff, AZ; Navajo Nation Department of Fish and Wildlife, Window Rock, AZ; Kaibab National Forest, Fredonia, AZ and Williams, AZ; U.S.D.I. Bureau of Land Management Arizona Strip Field Office, St. George, UT

The spotted bat (*Euderma maculatum*) occurs in western North America from central Mexico to southern British Columbia, Canada, from the Pacific states to the Rocky Mountains. Although widespread, the species is rare, distribution is patchy, and ecology is not fully understood. In British Columbia, Texas, Arizona, and Utah, observations of spotted bats indicated that the bats typically used cracks and crevices in cliffs for day roosts; cave-roosts were reported only twice in the literature prior to 1995. In 1995, a mummified spotted bat was discovered in a limestone cave (1,530 m elevation; Great Basin desert scrub habitat) in eastern Grand Canyon on Navajo Nation lands in northern Arizona. The precise location of the cave is withheld at the request of the Navajo Nation. Using radiocarbon analysis (accelerator mass spectrometer technique), the bat was dated as 9180 ± 50 radiocarbon years old (^{14}C years Before Present [B.P.]; calendar calibration of BC 8130). Eleven other bat mummies were located at that time; at least six were *Euderma maculatum*. Mummies were in various stages of preservation, but were identifiable as spotted bats from hair on their dorsal surface. In 2003, we retrieved the six spotted bat mummies and submitted five of them for radiocarbon dating. Mummified remains dated from <50 yrs B.P. to 2110 ± 40 yrs B.P. (ages were: <50 yrs B.P., 120 ± 40 yrs B.P., 300 ± 30 yrs B.P., 1450 ± 40 yrs B.P., 2110 ± 40 yrs B.P.). Because mummified remains were documented as dating from present to >9000 yrs B.P., we suspected that spotted bats likely used this roost since the early Holocene. Spotted bats currently use this cave for day roosting from at least May to October, making it the only known long-term stable cave roost for the species.

The Effect of Post-logging Forest Recovery on a Neotropical Bat Community

Clarke, Frank M., Luke Rostant, and Paul A. Racey, University of Aberdeen, Aberdeen, Scotland, UK

There is considerable debate about how best to conserve forest biodiversity. Some urge that more forest is included in reserves and protected areas, whereas others believe that forests can be managed in a sustainable way that conserves biodiversity. The reality is that only a small proportion of tropical forest is adequately protected in national parks and reserves and logging of most of the remaining unprotected forest appears inevitable. Sustainable exploitation of tropical forests may be the most realistic way of conserving biodiversity outside protected forest reserves and polycyclic systems of selective logging may be a viable and sustainable land use option. In SE Trinidad part of the Victoria-Mayaro Forest Reserve is logged using the Periodic Block management system, a polycyclic selective system that incorporates a set of ecologically sensitive extraction procedures supposed to benefit wildlife. It has been hailed by the World Bank as an example of a 'best practice' management system. Typically each year one block of forest is logged and then closed for around 30 years to allow forest recovery, before being harvested again. To develop sustainable logging systems that conserve biodiversity, it is of paramount importance that we understand how faunal and floral communities are affected by logging. This information can be used to include into management practices measures to maintain biodiversity. It is important to determine the responses of bats to forest disturbance brought about by logging. Their numerical abundance, diversity, and the fact that they play key ecological roles in tropical forests, may make them model taxa for evaluating the effects of management activities on tropical forests. Previously our research in Trinidad has focused on how methods of logging affect biodiversity by evaluating the responses of bats to different systems of natural forest man-

agement. Here we discuss the results of our investigation into the effects of post-logging forest recovery on a neotropical bat community over a full harvesting rotation. Fieldwork was conducted between 2000 and 2002. We trapped bats in primary forest and in five blocks of forest logged 33, 31, 21, 20, and 10 years previously, using a wide variety of standardised sampling methods. Preliminary analysis shows that though alpha diversity decreases following logging, there is strong evidence of bat community recovery with post-logging forest recovery suggesting that the logging system is largely sustainable.

Local Schools as Partners in Bat Research

Coltrain, Pamela, Ricky Parren, and Stephen Burnett
Clayton College and State University, Morrow GA; Morrow High School, Morrow GA

Research aimed at studying bat behavior and ecology often suffers from a requirement for large amounts of labor to achieve worthwhile results. Often such labor is difficult to obtain because of lack of funding or other logistical difficulties. We describe the results of an initial partnership with local schools as a source of equipment, expertise, and labor that would be expensive to obtain from other sources. Our initial project used a local high school program to have students build bat boxes using plans produced by Bat Conservation International. Because the labor was provided for free, we were able to build a larger number of boxes than would otherwise have been possible. We will discuss the benefits and challenges of such a program, as well as possibilities for further expanding this research partnership into other areas.

Impacts of Landscape Transformation on Bat Activity and Diversity in Puerto Rico

Cruz, Wilmarie, and Armando Rodríguez-Durán
Inter American University of Puerto Rico-San Germán; Inter American University of Puerto Rico-Bayamôn.

We report the completion of a study where we examined differences in bat activity among urban, rural, and forest areas on the island of Puerto Rico, to assess the impact on density and diversity due to human transformation of landscapes. Four study sites were selected: (1) Mata de Plátano Field Station, a forest in the northern karsts country of the island; (2) Hacienda Buena Vista, a forest in the southern slope of the Cordillera Central, the island's central mountain range; (3) Hacienda La Esperanza, an agricultural area in the northern coastal plain; and, (4) The Botanical Garden, a wooded area at the heart of the San Juan metropolitan area. At each site we set 51m of mist nets and an ANABAT station to assess bat activity. We also ran an ultraviolet light trap to compare insect abundance among study sites. Our results reveal differences among study sites, showing greater diversity of species and numbers of individuals in forested areas as compared to transformed areas. At Hacienda Buena Vista, an abandoned coffee plantation, we captured an average of 13 bats per night, as compared to 0.46 bats per night at Hacienda la Esperanza, a mosaic of active pastures and a few karstic hills covered by forest. The Botanical Garden revealed a capture rate as high as that of the forest areas. However, with only four species, the diversity at the Botanical Garden was as low as that of Hacienda La Esperanza. The two forest areas exhibited the highest diversity, eleven species at Mata de Plátano and ten at Hacienda Buena Vista. A total of 13 extant species of bats are known from the island. A multiple regression analysis considering nine variables reveals that study site and time of the year are the best predictors of the number of bats captured with mist nets or detected with the ANABAT. We examine aspects of the study sites, such as geographic location and vegetation cover, that may help explain these differences.

Oligocene and Early Miocene Noctilionoid Bats from Florida, USA

Czaplewski, Nicholas J., and Gary S. Morgan
University of Oklahoma, Norman, OK; New Mexico Museum of Natural History, Albuquerque, NM

Several Oligocene and Miocene localities in Florida have produced abundant microvertebrate fossils including rare specimens of Chiroptera, a group with a sparse Tertiary record in North America. At two of the localities, I-75 and Brooksville 2, the bats include several specimens of a large and a small species that are the earliest known representatives of the Noctilionoidea. The specimens represent two new species, both belonging to an undescribed new genus, and possibly a new family. The samples overlap in including an upper molar of each species; except for size, this tooth is identical in the large and small species. The large species is approximately the same size as the extant greater spear-nosed bat (*Phyllostomus hastatus*); the smaller, near the size of the pale-faced bat (*Phylloderma stenops*). Only the large species is present in the Brooksville 2 fauna, where a better sample is available including an upper molar and all lower teeth except the incisors. Preliminary parsimony analysis of available dental-osteological data suggest that the new bats are sister to a phyllostomid-mystacinid-mormoopid clade, which in turn is sister to Noctilionidae. The Brooksville 2 local fauna is judged by recent authors and us to represent the late early Arikareean (about 25-28 Ma; late Oligocene). Each of the bat species is represented by a single tooth in the I-75 local fauna, which we interpret as being late Whitneyan LMA (about 30 Ma; late early Oligocene) in age. The age of these specimens more than doubles the known time depth of the noctilionoid lineage, previously known back to 12-13 Ma in South America. Both of the localities reflect deposition in paleokarstic situations and suggest a probable cave-dwelling habit for the bats. Several other families of bats also occur in various other late Oligocene and early Miocene sites in Florida (Emballonuridae, Mormoopidae, Natalidae, and Molossidae). Biogeographically, the occurrence of the new noctilionoids and these other families in what is now peninsular Florida, where these Neotropical groups no longer exist, bolsters other faunal data suggesting a subtropical to tropical aspect to the Florida paleoenvironment in the middle Tertiary, and a Neotropical influence or possible tropical North American origin for the Noctilionoidea.

Radiotelemetry Techniques for Tracking Bats at Night: How to Maximize Quality and Quantity of Data

Dalton, David C., and Sandy A. Wolf, Tucson, AZ

Tracking radio-transmittered bats at night is necessary to obtain information on foraging, home range, and night roosts; it can also lead to the discovery of new day roosts. Of course, tracking bats at night is difficult. Locations of bats are obtained solely through triangulation of bearings taken simultaneously, thus the quality of data depends on the quality of bearings and the coordination of trackers. The radio transmitter itself is small and produces a relatively weak signal, one whose strength varies continuously as the bat flies. Bats fly relatively fast, making it difficult to obtain accurate bearings, and they often fly low to the ground, exacerbating problems with radio shadows, refraction, and reflection. We present several techniques, developed over the past decade, that maximize the accuracy of bearings and the quantity of data collected. Five-element antennae, which improve directionality and sensitivity, and transmitters with a fast pulse rate are part of this protocol. Our equipment setup and data-recording systems minimize tracker error and fatigue, and allow trackers to obtain bearings at 1-minute intervals all night long. We establish tracking stations at high elevations with good radio coverage to detect more radio signals and minimize bearing errors caused by shadows, refraction, and reflection. Beacon transmitters at known locations are used to test equipment and detect bearing errors attributable to magnetic anomalies. A central coordinator plots incoming data throughout the night, keeps trackers operating at maximum efficiency, and guides data collection to increase the value of information obtained. Although implementing these techniques is hard work, we believe high-quality results justify the effort.

*Historical Biogeography of the Bats of the West Indies

Dávalos, Liliana M., American Museum of Natural History and Columbia University, New York

The historical biogeography of Caribbean bats, the most speciose mammals on the Antilles, provides evidence to discriminate between models of diversification based on vicariance or dispersal. The objective of this study was to test the congruence among area relationships derived from bat phylogenies and those derived from other organisms, as well as current hypotheses of geological history. *Cytochrome b* sequences for the entire range of five monophyletic bat clades: *Mormoops*, *Pteronotus*, *Brachyphylla*, the subtribe Stenodermatina, and the family Natalidae were generated or compiled including several exemplars of all named subspecies. By combining these new data with morphological and nuclear molecular characters, the most corroborated phylogenies for these groups were obtained. These phylogenies were analyzed using cladistic biogeography, reconciled trees, dispersal-vicariance, ancestral area, and nested clade analysis. Results of these analyses challenge longstanding assumptions about the origin and diversification of the Caribbean chiropteran fauna, such as the monophyly of island populations of Antillean endemics, or the relatively minor role hitherto assigned to vicariance in shaping bat faunas. The phylogenies of Antillean endemic bats do not support a single hypothesis of area relationships, but rather reflect the effect of plate tectonics, changing continental margins, and habitat availability in the Caribbean.

*** Liliana Dávalos** received the **Karl F. Koopman Award**

The Force Is with Them: Bats Evade the Dark Side (West Nile Virus)

Davis, April D., Richard A Bowen, and Michael L. Bunning
Colorado State University CO; Center for Disease Control, CO

Like the numerous species of birds in the class of Aves, the species diversity within the Order Chiroptera is extraordinary. There are over 900 species in the order Chiroptera found throughout the world. This study focuses on two of the most numerous species found within the United States, *Tadarida brasiliensis* (Mexican free-tailed bat) and *Eptesicus fuscus* (big brown bat). They are likely to live within or nearby urban populations and come into contact with humans with high frequency (Fenton, 2001). *Tadarida brasiliensis* (Tb) are migratory and millions of bats fly between the southern United States and Latin America every year. If Tb were found to be vectors, this yearly event could promote the spread of West Nile Virus (WNV) into countries currently free of the disease. These two species of bats, Tb and *Eptesicus fuscus* (Ef) were tested for viremia and the presence of neutralizing antibodies against WNV. The purpose of this study is to elucidate the role bats might play as a vector in the WNV transmission cycle. We tested twenty-seven Tb, none of which were found to have viremia at any point in the study. Of the 27 Ef we tested for viremia, seven were seen to have viremia. The levels of viremia from these seven bats were very low ($1.8x10^2$), below the level that is considered infectious to feeding mosquitoes. The serology results were surprising; none of the bats developed a significant level of neutralizing antibodies. One hundred fifty eight bats from Louisiana were tested for antibodies, but only two were found to be seropositive. The results of our study indicate that bats play a very small role, if any, in the transmission cycle of West Nile Virus.

Rising to the Challenge: Exposing *Eptesicus fuscus* to Rabies Virus

Davis, April D., Richard A. Bowen, and Tom J. O'Shea,
Colorado State University, CO; United States Geological Service, CO

Rabies has long been considered an invariably fatal disease. However, exposure to rabies does not always lead to productive infection and disease. Anti-rabies virus neutralizing antibodies

(VNAs) have been found in several species of wild animals, including raccoons, dogs, insectivorous bats, non-human primates, marsupials, and rodents. These animals were healthy at the time of sampling, and those that were followed remained healthy. The quandary of VNA in animals has not yet been elucidated. Some believe they may indicate future infection; some believe it is indicative of past exposure resulting in immunization. Our study supports the idea that the majority of bats exposed to rabies does not develop clinical disease and may become immunized against the disease. We inoculated 29 seronegative and five seropositive bats with unpassaged rabies virus suspension from the salivary glands of two *Eptesicus fuscus*; all but nine seroconverted within two weeks. Four weeks after inoculation, only three had not seroconverted. Five bats died of rabies during the study, all within the first six weeks. Five bats that were seropositive at the beginning of the study were also inoculated with rabies. Their level of VNAs rose far above that of the bats that were seronegative at the start of the study. None of these bats developed rabies. Our results indicate that bats are able to survive a large dose of rabies virus and produce an antibody titre that would be considered protective in humans.

Re-defining Our Understanding of *Myotis lucifugus* Identity and Distribution

Dewey, Tanya A., Jan Zinck, and Maarten Vonhof
University of Michigan Museum of Zoology, Ann Arbor, MI; Portland State University, Portland, OR; University of Tennessee, Knoxville, TN

Several North American *Myotis* species are notoriously difficult to distinguish morphologically, especially in the field. An improved knowledge of the patterns of genetic variation within and among these morphologically similar species may profoundly alter our understanding of specific and sub-specific distributions. An excellent example of this is the species pair *Myotis lucifugus* and *Myotis occultus*. *Myotis occultus* has been variously considered a distinct species or a subspecies of *Myotis lucifugus*. The genetic distinctiveness of *Myotis occultus* was recently recognized by Piaggio et. al. (2002). Recent analyses of patterns of *cytochrome-b* variation among North American *Myotis* species suggests that *Myotis occultus* may be much more widely distributed than previously thought and argues for a re-evaluation of lineage identities within the traditionally recognized *Myotis lucifugus-occultus* group. Because *Myotis lucifugus* is one of the most extensively studied bat species worldwide, a continent-wide analysis of genetic variation and lineage identity is crucial in interpreting the results of previous research.

*Estimating the Probability of Detection for Remotely Set Bat Detectors: An Application of the Double Detection Method

Duchamp, Joseph E., Mark Yates, Rose-Marie Muzika, and Robert K. Swihart
Purdue University, West Lafayette, IN; University of Missouri, Columbia, MO

Bat detectors are increasingly being used in survey efforts. Differential detectability is a concern when using this tool, both among study areas and species. A recently developed avian survey technique uses two observers at a site to estimate the probability of detection by comparing the species recorded independently by the two observers. We applied this method to bat surveys using remotely set ANABAT detectors. Our sample points were randomly selected across forested sites within two watersheds in Indiana and one in Missouri. We set two detectors at each sample point. The first detector was oriented toward the most open area of forest, and the second detector was set 5m away and oriented toward the most open area that allowed sampling of an area independent of the first detector. Detection probabilities were estimated using program MARK. We estimated the overall probability of detection of bats to be 0.69 using two detectors. We also made preliminary estimates of the detection probability for five species as identified using discriminant function analysis. *Myotis sodalis* had the lowest detection probability (0.38)

and *Eptesicus fuscus* had the highest detection probability (0.60). In our study sites and for the bat species surveyed, the use of two detectors at each sample point appears to be warranted.
***Joseph Duchamp** received the **Speleobooks Award**

Modeling Bat Species Occurrence at Whiskeytown National Recreation Area, California using Logistic Regression and Ordinary Point Kriging: Preliminary Results

Duff, Andrew A., and Thomas E. Morrell, Ball State University, Muncie, IN

Predicting species occurrence based upon landscape scale characteristics is a fundamental goal of ecology and conservation biology. Accurately predicting the potential occurrence of a species is particularly important to management activities that involve large areas where sampling is difficult due to logistical or financial constraints. We employed two different methods to model the distribution of bats in Whiskeytown National Recreation Area (WNRA), a rugged 17,000 ha park located in north-central California. From 19 June to 9 August 2002 we used mist nets to capture bats at 30 sites. Two different methods, logistic regression and ordinary point kriging were used to develop predictive probability models for *Eptesicus fuscus*, *Myotis yumanensis*, and all species combined. Logistic regression was used to determine which landscape-scale variables best discriminated between sites where a species was captured and sites where they were not captured. Regressions were performed on four competing models that were developed *a priori*. Second order Akaike's information criterion (AIC_c) was used to select the most parsimonious model ($\Delta_i = 0$). Predictive occurrence maps were generated using the regression equation coefficients, the log probability formula and Geographic Information Systems data in ArcInfo 8. A surface water model was the most parsimonious for both species. However, a landscape connectivity model was the best fitting model when all species were combined. The second modeling approach used a geostatistical interpolation method, ordinary point kriging, to examine spatial patterns in bat species relative abundances throughout the park. This approach incorporates spatial autocorrelation among sampling sites by using semivariograms to predict the probability of any site in the park (sampled or not) of having a relative abundance (m^2 net effort per hour) of $\geq$1 bat. Contoured surface maps were generated from the results using 0.8 and 0.9 probability cutoff points. Compared to logistic regression based maps, kriging maps ranged from being highly concordant (*M. yumanensis*), to being discordant (*E. fuscus*).

Diversity and Constraint in Cranial Shape Among Plant-visiting Bats

Dumont, Elizabeth R., University of Massachusetts, Amherst, MA

The dietary adaptations of mammals are commonly reflected in the morphology of their skulls, and many studies of bats have documented associations between cranial morphology and diets of insects, fruit, nectar, and small vertebrates. Plant-visiting bats have evolved independently within the families Phyllostomidae and Pteropodidae. Although all plant-visiting bats appear to use olfaction during foraging and to exhibit relatively large eyes, enlarged brains, and reduced molar complexity in comparison to their insectivorous relatives, the skulls of the two families look very different. The goal of this study is to identify fundamental differences in cranial shape between pteropodids and plant-visiting phyllostomids and to investigate patterns of constraint and variation in cranial form within each lineage. Results of a step-wise discriminant function analysis indicate that differences in skull shape between pteropodids and plant-visiting phyllostomids involve general aspects of braincase width, palate width, and coronoid process height. Pteropodids have relatively narrow skulls and palates and dentaries with tall coronoid processes, while phyllostomids have relatively wide skulls and palates and short coronoid processes. Principle components analysis and an investigation of statistics for coefficients of variation reveal that although a few elements of cranial shape are highly variable among pteropodids, cranial shape is more conserved within Pteropodidae than within Phyllostomidae.

One possibility is that the different patterns of variation and constraint reflect the importance of different sensory modalities in the two groups. The skull is not simply a tool for feeding, but accommodates the competing demands of the visual, olfactory, auditory, and nervous systems. The pteropodid reliance on vision (and need to support and protect the eyes) may limit the range of potential re-arrangements of the skull to optimize the feeding apparatus over evolutionary time. On the other hand, the phyllostomid reliance on a combination of echolocation and vision may constrain a few regions of the skull but allow others to vary. Further analyses of development, evolution, biomechanics, and sensory ecology are needed to fully address this idea.

Using PIT Readers and Mark-Recapture Approaches to Study Survival and Movements of Big Brown Bats (*Eptesicus fuscus*) in Fort Collins, Colorado

Ellison, Laura E., Thomas J. O'Shea, Daniel J. Neubaum, and Richard A. Bowen
U. S. Geological Survey, Fort Collins Science Center, Fort Collins, CO; Animal Reproduction and Biotechnology Laboratory, Colorado State University, Fort Collins, CO

We used passive integrated transponders (PIT tags) and PIT readers to examine the short-term daily survival, over winter return rates, and movements of big brown bats (*Eptesicus fuscus*) that roosted in maternity colonies in Fort Collins, Colorado. This effort is part of an ongoing research project investigating rabies transmission in commensal bat colonies in an urban setting. We PIT tagged and released more than 4,000 individuals during the summers of 2001-2003, and monitored their presence at up to 24 different buildings using PIT readers. We also captured individuals by hand at these roosts to gather individual measurements and sample blood for the rabies virus (under anesthesia). We specifically addressed the following questions: 1) How do apparent survival and capture probabilities differ between hand capture (netting) events and PIT reader encounters?; 2) Is there an effect of bleeding and anesthesia on short-term daily survival and one-year return rates of adult and juvenile big brown bats?; 3) What are the over-winter return rates for marked individuals?; and, 4) What is the frequency of movement within roosts and among roosts, and what factors influence these movements? We used Program MARK to estimate short-term survival and capture probabilities by roost, age class, and bleeding history. Capture probabilities varied by roost and were substantially lower for hand capture events than for PIT reader encounters. Hand captures in 2002 failed to detect 57.4% (253 of 441) of the bats marked in 2001 that were registered by PIT readers in 2002. We found no difference in short-term survival over 14 days post-bleeding for individuals anesthetized and bled compared to those individuals not sampled for blood. Return rates from 2001 and 2002 were high. The 2002 return rates for bats that were captured, anesthetized and bled at the largest colony in 2001 were nearly 90% for adult females and 77% for juvenile females. Movements among and within roosts were frequent. Seven bats captured and marked at roosts during summer 2001 switched to different roosts in 2002. Thirty-nine individuals moved between two roosts during 2002 and one bat moved among three roosts. Using multi-strata models in Program MARK, we will present results on estimates of movement probabilities for female big brown bats in relation to ambient temperature, date, ectoparasite loads, and reproductive status. We also present preliminary estimates of annual survival using PIT readers and mark-recapture techniques.

Flocking Bats?

Fenton, M. Brock, University of Western Ontario, London, ON, Canada

The purpose of this presentation is to explore the hypothesis that some (but not all) insectivorous bats forage in 'flocks', situations where several conspecifics apparently operate together. Four types of evidence support this proposal. First, comparisons of four call features (duration, lowest frequency, highest frequency, frequency with most energy) demonstrate that at least some species of rhinopomatid and molossid bats significantly alter the frequencies domin-

ating their echolocation calls when flying in the presence of conspecifics. Other species, including some emballonurids and vespertilionids, do not show these marked changes in call features when several individuals fly in the same air space. Second, molossids frequently produce distinctive social calls when flying with conspecifics. These calls, including 'social buzzes' that are superficially like feeding buzzes, differ from echolocation calls in many call features. Third, feeding buzzes indicate the presence of prey, potentially allowing group members to locate accumulations of flying insects. Four, in some cases, conspicuous groups of molossids travel and forage together. To date, evidence of changes in call features and the inclusion of social calls have been demonstrated for *Tadarida brasiliensis*, *Tadarida teniotis* and *Molossus molossus*. Playback experiments have indicated how *Lasiurus borealis* and *Lasiurus cinereus* as well as *Tadarida brasiliensis* respond to feeding buzzes. *Molossus molossus* travel and forage in groups. Changes in call parameters and social calls could facilitate air traffic control, keeping track of who is flying where in the airspace. Feeding buzzes identify the availability of prey, while social buzzes resemble the trill calls of primates, signals that serve there in maintaining contact between group members. By flying in groups, individual bats could readily search out and exploit concentrations of insects, such as those in lees, or around lights. The effectiveness of this approach to foraging will be determined by group size, and formation. Of course, social calls and other signals may also serve in communication between roosting individuals.

Community Assembly Rules for Nectar- and Fruit-eating Vertebrates

Fleming, Theodore H., University of Miami, Coral Gables, FL

Community assembly rules specify quantitatively how different deterministic factors influence patterns of species co-occurrence and richness and, in some cases, relative abundances in biological communities. Competition-mediated assembly rules have been much discussed in the ecological literature, but relatively little attention has been paid to potential assembly rules associated with mutualistic interactions. I reviewed 85 studies that quantify the relationship between species richness of nectar- or fruit-eating birds and bats and species richness of their food plants in New and Old World, mostly tropical communities. This analysis revealed that two qualitatively different assembly rules appear to operate in these communities. In the New World, the number of plant-visiting birds and bats per community was significantly correlated with number of food plants, and slopes of regression equations were the same for nectarivores and frugivores. The New World assembly rule states that it takes about three species of flowers or fruits to support one species of plant-visiting bird or bat. This relationship does not appear to exist in Old World communities, in which species richness of nectar- or fruit-eating birds or bats was independent of species richness of their food plants. These geographic differences likely reflect a greater degree of feeding specialization in plant-visiting vertebrates in the New World than in the Old World. I hypothesize that hemispheric differences in the spatio-temporal predictability (STP) of food resources ultimately determine levels of dietary specialization and the form of assembly rules in communities of New and Old World plant-visiting vertebrates.

Morphological Differentiation Among Large Species of Genus *Lophostoma* (Chiroptera: Phyllostomidae), with Comments on the Centers of Speciation for Phyllostominae Bats in the Neotropics

Fonseca, René M., and Robert J. Baker, Texas Tech University, Lubbock, TX

Large sized species of genus *Lophostoma* are represented by the four recognized subspecies of *L. silvicolum* (*centralis*, *laephotis*, *occidentalis*, and *silvicolum*) and an unrecognized species from northwest Ecuador. Although differences among the subspecies of *silvicolum* are based mostly in size, the finding of the northwestern Ecuadorian form showed discrete characters that may be present in the other taxa. To evaluate the morphological differ-

entiation among these taxa of *Lophostoma*, we examined 150 specimens throughout Middle and South America, including the holotypes of subspecies *centralis* and *occidentalis*. External and cranial measurements, and discrete characters were recorded for each group. A size-free discriminant function analysis revealed that size variation is continuous among these taxa, although populations of *L. s. silvicolum* from eastern Ecuador differ greatly from the Amazon basin populations. Nevertheless, discrete morphological characters appear to be the strongest

evidence separating populations. Thus, striking differences in shape of the foramen magnum, the lower incisors, and the middle lower premolar indicate that subspecies of *L. silvicolum* may deserve specific status. The patterns of morphological divergence found among large taxa of genus *Lophostoma* are in concordance with geographic areas where other phyllostomid bats have been identified. Taxa from western South America tend to be smaller in size, and possess the most striking differences in skull morphology. However, they are also quite different from Middle American forms, despite the morphological similarity indicated for other genera shared between these regions. Additionally, specimens from the Guiana region present morphological differences compared to specimens from Panama and eastern South America. To test the hypothesis that this differentiation is the result of geographic isolation, specimens of *Phyllostomus discolor* and *P. hastatus* were analyzed, repeating the same analysis as in *Lophostoma*. Size differences are present between populations from both sides of the Andes in both species of *Phyllostomus*, although no morphological differences were found to distinguish populations from east and west sides of the Andes for these species. The influence of the Andes as a factor of speciation on these two genera is evident. This hypothesis of differentiation by the isolation of the Andes may be tested in other widely distributed species of the subfamily Phyllostominae.

Using Bats to Design Natural Reserves: A First Attempt in Ecuador

Fonseca, René M., Juan P. Carrera-Estupiñan, Xavier Viteri, and Julio Novoa, Museo de Zoología, Pontificia Universidad Católica del Ecuador, Quito, Ecuador; Fundación Natura, Quito, Ecuador

Recent natural reserves in Ecuador have been designed using flagship species such as large mammals. Because these species require large amounts of habitat, it is assumed that their protection may also protect entire ecosystems and their diversity. Nevertheless, several problems are related to the use of the umbrella concept in Ecuador, especially the difficulty for monitoring and obtaining information from these flagship taxa. Thus, urgent decisions to protect important areas may not be taken in the short-term. The cloud forest remnants between Llanganates and Sangay National Parks, in the eastern Ecuadorian Andes, constitute a key sector for tourism and conservation. A great diversity has been recorded for several groups, although the area has not been officially included in the National System of Protected Areas (SNAP). Bats constitute a good alternative to large mammals to design natural reserves because of 1) the ease in monitoring them, 2) their relationship with habitat quality, and 3) their current use for evaluating the effectiveness of protected areas. Zones to protect good quality habitats were defined by combining bat diversity and abundance with multivariate statistical models using Geographic Information Systems (GIS). Bats were captured from May to November 2001 at 18 localities in the study area. Information on the abundance of species characteristic of disturbed habitat, the abundance of insectivorous species characteristic of undisturbed habitats, the presence of endangered species, the abundance of species that disperse seeds, and species richness for each locality were recorded. These data were analyzed with variables such as slope, vegetation type, accessibility, water sources, human settlements, and elevation. Multivariate statistical analyses, using the Mahalanobis Distance algorithm, were used to estimate areas with high potential for conservation activities. The area defined by this model embraces 37,073 has, from 958 to 3,802 m above sea level. Important localities are concentrated at low elevations and surrounding karstic places. *Diphylla ecaudata*, *Furipterus horrens*, *Koopmania concolor* and other rare species have

been recorded from this area. Some of those are unique records for Ecuador. Within the proposed area, 194 endemic species of plants, 242 species of birds, and 101 species of mammals were recorded in further surveys, constituting one of the most diverse mountain reserves in Ecuador. The reserve connects both National Parks, and studies on its function as a biological corridor are currently being executed.

Defining the Molecular Landscape of Townsend's Big-eared Bat (*Corynorhinus townsendii*) from Central Nevada: Spatial and Temporal Delineation of Genetic Populations

Gannon, William L, Richard E. Sherwin, and Jerry W. Dragoo,
University of New Mexico, Albuquerque, NM

Management and conservation practices of Townsend's big-eared bat (*Corynorhinus townsendii*) have largely assumed that maternity colonies delineate populations. Those practices have been based upon little data and driven mostly by dogma. In fact, the molecular landscape of this species has not been resolved. Without clearly understanding the effective unit of management and establishing levels of diversity at the correct scale, efforts to manage this species at a number of scales may be misled. The goal of conservation activities should be to maintain populations in the landscape. In this study we investigated impacts on the genetic landscape of colonies of abandoned-mine roosting *C. townsendii* in north-central Nevada. We report on the relatedness among and between hibernating and roosting individuals within the sample site. DNA extraction, amplification, and sequencing of the mitochondrial D-loop was conducted for genetic analyses aimed at resolving patterns within the genetic landscape of this species. The simplification of the genetic landscape or the identification of several haplotypes at the same site has great impact for management and long-term maintenance goals of *C. townsendii* populations. Two haplotypes (distance > 20 bp) have been identified at a single site with no discernible geographic boundary indicating that higher levels of variation may occur in a population of this species than has previously been assumed.

Echolocation Call Parameters of *Nycticeius humeralis*

Garner, Steven M., Cris D. Hein, Adam C. Miles, and Steven S. Castleberry
University of Georgia, Athens, GA

Little research addresses echolocation calls of the evening bat (*Nycticeius humeralis*). We recorded calls of evening bats during the summer of 2003 on the southeastern coastal plain using Anabat II detectors. All recordings were taken over clear cuts using either a spot light or glued light tag. Call parameters discussed include: initial and characteristic slope; maximum, minimum, and mean frequency; duration of calls, and amount of time between calls.

Reproduction and Seasonal Activity of Silver-haired Bats (*Lasionycteris noctivagans*) in Western Nebraska

Geluso, Keith, Jeffery J. Huebschman, Jeremy A. White, and Michael A. Bogan
USGS, University of New Mexico, Albuquerque, NM; University of Nebraska-Lincoln, Lincoln, NE;
University of Nebraska, Omaha, NE

Silver-haired bats (*Lasionycteris noctivagans*) were thought only to migrate through Nebraska; however, recent surveys in eastern Nebraska report summer records of females and their young. Our study in western Nebraska also shows that silver-haired bats are summer residents. We discovered the first reproductively active *L. noctivagans* in this part of the state. We caught lactating females and volant young in riparian forests along the North Platte River and in forested areas of the Pine Ridge. Previously, adult males were not known from Nebraska in sum-

mer, and only four records of *L. noctivagans* were known from western Nebraska during migration. On 28 July, we captured an adult male in a coniferous forest of the Wildcat Hills, and we have more than 100 records of migrating individuals. Lastly, an obese *L. noctivagans* captured on 4 November may represent an individual preparing to hibernate in Nebraska.

Does Reproductive State Affect Echolocation Signals in *Eptesicus fuscus*? A Preliminary Study

Grilliot, Matthew E., Stephen C. Burnett, and Mary T. Mendonca
Auburn University, Auburn, AL; Clayton College and State University, Morrow, GA

Ultrasound is a widely used acoustical method for social communication, as well as for navigation and foraging. Although bats are well known for their use of ultrasound for the latter function, there is presently limited evidence for its use in the former function. Studies have indicated its use in mother-young interactions, and there is some evidence that male and female vocalizations differ in some species. However, no studies have explored its use in courtship and mating. We have a captive colony of big brown bats housed in environmental chambers that allow us to alter temperature and photoperiod in order to mimic seasonal changes and induce mating behavior. This offers us a unique opportunity to investigate seasonal differences in the echolocation calls of big brown bats. We have recorded the echolocation calls of eight adult female and eight adult male big brown bats in different reproductive states. Thirty-four parameters (e.g., duration, starting and ending frequency of fundamental, frequency of maximum amplitude for fundamental) for each echolocation call were analyzed for seasonal differences, sex differences, and individual distinctiveness. Results from these studies could provide insight into the role of echolocation (if any) in big brown bat mating systems.

Preliminary Analysis of the Importance of Forested Corridors in Roost-site Selection of Evening (*Nycticeius humeralis*) and Seminole (*Lasiurus seminolus*) Bats in Managed Forests

Hein, Cris D., Steven B. Castleberry, and Karl V. Miller, University of Georgia, Athens, GA

The creation and maintenance of corridor systems are often used to mitigate loss of habitat due to agricultural and forestry practices. Our knowledge concerning the response by bats to these linear habitat features is limited. A study was initiated during summer 2003 to assess the importance of forested corridors in roost-site selection in cavity and foliage roosting bats. The study area was located in the Lower Coastal Plain of South Carolina on 145,848 ha of managed forest owned by the Meadwestvaco Corporation. Preliminary data were collected from 9 June to 31 July 2003. We radiotracked five female and three male evening bats (*Nycticeius humeralis*) to thirteen and three day-roosts, and three female and three male Seminole bats (*Lasiurus seminolus*) to 20 and 33 day-roosts. Evening bats were located primarily in fork-top trees (50%, n=8), but also were tracked to trees with cavities (31%, n=5), live trees (13%, n=2), and snags (6%, n=1). Seminole bats roosted exclusively in the canopy of live Loblolly pines (*Pinus taeda*). Forty-three percent (n=23) of Seminole bat day-roosts were located in forested corridors compared to 13% (n=3) of evening bat day-roosts. Data were collected on roost structures (e.g., dbh, height) and compared to nearest neighbor and random stand level structures. In addition, habitat variables (e.g., basal area, species diversity) and landscape variables (e.g., distance to edge, distance to water) were collected and compared between roost and random structures. These results and additional research objectives for the following seasons will be discussed.

Growth and Development of Two Species of Florida Bats: *Tadarida brasiliensis* and *Myotis austroriparius*

Hermanson, John W., and Kenneth T. Wilkins, Cornell University, Ithaca, NY; Waco, TX

A single roost containing a maternity colony of *Tadarida brasiliensis* and *Myotis austroriparius* was studied. Earlier reports by the authors documented relatively higher neonatal roost mortality rates in the southeastern brown bats as opposed to the southeastern free-tailed brown bats. Specimens of adults, fetuses and neonates were obtained during visits to the roost, which were exterminated by the property owners. Fetal and neonatal specimens were prepared with Alcian blue and alizarine red S protocols that highlight regions of cartilage development and bone deposition in the developing bats. Individual bones were observed under dissecting microscopes and illustrated using a camera lucida attachment. Images were used to measure the condition of (bone vs. cartilage) and growth (measured with dial calipers). These data support a hypothesis that hindlimb musculoskeletal structures develop earlier and are more advanced at birth in the free-tailed bats than in the southeastern brown bats. Despite developing in identical roost conditions, ontogenetic patterns of the two species are significantly different. Comparable analysis of the forelimb musculoskeletal system also demonstrates relatively advanced development in newborn free-tailed bats despite relatively longer time required to attain flapping flight. While cognizant of criticisms of the technique of estimating age based on morphologic criteria (instead of known age status based on banding programs), we seek to comment on patterns of development based on this existing collection of specimens.

Bats of the Zona Reservada Allpahuayo-Mishana: Comments on the Ecology, Biogeography, and Conservation of a Peruvian Hotspot of Biodiversity

Hice, Christine L., Paul M. Velazco, and Michael R. Willig
Texas Tech University, Lubbock, TX; Field Museum of Natural History and University of Illinois at Chicago, Chicago, IL

Complete inventories of mammals are notoriously difficult to obtain at neotropical lowland rainforest sites. This hinders our ability to understand processes governing the patterns of diversity that occur in this species-rich biome. I present an inventory of bats from a site in the western Amazon Basin, the Zona Reservada Allpahuayo-Mishana (ZRAM). A total of 63 species of bats were recorded in approximately one year of field collections. Based on ecogeographic range data (regional species richness) the inventory is ~60% complete. Based on extrapolation methods that estimate local species richness, the inventory is 85-90% complete. Analysis of faunal similarity indicates bat fauna of ZRAM is most similar to that of geographically proximal sites. To gain a tropical perspective of chiropteran diversity in Amazonia, data from ZRAM and other sites from the Amazon Basin with published inventories are used to compare and contrast community structure from both taxonomic and functional perspectives, and to explore the relationship of local to regional species richness. These analyses reveal that ecological filters of different strengths are functioning in different regions of the Amazon Basin, with strong filters in the western region and weak filters in the Guianas.

Foraging Behavior of *Leptonycteris curasoae* on *Agave palmeri* and Hummingbird Feeders

Hinman, Katharine E., State University of New York at Stony Brook, Stony Brook, NY

I used a combination of techniques to examine the foraging behavior of the nectar-feeding bat *Leptonycteris curasoae* on *Agave palmeri* and on hummingbird feeders in the Chiricahua Mountains of southeastern Arizona. Foraging behavior of pollinators affects not only the pollinators themselves, but also the reproductive strategies of the plants that they visit. Howell (1979) described cooperative flock foraging behavior in this species, with a pattern of giving-up

times that she contended was an optimal foraging strategy (Howell and Hartl 1980). Although I observed groups of up to ten bats foraging on a single resource at one time, I did not find evidence of cooperative behavior such as that described by Howell (1979). Group foraging can be explained by concentration of bats at a rich resource without requiring cooperation between individuals. The use of hummingbird feeders as an energy resource may influence the ways in which *L. curasoae* forage on *Agave palmeri*, and the extent to which they rely on it as an energy source. I found no evidence for active monitoring of *A. palmeri* patches prior to blooming or for active searching for resources outside of known food patches. *Leptonycteris curasoae* appears to separate searching behavior from commuting behavior, and does not appear to search actively for hummingbird feeders.

The Arizona Bat Conservation Strategic Plan: Use of a Statewide Plan to Direct Conservation Activities

Hinman, Katharine E., and Tim K. Snow, Arizona Game and Fish Department, Phoenix, AZ

The Arizona Game and Fish Department (AGFD) has worked with members of the Arizona Bat Resource Group to develop a statewide conservation plan for Arizona's 28 bat species. While originally based on the framework of the North American Bat Conservation Partnership's Strategic Plan, the AGFD plan has developed into a comprehensive document that includes not only goals and objectives for research, inventory and monitoring, management, and education activities, but also background on the species of bats found in Arizona, the resources of most importance to these species, threats to these species and their resources, and specific goals and objectives to address these issues in the different habitat types found throughout the state. This plan will be used by the AGFD as well as by other state and federal agencies that have management responsibilities over bats, and by researchers seeking to integrate their work with conservation and management efforts. A workshop hosted by AGFD in April allowed both governmental agencies and non-governmental organizations an introduction to the plan, and an opportunity to discuss implementation of the plan and prioritization of activities.

*Censusing Brazilian Free-tailed Bats Using Infrared Thermal Imaging and Computer Vision Methods

Hirsh, Diane E., Margrit Betke, Stephen Crampton, Jason Horn, and Thomas H. Kunz
Boston University, Boston, MA

Censusing natural populations of bats is important for understanding population dynamics and for determining the ecological and economic impact of these animals on terrestrial ecosystems. Colonies of Brazilian free-tailed bats (*Tadarida brasiliensis*) are of particular interest because they represent some of the largest known or suspected aggregations of mammals known to mankind. Obtaining accurate and reliable estimates of these bats poses several challenges, such as recording bats in the dark and analyzing the large numbers of individuals that emerge from different roosting sites. We have used an infrared thermal camera to record Brazilian free-tailed bats as they emerge nightly from caves in south-central Texas. One of our goals is to develop an automated image analysis system that is capable of detecting and analyzing emerging bats. In this paper, we describe a census method that uses infrared thermal images and computer vision techniques to census Brazilian free-tailed bats. We developed automated adaptive filtering methods to analyze the motion, intensity, and spatial characteristics of the images. Regions of interest are identified and analyzed to estimate the number of bats in each image. We validated these estimates by comparing them with human estimates. By performing analysis that combines these estimates with flow rate observations, we are able to provide an estimate of colony size at Frio Cave in south-central Texas.

* **Diane Hirsh** received the **Lubee Bat Conservancy Award**

Comparative Phylogeography of Short-tailed Bats (*Carollia*: Phyllostomidae)

Hoffmann, Federico G., and Robert J. Baker, Texas Tech University, Lubbock, TX

This is the first study of comparative phylogeography involving closely related species of Neotropical bats in the family Phyllostomidae. We compared the patterns of geographic variation within the five species of fruit-eating bats currently recognized in the genus *Carollia* using the complete mitochondrial *cytochrome-b* gene. Our results suggest that the combined effect of the uplift of the Andes and the Panamanian land bridge have been as important for bats as for terrestrial mammals in shaping present day biodiversity in the New World tropics. Species in this genus can be arranged into two highly supported clades, with a deep subdivision within each of them that corresponds well to differences across the Andes. We found three congruent patterns of phylogeographic across species in this genus. First is the closer relationship of samples from western Ecuador to samples from Central America, rather than to populations east of the Andes in *C. brevicauda*, *C. castanea* and *C. perspicillata*. Second is the likelihood of a similar timing for the arrival and diversification of *C. brevicauda* and *C. perspicillata* in South America from Central America ancestors. Third is the expansion of *C. perspicillata* and *C. sowelli* into northwestern Central America in the relatively recent past. Using a molecular clock, with rates ranging from 2.3-5% per 106 years, diversification within *Carollia* would have occurred over the last 3 to 6 million years. These estimates agree well with the last rise of the Northern Andes and the Panama isthmus.

Development of Thermoregulation and Metabolic Savings Associated With Clustering in Big Brown Bats, *Eptesicus fuscus*

Hollis, Lydia, University of Calgary, Calgary, AB

Like adults, juvenile bats can conserve energy during times of energetic stress (e.g., low food availability and adverse environmental conditions) by entering torpor. Torpor is characterized by a periodic lowering of the body temperature, with a reduction in metabolism, followed by arousal using endogenous heat sources. Although using torpor can be beneficial in terms of energy savings and survival during emergency situations, there are costs for juveniles. For example, juveniles that do not enter torpor may maximize their growth rates, which in turn influence their survival and reproductive success. One means of increasing growth and reducing thermoregulatory costs at low ambient temperatures is through clustering. The purpose of my study is to investigate changes in thermoregulation with age and determine metabolic savings associated with clustering behaviour by big brown bats, *Eptesicus fuscus*. I measured body temperatures (indirectly as skin temperature) and metabolic rates (indirectly as oxygen consumption) of individuals or groups of four captive big browns at six different ambient temperatures (10-35^0 C, increasing in 5^0 C increments) for four different age classes (early prevolant, late prevolant, and volant juveniles, and adults). Despite their low body temperatures, early prevolant bats had significantly higher metabolic rates than older juveniles and adults at low ambient temperatures. Even within clusters, early prevolant juveniles did not maintain active body temperatures at low ambient temperatures in the metabolic chamber. This contradicts data from the field (in the roost). Body temperatures (via temperature-sensitive radio transmitters) indicate that although prevolant juveniles use torpor more than fledged young within the roost, they stay warm while their mothers are foraging. Visual observations in the roost reveal that pups are typically in clusters (2-10 individuals) along with 1-2 adults. One possible explanation for the juveniles' "ability" to stay warm is that the mothers do not forage for long bouts while the pups are young and thus juveniles are kept warm by other adults within the roost (who may be feeding their own young). Within the metabolic chamber, individual late prevolant and volant juveniles either went torpid (i.e., low body temperature and metabolic rate) or maintained an active body temperature (high metabolic rate) at low ambient temperatures. Likewise, some adults went torpid while others maintained a euthermic body temperature at low ambient temperatures when in-

dividually placed in the chamber. By comparing metabolic rates of individuals and groups of bats at different ages, I will estimate the thermoregulatory savings associated with clustering behaviour.

Molecular Phylogenetics of the Chiropteran Family Vespertilionidae

Hoofer, Steven R., and Ronald A. Van Den Bussche
Texas Tech University, Lubbock TX; Oklahoma State University, Stillwater, OK

Limited information from existing data sets and the tremendous amount of diversity in number and kind within the Vespertilionidae (about one-third of all bat species) have hampered efforts to provide adequate assessments of long-standing genealogic hypotheses (e.g., monophyly

of the five or six subfamilies and of the family). We generated mitochondrial ribosomal DNA sequences (about 3,000 base pairs) for 120 vespertilionids representing 110 species, 37 of 44 genera, and all subfamilies. We assessed monophyly of Vespertilionidae in initial analyses of 171 taxa including representatives of all bat families (except the monotypic Craseonycteridae), and examined several truncated taxon sets with new alignments to assess lower-level relationships. Bayesian and Parsimony analyses suggest relationships that in many respects support the traditional classification but which also support several changes, at various taxonomic levels. The majority of 'contradictory' relationships also receives support from other data sources, particularly bacular and karyotypic data. We make more than 20 taxonomic conclusions or recommendations. Highlights include: *Miniopterus* is recognized in its own family, Miniopteridae, as it represents an extremely divergent lineage relative to other vespertilionids, and in some analyses is sister to the molossids and natalids; all other vespertilionids examined represent a monophyletic assemblage; two of the traditional subfamilies within Vespertilionidae (*sensu stricto*) are monophyletic, Murininae and Kerivoulinae; Nyctophilinae has no validity and Vespertilioninae is paraphyletic relative to the position of *Myotis*; *Myotis* is sister to a clade containing Kerivoulinae and Murininae and is recognized in its own subfamily, Myotinae; *Myotis* subgenera *Leuconoe*, *Selysius*, and *Myotis* are polyphyletic, and a subgeneric classification reflecting geography is suggested, broadening subgenus *Myotis* to include the sampled Old World species, and allocating the sampled New World species to another subgenus (*Aeorestes* Fitzinger, 1870); Vespertilioninae (excluding *Myotis*) is monophyletic; *Pipistrellus*-like bats (i.e., traditional Vespertilionini) are divided into three tribes (Nycticeiini; Pipistrellini; Vespertilionini). Overall, this study offers a robust working hypothesis for vespertilionid relationships and provides a good starting point for new investigations into the evolutionary history of Vespertilionidae.

Evidence for the Thermoregulatory Function of Night-roosting in Little Brown Bats (*Myotis lucifugus*)

Horn, Jason W, and Thomas H Kunz, Boston University, Boston, MA

Although many bats spend a part of their daily activity budgets in night-roosts, the function of the behavior remains unclear for many species. Night roosts may facilitate social interactions and communication, such as learning between mothers and pups. Night roosting is also an important component of various energy conservation strategies, especially for species with smaller body masses. Night roosting can minimize commuting distances to feeding areas. Clustering in night roosts can reduce the energy expended on maintaining a high body temperature and can defer the use of torpor by lactating females that would slow milk production and development. We tested the hypothesis that thermoregulation is an important benefit of night-roosting by providing bats the opportunity to chose night roosts with varying thermal properties. We chose an existing maternity colony of approximately 800 female *Myotis lucifugus* where individuals frequently spend an hour or more roosting inside mortice cavities in wooden beams during the night. We constructed a series of test roosts that were of the same material anddimen-

sions as existing mortices and mounted them adjacent to two such frequently used roosts. One flanking roost was heated 10^0 C above ambient, while the other flanking roost was cooled with a closed refrigerated water system. All test apparatus were erected in early April prior to the arrival of bats from hibernacula. We monitored and quantified duration of use and number of individuals present with reflective infrared video cameras for a period of ten days in June prior to parturition - five days without treatment, followed by five days with treatment. All roosts were utilized, and varied in occupancy from small groups to complete filling of the mortice cavity. Before treatment, the central pre-existing mortice was occupied most heavily, with some use of the newly introduced test mortices. During treatment, pre-existing roosts maintained previous levels of occupancy, while heated roosts attracted an equal or greater number of bats. Cooled roosts did not appear to affect occupancy rates or duration. Our previous investigations of this same system have not detected evidence of social interaction that might influence foraging behavior. This new evidence supports the notion that the primary function of night-roosting behavior in *M. lucifugus* appears to be thermoregulatory.

Acoustic Warfare in Space and Time: 3D-Analysis of Bat–Tiger Moth Interactions

Hristov, Nickolay I., and William E. Conner, Wake Forest University, Winston-Salem, NC

The acoustic interaction between insectivorous bats and tiger moths (Lepidoptera: Arctiidae) is a classical model of predator-prey interaction and an evolutionary arms race. When approached by hunting bats, tiger moths answer with a series of intense ultrasound clicks that stimulate the bat to abort its attack. The specific mechanism of the interaction, however, has puzzled behavioral biologists for four decades. Three hypotheses, (1) jamming, (2) startle and (3) acoustic aposematism, have been proposed as possible explanations for the interaction; however, disagreement remains about the specific proximate and ultimate mechanisms. Our work looks at the bat-moth acoustic and flight interaction from a new perspective by analyzing how naive bats learn to cope with the acoustic, often distasteful tiger moths. We have employed 3D, infra-red, high-speed videography to test the three hypotheses and offer some insight into the details of the interaction.

Seasonal Changes in Populations of Nectar Feeding Bats in the Autlan Valley, Jalisco, Mexico

Ibarra, Pilar, Luis I. Iñiguez, and Carlos Ibarra,
Universidad de Guadalajara, Jalisco, Mexico; Universidad Nacional Autónoma de México, México D.F.

Nectar feeding bats are associated mainly with caves and other cavities for both diurnal and nocturnal roosting. The goals of this ongoing work are to describe seasonal changes in some basic parameters of the populations of nectar feeding species in roosts of the study area, and to elaborate a list of species present in their diet and its changes along one annual cycle. This work is conducted in the Autlan-El Grullo valley, in southwestern Jalisco. The climatic regime is strongly seasonal, with the rain season from June to September. Vegetation in the valley is mostly tropical deciduous forest and crop lands. The study began in February 2003, after locating several bats' roosts in the area. We visit monthly each roost to capture the bats with mist nets, mark with plastic collars coded with color bands and release them. For each bat we recorded species, age, sex, reproductive condition, weight, forearm length and capture time. To determine the feeding habits of the nectarivorous bats, we collect pollen using fuchsine stained gel on the fur, and also from the feces. These samples will be compared with pollen collected each month in the field from blooming plants, as well as herbarium samples. Presently we have located seven roosts in the area, with eleven species of six families, but only two species in two roosts are nectar feeding bats: *Leptonycteris curasoae* and *Glossophaga soricina*; there are at least three other species to be found. As of July we have captured 217 individuals of *Leptonycteris curasoae*, with the highest relative abundance in May. Sex ratio is 0.96 males Of the few females captured, 50% were

pregnant. Regarding age, 98% are adults and 2% subadults. For *Glossophaga soricina* we captured 77 individuals, also with the highest abundance in May. Sex ratio is 0.69 males. Of the females, 56% were inactives, 22% lactating, 9% pregnant and 13% postlactating. In age structure, 79% were adults and 21% subadults. Regarding the diet of both species, we have identified seven plant species, of which the most consumed up to now seems to be *Pseudobombax ellipticum, Stenocereus queretaroensis, Pachycereus pecten-aboriginum* and *Ipomoea arborescens*

Reliability of the Lesser Long-nosed Bat *Leptonycteris curasoae* for the Pollination of the Columnar Cactus *Stenocereus queretaroensis*

Ibarra-Cerdeña, Carlos, Luis I. Iñiguez, and Víctor Sánchez-Cordero
Universidad Nacional Autónoma de México, México D.F.; Universidad de Guadalajara, Jalisco, Mexico

Pollinator reliability is an important issue in the reproductive biology of plants because this is an important component in the evolutionary tradeoffs between plants and their pollinators. Columnar cactus have evolved both generalized and specialized strategies about pollinator systems, in response to the variability of temporal availability of the main pollinators in a particular environment. The pitayo (*Stenocereus queretaroensis*) is an endemic columnar cactus distributed in central Mexico, and presents quiropterophilic syndrome. We have studied the reproductive biology of this species and foraging behavior of its floral visitors for the last four years in the Autlan valley, located in southwestern region of the State of Jalisco, Mexico. In 2002, blooming began in mid February and had a peak in mid March; in 2003 blooming started late (early March), having the peak in April. Anthesis occurs one hour after sunset and stigma and anthers maximum turgidity starts after 22:00. Nectar production begins around 21:00. Both nectar secretion and sugar concentration have the highest values around midnight, after which the nectar reward decreases, being zero a couple of hours after sunrise. Comparative pollinator effect assessed by exclusions demonstrated that pitayo is an autoincompatible hermafrodite cactus, because no fruit was produced in totally excluded flowers (n=30 flowers). Open and nocturnal pollination has a 95% (n=30) and 90% (n=20) of fruit set respectively, whereas diurnal pollination produced 40% (n=20) fruits. Seed set did not present statistical differences among open and nocturnal pollination, whereas diurnal pollination was significantly inferior compared with both open and nocturnal. Visit rate analyzed by videotrapping showed that males of the lesser long-nosed bat *Leptonycteris curasoae* was the most common visitor of pitayo flowers, and most of the legitimate visits occurred when nectar reward was high. Bat captures with mist nets around pitayos demonstrate that the lesser long-nosed bat has been the most abundant nectarivorous bat in the last four years. The abundance of this bat was related to flower availability in foraging areas. Because of this findings, we consider that *L. curasoae* in Autlan is the main pollinator of pitayo cactus each blooming season, and its persistency among seasons secures the pitayo reproduction.

Geographic Variation, Sexual Dimorphism, and Character Displacement in the Pallid Bat (*Antrozous pallidus*)

Ingram, Kate, and Travis Perry, University of Nevada, Reno, NV; Furman University, Greenville, SC

Pallid bat (*Antrozous pallidus*) craniodental morphology (CDM) varies with region and gender. In the southern part of its range, *A. pallidus* is sympatric with a potential competitor, the California leaf-nosed bat (*Macrotus californicus)*. Our study describes geographic variation and sexual dimorphism in *A. pallidus* at regional and population scales and along environmental clines; further, we examine the possibility of character displacement. We found: (1) sexual dimorphism varies across regions; (2) CDM varies across populations within regions; (3) CDM variation along clines depends on region and gender; and (4) sympatry with *M. californicus* is associated with differences in skull length among *A. pallidus* populations. These results suggest

(1) *A. pallidus* is demic; (2) gender specific selection pressures vary along clines and these vary across regions; and (3) the possibility of character displacement between *A. pallidus* and *M. macrotus* warrants further investigation**.**

Seasonal Changes in Populations of Mormoopidae in the Autlan Valley, Jalisco, Mexico

Iñiguez, Luis I., and Pilar Ibarra, Universidad de Guadalajara, Jalisco, Mexico

The Mormoopidae family is endemic to the Neotropics and has eight species, of which four are found in the State of Jalisco, Mexico (*Mormoops megalophylla, Pteronotus parnellii, Pteronotus davyi* and *Pteronotus personatus)*. In the Autlán-El Grullo valley, in southwestern Jalisco, we have located two roosts of this family. Our objective in this ongoing work is to report seasonal changes in some parameters for the populations of the four species. The sampling is conducted in two abandoned mines, since February 2003. The climatic regime is strongly seasonal, with the rain season from June to September. Vegetation surrounding the mines is mostly tropical deciduous forest and croplands. We visit monthly both sites to capture the bats with mist nets, mark with plastic collars coded with color bands and release them. For each bat we recorded species, age, sex, reproductive condition, weight, forearm length and capture time. From February to July, in the Cucusiapa mine we captured 466 individuals of Mormoopidae. The most abundant species is *Pteronotus parnellii* accounting for a 54.4% of the total, followed by *Mormoops megalophylla* (27.9%), *Pteronotus davyi* (12.7%) and *Pteronotus personatus* (5%). The age structure, in average for all the species, is 86% adults and 14% subadults. Regarding sex proportion, *P. parnellii* has a higher females' proportion (0.696), while *M. megalophylla, P. davyi* and *P. personatus*, have bigger males' proportion (0.813, 0.660 y 0.727 respectively). In *P. parnellii* we captured few pregnant females in early stages between February to April; in June and July we captured pregnant (67%) and lactating (33%) females (n=67). For *M. megalophylla* the pregnant females were captured from February to May and lactating only in July. In *P. davyi* we haven't captured pregnant females; it is important to mention that there were no captures of this species in May and June. In the case of *P. personatus*, we only captured a pregnant female in July. In the San Francisco mine, from a total of 156 individuals captured, 73% were *P. parnellii* and 27% *M. megalophylla*. There are also differences in sex ratio; in *P. parnellii* the males proportion is 0.903, while for *M. megalophylla* is 0.574 for males. Regarding age structure, the average for both species is 86% adults and 14% subadults. In *P. parnellii* we registered pregnancy from March to May, and lactation in July, whereas for *M. megalophylla*, only one pregnant female was captured in March.

The Influence of Wing Morphology and Echolocation on the Gleaning Ability of the Insectivorous Bat *Myotis tricolor*

Jacobs, David S., and Samantha Stoffberg, University of Cape Town, South Africa

The relative influence of morphology and echolocation on the foraging behaviour of insectivorous bats is unknown. It has been proposed that morphology is the primary determinant of bat foraging behaviour but that broadband calls of short duration are an adaptation for gleaning. On the basis of its external morphology it has been predicted that *Myotis tricolor* should be able to both aerial feed and glean. Furthermore, this bat is known to use broadband calls of short duration reinforcing the prediction that it gleans. We tested this prediction by studying the foraging behaviour of *Myotis tricolor* in a flight room. We presented *M. tricolor* with mealworms, moths, beetles and cicadas in a variety of ways that required either gleaning and/or aerial feeding. Although *M. tricolor* readily took aerial prey, it did not take any of the variety of insects presented to it in a manner that required gleaning. We thus compared its wing morphology and echolocation calls to that of known gleaners (*Nycteris thebaica*, *Myotis lucifugus* and *Myotis septentrionalis*) and an aerial forager (*Neoromicia capensis*). *Myotis tricolor* was larger than bats

known to glean and also had more pointed wingtips like those of the aerial feeder *N. capensis*. Furthermore, *M. tricolor* used short broadband calls similar to those used by the gleaners but it did not use harmonics. These results suggest that short broadband calls might be an adaptation for aerial hunting in dense clutter and not for gleaning but that the addition of harmonics allow these calls to be used in gleaning.

A Habitat Use Study of the Mariana Fruit Bat (*Pteropus mariannus mariannus*): A Preliminary Report

Janeke, Dustin S., and Carlos A. Iudica, University of Guam, Mangilao, Guam

The Mariana fruit bat, or Fanihi locally, is the last of three bat species to survive on the West Pacific island of Guam. This 450 gram Old World fruit bat historically ranges throughout the 15 islands of the Mariana archipelago, with Guam being the largest and southernmost island of the chain. The entire population of the Mariana Fruit Bat is in decline, most likely due to the combined effects of illegal hunting, habitat loss, predation by introduced species, and typhoon disturbance; however, only the Guam population is listed as "endangered" by the United States Fish and Wildlife Service. Little to nothing is known about the biology of this species. The goal of this study is to investigate nocturnal movements and foraging patterns of the Mariana fruit bat in Guam using VHF radio telemetry. As many as 30 adult bats (15 per year over two years) will be trapped on Andersen Air Force Base in northern Guam using mist nets and attractants. Each adult bat will be weighed, measured, and marked with an identifying thumb band. Fecal, tissue and ectoparasite samples will also be collected. Each bat will then be fitted with a transmitter attached to a leather collar designed specifically for long-term radio tracking studies. The transmitter is equipped with a 12-month battery and a position switch, and the collar has a "weak link" allowing it to fall off after 12 to 18 months. Each individual will be tracked between 1800 and 0700 hours, four to six nights per week for 12 months. In addition, a remote radio tracking station at the main colony roosting site will constantly monitor the presence or absence of radio collared bats for the duration of the study. A phenology study of 10 to 15 native forest tree species is being conducted in concert with the radio tracking study to correlate movement patterns with food supply. Information acquired through the course of this study will allow for a more effective management of fruit bat habitat, which should aid in the recovery of this endangered species.

Geographical and Interspecific Variation of Highland and Lowland Species of the Genus *Sturnira* (Chiroptera: Phyllostomidae) in Ecuador: A Morphometric Approach

Jarrín–V, Pablo, Boston University, Boston, MA

Since the definition of the genus *Sturnira* in the early 19th century, there have been 15 descriptions for forms considered to be discrete phylogenetic entities or species. Recent phylogenetic studies suggest the presence of at least 17 different taxa in the Neotropics. The presence of pervasive problems with the taxonomy and phylogeny of *Sturnira* is reflected by the difficulties in differentiating closely related species such as the sister pairs *S. erythromos*-*S. bogotensis* or *S. ludovici*-*S. oporaphilum*. Current knowledge on this abundant and widely distributed genus is poor. The lack of studies on the biogeography, morphology, and ecology of populations and species of *Sturnira* throughout the Neotropical Region, in part, explains why there are so many controversies, mistakes, and misunderstandings in establishing the identity and distribution of taxa in this genus. Phylogenetic studies are useful to explain evolutionary relationships, hypothetical origins and historical distributions, but complementary studies are needed to better understand the evolutionary dynamics of the species that comprise the genus. This work presents the results of a morphometric analysis of more than 400 samples belonging to different populations or taxa occurring in Ecuador and the patterns of change in shape and size

across environmental gradients and geographical barriers. I describe current processes of speciation, broad distributional patterns, and taxonomic identities of groups that occur in the study area, based on evidence from traditional and geometric morphometric techniques. Only one sister pair of highland taxa is preset on the highlands of Ecuador, and only one species occurs in the lowlands for the *S. tildae-luisi-lilium* complex. Markedly different forms occur on both sides of the Andes for each of the putative species. The data suggest a process of parapatric speciation in two sympatric forms facilitated by gradual environmental change along altitudinal gradients in the Andes. Evidence is provided of additional patterns of morphological change along a latitudinal gradient, suggesting the presence of different taxa related to forms such as *S. oporaphilum* at southern latitudes and *S. ludovici* in northern areas (*S. ludovici* is probably endemic to Ecuador based on a recent phylogenetic study). A complex and dynamic process is described in which both barriers and gradients, as well as ecological interactions occurring between sympatric taxa, interact in an evolutionary framework.

The Use of Historic or Relic Anthropomorphic Structures for the Conservation of Bats

Johnston, Dave S., H. T. Harvey & Associates, San Jose, CA

One of the primary limiting resources for bats is roosting habitat. As human populations grow, natural habitat for bats decreases, and man-made structures become increasingly important as roosting habitat. As a municipality grows and ages, older structures often become potential bat roosting habitat when the human population abandons them. However, most of these abandoned structures become a public nuisance and liability for the landowner. The result is that the structures are usually either demolished, or bats are excluded during the restoration process. In a few situations, historic or relic structures are unsuitable for human occupation but good candidates as bat roosting habitat. For example, in the Carrizo Plains in Central California, an historic ranch house, built of cinder blocks, was occupied with a maternity colony of pallid bats (*Antrozous pallidus*). The Bureau of Land Management decided it would not restore the building because it would have involved a very expensive seismic retrofitting. Instead, the building was managed to conserve the colony of pallid bats and incorporated as a part of an historic farm equipment trail. Similarly, in Fremont California, an abandoned concrete silo was designated as historic, but was being considered for demolition by the landowner, the U.S. Fish and Wildlife Service, because the silo was considered a public nuisance. With the help of enterprising craftsmen and about $100,000, the silo is being converted into bat roosting habitat complete with a heat pump, solar panels to run the heat pump, and data loggers to monitor the temperatures at the various bat condominiums hanging inside the silo. At a third site on the Lemoore Naval Air Station in San Joaquin Valley, over 400 feet of 48 inch concrete piping and connector pieces had become an eyesore and financial liability. Rather than remove the piping, it was connected and buried in soil to form an artificial cave with potential roosting habitat for the Mexican free-tailed bat (*Tadarida brasiliensis*). These are three examples of ingenious measures that have been undertaken to conserve bats while natural habitat is being converted into developed lands. We must continue to take advantage of these opportunities to convert abandoned or relic structures into potential roosting habitat.

Monitoring Populations of the Yuma myotis (*Myotis yumanensis*) as an Indicator Species of Healthy Streams

Johnston, Dave, Laura Curtis, Matthew Pyrch, and Katie Reich
Santa Clara University, Santa Clara, CA

Although alarming declines of bat populations are increasingly documented, quantitative information on the population status of bat species in the San Francisco Bay Area is lamentably scarce. Because the Yuma myotis (*Myotis yumanensis*) is a widespread species in western North

America, is relatively long-lived, and forages over aquatic habitats, we suggest this species is a good candidate for monitoring long-term population trends and could be used as an indicator of intact riparian habitats. Our first goal was to establish a database for bats foraging on the Guadalupe River watercourse. To survey bats, we captured them with mist nets along the river and its tributaries and conducted acoustic surveys using an Anabat 5 program and Titley Electronics hardware. Because the results of aquatic macroinvertebrate surveys have been used as indicators of polluted and disturbed watercourses, our second goal was to determine if the Yuma myotis could be used as an indicator species of healthy (undisturbed) streams. Although we do not have enough data to warrant statistical analysis, trends indicate that in undeveloped areas, the amount of foraging by Yuma myotis is correlated with the abundance of macroinvertebrates. In the upper watershed we recorded a mean of 259.8 passes/hr and 262.2 invertebrates/unit and in the lower watershed a mean of 9.1 passes/hr and 9.2 invertebrates/unit. In the middle portion of the watershed, downtown San Jose, we recorded a mean of 2.3 passes/hr and 65.1 invertebrates/unit suggesting no correlation. In order to help establish a long-term monitoring program of Yuma myotis along the Guadalupe River, an educational program to schools adjacent to the river was started in the fall of 2002 to train interested teachers and their students to help with acoustic surveys. We also started monitoring prey taken by Yuma myotis. We collected 40 fecal pellets from 8 captured bats and analyzed the guano with a dissecting microscope. Using pooled data, four bats ate 34% Trichoptera, 16% Diptera, 4% Coleoptera, 16% Hemiptera, and 30% Ephemeroptera in a white alder (*Alnus rhombifolia*) – willow (*Salix lasiolepis* and *S. laevigata*) dominated riparian habitat in the upper watershed. In the lower watershed, four bats ate 32% Diptera, 1% Lepidoptera, and 67% Hemiptera in an alkali bulrush (*Scirpus robustus*) dominated saltwater marsh. Based on the % volume of the remains of the reticulated water boatman (*Trichocorixa reticulata*) found in guano, we hypothesize that the Yuma myotis also forages on evaporation salt ponds in addition to saltmarshes and sloughs where we observed this myotis foraging.

Bat Roosts in Forests: An Empirical Synthesis Using Meta-Analysis

Kalcounis-Rueppell, Matina C., Jennifer M. Pysllakis and R. Mark Brigham
University of North Carolina-Greensboro, Greensboro, NC, University of Northern British Columbia, Prince George, BC; University of Regina, Regina, SK

Over the past two decades, we have begun to accumulate a basic understanding of the roosting and foraging ecology of temperate insectivorous bats in forests. As our understanding improves, it is not surprising that there should be attempts at synthesizing our knowledge to prioritize future research directions (e.g., Hayes in press). Miller et al. (in press) reviewed the results of 56 papers (1980-2001) and concluded that current data are unreliable because of small sample sizes, the short term nature of studies, pseudo-replication, inferences beyond the scale of data collected, study design, limitations of bat detectors, and statistical analyses. While acknowledging the limitations, our concern is that this type of synthesis will provide incentive for leaving bats out of forest management considerations. In this study, we assess whether general patterns in North American bats' use of roost trees and stand characteristics are robust enough to be distilled from the published literature. First, we used a meta-analysis on the same set of studies cited by Miller et al. (in press) to assess whether the limitations preclude bats from being incorporated into management practices. We used a second meta-analysis incorporating more recent data to determine the best current synthesis of knowledge on bats use of forests for roosting. We found that relative to other trees in the forest, the roost trees of bats are tall with large DBH in stands with open canopy (for all variables $p<0.001$). In contrast, relative to other trees in the forest, roost trees of bats did not differ with respect to tree density in the stand, snag density in the stand, or nearness to water. Our results clearly show that significant patterns can be detected from the literature when data sets are combined using a meta-analytic approach.

The Malaysian Bat Conservation Research Unit: Research, Capacity Building and Education in an Old World Hotspot

Kingston, Tigga, Zubaid Akbar, James Elder, Thomas H. Kunz, and Sucharita Gopal
Boston University, MA; University Kebangsaan Malaysia, Malaysia

Malaysia is a critical country for international bat conservation. At the centre of palaeotropical bat diversity with 10% of the global bat fauna, more than a quarter of the 118 species make the IUCN Red List. The Malaysian Bat Conservation Research Unit (MBCRU) was established in 2001 to promote research and conservation education of the unique bat fauna of Malaysia. It is a collaboration between scientists and educators from the USA (Boston University) and Malaysia (Universiti Kebangsaan Malaysia, Malaysian Nature Society, and the Department of Wildlife and National Parks). The mission of the MBCRU is three-fold: 1) long-term research on bat diversity and conservation; 2) capacity building of Malaysian scientists through workshops and student support to implement both long-term research and bat diversity inventories; 3) implementation of an education program to highlight the diversity and biology of bats, as well as the international importance of Malaysia to bat conservation. The primary research objective is to develop a predictive framework for identifying those bat species most at risk from habitat disturbance so that conservation efforts can be implemented before populations begin to decline. Our research currently focuses on the patterns and processes affecting diversity in insectivorous bat communities in undisturbed rain forest at the local and landscape level at five study plots in the Krau Wildlife Reserve (Pahang, Malaysia). Extinction risk predictors such as rarity, spatial distribution, reproductive phenology, home range, longevity, and population turnover rates, are derived from a standardized and spatially-explicit harp-trapping protocol, and are used to develop extinction risk profiles for the insectivorous species of the forest interior (the most vulnerable guild). Here we present preliminary data from the first round of trapping, and detail our capacity building and outreach activities.

A Comparison of the Effective Region of Maximum Bite Force Production in Bats

Korobov, Natasha D., and Elizabeth R. Dumont, University of Massachusetts, Amherst MA

Several workers have suggested that the need to prevent distraction (tensile dislocation) of the temporomandibular joint (TMJ) is a universal selective pressure that constrains the morphology of the masticatory apparatus in mammals. This idea has been examined through modeling experiments and validation using morphological data. To date, these studies have focused on clades with relatively derived masticatory systems and support the idea that diversity in cranial form is limited by the need to avoid the distraction of the TMJ. In this study, we use bats to examine this question because they exhibit relatively primitive masticatory morphology despite their incredible diversity in craniofacial form. We collected morphological data from the palates of over 60 species of bats from five families. These species varied widely in dental formula and relative length and width of the skull. Using these measurements, we calculated the effective length of the theoretical region of constant, maximal bite force production ('Region 2') along the toothrow. We then compared this predicted value to the actual lengths of the molar and premolar rows. Our results indicate that the effective length of Region 2 varies between species. As in previous studies, Region 2 always encompasses all the molars, suggesting that it is advantageous for the chewing and grinding teeth to be contained within the region of maximal, constant bite force production. Among insectivorous/animalivorous species, Region 2 is limited to the molars. In plant-visiting bats, however, this region of maximal force production has shifted anteriorly to include a significant portion of the premolar row, in some cases encompassing the entire premolar series. This anterior shift in Region 2 is usually, but not always, associated with the loss of one or more molar teeth. The anterior shift in Region 2 among plant-visiting bats indicates that the premolars are perhaps as important as the molars in food processing. This ac-

cords well with documented diversity in premolar structure among frugivores as well as recent studies demonstrating species-specific biting patterns that often focus on the premolar teeth.

Geographic Variation in Carbon and Nitrogen Isotope Ratios for Assessing Dietary Differences in Big Brown Bats (*Eptesicus fuscus*)

Kunz, Thomas H., Kendra J. Buscetta, and Robert H. Michener, Boston University, Boston, MA

Stable isotope ratios of carbon and nitrogen frequently have been used in ecological research to investigate dietary habits and food webs. These studies are valuable for establishing the tropic structure of entire ecosystems or the dietary patterns of a single species, including both aquatic and terrestrial organisms. Different tissues have been used to evaluate dietary habits using stable isotope ratios, including organs, fecal matter, hair, shells, etc. For this study, we mostly analyzed wing tissue from big brown bats (*Eptesicus fuscus*), collected from throughout its range in North America. Because big brown bats commonly occur in both urban and rural settings, they are ideally suited for geographic comparisons of diet. We tested the hypothesis that bats from agricultural and non-agricultural regions in North America show marked differences in isotope ratios of carbon and nitrogen—based on the consumption of insects that feed primarily on live plants or plant detritus available in these different environments. Wing tissue was collected from several populations of big brown bats from throughout North America, including samples both urban and rural habits. A statistically significant difference was found in the carbon and nitrogen isotope ratios between bats living in agricultural versus non-agricultural areas, whereas areas characterized by a combination of these two environments could not be distinguished statistically. To confirm these findings, two additional populations of big brown bats were sampled, one from an agricultural monoculture (corn) in western Indiana, and the other from a mixed deciduous/coniferous forest in southern New Hampshire. For the latter comparison, we analyzed wing tissue, blood plasma, compacted blood cells, hair, and guano (feces). Although our analyses of the latter data are incomplete, preliminary results support our initial findings that showed marked differences in isotope ratios between agricultural and non-agricultural regions.

Insect Availability and Diet Analysis of the Little Brown Bat (*Myotis lucifugus*) Population at Chautauqua Institution

LaBarr, Melinda F., and Karry A. Kazial, SUNY College at Fredonia, NY

The Chautauqua Institution contains one of the largest bat populations in western New York State. Anecdotal evidence suggests this little brown bat (*Myotis lucifugus*) population has suffered a decline. Through this research we address whether any decline might be due to changes in available insects the bats are feeding on. Bats were captured by hand or hand net in order to obtain fecal pellets to examine their diet. We also recorded the colony membership, gender, age category, reproductive condition and weight of each bat captured and we will describe their diet within these classifications. Flying insects were also trapped in several locations on the Chautauqua grounds using a Malaise trap to discover which insects are available to these bats. Results will include a diet analysis that will report the insect orders the bats are feeding on as well as the insect orders that are available to the bats. Preliminary results suggest the greatest percentages of the flying insect samples are made up of Diptera (60-95%) and Homoptera (1.1-20%). This data will be compared to past data taken on the same bat population at Chautauqua in 1991 and 1992 in order to gain some insight on any possible change in the flying insect availability and the diet of little brown bats at the Chautauqua Institution.

Monitoring Changes in Commensal Bat Populations: A Comparison between Roost Counts and Exit Counts

Laniewicz, Brian R., Stephen C. Frantz, John W. Hermanson, and Paul D. Curtis
New York State Department of Health, Albany, NY; Cornell University, Ithaca, NY

Populations of commensal bat species, such as the little brown bat, *Myotis lucifugus*, and the big brown bat, *Eptesicus fuscus*, are often difficult to monitor. Therefore, it may be difficult to accurately quantify changes in population size over a given period of time. This study was designed to assess the overall accuracy and effectiveness of two methodologies that can be used for monitoring populations of bats at individual roost sites located within structures. Factors contributing to difficulties in monitoring protocols may include: variability in site design, roost accessibility (both for bats and humans), availability and location of adequate roosting surfaces, overall roost site characteristics, population size, environmental conditions, and economic feasibility. For scientific studies that require the ability to determine detailed changes in the size of commensal bat colonies, a monitoring method, or a combination of methods, that takes such factors into consideration may be required to acquire satisfactory data to conduct valid scientific tests. We analyzed data collected from two different monitoring techniques (video exit counts and roost counts) that could be utilized for obtaining population data for commensal bat roosts located in structures at 16 sites in central New York during the summers of 2001, 2002, and 2003. At these 16 sites, bat colonies (roosts containing more than one bat) were located within a total of 36 structures (20 buildings and 16 bat houses). Thirty-three of these colonies were primarily *M. lucifugus* and three were primarily *E. fuscus*. Of the 16 sites monitored, eleven were monitored with a combination of both video exit and roost counts, three with roost counts only, and two with video exit counts only. At all roosts in which both roost counts and video exit counts took place, population estimates based on roost counts alone were always lower, and typically more variable, when compared to the video exit counts, but video analysis was a more costly and time intensive monitoring method. Under most circumstance the video exit count should provide an accurate overall population estimate for roosts located within structures.

Summer Roost Selection of Eastern Red Bats (*Lasiurus borealis*) in the Pocomoke River Watershed, Maryland

Limpert, Dana L., and Dixie L. Birch
Maryland Department of Natural Resources, Annapolis, MD; Maryland Cooperative Fish and Wildlife Research Unit, Princess Anne, MD

Temperate forest bats occupy an important niche as the primary predators of nocturnal flying insects. Declining bat populations have encouraged researchers to investigate roost selection. Few studies, however, have focused on tree roosts and even fewer projects have incorporated a multi-scale study of landscape pattern. We used radio-telemetry to locate bat roost trees, and described and quantified summer roost selection for eastern red bats (*Lasiurus borealis*) at three spatial scales: roost tree, plot, and landscape. In addition, we compared habitat use and availability by comparing random trees with trees that red bats selected. In 1999–2000, we tracked 24 red bats to 64 roost trees, primarily tulip poplar, sweet gum, black gum, red maple, and southern red oak and used Kruskal-Wallis analyses to compare variables at the three spatial scales. We found no significant differences in red bat selection of foliage roosts by sex, age, reproductive condition, or site. However, we did find that red bats selected roosts in mature deciduous trees with larger dbh's, higher canopy closure, and lower groundcover than random trees available in the study area. At the plot scale, we also found that red bats selected higher frequencies of saplings and mature trees, and higher canopy closure and lower groundcover percentages than available random plots. At the landscape scale (1000 m radius circle), red bats used more open urban land with less development, more deciduous forest, and less local roads than the available landscape. However, red bats used more trails, wetland areas and stream areas than random landscape buf-

fers. Red bat roost distances to the nearest street were significantly less than roost distances to the nearest stream. Our study results suggest that some anthropogenic disturbances in the landscape may enhance habitat for red bats.

Emergence Patterns of Evening Bats from Daytime Roosting Structures

Linehan, Jennifer M., Adam C. Miles, Steven B. Castleberry, L. Mike Conner, and Darren A. Miller, University of Georgia, Athens, GA; Joseph W. Jones Ecological Research Center, Newton, GA; Weyerhaeuser Company, Columbus, MS

Timing of bat emergence at roosting sites such as man-made structures and caves often is related to light intensity and the timing of sunset. Few studies have investigated emergence times for tree roosting bats, where other variables may affect departure timing. During the summer of 2003, we investigated external cues that signal evening bats, *Nycticeius humeralis*, to exit roosting locations at the Joseph W. Jones Ecological Research Center in Southwestern, Georgia. Emergence was observed at 48 roost trees identified through radio-telemetry. Roosting structures included snags and live pines and hardwoods. We recorded emergence time, number of bats exiting, light intensity, ambient temperature, humidity, barometric pressure, cloud cover, lunar phase, and precipitation. Factors affecting emergence time will be discussed.

What Good Is a Raincheck?
Weather Proofing for Bat Detectors and Its Effect on Call Reception

Livengood, Kimberly, Ronald Drobney, and Chris Corben, University of Missouri, Columbia, MO

Bat detectors are commonly used for monitoring bat communities and are being used increasingly in a passive mode. Compared to other bat monitoring methods, passive use of bat detectors has the advantage of allowing much better temporal and spatial coverage for the same resource commitment. Many passive detectors can be deployed for extended periods by a single person and left to collect data unattended for days or weeks at a time. A universal requirement of such deployments is the need to protect electronic equipment from adverse weather and interference by animals. Currently, two devices are commonly used for weather protection; curved pipes and flat reflector plates that deflect incoming ultrasound into a sheltered detector. Both approaches allow the detector itself to be positioned so that rain is unable to reach it, while still detecting bat calls from favorable directions. Little is known about how these devices affect the reception of bat calls. In this study, we conducted quantitative tests to establish what effects such devices have on the quality of signals received by a detector and on the detector's zone of reception. Results and practical implications are discussed.

California Bat House Research Project

Long, Rachael, University of California Cooperative Extension, Woodland, CA

A seven year bat house research project in California has confirmed the use of bat houses by four species of bats (pallid, myotis, big brown, and Mexican free-tailed bats). Bats in this study preferred houses that were attached to buildings that were at least ten feet off the ground and that received morning sun and afternoon shade.

[This paper was presented by Dharma Webber, Indigo Wings, Placerville, CA]

*Comparison of Morphology, Echolocation Call Structure, and Genetics of *Myotis lucifugus* and *Myotis yumanensis*

Luszcz, Tanya M. J., Jason M. K. Rip, Krista J. Patriquin, Lydia M. Hollis, Joanna M. Wilson, Heather D. M. Clarke, Robert M. R. Barclay, and Jan Zinck
University of Calgary, Calgary, AB, Canada; Portland State University, Portland, OR

The vespertilionid bats *Myotis lucifugus* and *M. yumanensis* are sympatric through parts of their range. These two species are morphologically similar, and can be difficult to tell apart in the hand. However, they exhibit differences in their reproductive chronology and foraging ecology, so it is important to be able to distinguish between them. Various researchers have described methods with which these two species can be distinguished in the hand using morphology, behav--iour and more recently, echolocation call structure. However, no published studies have combined these methods to identify individuals. A large maternity colony of both species in a building in North Cascades National Park, USA represented a unique opportunity for a comparative study of these bats in the same environment. Our objective was to compare the external morphology, echolocation call structure, and genetics of *M. lucifugus* and *M. yumanensis*. Based on previous literature, *M. lucifugus* is described as having longer, shinier fur with darker ears and wing membranes, while *M. yumanensis* has shorter, duller pelage with lighter ears and wing membranes. Previous studies suggest that *M. lucifugus* has a minimum echolocation call frequency near 40 kHz while *M. yumanensis* has a minimum call frequency around 50 kHz. We used genetic differentiation to determine the success of identification using external morphology and echolocation call structure. Bats were mistnetted at the building and measured independently to minimize bias. Fur and membrane colour were classified in two ways (using a Munsell colour chart and by classifying fur as shiny/dull, long/short and membranes as dark/light). Wing punches for DNA analysis were taken from the posterior part of the wing membrane away from major blood vessels. Upon release of the bat in a standard location, two researchers recorded echolocation calls using ANABAT II ultrasonic detectors and a spotlight to track each individual. Preliminary genetic analysis indicates that minimum call frequency is a good measure of species' membership between *M. yumanensis* and *M. lucifugus*, while identification based on external morphology does not produce consistent results and is subject to high researcher bias. Final results from all methods of species' identification will be presented and compared.

***Tanya M. J. Luszcz** received the **Basically Bats Wildlife Conservation Society Award**

Vertical Stratification of Bats in the Neotropics and Its Relationship with Environmental Variables

Mantilla-Meluk, Hugo, Texas Tech University Lubbock, TX

In spite of their importance in tropical ecosystems, little is known of the way in which chiropterans are distributed vertically in tropical forests. I studied the vertical stratification of bat communities in three different forest sites in the Neotropics: La Selva Biological field station (Costa Rica), Barro Colorado Island (Panama), and the Amazon Center for Environmental Education and research ACEER (Peru). Simultaneous mist netting samplings were carried out in both canopy (21.8 – 40 m) and understory (0 – 4m). The canopy captures were possible with the help of canopy walkways (Peru), and rope and pulley systems (Costa Rica and Panama). At the same time, temperature and humidity were recorded every fifteen minutes for each layer for a period of 12 hours. Each captured species was classified by feeding habits. I found significant differences in species composition between the two strata. A high diversity of species and feeding habits were found in the understory, in comparison with the canopy. In both strata canopy frugivores were most common in terms of number of individuals. This was particularly true in the canopy. The understory frugivores, foliage insectivores, and sanguivores were underrepresented

from the canopy samples, showing a restriction in the trophic range in the canopy. A high uniformity of species was found in the understory while the canopy was more uniform in term of feeding habits. In both strata the temperature fell during the night hours. A maximum temperature differential between the canopy and the understory occurred in the first hours of the night. After this time temperature became more homogeneous between the two strata. The same pattern was observed for the humidity. These two physical processes seem to be very important in determining the activity of bats.

Roost Exit and Entry Sequences, Roost Fidelity and Transport of Young by Big Brown Bats

Mayrberger, Sheri, Eugene H. Studier, and Dennis P. Viele, University of Michigan, Flint, MI

We recorded every exit and entry flight of each member of a big brown bat (*Eptesicus fuscus*) maternity colony using an infra-red camera and VCR at a roost with a single access/egress hole during 150 consecutive nights in the summer of 2002. Twenty-two bats were fitted with 'key-chain' necklaces bearing unique symbol tags to determine whether these maternity colony members exit or enter the roost in a specific sequence, i.e., exhibit a fixed hierarchy. We recorded flight times to the nearest second for all marked and unmarked individuals. Although we found no exact flight sequences, exit patterns at sunset and return patterns at sunrise were not random, and certain bats occupied specific positions within the sunset emergence and sunrise return flights more often than expected. The lone adult male in the roost routinely emerged after all other bats had exited and regularly returned earlier than all other bats before dawn. Overall fidelity of marked individuals varied between 37% and 93%, although a few individuals exhibited 100% fidelity during some portion of the reproductive period. Average roost fidelity of marked females decreased from 85% during early pregnancy to 62% during late pregnancy, increased to 83% during lactation, and then dropped rapidly to 9% during postlactation. Fidelity was affected by females occasionally transporting offspring to and from alternate roosts. During a 3-week period, 0.5% of all flights were with attached young. Babies were always transported singly and transport flights only occurred after the sunset foraging bout was completed. Mothers likely transported large babies only when they could not be disengaged from the teat, and occasionally transported large babies that were probably not their own.

Implications of Rabies for Bat Conservation Efforts

McCracken, Gary F., and Charles E. Rupprecht
University of Tennessee, Knoxville, TN; Centers for Disease Control and Prevention, Atlanta, GA

Those concerned for the conservation of bats must be proactive rather than reactive in response to public health concerns that result from rabies in bats. Actions to counter impacts on bats that result from human rabies infections and the fear of rabies must be based on scientific evidence. The risk of human rabies infection that currently exists in the U.S. and Canada should not be trivialized, and we must recognize that public health concerns will supersede concerns for bat populations. While rabies is a nationally reported disease in Canada, the U.S., and Mexico, no systematic data on the effects of bat rabies on conservation efforts for bats are available. Impacts on bat populations that result from fear of rabies occur locally, come haphazardly to the attention of conservationists, and are not systematically reported to any regional or national database. We know of no scientific studies that have investigated effects of the fear of rabies on public attitudes toward bats, or on actions against bats taken by the public or by local health officials. Education is necessary to ameliorate impacts on bat populations, but education must be based on scientific evidence, not anecdote. Our response to public health concerns regarding rabies will serve as a model with worldwide implications for bat conservation. With the elimination of canine rabies in the U.S. and Canada, public health surveillance and rabies control efforts have shifted to wildlife, including bats. A major concern for bat conservation efforts is that what we see now in the U.S.

and Canada will soon replay in the bat-rich faunas of the world. Canine rabies is now controlled in Chile, should be controlled within in the next few years in Mexico, Brazil, and Argentina, and should be controlled throughout Latin America within (most of) our lifetimes. As canine rabies is diminished, the focus and pressure for rabies control will be on wildlife, and significantly on bats. This is a "freight train" that is barreling down on the world's richest bat fauna.

Effects of Temperature on Mating Discrimination in Male Big Brown Bats

Mendonça, Mary T., Auburn University, AL

Over the last several years we have been exploring the relative role of temperature change and sex steroids in stimulating mating behavior in male big brown bats. In the course of these captive studies, we have observed males will mount males as well as females during the mating season. The frequency of this type of behavior varied with the temperature regimen to which the bats were exposed. Bat mating behavior was observed nightly, 8 hours/night, from December - March. Based on their behavior, males were placed in one of the following categories: Female Mounters (60-100% of a male's mounts were of a female), Equal Mounters (40-60% of the mounts were of a female), Male Mounters (0-40% of the mounts were of a female). Bats that were exposed to alternating cycles of 7 days of 5^0 C and 4 days at 22^0 C, a temperature regimen that was highly effective in stimulating mating behavior, had very few, if any males, categorized as Male Mounters. However, when temperature regimens had a very short (e.g., 1 day of 5^0 C) or no exposure (e.g., constant 22^0 C) to low temperature conditions, the proportion of males predominately mounting males rose significantly. Under the constant 22^0 C condition, proportionally more males were mounting males than females. When these males were then returned to the alternating 7 days of 5^0 C and 4 days at 22^0 C temperature regimen, they then began to mount significantly more females than males, indicating that they were again able to distinguish between the sexes. These results will be discussed in the context of what signals the males are using to distinguish females and how this might be affected by temperature change.

Interesting Observations at Evening Bat Maternity Colonies in Southwest Georgia

Miles, Adam C., Steven B. Castleberry, Darren A. Miller, and L. Mike Conner
University of Georgia, Athens, GA; Weyerhaeuser Company, Columbus, MS; Joseph W. Jones Ecological Research Center, Newton, GA

Observations of interesting phenomena can easily be overlooked in the context of a large research project. We believe that such observations can contribute to overall knowledge and serve as a starting point for future research. We observed maternal visits to non-volant juvenile evening bats (*Nycticeius humeralis*) at two sites at the Joseph W. Jones Ecological Research Center in Southwestern, Georgia. Sites were previously used as day roosts by lactating females, but were believed to be unoccupied on the day of observations. Shortly after sunset we located juveniles making loud, low frequency, audible calls. We visually identified five locations containing single or multiple juvenile bats at these two sites. This included a single juvenile 5 - 7 m high on the trunk of a water oak (*Quercus nigra*) at one site, and multiple juveniles at the second site. The second site, which we term as a "nursery area," included a hardwood snag with multiple juveniles, a post oak (*Quercus stellata*) with a single bat on the trunk, and two shrubs containing one bat each. Adult bats were observed making frequent visits to the young. We believe that juveniles were deposited at these locations while their mothers went on foraging bouts. We will present a video and a qualitative description of the behavior, and a quantitative description of each site. An update on our roosting ecology study of evening bats also will be presented.

Protected Areas and the Conservation of India's Threatened and Endangered Bat Species

Mistry, Shahroukh, and Maria Daniela Biaggio
Westminster College, New Wilmington PA; Bryn Mawr College, Bryn Mawr, PA

Well-targeted conservation efforts are needed to sustain biodiversity. With more than a thousand species, bats compose almost one fourth of all mammals, and should be important targets for conservation. However, the myths and folklore regarding bats have drastically affected their conservation status, and countries such as India still place bats species in the category of vermin. This study, as part of a larger ongoing project, uses known roost locations in conjunction with a geographic information system to create distribution maps of the threatened and endangered bat species in India. Initial results suggest that the three Conservation International (CI) biodiversity hotspots in India hold localities for 21 of the 29 threatened and endangered species. The Indo-Burma hotspot was the richest in number of localities (35) as well as number of species (15). The only hotspot containing a critically endangered species is the Western Ghats where the sole known roost of *Otomops wroughtoni* is located. However, the area within the biodiversity hotspots that is actually protected is minimal. Just three species (*Pteropus hypomelanus*, *Myotis mystacinus*, *Taphozous theobaldi*) are known to occur within protected areas. None of the seven endemic species exist in protected areas. Comparisons of bat distributions with the world eco-regions, land cover use and human population density, indicate that the majority of bat species are located in ecosystems that are at-risk or endangered, and exist in areas of moderate to high human densities. These results paint a grim picture for the future conservation of habitats to protect India's bats. The creation of new protected areas within the CI biodiversity hotspots would be highly beneficial to bats as well as other taxa.

The Extinct Pleistocene Molossid Bat *Tadarida constantinei* from Slaughter Canyon Cave, Carlsbad Caverns National Park, New Mexico

Morgan, Gary S., New Mexico Museum of Natural History, Albuquerque, NM

In 1960 Barbara Lawrence described *Tadarida constantinei*, a large extinct species of free-tailed bat (family Molossidae), from New Cave (now known as Slaughter Canyon Cave), Carlsbad Caverns National Park (CCNP), Eddy County, southeastern New Mexico. Paleontologists and volunteers from the New Mexico Museum of Natural History (NMMNH), CCNP, and Kartchner Caverns in Arizona excavated fossiliferous Pleistocene bat guano deposits in Slaughter Canyon Cave in April 2002, collecting ~300 kg of sediment from two different test pits. We removed sediment from the vertical walls of trenches (some up to ~5 m deep) left behind by guano miners and placed the sediment into nylon bags for transport to the NMMNH for screenwashing and sorting. Slaughter Canyon Cave contains thousands of bones of *T. constantinei*, along with smaller samples of ten other vertebrates, including toad, desert tortoise, horned lizard, snake, bird, rabbit, two rodents, extinct pronghorn antelope (*Capromeryx minor*), short-faced bear (*Arctodus simus*), and an unidentified species of *Myotis*. Lawrence described *T. constantinei* (named for Denny Constantine who collected the fossils) from a series of twenty skulls. She did not illustrate a skull of *T. constantinei* but provided a description and series of cranial measurements. *Tadarida constantinei* is most similar to the living Mexican free-tailed bat *T. brasiliensis*, although it is 10-20% larger in most cranial and postcranial measurements. *Tadarida constantinei* also differs from *T. brasiliensis* in having a somewhat flatter skull. *Tadarida constantinei* is similar to *T. brasiliensis* and differs from *Nyctinomops* (e.g., *N. femorosaccus*) in: shorter, broader rostrum; broader frontal and interorbital region; and shorter paralophs and metalophs on upper molars that do not extend to protocone. Other fossil samples of a large *Tadarida* that may be referable to *T. constantinei* are known from Mammoth Cave, Kentucky and Hamilton Cave, West Virginia, both of which are medial Pleistocene in age (Irvingtonian land-mammal age), about 500 - 800,000 years Before Present (yrBP). Previous

attempts to radiocarbon date the guano and fossil bat bones from Slaughter Canyon Cave were unsuccessful, suggesting these deposits are older than 40,000 yrBP. Recently obtained uranium-series dates on flowstone deposits overlying the guano in Slaughter Canyon Cave indicate a medial Pleistocene (130-800,000 yrBP) age for *T. constantinei*. *Tadarida brasiliensis* forms huge colonies in caves throughout the southwestern United States, including the main cave at Carlsbad Caverns. The remarkable abundance of *T. constantinei* fossils in Slaughter Canyon Cave suggests this extinct species also formed large colonies.

The Relationship Between Bat Activity, Insect Abundance, and Weather Conditions

Mudd, Tom, and Sam Hui
Jasper Ridge Biological Preserve, Stanford, CA; Stanford University, Stanford, CA

At a site on the shores of Searsville Lake, Jasper Ridge Biological Preserve, Stanford, California, we have recorded bat echolocation calls on a nightly basis for more than two years. We have observed that there is enormous and unaccountable variation in bat activity from night to night. We have also collected weather data over the same period. For three months this summer we have collected insects on a nightly basis. We have attempted to determine the relationship between bat activity as determined by the number of bat calls recorded by an Anabat detector and insect abundance, and weather parameters including temperature, relative humidity, barometric pressure, wind velocity and direction, and precipitation. Following standard transformation of variables, a multiple linear regression model was fit to the data. Preliminary analysis suggests that bat activity is not significantly correlated with insect abundance. Increased bat activity is correlated with lower temperatures, low relative humidity, and high barometric pressure. This relationship may be an artifact of the way sound travels in the atmosphere and is an issue that we plan to investigate thoroughly. Given this result for the data collected between June 1 and August 31, 2003, we analyzed bat activity and weather data collected over the prior two years in an attempt to determine whether or not the same correlations apply. The most numerous species recorded at this site are *Myotis yumanensis*, *M. californicus*, and *Tadarida brasiliensis*.

Effects of Radiotransmitters on the Fate of Big Brown Bats (*Eptesicus fuscus*) One Year After Tagging

Neubaum, Daniel J., Melissa D. Andre, and Thomas J. O'Shea
Colorado State University, Fort Collins, CO; United States Geological Survey, Fort Collins, CO

Little is known about the effects of radiotransmitters on bats after the lifespan of the radio has passed. Most studies presume that the movement of tagged bats verifies the animal's short-term survival. However, less consideration has been given to understanding whether or not the carrying of a radio results in reduced future survival, perhaps due to reduced feeding efficiency or fat storage during the period the radio was attached. During the summer of 2001, radiotransmitters were placed on big brown bats (*Eptesicus fuscus*) as part of a larger study of disease transmission within an urban population in Fort Collins, Colorado. Radiotransmitters ranged from 0.52 to 0.95 grams, following the standard < 5% body mass rule. Transmitters have a mean (± SE) proportion of body weight at tagging of 3.93 ± 0.70% (n = 40). Bats were also implanted with a passive integrated transponder (pit tag) to give them a unique identification number. Extensive tracking efforts in 2001 identified 58 roost sites, 14 of which were equipped with AVID pit tag readers in 2002. The 2002 pit tag reader data were searched for the presence of the 2001 radiotagged bats that had been known to use these monitored roosts in the year of their capture. A total of 34 out of 40 (85%) previously radiotagged bats expected at monitored roosts were recorded by the readers, thus verifying their presence one year later. In addition, two of the six bats that were not recorded were re-captured during netting in 2002 for a total of 90% known to return. This percentage compares favorably with the literature on big brown bat life history, and with the total return rate at our maternity colonies equipped with readers, where 80% (269

out of 336) of the adult females that were pit tagged in 2001 returned in 2002. All previously radiotagged adult females recaptured by hand one year later (n = 21) were reproductive and exhibited normal body masses the second summer. Based on this evidence, we conclude that adult female big brown bats handle the stress of carrying a transmitter within the 5% rule well.

Do Bats Acquire Immunity to Rabies? Evidence from the Field

O'Shea, Thomas J., Vidya Shankar, Richard A. Bowen, Charles E. Rupprecht, and Jeffrey H. Wimsatt, U.S. Geological Survey, Fort Collins, CO; Colorado State University, Fort Collins CO; Centers for Disease Control and Prevention, Atlanta, GA; University of Virginia, Charlottesville, VA

We have obtained evidence from field studies that suggests bats may acquire immunity to rabies virus (RV). During a three-year period from 2001 through 2003, we obtained blood samples for a serology survey of over 2,000 big brown bats (*Eptesicus fuscus*) at more than 20 colony sites in Fort Collins, Colorado. These bats were marked with passive integrated transponder (PIT) tags for subsequent determination of their fate and for repeat blood sampling and serology of known individual bats. Serum was analyzed for the presence of RV neutralizing antibodies using the Rapid Fluorescent Focus Inhibition Test (RFFIT). Isolation of IgG from a sample of rabies seropositive bats and its subsequent effect in RFFIT demonstrated that the IgG fraction in the serum neutralizes RV. Seropositive big brown bats were found in every colony, and the seroprevalence (the proportion of bats with RV antibodies) in adult bats varied by roost, ranging from 3 to 35%. Seropositive bats were recaptured or demonstrated to be alive by PIT tag readers even after 1-2 years following the initial detection of RV antibodies in them. RV antibodies in seropositive bats also persisted even after 1-2 years since the first sampling, which is longer than any expected incubation period for RV. We also report: results of reverse transcriptase polymerase chain reaction (RT-PCR) assays for the detection of RV genome in tissues of seropositive bats known to be alive one year after initial blood sampling; changes in overall seroprevalence by age groupings of bats; and seroprevalence data for additional species of bats sampled at other locations, including migratory silver-haired bats (*Lasionycteris noctivagans*, seroprevalence 7%, n = 60 adults) and hoary bats (*Lasiurus cinereus*, seroprevalence 31%, n = 58 adults) sampled in New Mexico. These data support the hypothesis that bats are commonly exposed to the RV and can acquire immunity, perhaps through exposure to low doses of RV that do not result in productive virus infection. The immunity conferred to segments of bat populations together with their ability to endure some level of RV exposure may explain why it is uncommon to observe widespread decimation of entire colonies of bats by rabies epizootics.

A New *Carollia* (Phyllostomidae) from Peru and Bolivia, with a Cladistic Hypothesis of Its Relationships

Pacheco, Víctor, Sergio Solari, and Paul M. Velazco
UNMSM, Lima, Perú; Texas Tech University, Lubbock, TX; The Field Museum, Chicago, IL; University of Illinois at Chicago, Chicago, IL

Carollia (Phyllostomidae: Carolliinae) is a genus of relatively common Neotropical bats. Six species are recognized in the genus. Some of them are restricted to Middle America and Mexico (*C. sowelli*, *C. subrufa*) or the Northern Andes (*C. colombiana*), while the others (*C. brevicauda*, *C. castanea*, *C. perspicillata*) exhibit wide distributions in South America. Here, we point out an undescribed species with an apparent restricted distribution, which was first collected in Puno, SE Peru, more than 50 years ago. At present, additional specimens document its geographic distribution to the montane forests of Peru and Bolivia, ranging from 1300 to 2250 m. The new taxon is one of the largest species known in the genus, being sympatric with the smaller *C. brevicauda* in several localities, and with *C. brevicauda* and *C. perspicillata* in a single locality in Cuzco, Peru. The new taxon is characterized by a combination of large size, long fur, furred forearm and short tibia, with a deep-notched uropatagium. Cranially, it has a broad rostrum, with

a markedly broad interorbital region, large and massive teeth, with broad overlap between the upper canine and first premolar, among other characteristics. This new *Carollia* increases the diversity of the genus up to seven species, but recent analysis using molecular methods suggests this estimate would be rather conservative, and that geographic features play a significant role on the delimitation of phylogeographic units (i.e., species). Comparisons of this undescribed species with other congeners show a large deal of morphological variation, which could be used to assess the evolutionary relationships within the genus *Carollia*. Cladistic analyses of a set of discrete morphological characters suggest a closer relationship of the new taxon with *C. brevicauda*.

Biogeography of the Northern Lesser Antilles: Comments on the Lesser Antillean Faunal Core

Pedersen, Scott, Hugh Genoways, Gary Kwiecinski, and Peter Larsen
South Dakota State University, Brookings, SD; University of Nebraska, Lincoln, NE; University of Scranton, Dalton, PA; Texas Tech University, Lubbock, TX

We have been working on the bat fauna of the northern Lesser Antilles since 1993. Though the primary focus of these efforts has been to document how bat populations on Montserrat cope with the ongoing volcanic activity (1995-2003), we have conducted survey work on the adjacent islands of Antigua, Barbuda, Nevis, St. Kitts, Saba, St. Eustatius, St. Maarten, and Anguilla to better understand that fauna in this corner of the Caribbean and to provide a backdrop (natural controls) for what is happening on Montserrat. Presumably, the paucity of Chiroptera in the Dutch Antilles relates to the small size of these islands and their down-wind distance from large source-islands such as Guadeloupe. Nevertheless, the Dutch Antilles, located at the northern end of the Lesser Antilles, support a bat fauna that Genoways et al. (2001) termed the Lesser Antillean Faunal Core. Indeed, three species of fruit bat-*Ardops nichollsi*, *Sturnira thomasi*, *Chiroderma improvisum*– have been reported from Montserrat (50 km WSW) and Guadeloupe (75 km SSE), but are unknown north of Saba. Several species of bat are extremely difficult to mist-net (e.g., *Natalus*) and would easily be overlooked if roost surveys were not conducted in parallel with netting efforts. Different habitats are extremely difficult (if not impossible) to sample adequately (tree canopy), or perhaps have never been sampled due to lack of material or logistical difficulties. Nevertheless, our 2001 census doubled the number of species reported from the small island of Nevis. Here we provide an updated faunal listing for each of these islands that vary greatly in size and physiography, and provide a brief commentary concerning island size and bio-geographical patterns in this region.

Sonar Variability of Little Brown Bats, *Myotis lucifugus* in Relation to Colony Membership, Gender, Age Category, and Reproductive Condition

Peters, Ethan R. A., and Karry A. Kazial, SUNY College at Fredonia, NY

The sonar calls of little brown bats (*Myotis lucifugus*) were recorded at Chautauqua Institution in Chautauqua, New York. Chautauqua Institution holds one of the largest populations of little brown bats in the western New York region. The main goal of this project was to determine variability in the structure of sonar calls of little brown bats that live in different colonies at the Institution. If such variability in sonar calls exists, it may be useful for communication between bats. Once positive identification of bat roosts in the attics of the homes was made, usually by entering the attic and seeing bats roosting, bats were captured by hand or hand net. The bats were housed in plastic containers with netting to allow easier movement. Colony membership, gender, age category (adult or young of year), reproductive condition, and weight of each bat captured were obtained. Sonar recordings of the bats were taken while holding the bat in the hand and also while the bat was in flight, upon release. Bats were recorded with a laptop computer, a D/A converter card (500 kHz sampling rate maximum), a connecter box, an

amplifier, and a U30 bat detector used as a microphone. Sonar calls will be analyzed using a specially written computer program in MATLAB, which will extract several variables per sonar call. We will report on variability in the sonar calls related to colony membership, gender, age category (adult or young of year), and the reproductive condition of each bat. If variability in the sonar calls exists that is based on these characteristics of the bats, it would allow for the use of sonar for communication in little brown bats.

Roosting and Foraging Ecology of the Eastern Pipistrelle (*Pipistrellus subflavus*)

Quinn, Greg M., and Hugh G. Broders, Saint Mary's University, Halifax, NS

Preliminary research in 2001 indicated that there might be a forest-dwelling, breeding population of eastern pipistrelles in SW Nova Scotia (Kejimkujik National Park) that would represent the only recorded breeding population in Canada. Given the paucity of records of this species in Nova Scotia, or even Canada, it seems likely that this represents a disjunct, actively breeding population. In 2003 we initiated more intensive work on the roosting and foraging ecology in Kejimkujik National Park, NS. So far the data indicate: 1. The local population is female-biased (none of eight individuals captured were males); 2. Females travel >5 km from roosting sites to foraging areas; 3. Females display fidelity to roosting areas but switch trees regularly; 4. Females are colonial roosters with 3-11 individuals per colony (n=8); and 5. Roosts are located in hardwood and softwood tree species and of eight colonies we were able to find, all were located in clumps of old man's beard (*Usnea* spa.) on branches near the main stem at heights > 8 m. Echolocation sampling using ground-based ultrasonic detectors found most activity was recorded over water. Little or no activity was found over grassy, open areas, bogs, forests, and over the forest canopy. Telemetry has been difficult to date, primarily due to large home ranges (>5 km radius) and the sparse road network in the study area. Pipistrelles have been recorded foraging over rivers, lakes, bogs, and over the canopy at river-edge. This study is in the early stages, and is scheduled to continue until spring 2005.

Roosts as Information Centers: Social Transmission of Flavor Preferences in the Short-tailed Fruit Bat, *Carollia perspicillata*

Ratcliffe, John M., and Hannah M. ter Hofstede, University of Toronto, ON; York University, ON

Though palatable food may be close at hand, information about possible foraging opportunities, and thus food itself, is available only as a function of the sensory mechanisms and cognitive capabilities species possess and constrain each to a limited number of food items and situations in which these items might be had. While neophobia and taste aversion learning are adaptive strategies for the prevention of poisonings, social transmission of food preferences allows individuals to learn from one another about available, and in some instances novel, food resources. We expect to observe social transmission among species that spend some or all of their time living in a group. The short-tailed fruit bat, *Carollia perspicillata* (Phyllostomidae), lives in groups in both tree hollows and caves. To investigate whether roosts might serve as information centers for foraging opportunities for this species, we tested whether individual food preferences for novel flavored foods could be mediated by interactions with a conspecific that had already consumed one of these foods. We also tested whether these preferences could be easily reversed through further interaction with another conspecific to simulate changes in available food resources as a result, for example, of temporal variation in fruiting phenology in different plant species. We found that bats learned socially-mediated preferences from conspecifics and that these preferences changed readily after a second interaction with a conspecific that had eaten the subject's previously non-preferred food. We suggest that for this species roosts serve as centers for sharing information about novel and/or ephemeral food resources.

Baseline and Stress-induced Glucocorticoid Hormone Levels in Free-ranging Little Brown Myotis (*Myotis lucifugus*) During the Active Period

Reeder, DeeAnn M., Nicole S. Kosteczko, Thomas H. Kunz, and Eric P. Widmaier
Boston University, Boston, MA

The little brown myotis (*Myotis lucifugus*) is a small (7-11g), insectivorous, and hibernating species found throughout much of the United States and Canada. Due to their exceptionally high energetic intake and output and their need to tightly balance energy resources over variable seasonal conditions, little brown myotis in their natural environment provide an excellent system in which to examine seasonal fluctuations in metabolic hormones, such as glucocorticoids (GC). The objectives of this study were to characterize both baseline and stress-responsive GC levels during the active period in free-ranging male and reproductive female little brown myotis. Bats were trapped and blood was sampled within three min. of capture at two maternity sites and at one swarming site in New England. Both GC hormones, cortisol and corticosterone, were secreted, with cortisol accounting for an average of 95.2% of total GCs. Samples collected at emergence and after the first return from feeding showed significant seasonal differences across the active period (early pregnancy, mid-to-late pregnancy, lactation [and comparable mid-summer times for males] and prehibernation) within and between each sex. Elevated baseline values were found in mid-to-late pregnancy females at emergence, and in both males and females at the swarming site compared to other groups. These results suggest that GCs may be involved in the increased feeding and fat deposition characteristic of pregnancy and prehibernation. Female GC values during mid-to-late pregnancy and during the prehibernation period were greater than those for males. All animals exhibited a robust and significant stress response to 15 min. of restraint in all parts of the season. Despite different baseline levels, there were no differences between groups or sexes in the total GC levels reached in response to the stressor, suggesting that all animals maximally responded. In support of this, GC levels in little brown myotis are among the highest recorded for mammals. Future studies will characterize GC receptor levels and further explore endocrine physiology as it relates to energy balance and responses to temperate seasonality in this species.

Offspring Sex Ratios Provide Evidence for Local Mate Competition in *Rhinophylla pumilio* in Eastern Ecuador

Rinehart, J. Benjamin, Boston University, Boston, MA

The social system of the tent-roosting bat *Rhinophylla pumilio* is characterized as moderately polygynous, with roost groups comprising one or two adult males and up to four females and their offspring. Unlike most mammals, in *R. pumilio* males are philopatric whereas females disperse from their natal area. Successive generations overlap and the number of males within a roost area is apparently limited, thus there is a high potential for competition among related males for access to females. Hamilton's local mate competition hypothesis predicts that under such conditions sex ratios should be biased toward the dispersing sex. Although capture records indicate an adult sex ratio of 1:1, there appears to be a dramatic bias toward the production of females with juvenile females outnumbering juvenile males by nearly 2:1. I present data on offspring sex bias in a population of *R. pumilio* in eastern Ecuador and suggest possible explanations for this apparent phenomenon as it relates to local mate competition.

The Role of the Hindlimbs during Non-aerial Locomotion in Bats

Riskin, Daniel K., John W. Hermanson, and John E. A. Bertram
Cornell University; Florida State University

If two directional selective pressures act in opposing directions, the result is a trade-off, such that an animal's performance at some task is hindered by morphological requirements for another

aspect of its life history. The underperformance of bats as terrestrial locomotors, relative to non-aerial mammals, may result from the morphological constraints of flight. The hindlimbs of bats are rotated 90-180 degrees from the usual mammalian pattern, and in most species are very thin. On the ground, hindlimbs might be dragged passively behind the more powerful forelimbs, but they also might provide forces beneficial to locomotion. Using a digital camera, we recorded the movements of *Artibeus lituratus* and *Carollia perspicillata* at 250 fps as they crawled across two sequential force-measuring platforms. At the moment where one platform was below the forelimbs and the other below the hindlimbs, we measured the percentage of body mass supported by the legs. During locomotion, we quantified the contributions of the forelimbs and hindlimbs to vertical and horizontal force outputs. For comparison we repeated these experiments using the highly terrestrial *Desmodus rotundus*, and the arboreal *Diaemus youngi*. These experiments were conducted August of 2003 in Trinidad, so results were not yet available at the time of abstract submission.

Capture and Detection of Five Species Using Indiana Bat Protocol

Robbins, Lynn W., Kevin L. Murray, Justin G. Boyles, John C. Timpone, Matt N. Miller, and Scott A. Kelly
Southwest Missouri State University, Springfield, MO

The purpose of this study was to test the effectiveness of the accepted guidelines in determining the presence or absence of Indiana bats. In addition, four other species were collected in sufficient numbers to allow for comparisons. All collecting localities were within one mile of known maternity colonies. In addition to the standard mist-net protocol, Anabat II detectors were used at the same localities for the same time periods. Data were collected during three separate reproductive time periods, approximating pregnancy, lactation, and post-lactation. The capture and detection rates varied greatly among species, among time periods and between first and second nights at each location. For Indiana bats, total net success (NS = % of nets capturing at least one individual), was 25%, but ranged from 58% during pregnancy to 8% during post-lactation, and 44% for the first night to 6% for the second night. Total net success for *Myotis septentrionalis* was 44%, for *Nycticeius humeralis* was 36%, for *Eptesicus fuscus* was 44%, and for *Lasiurus borealis* was 69%. Net success for these species also varied greatly among netting periods. Net success for three species, *Pipistrellus subflavus* = 11%, *M. lucifugus* = 6%, and *L. cinereus* = 3%, was not used in additional comparisons. Detector success was higher for all species at all sampling periods.

Bats, People, and the Issue of "Cryptic" Rabies Cases

Rupprecht, Charles E., and Gary F. McCracken
Centers for Disease Control and Prevention, Atlanta, GA; University of Tennessee, Knoxville, TN

Rabies is an acute, progressive, fatal encephalitis caused by viruses in the Family Rhabdoviridae, Genus *Lyssavirus*. This zoonotic disease has been identified on all continents, except Antarctica. Primary reservoirs and vectors consist of mammals within the Orders Carnivora and Chiroptera. The majority of human rabies cases occur after animal bite, usually in developing countries where canine rabies is endemic. Cases after non-bite exposures, such as corneal transplants, are documented, but are quite rare. Viral variants isolated from different species are distinguishable by antigenic typing and genetic sequencing methods, allowing insights into the epidemiology and pathobiology of the disease. Such molecular 'signatures' are robust, and do not vary temporally during limited host passages. During the 20th century, hundreds of human rabies deaths from bat exposure have been reported from Africa, Australia, Eurasia, North America, and South America, usually after an identified bite. However, in the New World, human deaths associated with bat rabies virus variants with no known source of exposure are being reported with increasing frequency. For example, since 1981, only 2 of the 29 human deaths in

the United States from bat rabies had a history of a bite, even though the majority of these 'cryptic' cases implicated contact with bats. These data imply nothing unusual about the cases except that a history of suspicious animal bite could not be documented. Investigation of these cases demonstrates that a bat bite is the most parsimonious explanation as to the source of these exposures. Potential reasons, which are not mutually exclusive, for the failure to readily implicate a bat bite as the source of these deaths include: primary ignorance by a patient of the risk of disease acquisition via bat bite; failure to seek medical care due to perceived minor lesions that may be considered trivial in severity; non-recognition of the actual exposure event; communication (i.e., language) barriers; and recall bias from memory loss or impaired speech in encephalitic patients who present later in the course of disease. Typically, incubation periods in rabies range from one to three months after exposure, but on rare occasions can exceed one year from exposure, further complicating the collection of an adequate history. Prospective studies of rabid dogs and cats in the United States demonstrate that spill-over infections from bats to domestic animals are not common. Thus, suggestions that most humans affected by bat rabies are being infected by other animals, or via other unusual routes of transmission, are not objectively tenable with the available facts. Given all evidence, the "Resolution Concerning Bat Bites and Rabies," which was passed in 1999 by the membership of the North American Symposium on Bat Research (NASBR), is an embarrassment to the scientific credibility of the society. Since its passage, eight additional 'cryptic' human cases associated with bat rabies viruses have occurred in Canada and the United States, begging a reconsideration of the NASBR resolution.

Responses of Pipistrelle Bats to Their Experimentally Modified Distress Calls

Russ, Jon M., Gareth Jones, and Paul A. Racey
University of Aberdeen, UK; University of Bristol, UK

Distress calls are produced by bats in situations of extreme distress, usually when an individual is constrained in some way. Both playback experiments and experiments involving captured individuals have demonstrated that these calls produce strong inter- and intra-specific responses and distress calls probably function in attracting heterospecifics, which elicit mobbing behaviour. Previous work has demonstrated that distress calls of *Pipistrellus nathusii*, *P. pipistrellus* and *P. pygmaeus* are structurally convergent, consisting of a series of downward sweeping frequency-modulated elements of short duration and high intensity with a relatively strong harmonic content. In order to identify the key acoustic characteristics that elicit a response in both *P. pipistrellus* and *P. pygmaeus* we performed a series of playback experiments involving a modified synthetic distress call. Playbacks were performed at foraging sites in which both species were present consisting of experimentally modified distress call sequences and control sequences of random noise and sound recorded without bats present. Response, in terms of variation in the number of echolocation calls, was measured by simultaneously recording ultrasound during playbacks and counting the number of echolocation pulses above a predetermined threshold, which were then identified to species. Our findings demonstrate that increases in temporal and frequency parameters, and changes to within-call component frequency, lead to an enhanced response.

Phylogeography and the Designation of Subspecies in the Brazilian Free-tailed Bat, *Tadarida brasiliensis*

Russell, Amy L., Yale University, New Haven, CT

Subspecies of the Brazilian free-tailed bat, *Tadarida brasiliensis*, are defined by differences in roosting and migratory behavior and by slight differences in some morphological measurements. The majority of allozyme data, however, do not support significant genetic differentiation of North American subspecies, and instead indicate the presence of gene flow between the taxa. Additionally, previous analyses of genetic structuring at a local level revealed

that substantial gene flow exists among groups differentiated by both migratory tendency and direction, and suggest that migratory behavior in these populations is a plastic response to environmental conditions. I used mitochondrial DNA sequence data to investigate patterns of molecular diversity and genetic structuring within and among four subspecies of *T. brasiliensis* that are distributed throughout mainland North, Central, and South America. I found significant differentiation in populations from South America from those in North and Central America, suggesting that these regions may represent distinct species. Analyses of South American populations reveal a genetic division that is consistent with a model of regional isolation of populations caused by the Andes Mountains acting as a barrier to gene flow. Mitochondrial sequence data do not support the differentiation of the three recognized subspecies (*T. b. cynocephala*, *T. b. mexicana*, and *T. b. intermedia*) in North and Central America at the subspecific level; I have made taxonomic recommendations that reflect these data.

The Ouachita Mountains Bat Blitz

Sasse, D. Blake, David A. Saugey, Shawn M. Cochran, Dan A. Miller, and Clay Vanhorn
Arkansas Game and Fish Commission, Little Rock, AR; U.S. Forest Service, Jessieville, Mena, Glenwood, Mt. Ida, AR

Following the success of the Great Smoky Mountain Bat Blitz in 2001, the U.S. Forest Service, Arkansas Game and Fish Commission, and the Southeastern Bat Diversity Network sponsored a second Bat Blitz in 2003. Volunteer biologists from state and federal agencies, universities, and private companies from nine states came together in the Ouachita National Forest of western Arkansas to learn as much as possible about the bat fauna of the area while sharing techniques with each other. From August 4-7, 2003 a total of 209 bats, including 156 red bats (*Lasiurus borealis*), 25 eastern pipistrelles (*Pipistrellus subflavus*), 16 evening bats (*Nycticeius humeralis*), 7 northern long-eared bats (*Myotis septentrionalis*), and 5 big brown bats (*Eptesicus fuscus*) were captured at 22 sites on streams and roads in four Ranger Districts. Blood, DNA, feces, and hair samples from captured bats were collected to aid in ongoing research projects. In order to generate positive publicity for bats, one evening was designated as "media night" and representatives from Arkansas' statewide newspaper and seven television stations from Arkansas, Oklahoma, and Tennessee attended trapping sessions.

Bats Along the Big Hole River, Montana

Schmidt, Cheryl A., Shauna R. Marquardt, and Sarah L. LaMarr
BS BioServ, Inc., Newell, SD; Fort Hays State Univ., Hays, KS; Bureau of Land Management, Butte, MT

Mist net and acoustic surveys of bats were conducted on BLM holdings along and near the Big Hole River in southwestern Montana during late July to early August of 2003. At elevations of 5800-6000ft, *Myotis thysanodes* was the most frequently captured bat in the eastern portion of the survey area. Other species captured included *Eptesicus fuscus*, *Myotis ciliolabrum*, *M. evotis*, *M. lucifugus*, *M. septentrionalis*, *M. volans*, and *Lasiurus cinereus*. Captures of males significantly outnumbered captures of females in the eastern portion of the study area, with *M. volans* being the only species for which females (lactating and non-lactating) were captured. The most successful mist net site in terms of number of species captured was a shallow pool of water crossing a gravel road surrounded by open, rocky areas and sagebrush. Mist nets over running streams lined by either coniferous or deciduous trees generally captured fewer bats in terms of either diversity or number. As has been observed in other studies, most bats were captured in the initial feeding pulse that lasted from about 2140-2300 hours; however, mist nets and detectors run throughout the night provided evidence of bat activity throughout the early morning hours and well into the daylight period prior to sunrise.

Mimicry of Bats by Sphingid and Saturnid Moths

Schutt, William A., Jr., Norberto Giannini, Patricia J. Wynne, Erik Quinter, and William Godwin, Southampton College of Long Island University; American Museum of Natural History; Stephen F. Austin State University

Since the mid 19th Century, and the pioneering work of Henry Bates and Fritz Mueller, researchers have uncovered many examples of insect mimicry that vary both in the sensory modality involved (visual, auditory, or chemical) and in the object (e.g., bird droppings), plant (e.g., leaves), or animal (e.g., snakes) that serves as the model. Recently, we observed what appears be the first record of insect mimics with mammal models. In one case, numerous morphological features of the wings, head, thorax, and abdomen, indicate that a South American sphingid moth, *Nyceryx hyposticta*, mimics a vespertilionid bat (*Myotis*). In another example, the wing morphology of the neotropical saturnid moth, *Dysdaemonia boreas*, suggests mimicry of a small, phyllostomid bat. Additionally, there is some preliminary behavioral evidence to support the morphological evidence. Furthermore, both moths appear to exhibit dual mimicry, in that they combine features from two or more models. We hypothesize that mimicry of bats by these moths: 1) serves to protect the moths from insect eating predators (primarily foliage-gleaning birds); 2) evolved from leaf mimicry; 3) has gone unrecorded until now because of lepidopteran preservation methodology (i.e., how the moths are pinned out in collections).

*Identification and Distribution of *Myotis yumanensis* in Oregon

Scott, Shonene A., Patricia C. Ormsbee, Jan M. Zinck, Deborah A. Duffield, and Luis A. Ruedas Portland State University, Portland, OR; USDA Forest Service, Eugene, OR

The Yuma myotis, *Myotis yumanensis*, is listed as a "species of concern" by the US Fish and Wildlife Service; recent efforts to capture the species in Oregon indicate it may not be as common in that state as previously believed. In general, *M. yumanensis* can be distinguished from other bats using a set of external morphological characteristics. However, in Oregon and other northern portions of its range, the features of *M. yumanensis* converge with those of the little brown bat, *M. lucifugus*, making species identification difficult and inconsistent. Genetic analysis of the 16S rRNA region of mitochondrial DNA has been shown to be an accurate method of distinguishing between these two species. The purpose of the present project is to examine the distribution of *M. yumanensis* within Oregon using this mitochondrial DNA marker to confirm species identification and to examine the likelihood of correct species distinction using external morphological characteristics in the field. Bats were captured across the state of Oregon during the summers of 2002 and 2003 using a spatially distributed sampling scheme. The geographic area of the state was divided into a grid of cells, referred to as the Oregon Bat Grid, and bats were captured within as many cells as possible. Sites were selected within each cell using the Oregon Bat Database—a database consisting of historic capture data—and discussion with local biologists and private landowners. Once captured, bats were handled and measured using standard protocols and a 3-mm wing biopsy was taken to obtain DNA samples for genetic analysis. In the laboratory, standard protocols for RFLP analysis were followed in order to unequivocally identify each bat to species. We found significant differences between identifications undertaken using morphological characters relative to those determined by genetic data. Identification of bats using the genetic data suggests the need to revise the two species' distributional maps for Oregon. The application of genetic techniques to problems heretofore resolved using morphological approaches is therefore shown to have broad (and unforeseen) conservation and management implications.

***Shonene A. Scott** received the **Bat Conservation International Award**

Direct and Indirect Effects of Treefall Gaps on Local Bat Diversity in Central Panama

Sedlock, Jodi L, Lawrence University, Appleton, WI

Treefalls are known to enhance plant diversity in tropical forests. However, less attention has been given to their role in promoting local faunal diversity. On Barro Colorado Island, Panama, I predicted that treefalls enhance emballonurid diversity directly by increasing forest structural complexity and indirectly by promoting a more heterogeneous insect distribution that could be partitioned by bats. Over 30 nights, I sampled acoustic bat activity and insect abundance simultaneously at fifteen sites: five large gaps, five small gaps and five closed canopy dry stream beds. I found that emballonurid species differed with respect to their microhabitat use. *Centronycteris maximiliani* exhibited a strong preference for small forest gaps, while *Saccopteryx bilineata*, and *S. leptura* preferred large gaps. *Cormura brevirostris* was encountered almost exclusively in large gaps. Large gaps and closed canopy streams had significantly higher insect abundance – particularly during the first hour after sunset -- than small gaps. In large gaps, dynamic regression analysis revealed that species partitioned declining resource abundance. *Cormura brevirostris* responded significantly and positively to declining patch quality, *S. bilineata* responded, but not as strongly, and *S. leptura* and *C. maximiliani* did not track changes in insect abundance. These data suggest emballonurids coexist partly by partitioning both the structural diversity, as well as the variation in patch quality resulting from treefalls.

Conservation Planning for an African Flagship Species: A Strategy for Livingstone's Flying Fox and the Comorian Rainforest

Sewall, Brent J., and Elise F. Granek
University of California at Davis, Davis, CA; Oregon State University, Corvallis, OR

Livingstone's flying fox, *Pteropus livingstonei*, is a giant fruit bat endemic to two small islands of the Union of the Comoros, located near Madagascar in the western Indian Ocean. Due to its charismatic appearance, interesting natural history, and ecological role in seed dispersal and pollination, Livingstone's flying fox has become a flagship species for conservation of its montane rainforest habitat. This rainforest ecosystem contains a high concentration of endemic species, and provides essential ecological services to the Comorian people, including erosion control, stream maintenance, and the production of wood, fuel, food, and medicines. Livingstone's flying fox, however, is threatened due to increasing human encroachment on roost sites and deforestation of foraging habitat. Recent censuses indicate that only about 1,200 individuals remain in the wild, and the World Conservation Union (IUCN) has listed Livingstone's flying fox as Critically Endangered, indicating that conservation action is urgently needed. In response, the Comorian government has initiated the development of a national Conservation Action Plan for the species and its rainforest habitat. We are coordinating the development of this plan, through collaboration with the government, local Comorians, and international scientists and conservation organizations. The intent of the Conservation Action Plan is to provide a net benefit for local people, the endangered bat species, and the Comorian rainforest ecosystem. To achieve this mission, we have focused on several key programs: habitat protection, forest management, environmental education, population monitoring, ecological research, captive breeding, and the establishment of collaborative partnerships for sustainable development. The plan will emphasize local involvement and capacity-building, supplemented by support from the national government and international conservation organizations. We anticipate implementation of the plan over a five-year period beginning in late 2003 or early 2004.

On the Manipulation of Roost Temperatures by Maternity Colonies of Townsend's Big-eared Bat

Sherwin, Richard E., and J. Scott Altenbach, University of New Mexico, Albuquerque, NM

The distribution of maternity colonies of Townsend's big-eared bat has been thought limited by the availability of warm roosting habitat. We investigated this assumption at maternity roosts throughout the western United States and found that maternity colonies were capable of manipulating local roosting conditions. We found a correlation between colony size and degree of temperature increase such that large colonies were distributed independently of background internal temperatures.

Low Disturbance Monitoring, Gate Removal, and Cave Protection Have Yielded Dramatic Increases in Population Size of *Leptonycteris curasoae*, *Choeronycteris mexicana*, and *Myotis velifer* at Fort Huachuca, Arizona

Sidner, Ronnie, Ecological Consulting; University of Arizona, Tucson, AZ

The lesser long-nosed bat, *Leptonycteris curasoae*, was known from two cave roosts on Fort Huachuca (FH) prior to endangered species listing in 1988. No more than 20 *L. curasoae* were documented at these sites from the 1950s-1970s. Anecdotes were given of thousands of some type of bats exiting from the largest cave. After federal listing, the Army assessed the status of the species and their potential food plants, Palmer agaves, *Agave palmeri*, on FH. Surveys and a monitoring program were initiated in 1990, when *L. curasoae* was found at one small cave where 50 bats were observed. Skeletal material was found at two other caves where no live *L. curasoae* was found. The second potential roost was a large cave, popular for recreation, and it showed conspicuous vandalism. Only one live *L. curasoae* was observed there during the first six years of monitoring. From the beginning of the monitoring project, low disturbance methods were used at all potential roosts regardless of which species were present. Counts of individual bats during evening emergence flights provided population estimates of several bat species at different roosts. Before 1991, other protective actions that were initiated by the Army included temporary closure of potential roost sites, removal of gates and other obstructions at cave entryways, posted closure signs, fenced closure of caves and roads leading to caves, and prescriptions to prevent damage to fields of agaves during military operations. Following these actions, there was an immediate increase in population numbers of cave myotis, *Myotis velifer*. In 1997, *L. curasoae* began to recolonize the large cave. Maximum annual numbers of *L. curasoae* on FH increased from 50 bats in 1990 before protective actions to over 3000 bats in 1999 through 2001, and over 6000 in 2002. During the same period, the third protected cave showed an increase from a few to over 50 *Choeronycteris mexicana*. We have been accumulating information on foraging rates, foraging distances, and echolocation calls of the two nectar feeding species.

*Morphology and Thermoregulatory Behaviour of Reproductive Female Western Long-eared Bats (*Myotis evotis*) in the Mountains and Prairies of Alberta

Solick, Donald I., University of Calgary, Calgary, AB

Many bat species occupy large geographic areas and inhabit a variety of environments. Different environments impose different selective pressures on individuals, which may lead to the evolution of differences in morphology and/or behaviour between bat populations. For example, bats living in mountain environments experience cooler, wetter summers than bats living in prairie environments, and should therefore be under greater selective pressure to minimize heat loss to the environment. This should be true especially for reproductive females, given their high energy demands during pregnancy and lactation. The objectives of my research were to determine whether differences in morphology and behaviour occurred between reproductive female western

long-eared bats (*Myotis evotis*) from mountain and prairie populations (separated by 400 km) in Alberta. Specifically, I predicted that mountain females would have larger bodies (forearm length and mass), smaller extremities (ears, wings), and darker fur colour than prairie conspecifics, to reduce heat loss to the environment. I predicted that reproduction in the mountains would be delayed due to low ambient temperatures and frequent precipitation. To compensate for this delay, I predicted that reproductive females in the mountains would spend less time in torpor and maintain homeothermy by either selecting warmer roost microclimates or forming larger colonies than reproductive females in the prairies. Contrary to predictions, forearm length and mass of females did not differ between environments, and mountain females had larger ear area and wing area than prairie females. Fur colour, however, was darker among mountain individuals. The date that lactating females were first caught occurred 10.1 ± 0.36 days later in the mountains. As predicted, mountain females spent less time in torpor than prairie females. Females in the mountains selected roosts with warm microclimates during pregnancy and clustered with other individuals during lactation when ambient conditions were cooler. In contrast, prairie females roosted alone throughout the summer and switched roost types between pregnancy and lactation. These results suggest that barriers to gene flow may exist between the populations, leading to differences in morphology. However, this study also illustrates that bats exhibit considerable flexibility in behaviour – both between environments and reproductive stages – to adapt to local environment conditions.

Donald I. Solick** received the ***Bat Research News **Award**

Relative Density and Diversity of Bats in Urban and Suburban Areas

Soto-Ortíz, Manuel, and Armando Rodríguez-Durán, InterAmerican University, Bayamón, PR

In this study we examined four sites within the urban/suburban area of the San Juan Metropolitan Region, Puerto Rico, the West Indies. At each one of these sites we established a monitoring station using ANABAT, and the area was surveyed from sunset through midnight during the months of June and July. Each site was sampled a total of eight nights. We identified six of the 13 species of bats present on the island in all five families. The synanthropic species *Molossus molossus* accounted for most of the records. Built-up areas in the outskirts of the city do not show higher activity than inner city. Vegetation cover and, possibly, proximity of roosting areas may be more important in determining diversity.

Behavioral Responses of Bats to External and Dark Zone Cave and Mine Gates

Spanjer, Genevieve R., York University, ON

Many bat species depend on cave or mine roosts during part or all of the year, and gates are commonly used to protect them in their roosts. Gates designed to protect bats have sometimes adversely affected them. Most improvements in gate design have been based on anecdotal and observational evidence rather than experimental data. Despite improvements, some bat species avoid or hardly use gated sites. To assess behavioral responses of bats to gates, I measured the flight speed, flight behavior, and vocalizations in the presence and absence of actual gates and 'mock' gates at caves and mines ranging from southern Ontario to southern Tennessee. I studied bats' responses to gates located at entrances and within the dark zone of caves and mines. Fieldwork was conducted during swarming season (late summer to fall), when different groups of bats of both sexes and various ages were active at the site entrances for most of the night. Bat behavior at already-gated caves/mines was compared with behavior at ungated sites with mock gates at different distances from the entrance and in different orientations to the passage (straight across versus angled). I analyzed vocalizations, comparing calls recorded as bats approached gates with those from bats flying in unobstructed passages. I compared data from all parameters between different roost types (gated vs. ungated) and gate arrangements, which can hopefully lead to improved gate designs for bat protection.

Seasonal Environments, Dynamic Density Compensation and the Structure of Subtropical Frugivore Guilds

Stevens, Richard D., University of California Santa Barbara, Santa Barbara, CA

The subtropics are highly spatially and temporally dynamic and embody the transition between temperate and tropical faunas. The seasonal nature of environmental variation experienced in the subtropics may contribute substantially to temporal variation in community structure. This is particularly true for bats in the New World because the geographic terminus of most families occurs in the subtropics. The country of Paraguay provides an ideal setting from which to evaluate the effects of seasonality on the structure of subtropical bat communities. Not only does Paraguay exhibit notable spatial and seasonal environmental variation, but it also lies at the edge of the geographic distribution of most bat species that occur there. I evaluated seasonal differences from two perspectives. In the first, I evaluated differences related to decreases in the abundances of species from summer to winter (e.g., species composition, diversity, and evenness). Secondly, I evaluated whether seasonal changes may be associated with the strength of competition among taxa because decreases in resources from summer to winter may enhance the strength of interactions. All species exhibited lower abundances in the winter than in the summer. Nonetheless, the magnitude of differences was heterogeneous across taxa. Accordingly, highly significant differences between summer and winter existed with respect to a number of community indices such as species composition, evenness and diversity. Moreover, and consistent with theoretical predictions, the degree to which competitive interactions structure the frugivore guild was greater in the winter than in the summer. Across the range of bat communities that occur in the New World, seasonality assumes various forms (i.e., cold winter versus hot summer, dry versus wet seasons). These results suggest that a better understanding of the mechanistic basis of bat community structure in general may come from evaluating dynamics from a seasonal perspective.

Life on the "Big Muddy" Missouri: The Importance of Riparian Corridors as Habitat for Bats in the Northern Great Plains

Swier, Vicki J., South Dakota State University, Brookings, SD

Life history data for bats in eastern South Dakota is meager at best. Previous to this present study, research in eastern South Dakota was dated (30 years old) and provided only a few capture records. There had been no studies in eastern South Dakota describing foraging activity, roosts, diets of bats; and no studies in South Dakota had used acoustic methods to census bats. A study was needed to fill gaps in our knowledge about the current distributions and life history data of the bat population in eastern South Dakota. From May 2000 to August 2002, I conducted a study to document the distribution, roost site selection, and food habits of bats in South Dakota east of the Missouri River and along the Missouri River corridor. During the summers of 2000-2002, mist netting and acoustic sampling (Anabat) surveys were conducted at 36 different sites, including state parks, state recreation areas, and national wildlife refuges. Seven species of bat were documented along the river and throughout eastern South Dakota: *Myotis septentrionalis*, *Myotis lucifugus* (subspecies *lucifugus* and *carissima*), *Myotis ciliolabrum*, *Eptesicus fuscus* (subspecies *fuscus* and *pallidus*), *Lasiurus borealis*, *Lasiurus cinereus*, and *Lasionycteris noctivagans*. More individual animals of each species were collected along the Missouri River than any other location in eastern South Dakota during 2000 and 2001. Therefore, in the summer of 2002 census efforts were completely focused on the gallery forests of the Missouri River. Bat capture rates (BNN=bats/per net/per night), species richness, and activity were greater within the Missouri River gallery forests than in any habitat or location in eastern South Dakota. Throughout this region, capture rates greater than 2.0 BNN are considered to be high rates. Three of the five localities that had high capture rates were in fact located along the Missouri River. One species in particular, *Myotis septentrionalis*, was only captured along the Missouri River. Its distribution is

probably restricted to this area of eastern South Dakota because of the abundance of mature trees in the Missouri River gallery forests. Protection of these rare habitats is extremely important because the gallery forests make up less than 1% of the total land coverage in eastern South Dakota.

Bats, Bones and Bayes: A Complete, Interfamilial, Molecular Phylogenetic Investigation within the Order Chiroptera

Teeling, Emma C., William J. Murphy, Ole Madsen, Paul Bates, Mark S. Springer, and Stephen J. O'Brien, National Cancer Institute, MD; University of Nijmegen, The Netherlands; The Harrison Institute, UK; University of California, Riverside, CA

The evolutionary history of the order Chiroptera (bats) is rife with conflicting phylogenetic hypotheses, hampered by a poor fossil record. Traditionally, morphological analyses support the respective monophyly of the suborders Microchiroptera and Megachiroptera , while large molecular data sets support microbat paraphyly (Yinpterochiroptera). Resolution of this microbat monophyly / paraphyly question is essential for reconstructing the evolutionary history of laryngeal echolocation and flight in mammals. Currently, the majority of molecular support for microbat paraphyly derives from 7.1kb of nuclear sequence data for representatives of twelve out of the eighteen bat families. We examined both the intraordinal and interfamilial relationships within Chiroptera with 14.5kb of nuclear sequence data for representatives of all putative bat families. This is the largest molecular data set both in terms of length and taxonomic sampling that investigates bat phylogenetic relationships. We estimated the basal divergences within Chiroptera using the Thorne-Kishino Bayesian method of molecular dating incorporating simultaneous constraints from the fossil record and allowing rates of molecular evolution to vary on each branch. Funded in part by DHHS #NO1-CO-12400

Evening Bat (*Nycticeius humeralis*) Use of Fork-topped Trees: A Potential Tool for Conserving Bat Roosting Habitat in Managed Pine Plantations of the Southeast

Temple, Danielle L., Adam C. Miles, Darren A. Miller, L. Mike Conner, and Steven B. Castleberry Joseph W. Jones Ecological Research Center, Newton, GA; Weyerhaeuser Company, Columbus, MS; University of Georgia, Athens, GA

Over the last decade the southeastern United States has become the top timber producer in the country. The primary objective of the forest product industry and many other private forest landowners in this region is timber revenue, while secondary or often a tertiary objective is wildlife management. Intensive forest management may limit snag formation, as well as cavities and dead branches prevalent in older trees, reducing available bat roosting habitat. From May to August 2002 and 2003 we used radio telemetry to track evening bats to day roosts on a 14,000 hectare tract managed for loblolly pine (*Pinus taeda*) production by Weyerhaeuser Company in southwestern Georgia. Thirteen bats, ten of which were reproductive females and first year young, were tracked to 14 live loblolly pine trees with a forked top (also called bifurcated or codominant branched). Emergence counts indicated that bats were using cavities that formed at the base of the fork. These forked top pines constituted the dominant roost structure used in upland pine habitat on the study site. Based on these findings, we investigated basic characteristics of forked top pine trees used as evening bat roosts and compared them to random forked top pine trees. We suggest that forked top trees warrant further research as to their importance as bat roost structures, particularly for reproductive females and first year young, on industrial timber land in the Southeast.

Computer Code to Simulate Bat Movements and its Role in the Formation of Roosting Assemblages

Torres-Díaz, Nayda, Emmanuel Miranda-Maldonado, Rafael R. Canales-Pastrana,
and Armando Rodríguez - Durán, Universidad Interamericana, Bayamon Campus, Puerto Rico

Mechanisms that underlie the coexistence of species are a subject of great interest in ecology. By reducing the chance of immigration from source habitats, islands such as those in the archipelago of the West Indies can provide better models than continents for examining community structuring and species coexistence. Eighty percent of the bat fauna of Puerto Rico (over 40% for the entire archipelago) consists of cave-dwelling species. Many of these cave-dwelling species roost in hot-caves, where they form non-random assemblages and may function as physical ecosystem engineers. It has been proposed that the size of the opening of caves with multi-species assemblages influences the composition and density of these assemblages. It is the objective of this project to test that hypothesis. The question of coexistence in caves is been approached through the development of a flow model of the activity of bats that form non-random, multispecies assemblages. The code was created using "VisualBasic.Net" and, based on a species size and speed, calculates the amount of time needed to exit caves as a function of the size of the entrance. Based on these analyses it is possible to assess the role of the dimensions of the cave opening in limiting the number of bats. The results may offer an insight into the mechanisms underlying community structuring of some Antillean bats. Finally, the model will provide a means for biologically meaningful, theoretical evaluation of proposed conservation measures such as cave gating.

Tree-roosts of *Corynorhinus rafinesquii*, Rafinesque's Big-eared Bat, in Southern Mississippi (U.S.A.)

Trousdale, Austin W., and David C. Beckett, University of Southern Mississippi, Hattiesburg, MS

Most ecological studies of *Corynorhinus rafinesquii* have been based on populations that primarily used caves or manmade structures (e.g., abandoned buildings) as roosts. However, this species also utilizes cavities of trees, which are thought to be the historical day-roosts of *C. rafinesquii* in the Gulf Coastal Plain. Previous studies suggest that tree cavities have a finite "lifespan" as suitable roosts and are often a limited resource for populations of bats dependent upon them. Because knowledge of tree use by *C. rafinesquii* has been mostly anecdotal, the goals of our study were to identify and describe tree-roosts of *C. rafinesquii* in DeSoto National Forest, Mississippi. Using radiotelemetry to locate trees used by bats that we have captured, we characterized roosts using both qualitative and quantitative variables specific to the individual tree and to its surrounding habitat. Of ten tree-roosts that we located, six were *Nyssa* sp. and four were *Magnolia grandiflora.* Roost trees were typically large (mean DBH = 79 cm), seven were alive, and all but one possessed "trunk hollows" rather than basal openings. Four trees were located directly beside the main channel of streams with four others located ≤ 20 m of a stream. Five trees were used by multiple radiotagged individuals. As predicted by behavioral models (e.g., Lewis 1995), roost fidelity (measured in days) was generally low, but several bats returned to the same tree multiple times within the session that they were monitored. Some trees were also re-used by *C. rafinesquii* over a number of years.

Summer Roost Characteristics of Eastern Red Bats (*Lasiurus borealis*) in the Ouachita Mountains of Arkansas

Thill, Ronald E., and Roger W. Perry
U.S. Forest Service, Southern Research Station, Nacogdoches, TX; Hot Springs, AR

Although eastern red bats (*Lasiurus borealis*) are relatively abundant throughout much of North America, little research has been conducted on their roosting ecology until recently. We

studied summer diurnal roosts of red bats in a diverse forested landscape in the Ouachita Mountains of central Arkansas to characterize roosts of both males and females at the tree, site, and stand levels. Using radiotelemetry, we tracked ten male and fifteen female red bats to 93 roost locations and quantified roost characteristics during the summers of 2000-2002. Of these 93 roosts, 72 were visually confirmed (26 male and 46 female roosts) and 27 (59%) of the female roosts were confirmed maternal roosts. Red bats roosted primarily in the foliage of 12 deciduous hardwood tree species. Most roosts were in white oaks (*Quercus alba*), but mockernut hickory (*Carya tomentosa*) was the only preferred species. They avoided trees <10 cm dbh for roosting, but displayed preferences for all larger tree size classes. Although 74.6% of all tree roosts were in trees >20.0 cm dbh, these larger trees comprised <5% of trees in randomly selected plots. The only non-tree roost encountered to date for instrumented bats was on a blackberry (*Rubus* spp.) stem; the female involved behaved abnormally and died 4 days later. Although males and females roosted in trees of similar height and diameter, females roosted higher in the tree canopy, further from the edge of the canopy, and in denser foliage conditions than males. Red bats often roosted in close proximity to forest roads. Although 40% of roosts were located in mature (>50 years old), unharvested, pine-hardwood or hardwood stands, 48% were located in predominantly pine stands that had been recently thinned or partially harvested and most had received partial or complete mid-story hardwood removal; however, these stands contained a residual overstory hardwood component. Thus, stands that have undergone recent thinning and mid-story removal are readily used by red bats as long as an overstory hardwood component is retained. Roost sites typically had a sparser understory (especially of woody stems <5 cm dbh) and a somewhat higher abundance of large hardwoods than random plots. These conditions can be achieved using periodic thinning and prescribed burning coupled with retention of overstory hardwoods.

Phylogeography and Population Structure of the Big Brown Bat (*Eptesicus fuscus*)

Turmelle, Amy S., Thomas H. Kunz, and Michael D. Sorenson
American Museum of Natural History, New York, NY; Boston University, Boston, MA

The big brown bat (*Eptesicus fuscus*) is widely distributed throughout North and Central America, occupying a diverse range of habitats. In eastern North America, maternity colonies typically are formed in buildings where females return each year and give birth to pups. In western North America, maternity colonies are more commonly found in tree cavities. Strong female site fidelity in both areas suggests the potential for significant phylogeographic structure in this species. We sequenced the hypervariable 5' end of the control region from 246 individuals distributed throughout North, Central and South America. Consistent with morphological studies, eastern and western populations exhibited strong haplotypic divergence, but with contrasting patterns of genetic variation in the two regions. Eastern populations share a closely related group of mtDNA haplotypes. In contrast, genetic variation in western populations is highly structured with different mtDNA clades restricted to two major subregions--one in the Pacific Northwest and California and one including southwestern North America, Mexico and northern South America. Within each of these subregions, there is additional sub-structuring of genetic variation among localities. Genetic differentiation in western North America suggests that topographic barriers limit dispersal of females between local subpopulations. A contact zone in Colorado was thoroughly explored by sequencing 30 bats from four roost sites, of variable stability, in Fort Collins, CO. An even distribution of eastern and western mitochondrial haplotypes was found in all four roosts. Additionally, 17 individuals, representing 4 of the 5 major clades supported by control region data, were sequenced for regions of the mitochondrial ND2 and ND5 genes. These data suggest that Puerto Rican bats are more closely related to bats in the eastern United States than to western bats, suggesting dispersal into the Caribbean from the southeastern United States rather than Central America and Mexico. Different patterns of haplotypic variation observed between eastern and western populations reflect variable dispersal patterns for big brown bat females in these different regions and are likely influenced by historical climate change.

Microsatellite markers were used to type 80 bats across three hypervariable loci, representing regional clades. Significant variation was found, FST = 0.037 (p<0.0001) and RST = 0.322 (p<0.0001), but not among mainland populations. Results suggest male-mediated gene flow among mainland populations, with regional structure in stable matrilines. Nuclear intron data are also being explored, in a subsample of bats, for consistent trends of population substructure and historical dispersal patterns for this species.

Phylogenetic Relationships Among Recent Chiropteran Families

Van Den Bussche, Ronald A., and Steven R. Hoofer, Oklahoma State University, Stillwater, OK

Results of recent molecular studies cast doubt on the validity of Archonta, Megachiroptera, Microchiroptera, Yinochiroptera and has even led some to consider novel alternatives for the evolution of flight and echolocation in mammals. At present, higher-level relationships of Chiroptera still are without consensus and much of this controversy is related to (1) how bats are related to other mammals and (2) relationships among family-level lineages within Chiroptera. Although this controversy superficially manifests as differences in the relative merits of morphologic versus molecular data, both classes of data are themselves conflicting. It is our contention that much of the discrepancy among these studies is due to improper choice of outgroup, limited taxonomic sampling, or both. We examined approximately 3kb of mitochondrial DNA from 104 bats representing the taxonomic, geographic, and morphologic diversity within all families (except the monotypic Craseonycteridae) and 58 additional taxa representing Artiodactyla, Carnivora, Cetacea, Dermoptera, Insectivora, Lagomorpha, Perissodactyla, Pholidota, Primates, Scandentia, Sirenia, and Rodentia. Results of our analyses strongly support other recent work indicating that Archonta is not a natural assemblage and that the sister-taxon to Chiroptera, although still unclear, includes Cetartiodactyla, Perissodactyla, Carnivora, and possibly Pholidota. Using representatives of these taxa as outgroups to evaluate interfamilial relationships within Chiroptera we detected strong support for recognition of the suborders Yinpterochiroptera (Pteropodidae, Rhinolophidae, Megadermatidae, Rhinopomatidae) and Yangochiroptera (all other families). Within Yangochiroptera, our analyses strongly support expansion of the superfamily Noctilionoidea to include the New World Thyropteridae and Furipteridae.

Does Feeding Time Constrain Energy Intake for Neotropical Fruit Bats?

Villeneuve, François, and Don W. Thomas, Université de Sherbrooke, Sherbrooke, QC, Canada

The central limitation hypothesis states that the energy available for the different activities of an animal may be limited by the capacity of the different phases of the digestive processes: quantity of food ingested, assimilation efficiency, distribution by the blood, utilization by the cells. This would limit the energy expenditure that an animal could sustain over a period of time. Neotropical fruit bats have a high metabolism, low thermal inertia and are known to process the equivalent of their body weight of food per day. These bats are also known to use hypothermia when they are faced with constraints like food deprivation or a low ambient temperature. In this study we wanted to test the hypothesis that limitation in feeding time would constrain the bats to accelerate food ingestion,force them to use hypothermia, or utilize their fat stores in order to main maintain their energy budget. We submitted twelve *Carollia perspicillata* to four different photoperiods, from 12D/12L to 6D/18L, in a set-up permitting to continuously monitor food ingestion, body weight and skin temperature. Bats were in captivity but free to fly from their perch to the food. Preliminary results show that the bats were able to raise their feeding rate, ingest the same amount of food, and maintain their body weight even when submitted to a reduced feeding time of 33% (8D/16L). Ingestion of food was lower at 6D/18L. At an ambient temperature between 24 and 27 ºC, skin temperature (34 – 35 ºC) did not vary significantly

between photoperiods. These bats appear to retain substantial flexibility in the rate that they process food despite the impressive quantities that they require daily.

Population Genetic Structure of Wintering Populations of Indiana bats (*Myotis sodalis*)

Vonhof, Maarten J., Gary F. McCracken, Robert R. Currie, and Leslie R. Saidak
University of Tennessee, Knoxville, TN; U. S. Fish and Wildlife Service, Asheville, NC

Populations of the endangered Indiana bat (*Myotis sodalis*) have been steadily declining for decades. Although the exact causes of this decline are unknown, considerable effort has been expended to find and protect hibernacula used by this species. To provide the necessary context for ongoing studies on demographics and habitat use of this species, we initiated a study to 1) assess levels of population genetic structure between hibernacula, and 2) determine levels of gene flow between hibernating populations using mitochondrial DNA (mtDNA) sequences. Samples were collected by biologists involved in monitoring populations at 21 hibernacula, including four Priority One, nine Priority Two, and eight Priority Three sites. We sequenced the hypervariable region I of the mtDNA control region for 230 individuals (97 females, 133 males). In addition, sequences of this region and a mitochondrial gene (*cytochrome c oxidase* subunit I) were compared with representatives of other *Myotis* spp. to clarify species identification. Our study will provide critical information on whether populations of *M. sodalis* are divided into discrete genetic units, and hence aid management efforts to protect this endangered species.

Phylogeographic Structuring and Volant Mammals: A Case Study Using the Pallid Bat (*Antrozous pallidus*)

Weyandt, Sarah E., and Ronald A. Van Den Bussche, Oklahoma State University, Stillwater, OK

A number of terrestrial vertebrate species of the arid southwestern United States exhibit phylogeographic patterns reflective of the formation of current deserts. It has been suggested that bats will show patterns of genealogic lineage sorting independent of climatic factors, such as glacial cycles, as they have the capacity for frequent movements of considerable distance. We sequenced approximately 500 bp from the mitochondrial control region of 178 pallid bats (*Antrozous pallidus*) collected throughout much of the species range. Haplotype distributions show both significant variation between populations and associations to current physiographic features in North America. With few exceptions, haplotypes are not shared between any pair of collecting localities and generally more than one haplotype is present at each site. Additionally, at least one individual from each control region (d-loop) haplotype has been sequenced for a portion of the linked *cytochrome b* gene to aid in comparison with other species level studies. Divergent haplotypic lineages with allopatric distributions suggest that the pallid bat has responded to evolutionary pressures in a manner consistent with other vertebrate taxa of the American Southwest.

Insectivorous Bats as Predators During an Outbreak of Western Spruce Budworm

Wilson, Joanna M., University of Calgary, Calgary, AB

Because they consume large numbers of insects, bats may play a role in limiting populations of some forest pests. Moreover, the dense concentrations of insect prey that occur during forest pest outbreaks may be important for bats. During 2002 and 2003 I studied interactions between bats and western spruce budworm (*Choristoneura occidentalis*, Lepidoptera: Tortricidae), a serious defoliator of Douglas-fir trees, in central interior British Columbia. I predicted that bats would respond to a western spruce budworm outbreak by foraging more in outbreak areas (an aggregative numerical response) and by including more moths in their diet (a functional response). Using bat detectors, fecal analysis and insect traps, I compared bat activity, bat diet and insect abundance before and during the budworm moth flight period, in both outbreak and

non-outbreak areas. Preliminary results from 2002 showed that bats ate few moths early in the summer, but switched to eating mostly moths when budworm moths started flying. Comparisons of 2003 outbreak and non-outbreak sites will clarify whether increases in moth consumption and bat activity are directly related to western spruce budworm. I will discuss the implications of this study for bat foraging behaviour and bat conservation.

Niche Overlap Among Frugivorous Phyllostomid Bats

York, Heather A., University of Kansas, Lawrence, KS

A wide array of dietary strategies is exhibited by phyllostomid bats, yet the pure numbers of species in each feeding guild and the great extent to which they overlap in range suggest that niche overlap is likely to occur among sympatric species, creating the potential for food competition and bringing into question their ability to maintain coexistence. As an initial step in addressing competition and resource partitioning among sympatric ground-story frugivores, I determined the extent of niche overlap among *Carollia brevicauda*, *C. castanea*, *C. perspicillata*, *C. subrufa*, and *Sturnira lilium* in Costa Rica. Species, body size, sex, reproductive condition, morphospecies of seeds eaten, and level of insectivory were among the factors considered in niche-matrix analyses. Comparison of the degree of niche overlap among these species between seasons and forest types illustrates the dynamic nature of niches and the importance of considering temporal and spatial variation when assessing the role of competition in community structure.

Report on the 33rd Annual North American Symposium on Bat Research

by
Thomas A. Griffiths, Program Director, NASBR
and
Margaret A. Griffiths, Associate Program Director, NASBR

The 33rd Annual North American Symposium on Bat Research was held at the Cornhusker Hotel in Lincoln, Nebraska, 8-11 October 2003. Patricia (Trish) Freeman of the University of Nebraska-Lincoln School of Natural Resources and the University of Nebraska State Museum was the local host. There were 247 registered participants who attended the three-day scientific conference. In addition to these participants, there were people from the Lincoln community who attended the Thursday evening open forum on Rabies and Bats: Concerns for Conservation and Public Health, as well as approximately 25 local educators who attended the special Bat Education Workshop on Saturday morning.

Most of the meeting participants were affiliated with academic institutions (65.6%); 16.2% were from federal or state government agencies; 13.8% were from private business or private consulting groups; 1.6% were from zoos and parks; and 2.8% were individuals who attended simply because they were interested in bats. Students represented 40.5% of the meeting participants. The majority of NASBR participants were from North America; 88.3% from the United States, 5.3% from Canada, 2.4% from Puerto Rico, and 1.2% from Mexico. The rest of the participants came from countries outside of North America [the United Kingdom (1.6%), Spain (0.4%), South Africa(0.4%), and Guam (0.4%)].

One hundred sixteen scientific papers were presented at the Lincoln meeting, not counting the six special presentations given during the Saturday morning workshop for local teachers. Of the scientific papers presented, 72 were platform presentations and 44 were poster presentations. All student platform papers, both competition and non-competition papers, were presented in plenary

sessions on Thursday and Friday. The poster presentation session followed on late Friday afternoon. Concurrent sessions, from Anatomy to Zoogeography, were held on Saturday.

In addition to these scientific sessions, a special workshop, "Rabies and Bats: Concerns for Conservation and Public Health," was held on Thursday evening. Gary McCracken (University of Tennessee-Knoxville) and Charles Rupprecht (Centers for Disease Control and Prevention), the two conveners of the workshop, presented opening statements. Brief statements were also made by Brock Fenton (University of Western Ontario), Tom Kunz (Boston University), Tom O'Shea (U.S. Geological Survey), Paul Racey (University of Aberdeen/Bat Conservation Trust), and Merlin Tuttle (Bat Conservation International). The forum was then opened to questions and discussion from the floor. Statements and discussion at the workshop included recently published epidemiologic data, incidence of rabies in bats versus other animals, transmission of rabies by bats versus other animals, public health concerns (national and international), conservation efforts, concerns of bat biologists and the general public, data/information presented to the public, and interpretation (or misinterpretation) of this information by the public. The open forum was well attended by the meeting participants as well as by individuals from the Lincoln community.

Once again this year, graduate and undergraduate students were invited to enter their platform or poster papers in a competition that judged the scientific merits of their research presentations. A special committee headed by Betsy Dumont judged 14 student platform papers and 14 student poster presentations. Five cash prizes of $250 each and a special Speleobooks merchandise prize were presented at the Saturday night banquet. The award winners for outstanding platform papers were: Shonene A. Scott (Portland State University, Portland, OR) received the Bat Conservation International Award; Donald I. Solick (University of Calgary, Calgary, AB) received the Bat Research News Award; Liliana M. Davalos (American Museum of Natural History and Columbia University, NY, NY) received the Karl F. Koopman Award; and Diane E. Hirsh (Boston University, Boston, MA) received the Lubee Bat Conservancy Award. The award winners for outstanding poster presentations were: Tanya M. J. Luszcz (University of Calgary, Calgary, AB) received the Basically Bats Wildlife Conservation Society Award, and Joseph E. Duchamp (Purdue University, West Lafayette, IN) received the Speleobooks Award. Generous monetary donations from Merlin Tuttle of Bat Conservation International, from Roy Horst of Bat Research News, from Roger and Sherry Haagenson and Allyson Walsh of Lubee Bat Conservancy, from the Board of Directors of Basically Bats Wildlife Conservation Society, and from Emily Davis and Michael Warner of Speleobooks made five of the prizes possible. Donations from a number of individuals made the Karl F. Koopman Prize possible.

Presentation of the student awards was only one of the highlights of the Saturday night banquet. When the doors of the room were opened for the banquet, the first thing we saw was the ice sculpture in the center of the dessert table -- a bat! Debate regarding the species of the ice bat continued throughout the evening.... Was it Brachyphylla or Eptesicus? Craseonycteris? Natalus? Or perhaps Pipistrellus, Miniopterus, or Kerivoula? And as the evening wore on, the ice bat morphed into other possible species, adding to the debate: Pteropus, Rousettus, Myonycteris, or maybe Dobsonia. Kudos to the Cornhusker's executive chef, Terry Owen, for the magnificent ice bat sculpture, as well as for the delicious food and pastries that we enjoyed at the banquet! Also recognized at the banquet were the members who attended the very first bat meeting in 1970: Ken Geluso, Tom Kunz, Robert Baker, Phil Krutzsch (the first Host), and Roy Horst (the first Program Director). Thanks to them, and especially to Roy, the founder of our society, we continue to meet annually to share our research about bats. Pat Morton of Texas Parks and Wildlife once again organized a special bat education workshop on Saturday morning of the conference. (Note: Adobe Acrobat is required for viewing the Workshop's schedule.) Pat's local contact was Sara Toren of the Lincoln Public Schools and the Lincoln Zoo School. The workshop was well attended by Lincoln-area educators. This was the eighth consecutive year that Pat has organized this workshop in conjunction with the NASBR. We thank Pat and Sara for

their efforts in making the workshop possible. We also thank Bat Conservation International, the Lubee Bat Conservancy, the Organization for Bat Conservation, Bat Research News, Speleobooks, Nebraska Game and Parks Commission, and Texas Parks and Wildlife for their generous donations to help support the workshop.

We also thank Troy Terwilliger, Pippa Miller, Kevin Wegner, Blake Tinsley, Larry Rassmussen, Greg Glathar, and the entire staff of the Cornhusker Hotel who helped to make the 33rd NASBR a very memorable and successful meeting. All meeting participants seemed to agree that the Cornhusker was a great venue for the meeting, and the hotel's staff was outstanding.

We extend a very special thank-you to Trish Freeman, our local host, and her local committee (Hugh Genoways, Zac Roehrs, Federico Hoffman, Angie Fox, Kestrel Lemen, and Sarah Toren), Cliff and Marsh Lemen (Trish's husband and son), Al Kisner, and Donna Mathisen for their help. We also thank the members of the Board of Directors 2002-2003 (Robert Barclay, Betsy Dumont, Trish Freeman, Michael Herder, Roy Horst, Gary McCracken, Arnulfo Moreno, Dixie Pierson, and Nancy Simmons) and the Student Observer to the Board (Dan Riskin) for all the hard work they did to make this meeting a success. And finally, on behalf of the entire NASBR membership, special thanks from all of us to Roy, the "founding father" of the society, and, of course, to the bats!

Our host for the 34th Annual Symposium on Bat Research will be Michael Herder, USDI Bureau of Land Management, Arizona Strip Field Office. All formal sessions of the 34th Symposium will be held at the Little America Hotel in downtown Salt Lake City. Please check our web page at http://www.nasbr.org/ for details about the 2004 NASBR. Additional information will be posted here as it becomes available.

The Bernardo Villa Student Travel Scholarship

The North American Symposium on Bat Research, wishing to encourage dialogue between Mexico and the United States, has recently established a fund to support the travel of one or more graduate students from Mexico to its annual meeting.

During the thirty years that the NASBR has been meeting, many of its members – from students to senior researchers -- have had the privilege of meeting and working with Dr. Bernardo Villa. To those who have benefited directly from his wisdom and guidance, and to those who know him only by reputation, it is impossible to think of Mexican bat biology and not think of Dr. Villa. One of the most remarkable features of his long and distinguished career has been his sincere encouragement of young aspiring scientists. Many who met him first when they were young, were inspired by him, and have regarded him throughout their careers as an important mentor and life long friend. When colleagues or students arrived from the United States wanting to study Mexican bats, he generously supported their work – often accompanying them in the field and welcoming them into his home.

In recognition of Dr. Bernardo Villa's invaluable contribution to bat scholarship, his great generosity towards colleagues, and his life long commitment to students, the members of the Symposium meeting in Lincoln, Nebraska in October, 2003, voted to name their new fund "The Dr. Bernardo Villa Student Travel Scholarship".

The funds provided by this scholarship will cover the expenses (travel, per diem, registration) for one or more students to attend the annual symposium. The student will be selected by the Mexican bat community, through a process to be defined by them. Efforts are underway to establish an endowment fund to support this award and details of how interested individuals can contribute to the fund will be announced in the next issue of Bat Research News.

Submitted by Elizabeth Pierson and Roy Horst

RECENT LITERATURE

Authors are requested to send reprints of their papers to the Editor for Recent Literature (Margaret Griffiths, Dept. of Biology, Illinois Wesleyan Univ., Bloomington, IL 61702-2900, U.S.A.) for inclusion in this section. If reprints are scarce, please send a complete citation (including complete name of journal and author mailing address) to **mgriff@illinoisalumni.org** by e-mail. Receipt of reprints is preferred as it will facilitate complete and correct citation. Our 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.

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Feature Articles

Possible Predation Attempt at a Roost Tree of Evening Bats (*Nycticeius humeralis*)

Sherry L. Veilleux[1], Jacques Pierre Veilleux[2], Joseph Duchamp[3], and John O. Whitaker, Jr. [1]
[1]Department of Life Sciences, Indiana State University, Terre Haute, IN 47809
[2]Department of Biology, Franklin Pierce College, Rindge, NH 03461
[3]Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN 47907

This paper describes an unusual event at a roost tree used by evening bats (*Nycticeius humeralis*), which may be the result of attempted predation. Between 16 and 20 June 1999, a lactating female evening bat was radiotracked to three roost trees in southwestern Vigo County, Indiana. The bat used the first roost tree on 16–17 June, and emergence counts yielded 104 and 36 individuals, respectively. The bat roosted in the second tree on 18–19 June, when emergence counts indicated the presence of ca. 100 and 114 bats, respectively. On 20 June, the bat roosted in a cavity, about 23 m above ground level, in a third tree, which was a silver maple (*Acer saccharinum*); 111 individuals left the roost that night.

Emergence of evening bats in Indiana typically begins near sunset. However, when we arrived at the third roost tree on 21 June at 1957 h (23 min before sunset), ca. 100 bats already had emerged and were swarming around the roost. Bats abruptly landed on the bark and foliage near the cavity opening. In addition, we heard bats striking mid- and low-canopy foliage, and we heard many high-pitched squeaks emanating from above and below eye level. Rustling sounds on the ground also could be heard, although searching for the origin of the sounds was difficult due to thick vegetation and dim light.

Nevertheless, we examined the foliage and bark of trees and the ground using flashlights, and at 2105 h, we observed a neonate clinging to the dorsal side of a leaf, ca. 2 m from the ground, on a tree next to the roost tree. This individual was producing loud (audible), high-pitched calls. Between 2105 h and 2300 h, five other pre-volant young were located. Three were on the roost tree (two were 1 meter above the ground on the bark and the other was on a leaf), one was on a branch of a tree next to the roost tree, and another was on the bark of a tree ca. 15 m from the roost tree. Although only six individuals were located, it was evident from the number of calls emanating from the surroundings that numerous young were outside the roost.

According to Jones' (1967) description of young evening bats, the neonate was likely $\leq$ 3 days old. It had darkly pigmented skin that was leathery and rough with sparse hairs, and the eyes were open. It was obvious that the bat could not fly. We estimated that the other juveniles were 1–2 weeks old, based on their furred appearance and inability to fly. Forearm length of one juvenile was 25 mm, indicating an age of ca. 2 weeks (Jones, 1967).

While searching for young, we observed volant bats hitting the foliage of the roost tree, landing on the tree, and then making audible calls. We assumed that these were mothers attempting to recover displaced pups. Watkins and Shump (1981) observed mother evening bats retrieving young after they had fallen from the ceiling of an attic roost in Missouri. Retrieval of fallen offspring by adult bats roosting within a cave or building is common among bats (Kunz and Hood 2000), and this behavior also was observed recently at a tree roost of Indiana bats, *Myotis sodalis* (Belwood, 2002).

Vocalizations and sounds of bats landing on the tree ceased by 2300 h. At 2330 h, we noticed that the two juveniles observed earlier on the bark of the roost tree were gone. We left the site at 2330 h, and returned at 0800 h on 22 June. We were able to relocate two of the six young observed during the previous night, and both appeared to be in good condition. The last two juveniles could not be relocated. We do not know if mothers later recovered these young.

To account for our observations, we suggest that a predator attempted to enter or reach into the roosting cavity. Once the predator was detected, mothers grasped their pups (evening bats produce twins) and proceeded to the nearest opening from the roost to avoid capture. During the confusion, some young apparently became detached from their mothers and fell, after which the

the mothers attempted to recover their offspring.

Predators of evening bats include short-eared owls (*Asio flammeus*), raccoons (*Procyon lotor*), domestic cats (*Felis cattus*), and black rat snakes (*Elaphe obsoleta*—Cahn and Kemp, 1930; Watkins, 1972). Stickel (1967) observed a black rat snake entering a nest hole of red-bellied woodpeckers (*Centurus carolinus*), ca. 9 m above the ground in a dead branch, where it apparently consumed three nestlings.

We can think of no reason other than predation that reasonably accounts for pre-volant young being located away from the roost and alone. During this study, 25 emergence counts were performed at 19 roost trees of 6 lactating bats. Bats switched trees often, remaining at a single roost for 1.6 ± 0.7 (*SD*) days, and mothers presumably carried their young to each new tree. Only on the occasion described in this paper were pre-volant young observed; therefore, we assume that under normal circumstances mothers carry young without the offspring becoming detached. Presence of several pre-volant young outside the roost and the early emergence of adults suggests that an unusual event took place prior to their regular evening emergence on 21 June 1999.

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* * * * *

An Unusually Productive Net Site over an Upland Road Used as a Travel Corridor

R. Jeffrey Brown and Virgil Brack, Jr.
Environmental Solutions & Innovations, Inc, 781 Neeb Road, Cincinnati, OH 45233
jbrow@environmentalsi.com

Bats were captured in mist nets 14 - 15 August 2001, dusk - 0200 h over a gravel road, at 854 – 918 m elevation. The road transected a woodland and ended at Nantahala Reservoir, Macon Co., North Carolina. On each night, 2 nets 9 m high, one 6 m and the other 9 m long, were deployed approximately 30 m apart. The woodland was dense; about 30% of overstory trees had a dbh >38 cm and the understory was moderately closed. A right-of-way (ROW) for an electric distribution powerline, approximately 6 m wide, crossed the road at right angles approximately

5m beyond the mist net most distant to the reservoir. A 3rd mist net (9 m high and 6 m wide) was placed across a corridor along the edge of the reservoir.

In the 2 nets over the gravel road, 139 bats of 6 species were caught: 49 northern myotis (*Myotis septentrionalis*), 30 little brown myotis (*M. lucifugus*), 4 eastern small-footed myotis (*M. leibii*), 30 eastern pipistrelles (*Pipistrellus subflavus*), 24 eastern red bats (*Lasiurus borealis*), and 2 big brown bats (*Eptesicus fuscus*). No bats were caught along the edge of the reservoir. The species diversity (MacArthur, 1972; Diversity = $1/\sum P_i^2$, where P_i is the proportion of bats belonging to species i) was high, 4.03. Catch was lower early and late, and higher at 2300 h (χ^2 = 28.266, P <0.000), when considered over 1-hour intervals dusk - 0200 h.

Apparently, the road was a travel corridor to and from the reservoir. We believe the powerline ROW intersecting the road was part of the travel corridor system. These data indicate upland travel corridors are sometimes used by large numbers of bats. Use of roads may have regulatory implications for federally and state listed threatened and endangered species.

It is often assumed that riparian areas support high concentrations of bats (Racey and Swift 1985; Brigham and Fenton 1991), but few studies have tested this hypothesis. Grindal et al. (1999) found bat activity in riparian areas, determined with bat detectors, was 40 times greater for foraging and 10 times greater for travel, than in upland areas. They also caught more bats in riparian habitat. In Hoosier National Forest, Indiana, Brack et al. (2004) caught bats at similar rates in upland and riparian habitats in 1998, but nearly 10 times more frequently in riparian habitat in 1990. In northern Indiana, Brack (1983) caught 1.6 times as many bats in riparian as in upland habitats. In contrast, the riparian net site in the current study produced no bats while the upland site was very productive.

Habitat corridors are frequently used in conservation biology to maintain connectivity of isolated habitat patches (Haddad et al. 2003). However, North American microchiropterans use travel corridors that consist of open flyways, which may be independent of the suitability of that habitat for foraging, roosting, or other life requisites. Thus, captures in upland and riparian habitat should be interpreted with caution and use of the term travel corridor is proposed to distinguish this type of corridor from other more typical uses of the term habitat corridor.

ACKNOWLEDGMENTS

Duke Power funded field studies. Scott Fletcher and Gene Vaughan coordinated studies and reviewed the manuscript.

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News

From Canada

Effective 1 October 2003, Brock Fenton and his gang relocated from York University (Toronto) to the University of Western Ontario (London) where he began a five-year term as Chair of the Department of Biology. The "gang" now includes Jen Blasko, Shelley McLennan, John Ratcliffe, Genni Spanjer, and Ying-Yi Ho. Jen is working on her M.Sc. thesis (at York University) and studying visual patterns in bats. Shelley has just started her M.Sc. (at UWO) and plans to work on bat vocalizations. John Ratcliffe is well into his Ph.D. (Zoology, University of Toronto) and continues to be part of the lab working on foraging behaviour and vocalizations. Genni also is working on her M.Sc. thesis (at York University), examining the behavioural responses of bats to gates (or gate-like structures) erected at the entrances to caves and mines. Ying-Yi Ho has just started his Ph.D. (at UWO) and plans to work on the genetic implications and consequences of behaviour. Some recent contributions from the lab are listed below:

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From Canada, (via Australia)

I am on sabbatical in Australia until 30 June 2004 working in the lab of Fritz Geiser at the University of New England in Armidale NSW. AS far as bat work goes, I have pretty much turned to the dark side and am working mostly on birds. We have a project going on thermoregulation by Laughing Kookaburras and I have done some preliminary work on starting a project on Australian Owlet-nightjars in the area around Alice Sponges in the Northern Territory. This work will hopefully become part of a Ph.D. project starting in 2004. I am presenting a paper about the social behaviour of Eptesicus (co-authored by Craig Willis - they are his data) at the Ecological Society of Australia meeting to be held in Armidale in early December and intend to attend and present at the Australasia bat meetings which will be held in April 2004 in Toowoomba, QLD. As for the "bat types" in the lab who got left behind in Canada, Craig Willis completed his PhD in June and is doing some sessional teaching this term before coming here to undertake a Post-doc with Geiser. Danieala Rambaldini and Kristen Kolar, who were to have attended the meeting in Lincoln but were involved in a vehicle crash (fortunately they were not hurt - though the vehicle was), are both mid way through M.Sc. degrees on torpor use by pallid bats and social behaviour of big browns respectively.

Dr. R. Mark Brigham, mark.brigham@uregina.ca
http://www.uregina.ca/science/biology/faculty/brigham/index.htm

From Brazil

A Comment: by Phyllis C. Romijn

Dilemma among biologists and veterinarians in Rio de Janeiro City: What to do with entire colonies of bats when a single individual is found infected with rabies virus?

Rio de Janeiro city owns part of its tourist attraction to its beautiful scenery of modern buildings amid high mountains still covered by rain forests and almost always tropical weather. This attracts not only tourists from all over the world, who come and sometimes just stay for ever, but also BATS are attracted from the nearby forests, in their case by the wealth of food (insects, fruits) and shelter (dilatation fences between buildings). They are not exposed to predators of any kind, and their colonies sometimes grow into a few thousand individuals.

Certain species of bats are becoming more and more frequent in the Rio de Janeiro city night scenario. Besides insectivorous and frugivorous ones, haematophagous bats have been reported in the last decade, feeding on domestic animals such as dogs and horses, but also on human beings.

If not for an eventual diseased bat that is found during daytime, these animals would not attract any attention at all of the Public Health services. Unfortunately, several cases of rabies in urban bats have been detected, and together with public awareness, this number seems to be increasing.

Health services are being notified more and more about bats flying into rooms through open windows, and also of bat bites afflicted during the procedure of removing the intruder. People complaining about bat colonies in their attics they want to remove is becoming frequent. The first impulse is to carry out the job themselves. Their attempts are often unsuccessful, and in a few weeks the colony is back. When they search technical advice, they found out that bats are sylvatic mammals and as such protected by law, and the only accepted procedure is blocking the bats entry. Anyway, there is no way of avoiding the coming and going of frugivorous species amid the trees in the parks, or the insect chasing of *Mollosidea* and other species around the lights of the lamp posts in the street.

The unique topography of the city, offering shelter in caves amid the forest very close to buildings is giving place to an uncommon situation: haematophagous bats, such as *Diphylla*

ecaudata, have been identified feeding on hens and other birds, and *Desmodus rotundus* seem to have found dogs an alternative and safe food source.

Interactions of bats of different species may occur. The identification of diseased bats of several species, and found infected with rabies, posses a Public Health question about risks of transmission to the human population, as well as among bats themselves: What kind of risks would these colonies represent, if one consider rabies transmission? What measures would be adequate in preventing human rabies cases?

These questions were raised during symposiums on strategies for animal rabies control, held in Rio de Janeiro and Brasilia, Brazil, in April 2003. Should the diagnosis of rabies in one single individual indicate that others from the same colony are also infected? Suggestions were made for carrying out a serological survey to find out the serological status of the colony. But what would be the real meaning of the identification of 10%, 20% or 50% of seropositive individuals? If antibodies reacting with rabies virus antigens are found, this may be an indication of a past infection in the colony or persistent infection without disease. At a first moment, comparisons were tried to be made with other animal groupings, without success. One can not attempt to vaccinate bats in a same manner terrestrial wildlife has been immunised throughout Europe.

Researchers of the medical and veterinarian areas who analysed the cases of rabies caused through bat bites may present different considerations on how to manage these colonies, in opposition to bat biologists, since the focus on the subject is different.

In other countries, the identification of rabid bats has lead to different approaches, but all acted primarily at an educational level. There is a consensus that the local community involved should be made aware of the findings at the same time that they should be educated to respect wildlife and leave bats on their own.

Several human deaths have occurred recently due to bat bites followed by the development of rabies. Post-exposure prophylactics has been applied to all humans that notify having being bitten by a bat.

The question is: should bat colonies with rabies infected individuals be destroyed, removed and isolated, have their population controlled, or just left as they are? Should it make a difference if these colonies are situated in urban or rural areas?

Dra. Phyllis Catherina Romijn, Alameda São Bonaventura, 770
Fonseca- Niterói - RJ - CEP 24.120-191, Rio de Janeiro, BRAZIL
phyllis@predialnet.com.br

Future Meetings and Events

January 27 – 30, 2004

The Annual "Bat Tag" Meeting will be held at the **Lubee Bat Conservancy** in Gainesville, Florida. For additional information please contact Steve Wing at the Riverbanks Zoo in Columbia, SC. E-mail stevew@riverbanks.org.

March 9 – 12, 2004

The Second Bats and Forests Meeting will be held in Hot Springs, Arkansas. For registration information contact Daniel Taylor at Bat Conservation International.

April 14 - 16, 2004

The 11th meeting of the Australasian Bat Research Symposium will be held The University of Southern Queensland in Toowoomba, near Brisbane, Australia just after Easter in 2004. For additional information contact Greg Ford at: fordg@powerup.com.au

June 12- 16, 2004

The 84th Annual Meeting of the American Society of Mammalogists will meet at Humboldt State University in Arcata, CA. For additional information visit the website at: http://www.humboldt.edu/~asm or the society website at www.mammalogy.org

August 23 - 28, 2004

The **13th International Bat Research Conference** is planned to be organised in Poland from 23-28 August 2004. More information about the conference will is available at: http://www.miiz.waw.pl/IBRC also http://www.miiz.waw.pl/IBRC

October, 27 - 30, 2004

The **34th Annual North American Symposium on Bat Research,** will convene in Salt Lake City, Utah, October 27-30, 2004 Hosted by Michael Herder. For additional information see our web-site at http://www.nasbr.org

August, 2005

The next **European Bat Research Symposium** will be held in Ireland in August 2005. More details will appear here as they become available.

If you know of other planned meetings, large or small, concerning any aspect of bat biology, please send details to Roy Horst horstgr@potsdam.edu for publication in the next issue.