

BAT RESEARCH NEWS



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SPRING 2002

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Number 1

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Front Cover

The front cover illustration, a handsome resident of The Lube Foundation Research Center in Gainesville Florida invites you to come visit him in May during the Symposium on Medical Management and Captive Care of Chiroptera see page 41.

My apologies for the error in the caption (rear cover) describing the cover illustration on Volume 42: #4. The bat depicted is *Rhinolophus ferrumequinum* not *R. ferrumquinum*. GRH

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Front Cover

The front cover illustration was generously provided by Jacqueline J. Belwood from her Book, *The Bats of Ohio*. This artwork was created by Ann E. Geise of the Ohio Bat Survey.

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FRONT COVER

Our cover this issue is the logo from the
IVth European Bat Research Symposium, Le Havre, France

We prefer to use sharp black and white photos or line drawings of bats or great bat sites, so would you please send your favorite illustration. If your illustration is accepted as a future cover, you will receive one free banquet ticket at the next North American Symposium. Send your copy to: horstgr@potsdam.edu

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Front Cover

The front cover is a portrait of *Lasiurus cinereus* by Suzanne Lebeda of South Colton, NY. Suzanne has created many illustrations for wildlife publications as well as many beautiful posters for such agencies as the Adirondack Park Commission and The Saint Lawrence Seaway Natural History Center. This portrait was the master copy of the tee-shirt created for the recent 32nd North American Symposium. The original is in color and its attractiveness guaranteed that all the shirts were sold, the profits (nearly \$1,000) which donated to the student awards program sponsored by Bat Research News and other participants of the symposium. Thank you, Suzanne

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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- 556-3230, FAX 309-556- 3411
e-mail: tgriff@titan.iwu.edu

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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SPRING 2002

Bats in Bulgaria, with an Emphasis on Geoffroy's Bat (*Myotis emarginatus*)

Rumyana Pandurska-Whitcher and Ivan Pandourski

Institute of Zoology, Bulgarian Academy of Sciences, Sofia, Bulgaria

Twenty-nine of 31 species of bat known in Europe have been found recently in Bulgaria. The geographical position and inherent geological features of the country determine its specific climate, landscapes, and high faunal diversity. A continental climate is typical for the lowlands of northern Bulgaria, while southern Bulgaria and the south coast of the Black Sea exhibit a more sub-Mediterranean climate. Located in the middle of the Balkan Peninsula, Bulgaria is characterized by a variety of landscapes, including lowlands and mountains, from sea level to 2,925 m. The Stara Planina Mountains cross the country from the western border to the eastern coast. About 25% of Bulgaria is covered with karst, with many natural caves (more than 4,000 recently mapped), rocky cliffs, canyons, and karstic plateaus.

Bats inhabit more than 100 caves in Bulgaria (Beshkov, 1998), and ca. 50 of these are important for bat conservation because each contains 100 to several thousand bats. About 15 species use caves or mines for roosting, reproduction, and/or hibernation. Caves and mines suitable for bat roosting in Bulgaria occur from sea level to ca. 1,700 m, but the largest colonies are found at low and middle altitudes (ca. 300–800 m—Pandurska, 1996), reflecting the species' central-European or Mediterranean origin.

Mixed colonies of *Miniopterus schreibersii*, *Myotis myotis*, *Myotis blythi*, and *Myotis capaccinii* have the greatest number of individuals in their nursery and hibernation sites (up to 14,000). Other species that form mixed colonies with hundreds of individuals are the endangered species *Myotis emarginatus*, *Rhinolophus ferrumequinum*, and *Rhinolophus euryale*. These species are not strict cave dwellers, but they usually form reproductive colonies in natural caves, mines, or abandoned buildings.

Since 1986, all bat species in Bulgaria are protected by law, and the legislation prohibits capturing bats without permission or disturbing and killing them in their roosts. However, *M. emarginatus* and *M. capaccinii* are included in the Red Data Book of Bulgaria, and *M. emarginatus* is one of the rarest cave-dwelling species in the country (Beshkov, 1985).

The present article summarizes a project carried out in Bulgaria during 2000–2001. The goal of the project was to estimate the conservation status of the Geoffroy's bat (*Myotis emarginatus*), preserve the most important reproductive colonies, study seasonal roost preferences and reproductive behavior of the species, and promote conservation and educational activities. Bat Conservation International sponsored the project through a Global Grassroots Conservation Award, and specialists at the Institute of Zoology, Bulgarian Academy of Sciences, coordinated the activities. Fieldwork occurred in some karstic regions of western, central, and southern Bulgaria, where the largest colonies of *M. emarginatus* were recorded during the past 10 years (Beshkov, 1998; Pandurska, 1999). Number of reproductive females in each roost was estimated by visual observation, and mistnets were used to capture bats at entrances of caves to determine age and reproductive status of individuals.

Distribution and roosting behavior.—Geoffroy's bat is rare in Bulgaria, and only a few reproductive colonies are known, together with isolated hibernating or netted individuals (Fig. 1). All roosts are in karstic areas. Reproductive colonies inhabit mainly caves or mines, but during the reproductive period, colonies may move to the roofs of abandoned houses and bunkers, presumably in a search for more favorable microclimatic conditions during the birthing period.

The species is mainly found in southwestern Europe and the Levant region as far as northwestern Africa (Benda, 1999; Gerner and Hackethal, 1988), indicating that it is a stenotopic species preferring warm roosting conditions. The roosts found in Bulgaria are distributed from sea level

to ca. 1,200 m (Fig. 2), but reproductive colonies are formed only at low and middle altitudes, below ca. 700 m. Solitary animals have been captured in mountainous areas during spring and autumn (Pandurska and Beshkov, 1998).

When using caves, it usually inhabits the entrance where temperatures in summer are higher. Colonies roost in a wide range of temperatures and humidity, but always where ambient temperature is high. Temperatures in roosts used by reproductive colonies vary from 12 to 26°C, and relative humidity ranges from 50 to 92%. The rarity of the species in most of its distribution probably results from its specific roosting and feeding requirements, particularly landscape characteristics and food supply.

Reproduction.—Reproductive colonies of *M. emarginatus* start to form in different roosts at different times of the year, thus resulting in variations in time of birth. In two cases in south Bulgaria (in a warm underground bunker and an abandoned building), colonies started to form in early-to-mid May, and birth in these roosts usually occurred in May. However, in caves located at middle altitudes (ca. 500–700 m), births occurred later, in late June to July. The highest number of females (400–600 individuals) occurred in three colonies, but number of adult females usually varied from 80 to 250 bats.

Females give birth to one juvenile that is capable of flying and feeding independently at only 4 weeks of age. Geoffroy's bat is one of the smallest species of *Myotis*, and average measurements of adult females from Bulgaria are: length of forearm, 39.8 cm; length of body, 43.5 cm; wing span, 26.9 cm; and weight, 8.0 g. At the age of 1 month, juveniles reach ca. 90% of adult size. Dispersal starts in August, with adult females usually leaving roosts earlier than the newborn.

During the parturition period, Geoffroy's bat often forms mixed clusters with the greater horseshoe bat and the Mediterranean horseshoe bat, but we found that neonatal growth is usually faster for Geoffroy's bat than for the horseshoe bats. Bats from colonies of Geoffroy's bat also leave maternity roosts earlier than the other two coexisting species.

Conservation needs.—Number of reproductive females in three nurseries has remained almost unchanged over the past 10 years, whereas in other cases, number of bats has decreased. The main reason for decline of cave-dwelling bats apparently is disturbance by human visitors during the reproductive period, resulting in the early dispersal of bats from their roosts. Recent legislation has protected five roosts inhabited by Geoffroy's bat, but it is not always possible to control visits. One reason for this is that local people and nonprofessionals are not well educated about the ecological importance of bat populations. Caves sometimes are used for recreational caving or even for storage of cattle. Traces of fires and digging in cave galleries near bat colonies also have been found.

Details about roosting behavior and foraging sites of the species are still poorly understood, and hibernation sites and seasonal movements of the species have not yet been subject to detailed study in southern Europe and the Balkan Peninsula. During this project, several activities were initiated in Bulgaria that were aimed at developing a conservation and monitoring program. A proposal for legal protection of one important nursery of the species was submitted to the Ministry of Environment and Waters in Sofia. Protection of these roosts should reduce visits and decrease disturbance of colonies during the reproductive period (May–July). Informative signs will be installed in front of protected roosts to explain the status of bats and to inform people about the restriction of visits during the reproductive periods.

In 1999–2000, the Institute of Zoology (Bulgarian Academy of Sciences) initiated an education program, with the assistance of various natural parks and local environmental author-

-ities. Over 1,000 posters were printed that describe the rarity and protected status of *M. emarginatus* in Bulgaria. These posters have been distributed among scholars and speleological and environmental clubs. It was observed that a decrease in human disturbance in some nurseries resulted in an increase in their reproductive success. A proper national program for

monitoring and conservation of bat roosts will diminish threats caused by human impact and help human impact and help preserve local populations of cave-dwelling bats.

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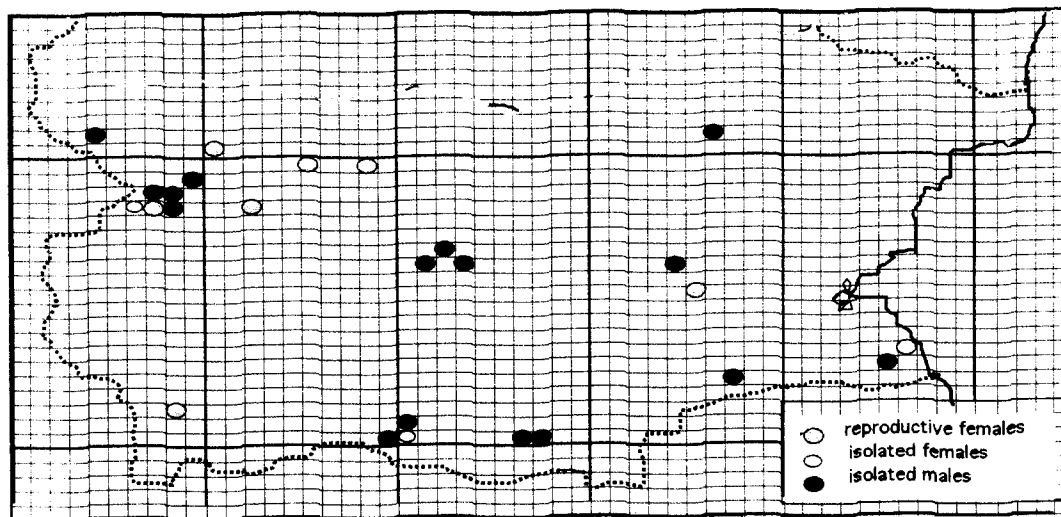


Figure 1. Recent distribution of *Myotis emarginatus* in Bulgaria.

PandurskaWhitcher and Pandourski continued...

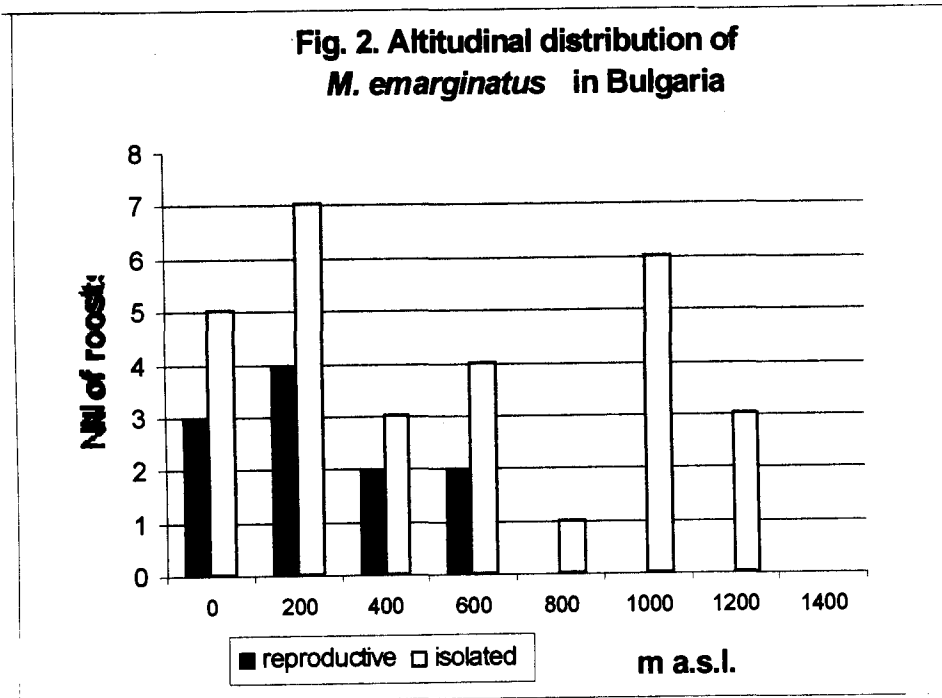


Figure 2. Altitudinal distribution of roosts of *Myotis emarginatus* in Bulgaria.

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.

Centipede (Chilipoda: Scolopendromorpha) Feeding on Mexican Free-tailed Bat (*Tadarida brasiliensis mexicana*)

On 29 March 1997 at ca. 1000 h, I was hiking in Big Bend National Park, Brewster Co., Texas, and observed a large centipede, ca. 25 cm in length, feeding on a Mexican free-tailed bat (*Tadarida brasiliensis mexicana*). While working my way along a ledge ca. 7-8 m above the floor of a canyon, the odor of Mexican free-tailed bats attracted my attention to a nearby vertical rock crevice, where droppings and staining were visible. Inside the crevice, a centipede with a blue body and orange-yellow legs and mandibles (probably *Scolependra* sp.) could be seen feeding on a Mexican free-tailed bat. The centipede sensed my presence and withdrew from the bat as I watched. I removed the bat for closer inspection. Approximately 30% of the tissues of the bat, including portions of the head, all the neck, and the heart and lungs had been devoured, exposing clean bone.

Although it was not known if the centipede actually killed the bat, several factors suggest that it did. Centipedes are venomous predators with large maxillipeds, and this was an exceptionally large individual. The centipede did not encounter a bat lying on the ground but was found with the bat in the roost. The blood and tissue of the bat was still fresh, and joints had not yet stiffened, indicating that it had died recently. Within 30 min, the bat did become stiff. A cold front had moved in during the night dropping ambient temperature that morning to ca. 10°C. Mexican free-tailed bats, like other bat species, are easily captured when in torpor. I speculate that the roosting bat was unable to escape while in a torpid state and that the centipede was able to inflict a lethal bite and begin feeding on the bat.

Submitted by Brian W. Keeley, Bat Conservation International, P.O. Box 162603, Austin, Texas 78716

Savi's Pipistrelle (*Hypsugo savii*) Is Expanding Its Range in Central Europe

On 21 May 2001, an adult, male, Savi's pipistrelle (*Hypsugo savii*) was found 20 km S of Brno, Czech Republic, 49°00 N, 16°33 E, at an altitude of 180 m. This is the first reliable record of the species on territory of the present Czech Republic or the former Czechoslovakia. The range of *H. savii* includes the southern Palearctic and Oriental regions, and it is marginally Afrotropic (Cape Verde Islands). In Europe, it is widespread in Mediterranean and sub-Mediterranean regions. A few vagrants are recorded in England, and there are two recent records from northern Germany, both supposedly animals that were passively transported with goods. The closest, previous record is 90 km S of our locality, in Vienna, Austria, where the bat has been recorded several times, with the latest in May 2001.

The distribution, habitat preference, and range expansion of *H. savii* in central Europe is analyzed by Spitzenberger (1997, in litt.). She concludes that the species is a petrophilous paleo-xeromontane faunal element ranging from sea level to high mountains. The expanding population of *H. savii* apparently is an urban one adapted to low altitudes. In light of these considerations, the individual found in the Czech Republic is assumed to be an active, rather than a passively transported, immigrant. It also could have originated from a hitherto unknown, recently formed, local population of the species. Urban agglomerations possibly play a role in the expansion because of the petrophily displayed by this species. This has been the case, for example, with feral populations of the domestic pigeon (*Columba livia*) and the parti-colored bat (*Vespertilio murinus*). For more details, refer to: Gaisler, J. 2001. A mammal species new to the Czech Republic—Savi's pipistrelle, *Hypsugo savii*. Folia Zoologica, Brno (in press). Submitted by Jiri Gaisler, Faculty of Science, Masaryk University, CZ 611 37 Brno, Czech Republic e-mail: gaisler@sci.muni.cz

Hibernating Behavior of a Silver-haired Bat (*Lasionycteris noctivagans*)

Although the silver-haired bat (*Lasionycteris noctivagans*) usually is migratory, it sometimes is a winter hibernator utilizing diverse hibernacula (R. W. Barbour and W. H. Davis, 1969, Bats of America, University Press of Kentucky, Lexington). There are, however, no descriptions of the behavior of the silver-haired bat during hibernation. We now describe hibernating behavior of an adult female for 52 days under controlled, laboratory conditions.

We found this bat on 23 December 2000, while it was hibernating in a shallow crack in Easley Quarry, Boone County, Missouri, on bluffs overlooking the Missouri River. The hibernaculum was a spacious and well-ventilated mine that was located within an inactive dolomite quarry. Within 25 cm of the silver-haired bat, there were three hibernating big brown bats (*Eptesicus fuscus*). During 26 years of studying bats hibernating in this quarry, we have found predominately big brown bats, an occasional eastern pipistrelle (*Pipistrellus subflavus*) and, rarely, a little brown bat (*Myotis lucifugus*).

The silver-haired bat was taken to the laboratory, weighed, banded, and placed in a hibernation cage. This cage was constructed from a styrofoam acid-bottle protector lined with thick synthetic sponge rubber. Drinking water was available from a small dish at the bottom of the cage. The unit was placed in a controlled environmental chamber in constant darkness at 7°C. Low-level white noise was generated by the chamber's circulating fans. Three, 24-gauge, copper-constantan thermocouples extended to different depths in the cage. These indirectly measured changes in the bat's body temperature, thereby yielding data pertinent to hibernation behavior. Temperatures were recorded remotely at 5-min intervals on time-printed chart paper by 20-point recording potentiometers (Leeds and Northrup, Speedomax G). The bat was undisturbed during the 52 days of the study, from 23 December 2000 to 13 February 2001. On this latter date, she was weighed while still hibernating and then returned to the point of capture, where she flew readily.

Our laboratory setup allowed for indirect measurement of four standard events characterizing the cycle of hibernation, which is repeated numerous times during winter. This cycle begins with "induction," at which time body temperatures fall to environmental levels, and is followed by a "period of hibernation," which lasts from the end of induction until the first increase in temperature of an arousal. "Arousal" is a rapid increase in body temperature to homeothermic levels, and it is followed by a "period of activity," which lasts from the end of arousal to the re-initiation of induction.

During the 52 days, the bat spontaneously aroused six times. Duration of the period of hibernation was 202.5 ± 171.2 (SD; range = 25.8–424) h, whereas duration of the period of activity was 64.2 ± 45.3 (30–145) h. Using the circular statistic of Batchelet (1965, American Institute of

Biological Sciences, Monograph), we calculated that the average time of day at which the bat aroused was 1850 (0035~2230) h. The bat's weight at capture was 9.69 g, and on the day of release, 8.29 g (Mettler, Type BD 202). Based on a mass loss of 1.4 g over 52 days, the energetic (lipid) cost of hibernation was 0.027 g/day.

Submitted by John W. Twente and Joel A. Maruniak, Biological Sciences, 114 Lefevre Hall, University of Missouri, Columbia, MO 65211 e-mail: maruniakj@missouri.edu

Round-eared Bat (*Tonatia bidens*) in Captivity

Only a few species of bat typically are maintained at zoos for exhibition to the public, particularly some frugivorous, nectarivorous, and hematophagous species. In Brazil, only the RIOZOO Foundation maintains an enclosure with a group of fruit bats (*Artibeus lituratus* and *Artibeus fimbriatus*), and these bats have been on exhibit since 1988, using a reversed photoperiod. Starting in August 1997, however, we began trying to maintain other, less-known species in captivity, and among these, was the round-eared bat (*Tonatia bidens*). Currently, these bats are still in off-exhibit facilities, using a normal photoperiod.

Tonatia bidens is found along the border of forests in eastern and southeastern Brazil, where it captures insects and birds as prey (P. Martuscelli, 1995, *Journal of Tropical Ecology*, 11:461–464). Fruits also are consumed apparently, although no fruit was recorded in our sample. This species forms harems composed of one male and up to 12 females and young, and in nature, the bats roost in caves, hollows trees, and abandoned buildings.

The animals described in this note were captured at five locations in the state of Rio de Janeiro, using mistnets placed near feeding roosts. On the night of capture, they were given a 10% solution of glucose and fed with insects. Bats were transported in individual cloth bags and housed separately in small cages (0.4 by 0.4 by 0.4 m) for at least 1 month.

Males maintained together showed cannibalism. After 1–3 months of observation, animals were placed into small groups composed of one male and two to four females or two

to four females by themselves. For groups, larger wire cages (1.0 by 0.5 by 0.5 m) were used, which allowed short flights by the bats.

Animals initially were fed with pieces of young mice that were substituted gradually with recently dead, adult mice. Although rodents are not confirmed prey in natural conditions, we know that these bats capture other small mammals (bats), birds, and amphibians through analysis of remains from feeding roosts, and captive bats readily accepted the mice. Eventually we offered live or frozen insects (Orthoptera, Lepidoptera, and Blattaria), frozen shrimp, and dried amphipods (TetraReptomin—*Gammarus*, Tetra) for variation. Each day, we offered each animal an amount of food equivalent to 60–130% of the bat's body mass. Recently, we began using canned food for cats (Whiskas). In the latter half of 1999, we noticed that the animals were losing fur, but supplementing the diet with vitamins and insect flour (Cedé) solved the problem. We fasted the bats 1 day per week to avoid the obesity that commonly results from use of canned food for cats, and use of larger cages also resulted in less obesity.

Isolated animals refused food more often than animals housed in small groups. Consequently, newly arrived animals were confined in cages next to a well-established group. Newly arrived animals were paired with older bats after 2–3 weeks.

From 1997 to 1998, we caught 24 *Tonatia bidens*, 12 of which survived to their 1st year in captivity, and six survived for 2 years after capture. The initially high mortality (more than 50% in 0–2 days after arrival) decreased after we started using larger cages and more diverse diets. For example, five animals that arrived this year showed no mortality after 6 months of captivity.

Rodriguo Medellin commented on the manuscript, and A. Pissinatti, Centro de Primatologia do Rio de Janeiro-FEEMA, provided permission to sample bats.

Submitted by Carlos Esbérard, Projeto Morcegos Urbanos, Fundação RIOZOO, Quinta da Boa Vista s.no., 20.940–040, Rio de Janeiro, RJ, Brazil e-mail: morcegos@pcrj.rj.gov.br

10th Australasian Bat Research Conference Cairns, Queensland

The organizers of the 10th Australasian Bat Research Conference have generously agreed that the abstracts of presentations at the conference be shared with the readers of Bat Research News. Dr. Jon Lully of James Cook University has assembled the abstracts and kindly forwarded them to us. The conference convened at the Cairns Colonial Club in Cairns in northern Queensland on April 2 to 5, 2002. As of this writing the conference has not yet convened and it is possible that some of the presentations may not be given, but we feel that the information deserves to be shared with all of us. Our thanks to the authors and to the organizers of the conference, Jenny Maclean, Olivia Whybird, and Chris Clague, and especially to Jon for their efforts on our behalf. The abstracts appear in alphabetical order by first authors. No distinction has been made between oral and poster presentations. GRH

Does increased forest clutter force bats onto the edges?

Maria Adams

Institute for Conservation Biology, Dept. of Biological Sciences, University of Wollongong, NSW, 2522.

Vespadelus vulturinus is a commonly trapped and detected bat in the forests of southeastern NSW, yet little is known of its ability to commute and forage within forested areas affected by logging. Current local logging practices incorporate the conservation of "habitat" trees for wildlife, thus ensuring the maintenance of some roosting sites for bats and other fauna. However, consideration is not given to the capacity of logged forests to support bat species with a variety of wing morphologies, echolocation call structures and, thus, differing commuting and foraging strategies. *V. vulturinus* is one species that may be negatively impacted by the increased structural clutter of young regrowth forest, which tends to have a higher density of stems and fewer/smaller gaps than old regrowth forest. This bat has been shown to forage between the canopy and understorey forest layers, flying close to vegetation and within gaps in the vegetation (O'Neill and Taylor 1986). While highly agile and manoeuvrable in flight, it does not appear to utilise denser areas within vegetation, such as has been demonstrated by the slower-flying *Nyctophilus* species.

In the summer of 2002, *V. vulturinus* individuals were trapped on tracks adjacent to old regrowth (little or no logging for 60+ years) and young regrowth (heavy logging ~30 years ago) sites in *Eucalyptus maculata* forest north of Batemans Bay, NSW. A cyalume light tag was attached to each individual and the bats were released at a point 50 m or more from the track at the same site. Observers were positioned around the perimeter of a 30 m radius circle, with the release point at its centre. A 50 m radius circle was also marked out from the same point. Observers recorded activity height and type and the times of leaving/entering the 30 and 50 m radius circles for each light-tagged bat.

As of February 2002, field work was still being undertaken, however early indications are that *V. vulturinus* spends more flight time in old regrowth sites than in young regrowth sites. Time spent within both the 30 and 50 m radius circles was greater in old regrowth and there were more observations of bats returning to the observation area after having exited. In contrast, in young regrowth most bats left the forest at canopy level, often before reaching the 30 m perimeter, and observations of returning bats were almost non-existent. Individuals in old regrowth demonstrated more apparent foraging activity from the shrub level up to the canopy, while those bats released in young regrowth tended to show a more direct climbing flight, finally disappearing at canopy level. The results of all replicate sites will be presented and the advantages and disadvantages of the methods used discussed.

O'Neill, M. G. and Taylor, R. J. (1986). Observations on the flight patterns and foraging behaviour of Tasmanian bats. *Australian Wildlife Research*. (13) 427-432. E-mail: mda01@uow.edu.au

The bats that time forgot: Pliocene relicts in the Pilbara of Western Australia

Kyle Armstrong

Department of Zoology, The University of Western Australia,
Crawley WA 6009.

The findings from my study on the Orange Leaf-nosed Bat *Rhinonicteris aurantius* are presented. There were two main lines of inquiry:

1. the distribution and roost habitat ;
2. taxonomic status of the Pilbara population.

Although widespread in the region, *R. aurantius* appeared restricted to certain rare types of underground structures for roosting including mines, gorge caves and granite rockpiles. Modelling the spatial distribution in the Pilbara using a GIS predicted that three main population subunits were present with infrequent dispersal over 'impediment' regions. Morphometric examination of the skull, noseleaf and wing revealed small but significant differences in the dimensions of the snout and the noseleaf between the Pilbara and the northern populations, but the taxon was otherwise conservative in terms of morphology. Snout size was further examined using measurements from x-rays, which confirmed the pattern of smaller nasal chamber size in Pilbara animals. The morphometric analyses provided a structural basis for differences found in the frequency of echolocation calls. Consistent with smaller snouts, Pilbara animals were found to have a higher call frequency (F_{peak}) than those in the Kimberley and Northern Territory. The functional and ecological bases for these differences have yet to be examined.

The final genetic component of the study entwined both lines of inquiry. Mitochondrial DNA markers showed evidence of subdivision between the spatial subpopulation units of the Pilbara modeled using GIS. Furthermore, they suggested that *R. aurantius* had existed as a set of semi-independent units throughout northern Australia for a long period of time. Minimum spanning network showed large differences between the Pilbara and Northern Territory populations. *R. aurantius* is a relict in the Pilbara, and the differences between the Pilbara and northern populations appear to have been shaped by their isolation by the Great Sandy Desert and the differences between the two environments. Thus, *R. aurantius* is part of a generalised track of evolution in the northwest as similar patterns are observed in other vertebrates.

History in a box: patterns of usage of bat roost boxes at Organ Pipes National Park 1994 to 2002

Robert Bender and Robert Irvine

Ten roost boxes were installed in 1992 and first used in 1994. 27 more boxes have been added, and three removed, in small increments, each time changing the range of alternatives open to the bats using the area. Other animal species (especially rats and ants) have also at times occupied the boxes, some of them tolerant of bats, others intolerant, and these, too have affected the history of individual box usage by bats. Bat species rarely mix in the same box. The range of group sizes using particular boxes varies – some accommodate only large groups, others only bachelor males, others are used by a wide range of group sizes. Thick-walled boxes, installed from 1998, significantly affected usage of thinner-walled boxes installed earlier. A relationship is suggested between the experience with these boxes and the dynamics of natural forests, in which hollows appear, change shape and collapse, thus altering the usage of remaining hollows. Implications of what we have learned for design and management of other roost box projects.

Foraging movements of little red flying-foxes *Pteropus scapulatus* (Chiroptera: Pteropodidae): implications for cross-pollination

Patrina Birt

School of Veterinary Science, University of Queensland, ST LUCIA Q 4072

Current address: PO Box 9845 Frenchville Q 4701

Ground radio-telemetry was used to investigate the significance of the foraging movements of little red flying-foxes (*Pteropus scapulatus*) to the pollination of eucalypts and other related genera in eastern Australia.

Fourteen individuals (six females and eight males) were tracked throughout the night from four daytime campsites located at Gladstone, Esk, Ipswich and Rockhampton. Foraging movements were primarily determined by territorial feeding. Those animals that were not successful in establishing and defending feeding territories (subdominant) spent the night continuously shuttling between flowering conspecifics both within a stand and within separate stands. Consequently these animals spent less time foraging in individual trees but utilised a greater number of trees than dominant individuals. Dominant animals however, did not remain in the same tree throughout the night but maintained feeding territories in several trees within a stand. Individuals returned to the same foraging site(s) each night until the resource was exhausted or another became available. The location of foraging sites varied from continuous forests, to remnant patches of forest, to solitary trees within an urban setting. Distances traveled from daytime campsites to initial foraging areas ranged from 4km to 23.5km. Distances between successive foraging areas for those individuals that commuted between separate stands ranged from 500m to 24km.

This study hypothesises that *P. scapulatus* have the potential to contribute significantly to cross-pollination of eucalypts (which are characterised by a reduction in fruit set and seed viability in self-pollinated flowers) by moving pollen between a large number of trees within a stand, and between trees located in separate, isolated stands. This has important implications not only for natural forest regeneration, but also for the forestry industry, which harvest extensive quantities of seed from native eucalypt populations for exportation to overseas countries and for use in Australian eucalypt domestication programs. The long term survival of native eucalypt populations is dependent upon maintaining their genetic diversity, which is in turn dependent upon maintaining viable populations of their pollinators, particularly those that promote cross-pollination.

E mail: walbirt@bigpond.com

Size does matter

Chris Clague

Vision Touch and Hearing Research Centre,

Department of Physiology and Pharmacology, School of Biomedical Sciences

University of Queensland, St Lucia 4072

An investigation into the mechanisms determining bat community structure was undertaken in the upland wet sclerophyll zone of tropical Australia. Seven summer assemblages and five winter assemblages were identified and the mechanisms determining species membership investigated. The potential mechanisms of structure examined were size, flight morphospace, dietary ecospace, echolocation ecospace, structural environmental complexity, history and roost requirements. A source pool was generated and the species broken into five guilds based on foraging style (slow aerial insectivore, fast aerial insectivore, flycatching, gleaning and trawling).

The source pool was found to be generally structured for size with only one species pair in the fast aerial insectivore guild and one species pair in the gleaning guild displaying overlap in size related morphospace. No overlaps were observed in the slow aerial insectivore, flycatcher or trawling guilds. The measures of flight morphospace were noted to have two gleaning guild species pairs in overlap at the source pool level, five species pairs in overlap in the fast aerial insectivore guild, five species pairs in overlap in the slow aerial insectivore guild and no overlaps were apparent in the flycatcher or trawling guilds. Echolocation ecospace was measured based upon the minimum frequency of the species calls and

numerous overlaps were noted in the Steep-FM (gleaning) and FM echolocation guilds whilst no overlaps were apparent in the CF-FM guild (flycatcher).

Dietary partitioning was investigated using gape as an estimate of the maximum manipulable prey size and echolocation parameters to determine the minimum detectable prey size. The slow aerial insectivore and gleaning guilds each had one overlap in this estimation of niche overlap. Environmental clutter, roost resources and history also influenced the membership of the identified assemblages. Competition between species overlapping in morphological or ecological space for one or more of the measured parameters is also suggested by the data to have a structuring influence through competitive exclusion and diffuse competition.

A structured decision-aiding approach for the establishment of an alternate camp site for the grey-headed flying-fox *Pteropus poliocephalus* in Melbourne

Tim Clancy, Andrew Bearlin, Lindy Lumsden and Ian Temby

*Arthur Rylah Institute for Environmental Research,, Department of Natural Resources & Environment,
PO Box 137, Heidelberg VIC 3084*

In March 2001, the Victorian Minister for Environment and Conservation announced the establishment of a Task Force to investigate the option of providing an alternative roost site for grey headed flying-fox as part of a broader strategy to alleviate damage to the Melbourne Royal Botanical Gardens. Provision of an alternative roost site was seen as a positive way of reducing numbers of flying-foxes in RBG while still allowing for the conservation of the species in Victoria.

A range of sources was used to build a conceptual model of what a potential camp site would look like, including the size of the area, the structure of the vegetation, and proximity to water, foraging areas and the existing site at the RBG. Anthropogenic factors such as land tenure, distance to houses, extent and land use within buffer zones, were also included. GIS techniques were used to identify potential sites within a 20 km radius of the RBG, which were then examined and assessed in relation to the conceptual model. Potential sites were scored and prioritised using a Multiple Criteria Decision Model. This decision support tool engages the decision maker in the process of assigning weights to the criteria selected. Weights were based on the best understanding of the biology of the grey headed flying-fox and of factors likely to influence camp establishment, including social issues and costs.

The decision aiding tool was also useful in the development of an active adaptive management framework for the relocation attempt. A site along the Yarra River in Ivanhoe (Wilsons Reserve – Horseshoe Bend) was selected, which has subsequently been approved by government as the preferred location for the trial establishment of an alternate roost site for the grey headed flying-fox in Melbourne.

Acoustic dimorphism in *Rhinolophus philippinensis*

Roger B. Coles

*Vision Touch and Hearing Research Centre,
Department of Physiology and Pharmacology,
School of Biomedical Sciences, University of Queensland, St Lucia 4072*

Traditionally, *Rhinolophus philippinensis* has been represented in Australia by the single species or sub-species *R. philippinensis robertsi*, although up to 6 sub-species have been recognised throughout its range in South East Asia. Two size morphs have been known in Australia since the early 1980's, readily distinguished by several external features (mean FA 57.6mm and 53.9mm for *R. p. maros*, and *R. p. achilles* respectively – Churchill 1999). Questions have been raised as to the taxonomic status of these forms, together with that of *R. megaphyllus*, and recent genetic evidence suggests that all three taxa are very

closely related indeed (Cooper *et al* 1998). Both forms of *R. philippinensis* (and *R. megaphyllus*) are sympatric in the region of Cape York around Iron Range, but the distribution of the larger form of *R. philippinensis* extends further south to near Townsville. *R. megaphyllus* is distributed widely along the entire east coast of Australia as far south as eastern Victoria.

In further support of the distinctiveness of the two forms of *R. philippinensis*, acoustical data reveal that the CF component of the echolocation call differs significantly between the two morphs. CF for the large (big) form is around 28kHz compared to 40kHz for the smaller 'intermediate' form, quite separate from *R. megaphyllus* echolocation call frequencies (CF 67-74kHz). These acoustic observations are consistent with the differing size and shape of the external ear (pinna) and noseleaf for each morphotype, and which determine the biophysical properties of their echolocation systems such as directionality and gain. The preferred use of such a low CF by the large form has been recorded in the field as well as from captive individuals. It is confirmed here as the expression of the first harmonic, in marked contrast to the dominance of the second harmonic in possibly all other Rhinolophids. As the CF is so low, it raises the question as to whether Doppler shift compensation is possible at all in the large form, and if not, whether there is any influence on the flight and foraging style between the two morphs, given that there are very few behavioural observations.

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Patterns of seed dispersal by spectacled flying-foxes in Australia's wet tropics

Andrew Dennis, David Westcott, Matt Bradford and Adam McKeown.
CSIRO Sustainable Ecosystems and the Rainforest Cooperative Research Centre.
Tropical Forest Research Centre, P.O. Box 780, Atherton 4883

Spectacled flying-foxes, *Pteropus conspicillatus*, are known to disperse the seeds of food plants in two ways, either: 1) by carrying fruit away in their mouth and dropping the seed/s; or 2) by ingesting seeds and voiding them away from the source. The former behaviour may involve the small-scale movement of fruits and seeds of any size (including very large fruits and seeds), whereas the latter method is restricted to fruits containing small seeds able to pass through the <5mm lumen. In this paper, we present data on the patterns and distances of seed dispersal by flying-foxes for seeds that are swallowed and defaecated. We do this by examining the rate of seed ingestion, the rate of seed passage through the gut and the movement of individual flying-foxes to calculate a typical seed shadow for the species.

We go on to look at the physical characteristics of the fruits eaten and use this to predict a list other plants whose fruits are likely to be consumed. Most seeds found in spectacled flying-fox defaecations were <3mm, rarely up to 5mm. The rate of ingestion of seeds from an individual fruit was low when compared to many other frugivores, suggesting a high level of seed "wastage". Over 90% of ingested seeds pass through the gut in less than three hours, many in only twenty minutes and a rare few continue to pass through 6, 9, 13 and even 19 hours later. These rates of seed passage through the gut, combined with patterns of movement mean that SFFs disperse seeds at a wide range of distances from their source. The pattern of seed dispersal is not unique. However, there are only a few other frugivores that show similar patterns of movement and there are a few plant species where dietary overlap with other wide-ranging frugivores is not currently recorded. Email: Andrew.Dennis@csiro.au

Spectacled flying-foxes, paralysis ticks and introduced *Solanum*: A novel and lethal ecological interaction

Andrew Dennis, Jenny Maclean, Ceinwen Edwards and Lisa Dwyer
CSIRO Sustainable Ecosystems and the Rainforest Cooperative Research Centre.
Tropical Forest Research Centre, P.O. Box 780, Atherton 4883

Spectacled flying-foxes, *Pteropus conspicillatus*, on the Atherton Tableland have suffered high levels of mortality from envenomation by paralysis ticks, *Ixodes holocyclus*, since at least the early 1990's. Bats

carrying a single tick always die unless treated, suggesting they are not a natural host. A change in foraging behaviour to include the fruit of an introduced weed (wild tobacco, *Solanum mauritianum*) was thought to have brought the bats into contact with questing ticks. The hypothesis had never been adequately tested and remains controversial.

This study used mortality and foraging data to design a sample regime to determine if paralysis ticks could infest flying foxes while they were foraging on tobacco bushes. A sample of 2,479 mock bat foraging events on tobacco bushes resulted in the collection of 12 paralysis ticks at heights up to 1.7m. From our calculations based on infestation rates measured at a colony, we were expecting only one tick in each 2500 foraging events. The large number collected suggests two things:

- 1) spectacled flying-foxes do acquire ticks from tobacco bushes;
- 2) mortality from paralysis ticks may be significantly greater than that measured at colonies. Many bats may die and fall undetected away from colonies.

While wild tobacco may not be the only source of infestations, our results suggest that a campaign of tobacco bush eradication should significantly reduce mortality due to paralysis tick envenomation. A project to test this is now under development. Email: Andrew.Dennis@csiro.au

A bloke in every port: group composition and gender bias in the migration patterns of grey-headed flying foxes *Pteropus poliocephalus*

Peggy Eby¹ and Vivien Jones²

¹ PO Box 3229, Tamarama, NSW 2026² PO Box 131, Bellingen, NSW 2454

Recent studies have demonstrated the influence of resource distribution on the social structure of mammals and birds. Studies of grey-headed flying-foxes (GHFF) have consistently shown their complex migration patterns to be largely determined by resource distribution. However, little is known of the influence of this complexity on social structure, group stability or the mating system of this social species.

We studied variations in the size and composition of roosts from September to May (pre-birth to conception). Variations in the natural markings of GHFF were sufficiently conspicuous to enable individuals to be distinguished, and we used photographic identification to additionally study the structure and stability of harems. Harem males were highly specific and consistent in their roosting locations; adult females were never observed roosting outside the territory of a male. The size and composition of harems varied considerably through time and there was a positive relationship between the size of harems and the size of the roost population. Females arrived and departed from harems throughout the study period, accompanied by dependent young at all stages of development. During the period of conception, males copulated with short-term harem members as well as females that had roosted within their territorial areas for several weeks.

When roost populations increased, males were first to inhabit previously unoccupied areas of the roost. They established territories that were later occupied by harem females. When populations decreased, females departed harems first, generally independently of each other. Males occupied territories in the absence of females for up to nine consecutive weeks.

We conclude that :

1. harems are generally unstable groupings, and members of harems do not migrate together or form long-term associations;
2. the tendency to migrate is greater in females than in males;
3. a greater proportion of adult females than males use rich resource flushes from flowering eucalypts and melaleucas;
4. females join the harem group of a different male at each new roost they occupy, including roosts used as short-term stop-over sites during migration;
5. the mating opportunities of males are related to resource distribution and roost size. We predict female mate choice and mixed mating systems in GHFF. Email: peby@ozemail.com.au

QPWS policy for issuing damage mitigation permits for flying-fox mitigation in commercial fruit crops

Bruno Greimel

Wildlife Management, Queensland Parks and Wildlife Service

Flying-foxes and fruit growers have a history of conflict that can be traced back to early European settlement. The conservation status of flying-foxes enjoys a similar colourful history. It was only 10 years ago that, with the assent of the *Nature Conservation Act 1992* flying foxes were permanently classified as protected wildlife in Queensland. The main objective of the Act is the conservation of nature. While this includes the conservation and management of all protected wildlife, the Act regulates other aspects of wildlife management, such as recreational keeping of wildlife, the sustainable use of wildlife and the lawful taking of common protected wildlife that causes significant economic loss under a damage mitigation permit.

It is well documented that flying-foxes can cause significant damage to commercial fruit crops and growers have traditionally employed lethal control methods for crop protection. In relation to crop damage, there are four species of fruit bats of concern: the grey-headed flying fox (*Pteropus poliocephalus*), the spectacled flying Fox (*P. conspicillatus*), the little red flying Fox (*P. scapulatus*) and the Black Flying Fox (*P. alecto*). All species are currently listed as common wildlife under Queensland legislation, although the conservation status of *P. conspicillatus* and *P. poliocephalus* is currently under review.

As a result of advice regarding the inhumaneness of this practice and of concerns regarding the ecological sustainability of using lethal electric grids, QPWS has banned the use of these devices and over the past year, has considerably changed the way in which damage mitigation permits are assessed and issued. This change in policy reflects a move towards a more comprehensive conservation strategy for flying foxes and collaborative partnerships with growers to achieve sustainable crop protection.

The structure of a tropical urban micro-bat community

Clare Hourigan

School of Tropical Biology and Ecology, James Cook University, Townsville 4811

I investigated the structuring of a micro-bat community in relation to variation in the urban environment in Townsville, tropical north Queensland. I determined the species composition and foraging activity of micro-bats within the area, and established if differences in the spatial distribution of species and foraging activity were influenced by gradients of environmental variation. To achieve this a random stratified sampling technique was adopted, and 32 sites across 8 habitat types (Old suburbs, Intermediate suburbs, New suburbs, Amenity grasslands, Riparian areas, Woodland areas, Cleared areas, and Gardens) were chosen to represent variation in the urban environment. Each site was sampled on three occasions using an automated ANABAT detector system. A number of environmental variables were measured at each site, including:

1. housing density,
2. numbers of mercury and sodium vapour streetlights
3. foliage density.

All species were identified from the recorded echolocation calls, and foraging activity was determined by the presence of feeding buzzes.

Fifteen micro-bat species/groups from four different families were detected in Townsville, and of these, ten were recorded foraging. *Chaerephon jobensis* was the most spatially common species in this study, being detected at all 32 sites. This is perhaps due to the high intensity at which this species calls, allowing it to be detected flying high above the canopy. *Nyctophilus spp* and *Rhinolophus megaphyllus* were detected in a small number of sites in close proximity to natural woodland or in riparian habitats. As these species are gleaning insectivores and clutter foragers, they are strongly influenced by habitat fragmentation and, as such, are less common in disturbed habitats. Foraging activity was dominated by species belonging to the Molossid and Vespertilionid families. *Mormopterus loriae* alone contributed 28% of all feeding buzzes recorded, reflecting its ability to exploit urban environments. *Rhinolophus megaphyllus* and *Nyctophilus spp* were not detected feeding. As these species are gleaning insectivores and clutter foragers they are less likely to be detected feeding than continuous aerial foragers.

Multidimensional scaling of the environmental data revealed two distinct gradients in foliage density and urbanization across Townsville. The species richness and total foraging activity of the community were negatively correlated with the urbanization gradient, so that increases in urbanization lead to decreases in species richness and foraging activity. This suggests that few species of microbat benefit from urban development. Regression trees were used to determine the individual foraging preferences of microbats within this community and revealed that only *Mormopterus loriae* benefited from increased urbanization, as this species preferred to forage in areas with higher numbers of white streetlights. The remaining species preferred to forage in close proximity to natural vegetation, where there were low numbers of streetlights, within close proximity to freshwater or where housing densities were low. This suggests that the extent to which most species of microbat are able to exploit urban environments is limited.

The population dynamics and roosting ecology of Gould's long-eared bat (*Nyctophilus gouldi*) in a coastal urban environment

Glenn Hoyer

Fly By Night Bat Surveys PL, PO Box 271, Belmont NSW 2280.

A population of Gould's Long-eared Bat (*Nyctophilus gouldi*) utilising remnant palm forest in an urban setting near Newcastle, New South Wales was studied over a period of seven years. Bats were captured using collapsible harp traps at selected sites within Cabbage Palm forest with sampling initially undertaken over a range of seasons to ascertain seasonal fluctuations in the abundance and sexual composition of the population. All bats captured were sexed, measured and banded to allow identification of individuals. Capture and banding of free-flying juveniles present in the population from late November, was undertaken to allow the fate of known age individuals to be monitored. Selected bats were fitted with transmitters prior to release and tracked to diurnal roosts.

192 bats were captured on 534 occasions over a seven year period from March 1995 until January 2002. This included 173 individuals, captured initially as free-flying juveniles. Many bats were recaptured on a number of occasions with one female recaptured 15 times. Juvenile males were seldom recaptured as adults despite comprising over half of all juveniles recorded at the site. Juvenile females exhibited a high fidelity to the site from year to year. In contrast, juvenile males free-flying in late November, are virtually absent by the following July. This may be due to dispersal of juvenile males to other areas or/and increased mortality in juvenile males as opposed to higher rates of survival of juvenile females. The effects of periodic fire on the population are also discussed.

Acoustic divergence in two cryptic *Hipposideros* species: a role for social selection?

Tigga Kingston, Marcia C. Lara, Gareth Jones, Zubaid Akbar

and Christopher J. Schneider

no addresses given

We present evidence that a relatively widespread and common bat from South East Asia comprises two morphologically cryptic but acoustically divergent species. A population of bicoloured leaf-nosed bat (*Hipposideros bicolor*) from Peninsular Malaysia exhibits a bimodal distribution of echolocation call frequencies, with peaks in the frequency of maximum energy at ca. 131 and 142 kHz. The two phonic types are genetically distinct, with a cytochrome *b* sequence divergence of just under 7%.

We consider the mechanisms by which acoustic divergence in these species might arise. Differences in call frequency are not likely to effect resource partitioning by detectable prey size or functional range. However, ecological segregation may be achieved by differences in microhabitat use; the 131 kHz *H. bicolor* is characterized by significantly longer forearms, lower wing loading, a lower aspect ratio and a more rounded wingtip, features that are associated with greater manoeuvrability in flight that might enable it to forage in more cluttered environments relative to the 142 kHz phonic type.

We suggest that acoustic divergence in these species is a consequence of social selection for receptor systems imposed by the highly specialized nature of the hipposiderid and rhinolophid echolocation system.

Neighbours of the Ku-ring-gai Flying-fox Reserve: Community attitudes survey 2001

Elisabeth Larsen¹, Marjorie Beck², Elizabeth Hartnell², Michael Creenaune³

¹*Division of Environmental and Life Sciences, Macquarie University, NSW 2101*

²*Ku-ring-gai Bat Conservation Society Inc., PO Box 607, Gordon, NSW 2072*

³*Michael Creenaune & Associates, 7 Eden St., Chatswood, NSW 2067*

The Grey-headed Flying-fox was listed as a vulnerable species (Schedule 2) under the *NSW Threatened Species Conservation Act 1995* in May 2001. As a result of this listing, the NSW National Parks and Wildlife Service is required to prepare a Recovery Plan for the grey headed flying-fox. To assist in the planning process, a community survey was conducted by the Ku-ring-gai Bat Conservation Society (KBCS) in November 2001 among residential properties neighbouring the Ku-ring-gai Flying-fox Reserve in Gordon, Sydney. Grey headed flying-foxes have occupied this Reserve for most of the year since 1965.

Door-to-door interviews were carried out among 126 properties, including 25 properties following the two main dusk fly-out paths. The survey was aimed at examining residents attitudes to flying-foxes, and how these attitudes are affected by a series of variables, including the location of properties relative to the flying-fox colony, the residents' general awareness of flying-fox ecology and the management of the Reserve, and the effectiveness of KBCS' education activities.

The majority of the respondents stated a strongly positive (28%) or positive (28%) attitude to living near the flying-fox colony. Only 11% stated a negative or strongly negative attitude, with as many as 32% being neutral. Smell and noise rated highest among the reasons for negative attitude change. There is an indication that the distance from the house to the edge of the flying-fox colony affects attitudes. Households living more than 100m from the edge of the colony generally expressed a positive attitude toward flying-foxes. The most adverse comments received were from people living closer than 100m. However, 60% stated that the presence of the colony does not affect property values. As many as 82% of the respondents had no awareness of the management plan for the Reserve, and only 50% were aware of the habitat restoration program.

Although the KBCS has an extensive education program targeting schools and the wider community, it was disappointing that the education program seems to have reached only approximately 50% of the respondents. Although 67% knew that flying-foxes carry diseases dangerous to humans, more than 50% answered incorrectly about the potential causes for disease transmission. Furthermore, 80% did not know what causes the fluctuations in flying-fox numbers in the colony. This result suggests that the way information is disseminated to the local residents needs to be reassessed.

Despite the lack of knowledge, a majority of the residents expressed appreciation of the bats, with 71% agreeing that 'Living near the colony is a source of interest and enjoyment to me' (43% strongly agreed, 28% agreed). Only 8% disagreed with this statement. Also, as many as 74% stated that they would choose to live as near to the flying-fox colony again.

Tracks and riparian zones facilitate the use of regrowth forest by insectivorous bats

Bradley Law and Mark Chidel

*Research and Development Division, State Forests of NSW
PO Box 100, Beecroft, NSW 2119.*

Little is known about habitat use by Australian microbats, although it is a key issue when assessing impacts from logging. Logging results in a successional change in forest structure from open (extent depends on whether logging is clear-fell or selective) immediately after logging to dense young regrowth as the forest regenerates. Regrowth eventually either self-thins slowly or is silviculturally thinned to produce a forest that has structural similarities to mature forest. We used bat detectors to compare activity between unlogged and regrowth forest 15 years after logging (pre-thinning age). Management history was replicated at the scale of small catchments, with detectors positioned on-tracks, off-tracks and in small riparian zones. The study was undertaken in wet sclerophyll forest in Chichester State Forest, northern NSW.

The highest bat activity was recorded on-tracks, with no significant difference between regrowth or unlogged catchments (regrowth=183 passes/night, unlogged=196 passes/night). Activity in riparian zones (regrowth=55 passes/night, unlogged=26 passes/night) was lower, while activity off-tracks in regrowth

(5 passes/night) was lowest. Clutter formed by regrowth eucalypts and understorey rainforest had a significant negative relationship with bat activity. Similar to activity, the number of species and foraging attempts was lowest off-tracks in regrowth and highest on-tracks (irrespective of treatment). Identification of calls to species revealed the species which used tracks and those that did not benefit from the presence of tracks. Our results suggest that many bat species are able to use otherwise unsuitable regrowth forest by focusing their activity on tracks and to some extent small riparian zones.

A short tale— getting the hang of New Zealand bats

Marieke Lettink

Department of Conservation, New Zealand

The bat fauna of New Zealand consists of two species of microbat (the long-tailed bat *Chalinolobus tuberculatus*, and the lesser short-tailed bat *Mystacina tuberculata*). A third species (*M. robusta*) was last recorded during the 1960s and may now be extinct. Both extant species have undergone a considerable decline in abundance since pre-European times and continue to face a number of threats, including loss of foraging and roosting habitat and predation.

This talk will cover aspects of the historical and cultural significance of bats (or *peka peka*) to Maori, and highlight emerging themes from past and present research. A Bat Recovery Plan (Department of Conservation) is now in place to address research and management issues, and ultimately, to preserve and restore bat populations throughout New Zealand.

Adapting to habitat change in rural environments: a comparison of the roosting ecology of the lesser long-eared bat *Nyctophilus geoffroyi* and Goulds' wattled bat *Chalinolobus gouldii* in contrasting rural landscapes

Lindy Lumsden^{1,2}, and Andrew Bennett²

¹ Arthur Rylah Institute for Environmental Research, Department of Natural Resources and Environment, PO Box 137, Heidelberg, Victoria 3084.

² School of Ecology and Environment, Deakin University, 221 Burwood Highway, Burwood, Victoria 3125 .

Roost sites are a critical habitat requirement for bats. There is now increasing knowledge of the roosting ecology of Australian tree-hole roosting bats, but little is known about the influence on roost site selection and roosting behaviour of differing levels of availability of roosts. Extensive clearing throughout agricultural regions of southern Australia has resulted in an overall reduction, and marked local variation, in the availability of potential roost sites. We propose five ways in which tree-hole roosting bats could respond to this change in roost abundance:

1. use a broader range of roost sites by being less specific in roost selection;
2. use fewer roosts by shifting between roost sites less frequently;
3. move regularly between roosts, but re-use roosts more frequently;
4. occupy a larger roost area by moving greater distances between roosts;
5. increase colony sizes so that fewer roosts are required for the population.

To investigate these options, we compared the roosting ecology of two species of common and widespread vespertilionids, the Lesser Long-eared Bat *Nyctophilus geoffroyi* and Gould's Wattled Bat *Chalinolobus gouldii*, between two study areas with contrasting tree cover, in rural environments of northern Victoria.

The Barmah area included farmland and adjacent extensive forests along the Murray River floodplain; while the Naring area consisted of small remnants of woodland vegetation within an intensive agricultural region, with less than 5% tree cover remaining. At Barmah, 45 *N. geoffroyi* and 27 *C. gouldii* were radio-tracked resulting in the location of 139 and 89 roosts, respectively. At Naring, 34 *N. geoffroyi* and 25 *C. gouldii* were radio-tracked resulting in the location of 86 and 62 roosts. *C. gouldii* selected similar types of roosts in both areas – predominantly dead spouts on large, live trees. *N. geoffroyi*, however, utilised a broader range of roost types, especially for maternity roosts. At Barmah, these were predominantly narrow

fissures in large-diameter, dead trees, while at Naring maternity roosts were also found under bark, in buildings, and in small-diameter, live and dead trees. Individuals shifted roost sites regularly in both areas, however, *N. geoffroyi* shifted significantly less frequently at Naring (2.5 vs 1.8 days), with a similar (but non-significant) trend for *C. gouldii* (2.5 vs 2.0 days). *C. gouldii* re-used roosts twice as often at Naring compared to Barmah, while roosts were re-used at a similar rate by *N. geoffroyi* in both areas. When *N. geoffroyi* moved to a new roost, the distance travelled was greater at Naring than at Barmah, while *C. gouldii* did not vary in this respect. Colony sizes for both male and female *N. geoffroyi* were similar in the two study areas, while colony sizes were either similar (females) or smaller (males) for *C. gouldii* at Naring compared with Barmah.

These differences in roosting ecology of *N. geoffroyi* and *C. gouldii* between study areas show that bats do not necessarily respond to changes in roost abundance in the same way. This suggests that habitat loss and modification in rural environments may affect population and behavioural processes of bats in different ways.

Raising public awareness of spectacled flying-fox issues – an NHT project about partnerships

Jenny Maclean

Tolga Bat Rescue & Research, PO Box 685 Atherton

The summary in the grant application read – “This project will raise public awareness of the threatening processes affecting the Spectacled Flying-Fox on the Atherton Tablelands. The listing of SFFs as a threatened species appears imminent. Education of the community will ease them through an acceptance of this species as a valued keystone species with natural resource management issues. Skills development and training can be gained through on the ground projects run in conjunction with the rescue of SFFs with tick paralysis. These projects will also serve to close some gaps in knowledge of the species and so help determine future management.”

The outcomes of the project have been:

1. Improved community knowledge and understanding of SFF issues. This has involved educational talks; film, radio, television and print media
2. Identification of wild tobacco as the main source of paralysis ticks for SFFs. Our partner is Dr. Andrew Dennis from CSIRO.
3. Removal of canine teeth from 245 dead adult SFFs for age analysis work. Our partners are Dr. David Blair *et al* from JCU who are applying for grants for the laboratory work. On Les Hall's advice, we also removed the penis bone for age analysis work on all dead males – 77 altogether.
4. Removal of wing tissue from 73 dead bats for JCU's molecular genetics project.
5. Improving the management of tick paralysis in SFF. Our partners have been Prof. Rick Atwell from UQ and Merial, a veterinary pharmaceutical company.
6. Information about the incidence of tick paralysis in SFFs on the Atherton Tablelands – 10 percent of the population at the Tolga Scrub colony this year.
7. The provision of rich volunteering experiences for the community.
8. The development and production of educational poster and car stickers.
9. The release in 2002 of about 90 adults and 105 orphans back to the wild.
10. Identification of the high incidence of severe cleft palate in SFF young born 2001. (Similar to 1998). Karyotyping work being done on fresh blood by Dr Graham Webb from Adelaide.

This project has been made easier by the provision of a new computer and peripherals from an IYV grant, free t-shirts for all volunteers from another IYV grant and free soap powder for the bat hospital from Planet Arc (buy Planet Arc products!).

We will continue to collect 'body parts' for JCU over the next few years in the belief that it will yield important information for SFF population modelling and management plans.

The Food for Wildlife Project: turning research into action

Nicola Markus

Consultant Zoologist, Brisbane, Ph: 0438 125 266

In the past 15 years, a number of detailed studies have enhanced our understanding of flying fox ecology. Declining forests, loss of foraging and roosting habitat, and human/wildlife conflict pose serious threats to flying foxes worldwide, and to at least two species in Australia. In response to diminishing forest resources, flying-fox populations have increased in areas of dense human settlement, where cultivated food resources in suburban gardens and green spaces provide comparatively reliable floral resources throughout the year. However, a recent radio-tracking study in Brisbane showed that there are substantial gaps in the annual menu of flying-foxes even in urban areas.

The Food for Wildlife Project is a pro-active community initiative to ameliorate seasonal resource shortages in suburban Brisbane, Queensland. The project is a collaboration of three local councils, Greening Australia and other non-government organisations and will coordinate the involvement of more than 40 volunteer bushcare groups with the aid of Natural Heritage Trust funding and in-kind contributions. Using a two-tiered approach, the project will focus on the restoration and maintenance of five established urban flying fox camps, and on the planting of native food-yielding trees and shrubs of local provenance in surrounding urban greenspaces. The planting of 30,000 trees, accompanied by an extensive public awareness program, in the first year will benefit a wide range of birds, mammals and insects in addition to local flying-fox populations. It is hoped that the project will encourage further initiatives to accommodate wildlife in urban areas. Email: nmarkus30@hotmail.com

On the intrinsic capacity for increase of Australian flying-foxes (*Pteropus* spp., Megachiroptera)

A.P. McIlwee¹ and L. Martin²

¹*Department of Zoology and Tropical Ecology, James Cook University, Townsville, Qld 4811, Australia.*

²*Department of Physiology and Pharmacology, The University of Queensland, QLD, 4072, Australia*

Address for correspondence: PO Box Nimbin NSW 2480

In the reproductive biology of organisms, a continuum exists from "highly reproductive species" at one end to "survivor species" at the other end. Among other factors, the position of a species along this continuum affects its sensitivity to human exploitation and its vulnerability to extinction. Flying foxes are long-lived, seasonal breeders, with a rigid, well-defined breeding season that is largely or wholly genetically determined. Unlike opportunistic, highly reproductive species, such as rabbits or mice, female flying foxes are unable to produce viable young before their second or third year of life, and are then capable of producing just one young per year. Such a breeding strategy will be successful only if flying-foxes are long-lived and suffer naturally low mortality rates.

In this paper, we assess the vulnerability of flying foxes to extinction, using basic parameters of reproduction observed in the wild, and in captive breeding colonies of *P. poliocephalus*, *P. alecto* and *P. scapulatus*, and survival rates that are likely to apply to Australian conditions. Our models show explicitly that flying-fox populations have a very low capacity for increase, even under the most ideal conditions. The implications of our models are discussed in reference to the long-term management and conservation needs of Australian flying foxes. We conclude that current death-rates of flying-foxes in NSW and Queensland fruit orchards are putting state populations at serious risk.

Emails: allen.mcilwee@jcu.edu.au and : Leonard.Martin@mailbox.uq.edu.au

Variability in numbers of long tailed bats (*Chalinolobus tuberculatus*) roosting in Grand Canyon Cave, New Zealand: implications for monitoring population trends

Colin F. J. O'Donnell

*Science and Research Unit, Department of Conservation,
Private Bag, Christchurch, New Zealand.*

Counts of roosting bats undertaken within caves are used frequently as indicators of population size, long-term indices of population trends, and as measures of response to management. Numbers of New Zealand long-tailed bats (*Chalinolobus tuberculatus*) using Grand Canyon Cave were monitored over 8 years. Grand Canyon Cave is a focal point for one of the largest known populations in New Zealand. It has been used by long-tailed bats consistently for >40 years. The aims were to examine the utility of cave-roost counts for long-term monitoring of population trends in this threatened species and to establish a baseline for future monitoring.

Two population indices, number of bats counted roosting inside the cave during the day and net number emerging at dusk, were not significantly different. Monthly and daily counts were characterised by high variability. Indices varied significantly through the year but not between years. Distribution of bats within the cave was not random. Bats avoided roosting within 30 m of each entrance and larger groups were always concentrated along two 50 m stretches of cave ceiling. Large groups occurred when cave temperatures were 10-13°C, suggesting an optimum temperature range. Maximum counts of 250 (day-roosting) and 358 (night-roosting) bats confirm that Grand Canyon Cave is significant as a site for *C. tuberculatus*.

Bat numbers using the cave appear not to have declined over the last ca. 40 years, if maximum group size is indicative of population trend. Counts can be used as a baseline against which to judge future trends in the population of *C. tuberculatus* at Grand Canyon Cave and contribute to national monitoring of bat populations. Effects of variation can be overcome with standardisation of repeat counts, adopting a sampling frequency that provides sufficient power to detect changes, and use of statistical models that separate sampling effects from variance in bat activity.

Email: codonnell@doc.govt.nz

Age estimation and confounding variations in growth rates of the grey headed flying-fox, *Pteropus poliocephalus*

Kerryn Parry-Jones

A08 Biological Sciences, University of Sydney 2006

As part of a larger study into the population structure and dynamics of the grey headed flying-fox *Pteropus poliocephalus* commonly used indicators of age in juvenile flying-foxes; forearm length and weight, were investigated to determine their reliability in aging wild free-living animals.

Three groups of animals were investigated. One group of flying-foxes was reared by their captive mothers fed on a typical captive flying-fox diet. Another group of flying-foxes was reared by their captive mothers fed on an enriched diet. The third group was fostered by humans and hand-reared on a commercially produced human infant milk. The growth curves from these animals showed that weight was not a good indicator of age in any of the groups. The forearm growth curve was far more uniform in shape however there were significant differences between the groups. The bats on the enriched diet produced young with the longest forearms while hand reared young had the smallest forearms.

A previous study has shown that the milk of wild lactating *P. poliocephalus* is significantly higher in protein than that of their captive counterparts. Hence wild juveniles may develop faster and have larger forearms than any of the animals in this study. As well, in this study the animals reared by captive flying-foxes showed a large range of values in both the size of the infant at birth and its subsequent growth rate and these characteristics are probably reflected in the wild population. Hence age curves based on the forearm lengths of captive-bred flying-foxes can only give an approximation of the age of a wild juvenile.

The growth rate and final size of the forearm of a flying-fox appears to be determined by its diet as an infant. This has important implications for both scientists and rehabilitators as the size of the forearm is related to the size of the wingspan and hence the flying ability of the animal. Animals with smaller than average forearms caused by a poor juvenile diet, either the result of a food shortage while their mother was lactating or as a side effect of being hand reared, are likely to be disadvantaged as adults.

Anabat-computer survey for microbats: sampling considerations, call identification and analysis

Patrick Prevett

University of Ballarat, Mount Helen, Victoria, 3355

Detection of bats from their ultrasonic echolocation calls has gained acceptance as a convenient and efficient method of bat survey where the main purpose is to detect and identify the presence of bats. Some researchers have recently made the transition from detectors linked to tape recorders to detectors linked to laptop computers with the equipment enclosed in a waterproof box. It is generally recognised that a detector linked to a laptop via a zero crossing unit provides cleaner calls than calls recorded using a detector linked to a tape recorder. Processing time is also saved since calls are not saved to disc. Often it is desirable to sample simultaneously at multiple sites using several sets of equipment. There are some obvious advantages in acquiring data simultaneously from multiple bat detector-computers deployed in the field. However few have reported on problems associated with simultaneous use of several sets of equipment or even considered the suitability of bat detectors for comparative studies. This technology is being applied to an assessment of the response of microbat guild structure to shelterwood management in a mixed species foothill forest.

Before using anabat equipment in comparative studies it is important to be aware of the capability and limitations of the equipment. Initially 9 sets of equipment were assembled using cheap second-hand laptops to satisfy the initial sampling strategy and research design. Following some initial electronic problems I am trialing the use of 4 anabat-computers simultaneously and rescheduling site visits accordingly. Some loss in statistical power has been replaced with gains in equipment reliability and savings in time. Ultimately the sampling strategy chosen is a compromise between time available for the survey, equipment availability and the purpose for which the results will be used.

Data collected in pilot studies confirmed the desirability of sampling at least at 2 points simultaneously to counter the apparent uneven use of forest habitat by bats. Sampling on two or more nights will provide a more accurate understanding of nightly variation in bat activity. It is important to sample continuously throughout the night to detect those species that become active at different times. Whilst there are advantages in standing by a computer through the night and observing bat activity in the air and on screen simultaneously, monitor mode becomes a more attractive proposition in the early hours of the morning. Calibration of equipment is important to reduce differences in instrument sensitivity, vital when attempting to compare one site with another. Differences have been found in numbers of calls with detectors deployed side by side. To counter this we are building a device to improve calibration of the detectors. It will produce artificial ultrasonic sound tunable to imitate the sound frequencies produced by the species of bats present. Some species of bats with low amplitude calls are however less detectable than others. Low batteries may also contribute to glitches and failures during the course of the night.

There are several potential sources of signal buffering in forest environments that may lead to underestimates of bat activity or (worse), spurious differences between sites. Of particular concern is the possibility that there is a reduction in bat ultrasonic sound reaching a detector due to absorption by vegetation clutter between source of sound emission and the microphone. Greater stem density may result in signal dispersion or loss particularly at certain frequencies.

A software program has been developed which facilitates rapid identification of large numbers of bat calls in the study region. The scheme uses pulse parameters unique to individual species enabling stepwise discrimination leading to identification. The system is fully automated and offers substantial time savings in identification.

Taxonomic and conservation status of *Taphozous troughtoni*

Terry Reardon¹ and Bruce Thomson²

¹South Australian Museum ²Queensland Parks and Wildlife Service

Taphozous troughtoni (Troughton's Sheathtail bat) was described by Tate in 1952, the type specimen collected from Rifle Creek near Mt Isa. Specimens identified as *T. troughtoni* are few in collections. In their revision of the Australian sheathtail bats, Chimimba and Kitchener 1991 recognised *troughtoni* as a distinct taxon based on four specimens.

In 1999 The bat Action Plan listed *T. troughtoni* as one of two Australian bat species as being Critically Endangered. The primary reasons for listing was that it was known from only three localities, one of which had recently been destroyed.

There has been a persistent doubt as to the taxonomic status of *troughtoni*, that is, whether it is distinct from the widespread and partly sympatric *T. georgianus* (common sheathtail bat).

A Recovery Plan for *T. troughtoni* was commissioned by Environment Australia through an NHT grant to Bruce Thomson and Terry Reardon. One of the key elements of the plan was to resolve the taxonomic status of *troughtoni*. A collecting trip to the Mt Isa region by the authors in March 2000, found *troughtoni* (as defined by Chimimba and Kitchener 1991), at several localities. Blood samples and some external measures were taken of some 15 specimens from the region.

Preliminary allozyme electrophoresis on the blood samples showed that at three loci, two genetic types were present (apparent departure from Hardy-Weinberg equilibrium). There appeared to be a correlation between size and genotype, although the *troughtoni* genotype specimens, had measures outside those defined by Chimimba and Kitchener (1991). A handful of tissue samples from WA and eastern Qld. *T. georgianus* became available, and these were subjected to allozyme analysis. These showed the surprising result that the *troughtoni* genotype ranged from Mt Isa to far eastern Qld while the *georgianus* genotype ranged from Mt Isa to northern WA. To fully check the apparent Hardy-Weinberg disequilibrium, and also to determine the area of overlap of the two genotypes, required more sampling.

Further NHT funding allowed us to survey through the region of overlap of genotypes in November December 2001. Results from the allozyme analysis are presented and interpreted.

Specialisation and breadth of habitats used for foraging by Microchiroptera in southeast Queensland

Martin P. Rhodes

Department of Veterinary Pathology, University of Queensland, Queensland 4072 Australia.

I observed habitat use of Microchiroptera in south east Queensland by light tagging. This is probably the best method at the moment, although potential biases have to be avoided. The strongest patterns within the eight species I examined were similar times spent in habitats, and frequent lack of habitat specialisation. The sum or percent times in habitats showed these patterns better than means, such as Habitat Use index. The 'evenness' or breadth of habitat use, was well described by the Shannon Diversity Index, and is as strong a characteristic of species habitat use as mean habitat use. Species that spent more time in the most cluttered habitat also had more even use of all habitats, and vice-versa (esp. *Tadarida australis*). This skewed the habitat use index of species with high times in cluttered habitats, such as *Phoniscus papuensis*. I compared habitat use to obstacle negotiation ability, measured in a flight chamber, and to wing morphology. The breadth of habitat use was correlated with obstacle negotiation ability, but was not correlated with 'standard' wing morphology descriptors (aspect ratio and wing loading). The (skewed) habitat use index was correlated with aspect ratio and wing loading, but not obstacle negotiation. The stronger relation between habitat breadth and obstacle negotiation suggests habitat use is related to morphological features other than wing aspect ratio and wing loading. Morphology that relates to the wing functions lift and thrust in *flapping* flight may be more strongly correlated with habitat use.

Roost and foraging ecology of the white striped freetail bat (*Tadarida australis*) in suburban Brisbane

Monika Rhodes

Suburban Wildlife Research Group

Australian School of Environmental Studies, Griffith University, Nathan Qld 4111

Tadarida australis is an abundant bat species and frequently heard foraging in suburban areas, yet very little is known about its roost and foraging ecology. Recent research in Brisbane shows *T. australis* to roost

in hollows of mostly old eucalypts with colony sizes up to 300 individuals. Roost exits and fly-outs can be easily observed using ambient light at dusk and numbers can be counted by observing bats against the evening sky (visual monitoring). Anabat detectors were used to confirm identification.

From May 2000 onwards, I monitored several known and newly found roost trees. Roost occupation, roost cohabitation, emergence time and behaviour were observed during a two year period. Foraging behaviour was observed using radio-telemetry in November 2001 (n=5). While radio-tracking *T. australis* in suburban Brisbane was very difficult, some new information emerged: *T. australis* used the Brisbane River and adjacent suburbs for foraging and returned to their roost after two hours. Individual bats were also found not to leave the roost every night. More radio-tracking will be undertaken in March 2002 using collars (n=6) instead of the glued attachment used here.

Bat box study in suburban Brisbane

Monika Rhodes

Suburban Wildlife Research Group

Australian School of Environmental Studies, Griffith University, Nathan Qld 4111.

While South-east Queensland has lost 65% of its native vegetation since European settlement in the 1820's, its capital city, Brisbane, has only 1% of the pre-European bushland remaining. Although some vegetation has been replanted, many old mature eucalypts, which provide important roosts for bats and other arboreal vertebrates in suburbia, have been already lost and the remaining trees are in danger due to vegetation clearance and trimming. A decrease in roosting habitat is directly linked to a decrease of wildlife biodiversity in suburban areas. Nest boxes have been shown to provide successful nesting opportunities in environments where hollow availability is limited (e.g. Organ Pipe National Park, Victoria).

In this study 70 bat boxes were installed between October and December 2000. Bat box monitoring started in January 2001. The first boxes were used by bats in the first six weeks. Although occupation progresses slowly, 25% of these boxes were occupied within the first year.

Managing flying-fox colonies in urban areas

Christiane Roetgers

Wildlife Management, Queensland Parks and Wildlife Service

Flying-foxes are subject to a number of threatening processes, particularly the loss of habitat through large scale clearing. This shift in the availability of resources is thought to have brought many flying-fox colonies closer to urban areas. Conflicts arise when flying-foxes select a camp site in or near residential areas and residents complain about noise, smell and disease implications.

Community pressure is often very high to shift flying-fox colonies away from the close proximity of human residences. However the dispersal or movement of a flying-fox colony can be a difficult task, requiring resources such as money, time and staff and under no circumstances is a success guaranteed. Often colonies will only move short distances and create the same problem for other members of the community.

Under the *Nature Conservation Act 1992* and associated regulations flying-foxes are a protected native species and the interference with a protected species requires a permit under the Act. Section 234 of the *Nature Conservation Regulation 1994* further restricts the interference with animal roost sites and during times when young are present.

To ensure consistency Queensland Parks and Wildlife Service (QPWS) responses to complaints about flying-fox camps in urban areas, QPWS has developed a policy for managing flying-fox camps in urban areas. The policy recognises that it is not feasible to provide uniform directions regarding the movement of flying-fox camps due to the unique circumstances of each individual situation. However it provides a framework, which guides decision makers in the dealings with urban flying-fox camps and sets out procedures to be followed in the decision-making process.

This paper will outline the guidelines and procedures put in place by the QPWS in response to public complaints about flying-fox camps in urban areas and discuss practical examples of the use of this policy in Queensland.

Does roost cavity quality affect reproductive success in the New Zealand long tailed bat? A preliminary investigation

Jane Sedgely and Colin O'Donnell

Department of Zoology, University of Otago, Dunedin, New Zealand

Science and Research Unit, Department of Conservation, Private Bag, Christchurch, New Zealand.

Roost cavity quality can profoundly affect reproductive success and survival in tree roosting bats. For example, roost temperature can influence length of the gestation period in breeding females, and post natal growth rates in young. This in turn can affect rate of over-winter survival.

Roosting behaviour of a population of long-tailed bats, *Chalinolobus tuberculatus*, was studied in the Eglinton Valley, an extensive area of unlogged primary beech forest in Fiordland. Reproductive history of 789 marked bats was studied over seven summers. Annual productivity was consistently high (mean = 0.91 ± 0.07 SE juveniles/female weaned). However, probability of survival of juveniles to one year old varied from 0.26 - 0.88 (mean = 0.53 ± 0.06). In contrast, productivity and survival in a more northerly population of *C. tuberculatus* inhabiting a highly modified agricultural landscape (Hanging Rock, Canterbury; 163 bats were studied over 3 summers), was considerably lower. Productivity averaged 0.23 ± 6.66 young per parous female weaned. Probability of surviving the first year averaged 0.23. We assume cavities used by bats in unmodified forest are likely to be of higher quality than those used by bats in a highly modified landscape, and suggest roost quality is a contributory factor explaining the differential in productivity and survival between the two populations.

We investigated differences in structural characteristics and internal microclimate of cavities used as maternity roost sites. In the Eglinton Valley roosts were in large diameter trees (mean = 96.1 ± 33.1 SD cm) and were small-moderate size knot-holes. The trees used at Hanging Rock had significantly smaller stem diameters (mean = 71.6 ± 48.6 SD cm), and cavity entrance and internal dimensions were significantly larger than Eglinton Valley roosts. Hanging Rock roosts were often poorly insulated, mean cavity wall thickness was 15.4 ± 9.6 cm, and internal roost temperature was highly variable often fluctuating in line with external ambient temperature. By contrast the cavity walls of Eglinton Valley roosts were significantly thicker (mean = 21.7 ± 11.1 cm) and internal temperatures were very stable. Thermal benefits of Hanging Rock roosts are likely to be further reduced because only comparatively small numbers of bats used the relatively large cavities. Mean roosting group size in Hanging Rock was 8.8 ± 7.6 bats ($n = 63$), compared with 34.7 ± 23.4 bats ($n = 178$) in Eglinton Valley. Other factors explaining differences in rates of productivity and survival between the two bat populations may include varying quality of foraging habitat, differential pressure from introduced predators, and quality of winter roost sites.

Email: mohua@xtra.co.nz

Utilisation of water resources by insectivorous bats in a semi-arid landscape

Andrea L. Solly

School of Science & Engineering, University of Ballarat, PO Box 663, Mt. Helen, VIC, 3353

The microbat fauna of the semi-arid regions of southeastern Australia represents a significant component of Australia's arid zone biodiversity. However due to its remote geographic location the bat fauna of these inland areas remain largely unstudied. All animals require a source of water to survive and the artificially boosted supplies of water resulting from farm dams may be a factor influencing current population sizes and distribution in semi-arid lands. Recent suggestions to close down artificial watering

points to restore natural landscapes across former pastoral regions emphasises the need to investigate the ways in which water is used by bats and determine the possible effects of return to the original landscape.

Through this study it is hoped to determine the significance of water available from earth tanks to bats in a semi-arid landscape including the distance bats move from roost sites to water and their movement patterns between water bodies. This will be possible through the use of banding and the recapturing of individuals at a number of different dams and radio tracking. This study will also assess any seasonal change in the bat's response and how this varies at temporary and permanent dams. Radio-tracking will be used primarily to locate roost-sites to determine the distances roosting occurs from water bodies and to also measure the temperatures of the roosts inside and out, to determine the bat's water requirements. An ultraviolet light trap and anabat equipment will be simultaneously set at each water body and a corresponding site distant from water for two consecutive nights. This will determine if insect densities are greater in the vicinity of water bodies in xeric environments compared to sites removed from water and whether there is evidence of increased foraging activity by microbats near water.

Preliminary results from Spring 2001 and Summer 2002, indicated that aerial insect abundance, principally beetles, moths and flies, was higher at sites located at water. Furthermore, bat activity as measured by frequency of echolocation calls was also higher near water. The prevalence of feeding activity at all sites suggests that in cooler months feeding activity takes precedence over drinking. Very few bats were seen to drink during periods of observation in the spring, however drinking was observed during the summer. It is considered that during times of higher water demand, summer and early autumn and during lactation, water consumption may take preference. Roosts have been located for two species *Nyctophilus geoffroyi* and *Chalinolobus gouldii* with distances ranging from 1 – 4 km distances from roost to closest watering point. Further studies will be conducted at replicated locations over all seasons as part of an ongoing three year study. Email: a.solly@ballarat.edu.au

The forgotten fruit bat: ecology and conservation of the Comoros Roussette, *Rousettus obliviosus*

W.J. Trehwella¹, B.J. Sewall² and E.F. Granek³

¹*Department of Ecology & Biodiversity, The University of Hong Kong*

²*Conservation Biology, University of Minnesota, St. Paul, Minnesota 55108, USA*

³*Zoology, Cordley Hall, University of Oregon, Corvallis, OR 97330, USA*

We present here the first study of the ecology and conservation of *Rousettus obliviosus*, a small Megachiropteran fruit bat endemic to the Comoros Islands in the West Indian Ocean. This species is broadly distributed on three of the Comoros Islands, but appears absent from the fourth, Mayotte. Total range for the species is less than 1,659 km². Roost sites are shallow and deep caves, and roosts are in dark locations with infrequent human disturbance. Colony size ranges from one hundred to several thousand, and at two sites we observed variation during different periods. Total known population size is 15,000–20,000.

R. obliviosus appeared to use a variety of native and non-native trees for fruit and flower resources, and was found in agricultural areas, underplanted forest, and native forest habitats flying below, at, and above the forest canopy. *R. obliviosus* is a manoeuvrable flyer able to hover for brief periods, and may be using echolocation to navigate. A small range, sensitivity to human disturbance, limited availability of suitable roost sites, and deforestation combine to make the future of this species uncertain. Protection of known roost sites, further surveys to identify additional roost sites, conservation of remaining forest, and research focused on foraging and roosting ecology are priorities for the conservation of *R. obliviosus*.

Email: will.trehwella@nottingham.ac.uk

The box-ironbark forests of central-western New South Wales are a distinct stronghold for *Nyctophilus timoriensis* (southeastern form)

Christopher Turbill¹ and Murray Ellis²

¹Zoology, School of Biological, Biomedical, Molecular Sciences, Univ.y of New England, Armidale, 2351.

²NSW National Parks and Wildlife Service, Western Directorate, Dubbo.

Little is known about the habitat preferences or general ecology of the south-eastern form (species) of *Nyctophilus timoriensis*, which has been captured rarely and sporadically across its range within the Murray Darling Basin (MDB). It was therefore of interest that 80 *N. timoriensis* were caught in harp traps out of a total of 935 bat captures during recent vertebrate fauna surveys in the Brigalow Belt South bioregion of central-western NSW.

Nyctophilus timoriensis comprised 8.8 % of total bat captures in Pilliga West State Forest (0.3 captures per harp-trap night), 7.0 % of total bat captures in Pilliga East State Forest/Pilliga Nature Reserve (0.6 captures per harp-trap night) and 6.6 % of total bat captures in Goonoo State Forest (0.14 captures per harp-trap night). A comparison with very low capture rates elsewhere in the MDB (i.e. 0.02 per harp-trap night in woodland of NW NSW and 0.06 per harp-trap night in mallee of SW NSW) indicates that the box-ironbark forests of central-western NSW are a distinct stronghold for this vulnerable species (EPBC Act 1999).

Within the Pilliga and Goonoo forests, *N. timoriensis* was relatively common in vegetation dominated by box and/or ironbark species, with scattered or dense patches of cypress pines and a shrubby understorey; but was also captured in belah (*Allocasuarina cristata*) and red gum dominated forests. *Nyctophilus timoriensis* was sympatric with *N. gouldi* and *N. geoffroyi* in this region, from which it was distinguished its large size (mean F.A. of females: 46.4 mm, males: 43.6 mm; mean Wt of females: 16.7 g, males: 13.2 g) and relatively short, broad snout (outer canine width >5.6 mm). Email: cturbill@hotmail.com

Putting bat biodiversity on the map: a global bat GIS

Allyson Walsh¹, Kate Jones², Wes Sechrest² and John Gittleman².

¹Bat Conservation International, Austin, Texas, USA

²University of Virginia, Charlottesville, Virginia, USA

The geographic ranges of species are profoundly important to our understanding and ultimately conserving ecological diversity. Worldwide, bats constitute over of all mammalian biodiversity and over a half of the thousand species of bats are threatened or near threatened with extinction. To understand the patterns of threats facing bats, and identify how and where effort should be invested to have maximum impact on the future conservation of bat biodiversity, a crucial element is an analytically rigorous data set of species geographic ranges. We are therefore constructing a taxonomically complete geographical information database (GIS) of geographic ranges for all extant bat species worldwide.

Extent of occurrence maps are being generated from the latest information (publications and unpublished records), and where point locality data is limited, a variety of range estimation techniques are being applied. The process of data collation and quality checking will involve a network of experts and researchers in the field, in particular we are collaborating with a consortium currently developing a global database of terrestrial vertebrate distributions and life history data. Consortium members include the IUCN, CABS/ Conservation International, University of Virginia, Insitute of Zoology London, Leiden University and the IUCN.

The completed GIS will be a publicly available resource on the web that will provide information to test hypotheses for explaining variation in range distributions in bats, and, more generally, to assist in establishing and refining conservation priorities. Importantly it will serve as a focus for future geospatial mapping and will highlight poorly surveyed areas and those species whose distributions are poorly known.

An assessment of counter accuracy in camp fly-out counts

David Westcott and Adam McKeown.

*CSIRO Sustainable Ecosystems and the Rainforest Cooperative Research Centre.
Tropical Forest Research Centre, P.O. Box 780, Atherton 4883*

Estimating population sizes is a fundamental part of any wildlife management program and inevitably incorporates errors. Understanding the nature of these errors provides i) an indication of the likely accuracy of surveys ii) guidelines for the degree of data interpretation, and, iii) potential means of improving survey methodologies. Like all animals, flying foxes present their own special challenges for survey attempts. One method, fly-out counts, is currently used in North Queensland to monitor population sizes of Spectacled Flying Foxes, *Pteropus conspicillatus*, and in NSW with Grey-Headed Flying Foxes, *P. poliocephalus*. These counts provide a quantitative assessment of population behaviour for these species, the importance of which is only highlighted by their current conservation status. In this paper we present an assessment of the accuracy with which counters are able to estimate fly-out size.

Fly-out counts are performed by volunteers, with a number assigned to each camp. Counters are stationed in positions around camps which give them a good view of each fly-out stream. Each counter then estimates the number of flying foxes in their stream or side of the camp. Population estimates for each camp are calculated from the estimates of individual counters, and in some cases overall population estimates are derived from these camp estimates. There are a number of stages at which errors can enter in this processes, however, of fundamental importance is the accuracy of individual counters.

We assessed counter error at camps by identifying a "window" in which flying foxes were counted. This window was framed using landscape features such as telephone poles and wires. Individual counts were performed onto audiotape and simultaneously videotaped using a low-light video camera. Minimum fly-out size was subsequently determined from the video tape and compared with the individual audio counts.

Comparison of the estimates of fly-out size by individual counters showed high levels of variation, maximum variation ranged between 25 and 100% of the video count. Variance between counters increased with time from start of count, potentially due to i) light conditions, ii) fatigue, and/or iii) compounding errors. When all counts of single fly outs are averaged, the estimate was generally lower than that of the video count. Based on our data and assuming no error other than counter errors, the population estimates in this study would at best have been within $\pm 13\%$ and at worst $\pm 35\%$ of the video estimate.

Assessing the World Heritage values of a single taxon: the case of the spectacled flying-fox

David Westcott, Andrew Dennis, Adam McKeown and Matt Bradford.

CSIRO, Sustainable Ecosystems and The Rainforest CRC, PO Box 790 Atherton Qld 4883, Australia.

The Convention Concerning the Protection of the World Cultural and Natural Heritage (UNESCO 1972), forms the basis of the listing and protecting of places of significant global heritage. While the convention explicitly protects natural heritage, listing is restricted to places and land rather than moveable or temporal entities such as species. This means that application of the Convention to species is possible only through their habitat. The Convention's focus on places also means that its use to protect species must be done through the contribution of that species to the value of the place rather than value of the species itself. Can the value of a single species be assessed in the context of World Heritage Values? In this paper we examine the spectacled flying-fox in the context of the World Heritage Values of the Wet Tropics World Heritage Area.

In our assessment spectacled flying foxes contribute to all four natural heritage values for which the Wet Tropics gained World Heritage Status. For some of the area's World Heritage values, such as representation of a major stage in the earth's evolutionary history, the spectacled flying fox is a clear embodiment of that value. Through their participation in ecosystem processes, such as pollen and seed dispersal, spectacled flying foxes also contribute to the maintenance of the ecosystems that underpin several of the World Heritage values. That they contribute to these processes is clear, however, their contribution relative to that of other species remains unquantified both in terms of its importance or even

necessity. Little data exists for the significance of pollen dispersal by spectacled flying foxes over and above the fact that flower feeding by the species is common in some contexts, particularly in sclerophyll forests. With respect to seed dispersal our current data suggests that the contribution of spectacled flying foxes is most likely to be additive rather than unique or even particularly efficient. There are only a handful of plant species for which spectacled flying foxes are the only known dispersers, and, for some of these, this situation is likely a sampling artefact. Unlike most dispersers, spectacled flying foxes are capable of very long distance dispersal and dispersal across a wide variety of ecological boundaries. Once again, they are not unique in this. Spectacled flying foxes probably contribute most significantly in providing long-distance and cross-boundary dispersal to cauliflorous (trunk-fruited) tree species. Taken together these observations lead to the conclusion that spectacled flying foxes do make a significant, even if not unique, contribution to the World Heritage Values of the Wet Tropics. Protection of the region's World Heritage values therefore requires appropriate management of this, and other species, that underpin those values. Email: david.westcott@csiro.au

Lost and found – spectacles

Olivia Whybird

Phoniscus Environmental Services P.O. Box 9 Millaa Millaa 4886

Spectacled flying-foxes are an extremely important species to the wet tropics ecosystem as they are both pollinators and seed dispersers of rainforest trees. Monitoring was commenced in 1998 due to anecdotal evidence of a decline in the species. This monitoring suggested a decline in the number of bats especially between November 1998 and November 1999 (reduction of 35 percent). November counts estimate the population size, at a population low, they include adult bats and the surviving juveniles from the previous breeding season, but not the non-flying young of the season.

The camps were located by checking all known camps - occupied during previous counts and historical camp sites. New sites of possible occupation were found through public information. Over 120 volunteers were organised to count the camps at fly-out. The fly-out counts were undertaken at all colonies on the 16th, 17th and 18th of November 2001. Very small camps were estimated from the ground, during the day.

In previous years count numbers for each camp have been very similar over the three nights. Where variation existed it was due to better count locations or weather on subsequent nights. However this year fly-out directions and camp numbers fluctuated wildly. In some cases counters had the impression that some bats did not fly-out or visibility was low. In other cases movement between camps is suspected. The November 2001 survey has located over 187,000 Spectacled Flying-foxes, a larger total number of bats than any previous year. This increase can be explained by an increase in the number of camp sites located. If the same camps are compared between 1998 and 2001 there are a reduced number of bats. However the number for these camps is greater than in 1999 and 2000. The addition of two significant camp sites this year accounts for much of the increase in numbers. According to locals these camps have been occupied in the past and in greater numbers than during the survey.

Even though more sites are known there are fewer camps occupied, however they contain a greater number of animals. Although the number of flying-foxes located is higher than previous years it is still much less than the number of Flying-foxes seen in the past. There has been some decreases in threatening processes including tick paralysis and damage mitigation in fruit farms. This survey has greatly increased the knowledge of the species behaviour, distribution and population trends. But until we understand more about flying-fox behaviour it is very hard to collect comparable results.

Email : Phoniscus@austarnet.com.au

**The ecology of insectivorous bats in the Simpson Desert:
roost site selection, food preferences and water availability**

Amy Williams

School of Biological Sciences, University of Sydney (supervisor Dr Chris Dickman)

Current address: Ecotone Ecological Consultants Pty Ltd, 39 Platt Street, Waratah, NSW 2298.

This honours project aimed to identify the species of insectivorous bats that occur in the Simpson Desert and to investigate aspects of their ecology, providing some insight into how bats successfully exploit this harsh, unpredictable environment. Roost site selection, food preferences and water availability will be the focus of this presentation.

Seven species of insectivorous bats were positively identified with the combined use of harp traps, cave inspections and ultrasonic call recordings (using Anabat II detector systems). These species were *Nyctophilus geoffroyi*, *Vespadelus finlaysoni*, *Chalinolobus gouldii*, *Scotorepens balstoni*, *Taphozous hilli*, *Saccolaimus flaviventris* and *Tadarida australis*. A total of six *N. geoffroyi* roosts were located in tree hollows and under the bark of coolibah and gidgee trees, which were either dead or in the dead part of a living tree, and all roost entrances had a minor dimension of less than 4 cm. *N. geoffroyi* did not appear to be highly selective in its roost choice. Several roost caves of *Taphozous hilli* and *V. finlaysoni* were located and although a small sample size, these caves illustrated little consistent pattern of shape or size.

This study showed that *S. balstoni*, *C. gouldii*, *N. geoffroyi*, *V. finlaysoni* and *T. hilli* consumed a variety of insect orders. Lepidoptera, Coleoptera, Hymenoptera, Hemiptera, Blattodea, Mantodea and Diptera were all positively identified in faecal pellets. Although there was some interspecific selectivity for softer or harder prey, and possibly an avoidance of the smaller size classes, these five species appear to be mostly opportunistic foragers. Overall, bats foraged most often over water, however they were also commonly found to forage in areas with no access to permanent water. High levels of bat activity were recorded around rocks and the creek line at 'Painted Gorge' and the river system at 'Field River'. Neither site had permanent water in the vicinity. At 'Main Camp' where habitats were more open, activity was concentrated over permanent water. Larger sample sizes and further investigation during harsher periods of less rainfall, and during warmer months in the year, are necessary to evaluate the temporal stability of the results presented.

RECENT LITERATURE

Authors are requested to send reprints of their papers to the Editor (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 tgriff@titan.iwu.edu 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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Notes and Announcements

Field Work in Costa Rica

Bernal Rodriguez and I are currently studying the country-wide distribution and distribution of insectivorous bats using Anabat equipment. This study is being done on a shoestring, mostly using personal funds. But we need volunteers to capture rare species and confirm their echolocation signatures. This would involve living near and working within the famous Monteverde Cloud Forest Reserve and perhaps other parts of Costa Rica as well, for as much time as the volunteers have available. You would have to pay your own expenses, but we would try to find ways for you to live as cheaply as possible if your budget is limited and would be willing to look for travel funds. This would require at least two volunteers working together, and would involve hiking and carrying equipment like bat traps, Anabat, and laptop computers, often during wet weather. If anyone is interested, let me know and we can discuss details. This is very preliminary at this time and we are very flexible in how it could be carried out. Richard and Meg LaVal, Apdo 24-5655, Monteverde, COSTA RICA
website: www.stellasbakery.com e-mail: rival@racsa.co.cr
Tel.645-5052 or 645-5419

Interesting Websites

There is a very interesting article by Gary F. McCracken and John K. Westbrook in the April, 2002 National Geographic Magazine on night-flying bats being picked up on the Doppler weather radar used to track storms. The authors also collected data by reaching the altitude at which the bats were foraging by ascending in a hot air balloon. Certainly a novel if somewhat intimidating "field vehicle" The bats were flying as high as 10,000 feet after emerging from Bracken Cave, near San Antonio, Texas. There is also an animation of bat radar tracking at this site at: nationalgeographic.com/ngm/0204

On the Basically Bats website I stumbled across an illustrated story for children entitled, "Benny, The Big Brown Bat." Although the story appears to be intended for children, The illustrations are beautiful and the story entertaining enough for a retired educator (like guess who?). I do recommend this story to teachers and parents for children of most ages. The link is: <http://basicallybats.org/kids/benny/bennytitle.html> Click the picture of Benny to go directly to the story.

Bat Photography Tutorial

At the next meeting of the North American Symposium on Bat Research in November, 2002 in Burlington, Vermont we will convene a workshop/tutorial about photographing bats. The purpose of the session is to give participants the opportunity to find out how to take better photographs of bats. We will prepare lists of the equipment that we would use for photographing bats in different situations. In addition to short presentations to illustrate problems and solutions, we also will answer questions. To ensure that we arrive ready to answer them, we ask people to send us their questions by 15 September 2002. We expect that many questions may be accompanied by pictures illustrating particular problems. We will endeavour to sort questions by general topic and use them to guide the workshop agenda.
Submitted by Merlin Tuttle and Brock Fenton

Future Meetings

April 15 - 17, 2002

A Bat Echolocation Symposium and Tutorial will be held at the Hyatt Regency Hotel on Town Lake, Austin, TX. Leading bat echolocation experts from around the world will be presenting on the capabilities, limitations and appropriate applications of ultrasound equipment, field techniques, analysis, reporting, and agency perspectives.

Symposium speakers include: Ahlen, Barclay, Boye, Brigham, Britzke, Corben, Fenton, Gannon, Griffin, Jones, Kalko, Krusac, Kunz, Limpens, McCracken, Miller, Parsons, Pettersson, Rainey, Siemers, Szewczak, Walsh and Waters.

The symposium is now full and the proceedings will be available in the early summer.

May 15 - 19, 2002

The Lube Foundation, Inc., the American Zoo and Aquarium Association Bat Taxon Advisory Group and the University of Florida Veterinary Medical Teaching Hospital will host a symposium on the **Medical Management and Captive Care of Chiroptera**. The venue will be the Holiday Inn, 1250 W. University Ave., Gainesville, Florida 32601 Program includes presentations on medical management, emerging diseases, field programs, conservation, education and captive husbandry and management of Chiroptera. The program will include sessions on Zoo Education, Emerging Diseases, and Ecology and Captive Management. Sessions, workshops, and the banquet dinner will be at the Holiday Inn. On Sunday evening (May 19) A special program "Rodrigues Fruit Bat Family Extravaganza" will be held at the Lube Foundation, Inc., 1309 NW 192nd Avenue, Gainesville, FL 32609. For further information on this conference or the workshops, please contact one of the following: John Seyjagat, Lube Foundation at 352 485-1250 or LUBEEBAT@aol.com, Peter Riger, Nashville Zoo at 615-746-2526 or priger@email.msn.com, or Denise Tomlinson, OBC Florida Bat Center at 941 637-6990 or: DRTomlinsn@aol.com

August, 26 - 30, 2002

The IXth European Bat Research Symposium will convene 26 - 30 August in Le Havre, France. The Organizing Committee will be chaired by Stephane Aulagnier, I.R.G.M., C.R.A. Toulouse, B.P. 27, 31326, Castenet-Tolosan Cedex, France. Please see the website for additional information. The website is: <http://www.univ-lehavre.fr/actu/9ERBS>. Aulagnier's e-mail is: aulagnie@teleirgm.toulouse.inra.fr

September 6 - 8, 2002

The 17th Bat Conservation Trust National Bat Conference - United Kingdom will be held at Reading University 6th - 8th September, 2002.

For further information please contact: Conor Kelleher at e-mail: conorkelleher@eircom.net

For bookings contact:

Andrew Walker, The Bat Conservation Trust, 15
Cloisters House, 8 Battersea Park Road, London SW8 4BG, UK.
Tel: 020 7627 2629 Fax: 020 7627 2628 Web site: www.bats.org.uk

November 6 - 9, 2002

The 32nd Annual North American Symposium on Bat Research will convene in Burlington, Vermont hosted by William Kilpatrick and Roy Horst. Arrangements have been made for participants in the symposium to stay at the Radisson Hotel at very reasonable rates. All of the

symposium sessions, displays, etc., will be in the Radisson Hotel which overlooks Lake Champlain only a 5 minute walk away. Just a few minutes away are historic St. Paul Street and Church Street, both famous for their number of fine restaurants, and the Burlington Brewpub. Unfortunately the spectacular fall foliage season will be past (which incidentally is why we can get such reasonable room rates). For details see our website at: www.nasbr.com

At the this meeting Merlin Tuttle and Brock Fenton will convene a workshop/tutorial about photographing bats. The purpose of the session is to give participants the opportunity to find out how to take better photographs of bats. We will prepare lists of the equipment that we would use for photographing bats in different situations. In addition to short presentations to illustrate problems and solutions, we also will answer questions. To ensure that we arrive ready to answer them, we ask people to send us their questions by 15 September 2002. We expect that many questions may be accompanied by pictures illustrating particular problems. We will endeavour to sort questions by general topic and use them to guide the workshop agenda.

Brock Fenton and Merlin Tuttle bfenton@YorkU.CA and mtuttle@batcon.org

NEWS FROM OUR READERS

From York University, Ontario, Canada

News from York is that two Ph.D. theses have been defended:

VONHOF, Maarten J. 2001. **Habitat availability, population size, and the composition, stability and genetic structure of social groups of Spix's Disk-winged bat, *Thyroptera tricolor*.**

FAWCETT, Leesa K. 2002. **Biological conservation of common and familiar animals: the roles of experience, age and gender in children's attitudes towards bats, frogs and raccoons.**

We have also had one graduate student visitor arrive:

STEFANIA BISCARDI from Italy is visiting us for a year. Stefania has worked with *Myotis capaccinii* in Central Italy. She studied with Professor L. Boitani and her project involved using radio tracking, analysis of guano and recording and analysis of the bats' echolocation calls. In the past she has worked with WWF both in the area of protecting turtles and in the area of CITES. She also has worked on banded mongooses in Queen Elisabeth National Park in Uganda. Submitted by Brock Fenton

Notice from the Publisher

The costs of printing and mailing the printed edition of Bat Research News is increasing at an alarming rate and it appears likely that we will need to increase our subscription rates yet again for Volume 44: 2003. Mailing costs for subscriptions to addresses outside of the United States are rising at an alarming rate. We encourage our readers, especially those outside of the United States, to consider converting to the electronic edition which has no printing or mailing costs and can continue to be offered at the current price of \$15.00 per year. The electronic edition has the same content as the printed edition, and all past editions of the electronic edition remain on the site. We are currently preparing to establish a "pdf" system (portable document format) which be easier to access and can readily be stored as your own personal library, and will be available to all electronic subscribers. We are currently working out the fiscal details of converting from the printed edition to the electronic editions at some discount to the subscribers. The conversion rates will be announced before renewal notices for volume 44:2003 will be sent out. As more information becomes available it will be posted in future issues in this space. G. Roy Horst

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Front Cover

The front cover illustration, a handsome resident of The Lube Foundation Research Center in Gainesville Florida invites you to come visit him in May during the Symposium on Medical Management and Captive Care of Chiroptera see page 41.

My apologies for the error in the caption (rear cover) describing the cover illustration on Volume 42: #4. The bat depicted is *Rhinolophus ferrumequinum* not *R. ferrumquinum*. GRH

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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. 309-556-3230, FAX 309-556-3411
e-mail: tgriff@titan.iwu.edu

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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Editors' Comments

Beginning with this edition we are making a few minor changes in lay-out of Bat Research News to facilitate the production of our electronic edition. BRN will now include 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 article 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 that subscribers outside the United States (and those in the U.S. who choose) to convert to the electronic subscription for volume 44:2003. The details of this conversion, at a substantial saving, will be given when invoices for renewal are mailed. 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 on this new arrangement please forward them to us. Thank you.

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

**Abstracts of Presentations at the Symposium
on the Medical Management and Captive Care of Chiroptera
May 15-18, 2002 in Gainesville, Florida, USA**

Abstracts are listed in the order in which they appeared on the program

Medical Management Session

Organized by Darryl Heard

**Veterinary Diagnostics of the Skeletal System of Bats:
Some Aspects of Bone Structure, Pathological Alterations and Their Healing**

Molnár V.¹, A. Beregi,¹ Z. Molnár,² P. Vajdovich,¹ B. Fenyves,³ E. Perge,⁴ Gy. Barátossy⁵

¹Department and Clinic of Internal Medicine, Faculty of Veterinary Science, Szent István University,
²Budapest Zoological and Botanical Garden, ³Department and Clinic of Surgery and Ophthalmology,
Szent István University, ⁴National Veterinary Institute, ⁵Veterinary Clinic Nyiregyhaza

The role of Chiroptera in the complex processes of ecosystems has been recognized only in the past few decades. There is an increasing demand for the correct veterinary treatment of these wild animals both on behalf of the public, and among professionals. Of the 1000 species of the order of bats (Chiroptera) there are 26 occurring in Hungary, all of them being protected.

The skeletal system of bats, obviously very different from the "normal", still carries lots of surprises for biological and veterinary research. Bone fracture is probably the most common problem that forces bats to "drop out" from the wild, and brings them to the operating theatre of the veterinary surgeon. The osteosynthesis of broken forelimb bones is essential in the case of these animals, being the only mammals capable of active flying, though they tolerate the fracture of the metacarpal and phalangeal bones quite well. The treatment of a broken humerus or radius has so far caused difficulties all over the world and no successful operations were reported in literature. In our early research, we had many negative experiences, and in spite of the intramedullary fixation and/or the application of splint, the prognosis of fractures was ambiguous or unfavorable. The suspected reason for this is the injury of the nutrient vessels of the medullary membrane, and the high degree of the mobility of bone ends.

The elaboration of the exact protocol of successful operations requires much effort. The analysis of interventions, which failed, the performance of histopathologic examinations is the most important duties. Probably the blood vessel running in the middle of the long tubular bones, uniquely among mammals, is responsible for the nutrition, therefore for the healing of the bones. The outline of the protocol of many operations will be presented in the lecture. The radiological and histopathologic pictures of bones spontaneously recovered with callus, as well as oncogenic tissues or those proliferating due to irritation of the bone membrane will be shown.

Bats and Lyssaviruse

Charles E. Rupprecht, Rabies Section, Centers for Disease Control, Atlanta, GA

Rabies is an acute progressive encephalitis caused by a lyssavirus. Besides members of the Carnivora, bats comprise the other major mammalian reservoirs for these etiological agents. Rabies virus is the type species and most significant member of the *Lyssavirus* genus, in the *Rhabdovirus* family. The historical association between bats and rabies was first appreciated in the Americas, where the disease is widespread. In the United States, most human rabies cases are due to rabies virus variants associated with bats, but most of these cases lack a documentation of bite exposure. Less is known about bats and rabies in other regions of the world. Principal applied attributes of rabies virus are believed largely interchangeable to the rabies-related lyssaviruses. (Lagos bat, Mokola, Duvenhage, European bat, and Australian bat viruses). By comparison to rabies virus, although not currently recognized as major zoonotic threats, non-rabies lyssaviruses

may pose future global public health problems because of the opportunity for international translocation and local establishment, compounded by the fact that traditional rabies virus vaccines do not always provide adequate protection. All of these non-rabies lyssaviruses have been associated with bats, with the exception of Mokola virus. The first identified member, Lagos bat virus, was isolated during 1956 from straw-colored fruit bats, *Eidolon helvum*, shot while roosting in a tree on Lagos Island, Nigeria. No abnormal behavior was noted in this host, nor in the dwarf epauletted bat, *Micropteropus pusillus*, during 1974 from the Central African Republic. Widespread morbidity and mortality was associated with later isolations of Lagos bat virus among Wahlberg's epauletted fruit bat, *Epomophorus wahlbergi* in Natal. During 1970, a case of 'classical' rabies was reported in a man near Pretoria, who was bitten on the lip by a bat, possibly the long-fingered bat, *Miniopterus schreibersii*. Eventual characterization allowed discovery of a new rabies-related agent, Duvenhage virus. Confirmation of the relationship between Duvenhage virus and the Chiroptera occurred when isolation was made from the brain of a sick bat, suggestive of *Miniopterus*, as well as from a slit-faced bat, *Nycteris thebaica*, in Zimbabwe. Existence of rabies among European bats was suspected as early as the 1950s, but distinct confirmation required several decades, demonstrating at least two unique lyssaviruses, the European bat virus variants, subtypes I and II. Reservoirs are insectivorous bats, such as *Eptesicus* and *Myotis* sp. Lacking definitive evidence of prior rabies establishment in Australia, during the spring of 1996 a novel virus infection was uncovered in a black flying fox, *Pteropus alecto*. Thereafter, this new Australian bat virus was isolated from other pteropids as well as insectivorous bats. Although undetected in earlier surveys in Malaysia or the Philippines, rabies was reported during 1978 from a grey-headed flying fox, found dead in India. Interpreted in the light of recent Australian data, lyssaviruses should be more prevalent among Asian-Pacific bat populations than previously realized. Recognition of rabies in bat populations throughout the world provides multiple opportunities for applied research in the study of the emergence of infectious diseases and their prevention and control.

Hendra and Nipah - Recently Emerged Zoonotic Paramyxoviruses of Flying foxes

Hume Field, Animal Research Institute, Depart. of Primary Industries, LMB 4 Moorooka 4105 Australia.

Hendra virus, unknown prior to its emergence in Australia in 1994, has now spilled from its natural reservoir three times in five years. Sixteen horses and two humans have died. The typical clinical picture of unresponsive interstitial pneumonia is due to the extensive vasculitis which is the dominant feature of infection. The case fatality rate approaches 70%. Extensive investigations to identify the origin of the virus revealed flying foxes (*Pteropus* spp., sub-order Megachiroptera) to be the natural host. Subsequent serosurveillance showed infection to be endemic in the four mainland Australian species (*Pteropus alecto*, *P. poliocephalus*, *P. scapulatus* and *P. conspicillatus*). Flying foxes have an extensive distribution in Australia and are common urban wildlife. Human cases have been attributed to exposure to infected horses.

The closely related Nipah virus was first identified in 1999 in peninsular Malaysia. In a parallel scenario, it manifest as an outbreak of disease in pigs, with secondary transmission to humans. Of 265 reported human cases, 105 were fatal. Direct contact with infected pigs was identified as the predominant mode of human infection. Approximately 1.1 million pigs were culled to contain the outbreak. Given its relatedness to Hendra virus, investigations of the origin of Nipah focused on bat species. Wildlife surveillance found serological evidence of infection in five species of bats (mega- and microchiroptera), but predominantly in two species of flying foxes, *Pteropus vampyrus* and *P. hypomelanus*. Virus has recently been isolated from the urine of *P. hypomelanus*.

The available evidence suggests that Hendra and Nipah are ancient viruses, well adapted to their natural flying fox hosts, and in whose populations they have long circulated. The close phylogenetic relationship between Hendra and Nipah suggests a common progenitor virus.

However it also appears that flying fox populations in Australia and Malaysia have been separate for a length of time sufficient for the respective viruses to evolve further in geographic isolation.

So why are we seeing these diseases emerge now? Have ecological changes lead to increased contact between flying foxes and naive susceptible hosts? In Australia, the apparent increasing urbanisation of flying foxes has been attributed to the negative impact of land-use changes on traditional food resources. Beyond Australia, there is evidence that populations of many flying fox species are in decline and disruption throughout their range. Are other zoonotic agents yet to emerge from flying foxes? With a series of geographically overlapping distributions from the Indian sub-continent to Australia, and a habit of communal roosting, any factors increasing the mobility of flying foxes makes such a scenario highly probable. e-mail: hume.field@dpi.qld.gov.au

Session on Captive Management

Organized by Pete Riger and Denise Tomlinson

Zoological Exhibit Design and Collection

John Seyjagat, Lube Foundation, Inc., Gainesville, FL 32609

The Order Chiroptera recognizes some 834 species subdivided into Megachiroptera with 157 species and Microchiroptera with 677 species, of these approximately 24 species are maintained in captivity worldwide, most of which are old world fruit bats in the family Pteropidae. Bats, the only mammals capable of true flight, pose major challenges to zoological collection managers and exhibit designers. Flying is a natural behavior of bats and the inability to fly results in a loss of muscle mass and poor health. Animal health is dependent on sound and adequate nutrition and flight maintenance in captivity is dependent on enclosure design. Species selection depicts activity patterns, which influences exhibition. There are three major bat enclosures designs that promote flight, public viewing and easy management.

The AZA Regional Collection Planning Process and How It Affects Bat Collections

Steven M. Wing

Riverbanks Zoo and Botanical Garden, Columbia, SC 29210

The primary responsibility of an Association of Zoos and Aquaria(AZA) Taxon Advisory Group(TAG) is to develop and implement a North American Regional Collection Plan(RCP). The goal of an RCP is to allocate the available space among species so that the maximum effect in terms of cooperative animal management and conservation can be obtained. The RCP is designed to be a resource for the development of institutional collection plans. The regional collection planning process takes into account, among other factors, the conservation status of each species, its potential to affect in situ conservation efforts, scientific study and education value. Each taxon is then ranked using a taxon-driven space analysis and appropriate programs are then recommended.

Legislative Issues and Zoos

John Seyjagat

Lubee Foundation, Inc., Gainesville FL 32609

Bats are considered vectors of human diseases by the Center for Disease Control (CDC). As a result the CDC has stipulated certain public health safety guidelines for the procurement, handling and exhibition of bats. State Public Health Departments and the Occupational Safety and Health Administration (OSHA) have adopted these guidelines making them enforceable regulations. The United States Fish and Wildlife Service has listed all bats of the genus Pteropus as injurious wildlife

under the Lacey Act of 1958. In some states state agencies have made it illegal to own or possess bats while others have adopted near unattainable standards making possession difficult or nearly impossible.

Browse Consumption in the Rodrigues Fruit Bat

K. D. Ange, S. Rhodes, S.D. Crissey

Daniel F. and Ada L. Rice Conservation Biology and Research Center
The Chicago Zoological Society, Brookfield Zoo, Brookfield, IL 60513

The Rodrigues fruit bat (*Pteropus rodricensis*) is known to eat browse. Reasons for this behavior are poorly understood. This study tested the hypothesis that Rodrigues Fruit Bats prefer certain browse types and that this preference is related to the nutrient composition of the browse. Twelve bats were fed three types of browse; elm, mulberry and willow. Average amount consumed daily was higher for mulberry than elm, with willow intermediate. Ash content of mulberry was higher than elm or willow; crude protein was higher for elm than willow with mulberry intermediate, and dry matter was lower for mulberry than willow with elm the intermediate. No acid detergent fiber differences were found. Hemicellulose was lower in mulberry than elm or willow, and neutral detergent fiber differed among browse with mulberry being the lowest. It appears that Rodrigues fruit bats prefer browses that provide adequate nutrients at as low a dry matter as possible.

Fluorosis as a Cause of Hyperostosis in *Pteropus rodricensis* and *Rousettus aegyptiacus*

John G. Trupkiewicz, B. Toddes and K. Whitman
Philadelphia Zoo, Philadelphia, PA

In October 1998, an adult female *Pteropus rodricensis* was found on the exhibit floor. On physical examination, the bat had a compound comminuted fracture of the distal left humerus, and a simple closed fracture of the right femur. The femur and digits showed multifocal and coalescing bony proliferations. The animal was euthanized. At necropsy examination, the bony lesions were the only significant abnormalities. Analysis of the bones showed markedly elevated levels of flouride (10,027 ppm). Additional cases were identified over the next 16 months, affecting both *P. rodricensis* and *Rousettus aegyptiacus*. Most animals were >7 years old, however elevated bone flouride was also detected in a 4 yr. old and a 4.5 yr. old *R. aegyptiacus*, as well as in the fetus of an affected female *P. rodricensis*. Bone flouride levels ranged from 4271 - 13452 ppm. (Unaffected animals showed bone flouride levels ranging from 695 - 5749 ppm.). Calcium, phosphorus and other mineral levels in these bone samples were considered within normal limits.

Repeated analyses of the diet, water, caging, substrate, and exhibit furnishings failed to identify a point source of the flouride. Diet levels were considered to be low (0.56-1.07 ppm as fed, 1.36 - 4.3 ppm DM). These levels are considered to be well below the safe levels as fed to livestock, and far below dietary levels of flouride reported by other institutions with fluorosis.

Flouride levels in tap water samples (used to clean the exhibit, and to formulate the diet) were consistently < 1ppm. Nonetheless, the diet was reformulated, replacing city tap water with distilled water. No other changes were made to the diet for a full year. Since this time, no new cases have been identified in either bat species. Several animals in the colony with previously detected bone lesions have shown partial to complete resolution of the bony changes.

Although the actual sources of flouride was not determined in these cases, the resolution of the lesions following removal of tap water suggests that chronic, low level exposure to flouride may result in toxicity in these species. *P. rodricensis* appears to be more sensitive to the cumulative effects of flouride, in that bony lesions were seen earlier, and were more severe, at lower bone flouride levels than *R. aegyptiacus*. Further research into appropriate dietary mineral levels, absorption and utilization of mineral, and the potential interaction of these minerals in frugivorous chiropterans is needed.

The Effects of Handling and Storage of Blood on Its Nutritive Value as a Meal For the Common Vampire Bat *Desmodus rotundus*

Claudia Coen, Cornell University, Ithaca NY 14850

An experiment was conducted to determine the differences in nutritive value of blood treated three ways for storage and subsequent feeding to captive colonies of vampire bats *Desmodus rotundus*. In order to feed captive vampire bats blood must be treated to prevent clotting and to maximize the liquid fraction of the diet for the bats. Captive colonies of the common vampire bat have traditionally been fed defibrinated or citrated blood. In this study an additional treatment was added. Whole blood was allowed to clot and was then liquidized in a standard domestic blender. The performance of *Desmodus* fed blood treated three ways was determined in a reciprocal balance trial in a 3x3 Latin square design. The eight adult male *Desmodus* were individually housed in digestion chambers specifically designed for this work. They were maintained in ambient temperature and humidity conditions under a natural 12:12 photoperiod in Palmira, Columbia. Daily feed (blood) and excreta samples were collected and pooled over 7 days within diet and within individuals to reduce the effects of daily variation. Chemical analysis of the feed and excreta samples were conducted for dry matter, crude protein, fat, ash, phosphorus, magnesium, calcium, iron, ammonia and energy. Amino acid composition of the diets was determined and is presented for the first time. The results of these have implications for feeding protocols of captive vampire bats.

The Rodrigues Environmental Educator Project

Mary Jane Raboude¹ and Kim Williams²

¹Mauritian Wildlife Federation Solitude, Rodrigues, Mauritius

²Philadelphia Zoo, Philadelphia, PA

Once a hot spot of floral and faunal endemism, by the mid-twentieth century, Rodrigues Island Mauritius had become severely environmentally degraded. To help empower the Rodriguan community with the knowledge and capacity to use their natural resources in a sustainable manner, in January 1998 the Rodrigues Environmental Educator Project (REEP) was initiated by the Philadelphia Zoo and the Mauritian Wildlife Foundation. With funding provided by grants and the Philadelphia Zoo, a full time environmental educator was hired to work with schools, community groups, governmental agencies and local non-governmental organizations to encourage positive environmental changes on Rodrigues. In four years since its inception, the REEP has grown considerably. The current scope of the project, its success and challenges, and plans for the coming year will be presented.

The Community Bat Education and Management Model: Application to Third World Countries and Conservation Issues

Claudia Coen, Cornell University, Ithaca NY 14850

An extensive community bat education and research program for under-resourced communities is described. The program is built around a two-pyramid education model with trickle down effects from academics, government and extension agencies through graduate and undergraduate students to farmers, professionals associated with agriculture and wildlife, the general public and school children of all ages. Inputs into the program include an assessment of community needs, concerns, and wildlife issues and a customized education trunk. Trunks typically include books, teaching materials, basic audio/visual equipment, basic research materials, models, communication tools and games. The program is initiated in co-ordination with an outside expert. The goal is to develop a program that the community grows with, integrates and continues with outside input. Outputs of the program include: education at all levels of the population by the population, academic theses and publications, improved knowledge of regional issue, improved conservation oriented wildlife and habitat usage and management practices. Each phase of the program generates regional information that feeds back into the trunk providing regional cultural perspective and atmosphere. This paper outlines the

community bat education model that was developed at Cornell University and field-tested in Columbia, South America with vampire bats.

Conservation Takes Flight: Sharing the Importance of Bat Conservation with Our Guests at Disney's Animal Kingdom

Mark Chag, Disney's Animal Kingdom, Lake Buena Vista, FL

Bat conservation is not a new image on the horizon. People from all levels in the zoological field have dedicated themselves to this concept for years, teaching people about bats, stressing their importance to the ecology and trying to dismiss the destructive myths they have carried for as long as they have been flying. Zoo education invites children into the classrooms, bat rehabilitators take their message (and their bats) to the schools, and researchers spend long dark hours, deep in the woods, documenting that small plots of land are habitats crucial to species survival. Together we try to shine a little appreciating light on an animal so important to us all, yet traditionally so neglected, exploited and feared. At Disney's Animal Kingdom we're working at various levels to emphasize the importance of bats and their habitats. With the bat exhibit, staff training classes, EcoWeb, and through the Disney Wildlife Conservation Fund, we hope to spread the wings of bat conservation a little further.

Ten Enrichment Priorities for Bats in Captivity

Dana LeBlanc, The Lube Foundation, Inc, Gainesville, Florida

Bats are managed in captivity by a variety of institutions such as zoos, living museums, and research facilities. In the wild these unique mammals have a life that is filled with dynamic experiences such as those associated with avoiding predators, searching for and acquiring food, defending territories and producing viable offspring (Martin 1996). In the past, humans traditionally have provided captive animals few choices or opportunities for activity when fulfilling their primary survival needs. Zoo animals are usually fed a basic diet at a given time of day in the same location, with emphasis being placed on nutritional requirements, economy, and ease of clean up. This practice allows the animals only the opportunity to consume their food, not to search for, pursue or process it, which can lead to boredom and the development of behavioral stereotypes (Hutchins et al, 1984; Poole, 1998). Advances in environmental enrichment and training are giving animals the freedom to make choices in their captive environment. Martin, 1996; Shepherdson, 1998). This paper outlines ten enrichment priorities for bats in captivity based on their natural history, their physical design, and behaviors essential for survival.

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Flying Fox Rehabilitation in Australia

Jenny MacLean, Tolga Bat Rescue and Research, Queensland, Australia

There are many groups of bat carers along the eastern coastal fringe of Australia as well as around Darwin in northern Australia. Megachiroptera are cared for in far greater numbers than microchiroptera. Most carers are in a general wildlife care group rather than a specifically bat care group. There are four main species of flying fox (*Pteropus*) that come into care - the Black (*Pteropus alecto*); Grey-headed (*P. Poliocephalus*); Little Red (*P. scapulatus*); and spectacled (*P. conspicillatus*). The main reasons for them coming into care are; being caught on barbed wire, usually the top wire, often as they take off from a fruit tree; being caught in nets thrown over

trees; electrocuted on power lines; young being orphaned; other trauma, e.g. hit by a car, paraplegia from falling while 'fighting'.

Each of these will be discussed with particular emphasis on rearing and release of orphans. More orphans come into care than all other cause put together. Mention will be made of the high incidence of orphans with severe cleft palate in two of the last four years. Other megachiroptera rarely come into care. They are the tube-nosed bats (*Nyctimene*) and blossom bats (*Macroglossus* and *Syconycteris*). *Nyctimene* usually come into care off barbed wire fences or cat attack. They are solitary animals and quite different to interact with and care for compared to pteropids. The only known *Macroglossus* that came into care was injured by a domestic cat.

Medical Disorders that Commonly Develop in Captive Insectivorous Bats

Amanda Lollar, Bat World Sanctuary, Mineral Wells, TX

A number of bats that bat rehabilitators receive for rehabilitation have sustained injuries that consequently render them non-releasable. These bats often serve as ambassadors for their kind through educational programs. Captive insectivorous bats can survive for many years if provided with roost mates, enrichment, proper nutrition and daily examinations. The importance of daily examinations and the diagnosis and treatment of medical disorders that commonly develop in captive insectivorous bats will be addressed.

Colonial Roosting Requirements of Captive Microbats

Dharma Webber, Bat World Sierra, CA

This case study demonstrates that the now common practice to keep colonial animals with same or similar species, is also beneficial to colonial species of bats. While not all bats in the United States are colonial, most crevice dwelling species live within and often together in social groups. Case studies detail how these social animals thrive physically and emotionally when housed colonially. The use of roosting pouches to integrate bats into a colonial environment is discussed. Construction diagrams and instructions are included to aid in making fabric pouches that simulate a natural environment and promote a colonial lifestyle by providing dark folds where the bats can hide. This article focuses on insuring humane habitat conditions by including companion animals as a vital part of colonial microbat husbandry.

An Alternative Method for Exhibition of Bats in Educational Outreach

Denise R. Tomlinson, Florida Bat Center, Port Charlotte, FL 33949

Most conservation programs utilize education as the primary focus for accomplishing their goals. Simply put: people conserve what they can identify with and understand. The use of live bats in educational programs is a very important part of most bat conservation programs. Throughout the years, educational programs have been performed in many ways. Through the use of video equipment, technology now allows audiences to view bats "up close and personal". As will be demonstrated, this new approach not only allows the public to see more of the bat's physical characteristics, especially in large audiences, but also follows the recommended AZA and Bat TAG guidelines for public education and reduces the stress and potential injury to the exhibit animal.

Session on Ecology and Behavior

Organized by Thomas Kunz

Feeding Ecology of Old World Fruit Bats: a Portrait of Diversity

Elizabeth R. Dumont

Department of Biology, University of Massachusetts, Amherst, MA 01003

Perhaps because of their impressive size, widespread distribution and pleasant faces, flying foxes (*Pteropus*) are almost universally viewed as representative of Old World fruit bats. While bats from the Family Pteropidae are highly visual animals who consume plant resources and can be relatively large in size these bats are surprisingly diverse. Much of this diversity can be traced to differences in diet and feeding ecology. In places where several species of Old World fruit bats inhabit the same area, they often utilize different subsets of plant resources. Which species uses which resources is linked to a number of factors, including the physical spacing and fruiting patterns of food plants, the nutritional quality of fruit and nectar, and the location of resources within the three-dimensional structure of a forest. Not surprisingly, many of the ecological differences are reflected in variation among species in the anatomy of the wings, skulls and teeth. Finally, as field-based studies add to our understanding of natural history, it is becoming clear that the feeding ecology of Old World fruit bats plays an integral role in the broader ecology of tropical forests. In sum, these bats should be viewed as an ecologically diverse group whose feeding strategies are tightly linked with the ecology of Old World forests.

Nutritional Ecology and Mineral Status of Old World Fruit Bats

Suzanne Nelson, Department of Wildlife Ecology and Conservation

University of Florida, Gainesville, Florida 32601, USA

This presentation will focus on available techniques for determining the nutritional status of captive bats and to identify mineral deficiencies in their diets. I will discuss methods of mineral retention experiments, how to calculate mineral retention for captive bats, and how to identify dietary deficiencies. Sample preparation, preservation, and laboratory analysis of diets will also be discussed. Examples from work done on wild-captured bats in American Samoa and captive bats at the Lube Foundation will illustrate two different techniques for mineral retention analysis. Research on both free-ranging and captive bats can increase knowledge about normal mineral levels, so that diets can be formulated to meet the changing dietary requirements of captive bats, including those that are pregnant and lactating.

Effect of Diet and Sunlight Exposure on 25-hydroxyvitamin D in Two Species of Old World Fruit Bats

Lizabeth Southworth,

Department of Biology, Boston University, Boston, MA 02215

Little is known about the vitamin D status of bats and what effect this important vitamin may have on calcium homeostasis and bone health in both captive and free-ranging animals. This study will help determine the importance of vitamin D to calcium metabolism and will enable us to better understand the evolution of vitamin D and its endogenous synthesis in bats. Changes in serum 25-hydroxyvitamin D [25-(OH)D] were assessed following manipulation of both dietary vitamin D and natural sunlight exposure in two species of Old World fruit bat (order Chiroptera; suborder Megachiroptera) with distinct difference in roosting ecology. Results are based on 50 bats, *Pteropus hypomelanus* (n=25), and *Rousettus aegyptiacus* (n=25) housed for thirteen weeks in 5 different treatment groups. All animals were fed an identical vitamin D-free diet for 8 months prior to the study with 25-(OH)D levels uniformly deficient (< 5 ng/mL). Both

species demonstrated a significant increase in 25-(OH)D following oral vitamin D supplementation and a smaller increase in 25-(OH)D following daily sunlight exposure with the largest 25-(OH)D increase in animals receiving both vitamin D supplementation and daily sunlight exposure. Results confirm that species differences do exist in relative amounts of 25-(OH)D produced when bats are exposed to daily sunlight without vitamin D supplement. This difference is likely due to variable amounts of melanin, which functions as an effective "sunscreen". These data have important implications for captive management of Old World fruit bats.

Phylogeography of the Old World fruit bat genus, *Cynopterus*

Polly Campbell, Center for Ecology and Conservation Biology,

Boston University, Boston, MA 02215, USA

The phylogeographic structure and distribution of Old World fruit bats are of considerable interest to ecologists and conservation biologists. Broad geographic ranges and considerable intraspecific variability in morphological traits, both across habitat types and along latitudinal gradients, make the genus *Cynopterus* a particularly interesting candidate for phylogeographic analysis. For this preliminary study, we sequenced ~663 base pairs of the mitochondrial DNA control region for >100 individuals from the three of the most widely distributed members of the genus: *C. brachyotis*, *C. sphinx*, and *C. horsfieldi*. Twenty-seven localities in Southeast Asia and India are represented in the analysis. Pronounced interdigitation between all three species, and the nesting of *C. sphinx* and *C. horsfieldi* within *C. brachyotis*, indicates that taxonomic boundaries within the genus are currently poorly defined. While *C. brachyotis* haplotypes segregated into five major lineages, geographic structuring was apparent only on a broad scale. Further analysis of *C. brachyotis* samples from peninsular Malaysia revealed two distinct trends in genetic and morphological divergence. Individuals from primary and ecotone habitat were consistently small and exhibited high sequence divergence both within, and between adjacent populations. Individuals from disturbed habitat were morphologically variable and exhibited low sequence divergence between geographically disparate localities. These patterns suggest a complex evolutionary history, characterized by recurrent patterns of population contraction and expansion, in which both historic and recent changes in forest cover may have played a significant role.

The Role of Fruit Bats in Maintaining Biodiversity in Malagasy Forests

P.A. Racey¹, C.E. Hawkins¹, E. Long¹, D. Andriafidison², R. Andrianaivoarivodeo²,

S. Fidiarisoavoninaro³, C. Nirina³, M. Raheeririarsena², S. Rakamiarison², J.

G. Rakotonratsimba², R. Ralisoamala², J. Ranivo², F. Ratrimomanarivo², N. Razadindrakoto²,

V. Razakarivony² and J.L. MacKinnon¹

¹Dept. of Zoology, Univ. of Aberdeen, AB92TN, ²Dept. of Animal Biology, University of Antananarivo, Madagascar, ³Dept. Of Plant Biology, University of Tulear, Madagascar

The objectives of this project: 1) to survey the roosts of three Malagasy Megachiroptera *Pteropus rufus*, *Eidolon dupreanum* and *Rousettus madagascarensis* all of which are endemic; 2) to study their feeding ecology by analysis of feces and ejecta; 3) To evaluate the effects of hunting and 4) To produce a national Action Plan for their conservation. *Pteropus* roosts are found mainly on the coastal lowlands. Twenty-six of the one hundred and thirty-three *Pteropus* roosts surveyed have become deserted within the past ten years, often as a result of hunting with guns and there were only two examples of *Pteropus* establishing new roosts. *Eidolon* roosts in clefts in rock faces and although little forest remains on the high central plateau, it still roosts there. Eighteen out of forty-one *Eidolon* roosts surveyed have become deserted because of hunting. Thirty-five plant species were found in the diet of *Eidolon* and thirty-eight in the diet of *Pteropus* for a total of fifty different plant species in all, only twenty - three of which were consumed by

both species. Approximately two thirds of the plant species in the diet were fruit and on third was pollen or parts of flowers. Over half the species in the diet of *Eidolon* were endemics. The germination rate of seeds passing through bats differed little from those seeds taken from ripe fruit, but at a significantly greater rate than seeds recovered from the feces of frugivorous birds. *Eidolon* visits the rare baobab *Adansonia suarezensis* and is likely to be its main pollinator.

Home Range and Territory in Nectar-Feeding Bats of Papua-New Guinea

Frank J. Bonaccorso¹ and John R. Winkleman²

¹National Museum and Art Gallery P. O. Box 5560, Boroko, NCD Papua-New Guinea

²Department of Biology, Gettysburg, College, Gettysburg, PA 17325

Movements of three species of nectar-feeding bats were compared using radio-telemetry in two lowland rainforest sites in Papua New Guinea. At Kau Wildlife Area, Madang Province, we monitored the movements of 11 individual *Syconycteris australis* (18 g) and 18 individual *Macroglossus minimus* (17 g) representing a total of 1,208 telemetry positions. At Mt. Garbuna, West New Britain Province we tracked four individuals of *Melonycteris melanops* (55 g). *Macroglossus* and *Melonycteris* are specialist feeders on banana inflorescences. These two species, despite a three-fold difference in body mass, occupy mean home ranges of five hectares and defend feeding territories around clumps of flowering banana plants. We postulate that defense of feeding territories occurs by means of sent-marking, vocalization, and occasional aggressive encounters with intruders. New individuals quickly occupy rich feeding territories if an established territory holder dies or vacates it. *Syconycteris australis* also occupies mean home ranges of five hectares but unlike the other species shows moderate intra-specific overlap in home range and is a generalist feeder. About half of the flights of *S. australis* center around fruiting fig and piper plants and half of its feeding forays are directed at taking nectar from banana flowers. Each of the three bat species roost alone in foliage by day within forested habitats. All are cryptic within the foliage roost, which often is under large leaves or between curled parts of dead leaves.

Roosting Ecology and Population Genetic Structure of an Old-World Tent-Making Bat, *Cynopterus sphinx*

Thomas H. Kunz, Department of Biology, Boston University, Boston, MA 02215, USA

Roosting and social ecology are important determinants of population genetic structure in the short-nosed fruit bat, *Cynopterus sphinx*. In this paper, I review results of our research conducted in western and south India. This work has revealed that *C. sphinx* typically forms single male, multi-female social groups (2 to 20 adults) that roost mostly in leaves, vines, and flower/fruit clusters that are modified by males to form so-called "tents." Two architectural styles of tents (stem and palmate umbrella tents) have been described for this species. Single males and small harem groups also may roost in man-made structures where no modification is involved--except for scent marking of roost substrates. Construction of a stem tent may take upwards of two months for a single male to complete. Males appear to defend these roosts as resources from possible intrusions by other males, often spending most of the day and night in these roosts during two annual mating periods. Fidelity to these tents is higher among males than females. Females sometime move sequentially among several adjacent tents in the course of a single breeding season, where they roost with different males and combinations of females. In western India, harem size of *C. sphinx* varies seasonally, averaging 6.1 adults in the wet season and 13.6 in the dry season. Juveniles of both sexes disperse after weaning and may form new roosting groups as yearlings. Male mating success was determined using direct paternity analysis based on 10-locus microsatellite genotypes of adults and progeny from two consecutive breeding periods ($n = 431$ individually marked bats). Seasonal differences in the environmental potential for polygyny are reflected in patterns of shared paternity within harem offspring cohorts.

RECENT LITERATURE

Authors are requested to send reprints of their papers to the Editor (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 tgriff@titan.iwu.edu 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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Notes and Announcements

Sandpiper Technologies announces the 2002 Equipment Grants winners

Sandpiper Technologies celebrates its fifth year of providing free use of its rental fleet to students conducting wildlife research. Sentinel Surveillance Video systems were granted to:

Jeffrey Ball of Simon Fraser University for his study, "Variation in parental provisioning and fledging success of Red-throated Loons in western Alaska".

Mary Ann Furedi of West Virginia University for her study, "The effects of browsing by white-tailed deer on individual plant fitness and population growth of American ginseng."

Steven Sykes of the University of California received a Peep-A-Roo grant for his study on California Tiger Salamanders.

Peeper Video Probes were granted to:

Karen Beck of North Carolina State University for her work on "Determining free-ranging red wolf litter sizes."

Craig Thompson of Utah State University for his study on "Reproductive ecology of den-dwelling mammals."

The TreeTop Peeper Telescoping Video System was granted to:

Julie Gibson of the University of Wisconsin to study "Predation incidence and habitat relationships between nesting woodland raptors and mammalian predators in the upper peninsula of Michigan."

Sandpiper Technologies is especially keen to receive grant applications from students involved in field studies on bats.

The deadline for submitting proposals for the 2003 spring/summer field season is December 1, 2002. For a list of available equipment and proposal requirements, go to the Sandpiper website at: <http://www.Peeperpeople.com>.

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Specializing in wildlife research equipment and video surveillance systems.

News

A Proposed New Listing of *Pteropus conspicillatus* as vulnerable.

This document was officially sent to the public by:

Bruno Greimel [e-mail: Bruno.Greimel@env.qld.gov.au] and forwarded to Bat Research News by Jayelle and Sonya Stanvic.

Recommendation to the Minister for the Environment and Heritage from the Threatened Species Scientific Committee (TSSC) (Government of Australia) on a public nomination for a species listing on the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

1. Scientific name, common name (where appropriate), major taxon group
Pteropus conspicillatus (Spectacled Flying-fox)

2. National Context

Known in Australia from major rainforest tracts in North East Queensland and Torres Strait. The species also occurs in Papua New Guinea and the Solomon Islands.

3. How judged by TSSC in relation to the EPBC Act criteria

TSSC judges the species to be eligible for listing as vulnerable under the EPBC Act. The justification against the criteria is as follows:

Criterion 1 - Decline in numbers

There is much anecdotal evidence that the Spectacled Flying-fox has declined in abundance over the last century, but little quantitative support for this argument. Many experts comment that there now appear to be fewer camps, and cite extensive habitat clearing, a decline in range, and increased mortality through pest management practices at orchards and tick paralysis as likely causes. However, there are no robust count data to support these observations.

Spectacled Flying foxes are highly mobile and have complex and irregular movement patterns primarily determined by seasonal nectar flows. This characteristic makes estimating population size a difficult task. In the last three years, there have been attempts to undertake this across the range of the species in the wet tropics (Ingham to Cooktown) through synchronised counts of animals leaving camps at dusk. These counts suffer from a number of deficiencies with respect to population assessment: they are a short time series dataset, the accuracy and precision of the counts is undefined, issues of count technique such as observer variability need refinement, and some camps are not counted due to resource issues or because their location is unknown.

The number of adult individuals counted in these surveys has ranged from 153,000 in 1998, to around 80,000 in 1999 and 2000 (estimated error 20%). These figures are likely to have under-estimated the true population size because of the difficulty of seeing bats leaving camps once night falls. Also, the northern population on Cape York Peninsula (McIlwraith Range and Iron Ranges) has not been surveyed, although it is likely to be much smaller.

Two experts have recently modeled the vulnerability of both the Grey-headed Flying-fox, *Pteropus poliocephalus*, and the Spectacled Flying-fox, to population decline an extinction using basic parameters of reproduction obtained from captive breeding data. This analysis shows that flying-fox populations have a low capacity for increase and depend on low levels of natural mortality and high survival of adults to maintain stable population levels. These experts conclude that current death rates of the Spectacled Flying-fox caused by the use of electrical grids (or 'fyre-foxes') to protect fruit crops places the wet tropics population at risk.

Two other experts challenged the validity of the inputs to the model, in particular, the extrapolation of data from captive animals to the wild population, and the dismissal of

published empirical evidence from wild populations. The model essentially assumes that flying-foxes do not breed until three years of age, based on observations of captive animals, but field based data is available for the closely related Black Flying-fox that indicates that females mature at two years. The sex ratio of flying-foxes in most camps is also closer to 70:30 (females:males), rather than the 1:1 ratio used in the model. Changes to these and other inputs to the model should be made to further explore the impacts of these influences on the population survival.

However, whilst the modeling is imperfect, it provides clear messages about the likely impact of increased mortality to adults. Sustained high levels of mortality additional to natural mortality would undoubtedly lead to population declines in the near future. Evidence is now available to indicate that this possibility is likely because large numbers of the Spectacled Flying-fox are being killed on electrocution grids established to protect orchards in the wet tropics in the main part of the Spectacled Flying foxes Australian range. There are currently 11 licensed grids in operation and the Queensland Department of Environment believes these grids cause the deaths of thousands of Spectacled Flying-foxes each year. Evidence from a Federal Court of Australia hearing (*Booth v Bosworth*, 2000) was provided which showed that 229 Spectacled Flying-foxes were killed over four nights on one property. It should be noted that these counts were only done on a small part of the property and its electrocution grid, so it is likely that the real level of mortality on this property is much higher. However, if the rate of observed mortality is consistent across the entire fruiting season at this orchard (2 months), then the mortality at this site alone is very extensive, and likely to exceed 3,500 animals. With the likelihood that similar levels of mortality are being achieved at the other 10 orchards using this form of crop protection, sustained electrocution of Spectacled Flying-foxes at these levels, added to natural mortality, is likely to lead to negative population growth and ultimately extinction of the species. As an example, modeling, assuming a total mortality rate of 30% for all age classes and a fecundity rate of 90% for females greater than 2 years old, predicts that the population will halve in nine years under this scenario, and suggests that at the current rate of decline it will be extinct (within the wet tropics) within 99 years. These assumptions are not unreasonable, given a maximum count for the wet tropics population of 153,000 animals.

The evidence on current population levels is equivocal. However, based upon the population modeling, and in the presence of high levels of non-natural mortality, it is reasonable to infer that there will be a substantial reduction in the existing population in the wet tropics in the immediate future. As this is where the bulk of the Australian population resides, the Spectacled Flying-fox is eligible for listing as vulnerable under this criterion.

Criterion 2 - Geographic distribution

The species is restricted to wet tropical areas in NE Queensland, ranging from Ingham to Cooktown in the south, with another population in eastern Cape York Peninsula. Despite extensive habitat loss (80%) in the coastal lowlands of tropical Queensland, the area of occurrence and occupancy is not considered to be so restricted as to be critical to the species survival, particularly given its ability to exploit alternative food sources.

Therefore, the species is not eligible for listing under this criterion.

Criterion 3 - Population size and decline in numbers or distribution

Information on population estimates for the Spectacled Flying-fox is provided under Criterion 1. Given these numbers (lowest estimate 80,000 individuals), the estimated total number of mature individuals is not considered to be limited. The geographic distribution of Spectacled Flying-fox is covered under Criterion 2. As stated above, its geographic distribution is not precarious, particularly given its ability to exploit both native and exotic food resources.

Therefore, the species is not eligible for listing under this criterion.

Criterion 4 - Population size

The data presented under Criterion 3 do not support listing under Criterion 4, in that the number of adult individuals is currently estimated to exceed 80,000.

Therefore, the species is not eligible for listing under this criterion.

Criterion 5 - The probability of its extinction in the wild is at least 10% in the medium-term future.

There is no quantitative evidence available against this criterion. However, as mentioned above under Criterion 1, two experts have recently modeled the vulnerability of the Spectacled Flying-fox to decline and extinction using data obtained from captive breeding studies. This analysis shows that flying-fox populations have a low capacity for increase and depend on low levels of natural mortality and high survival of adults to maintain stable population levels. These experts conclude that current death rates of the Spectacled Flying-fox caused by the use of electrical grids or 'fyre-foxes' to protect fruit crops places the wet tropics population at risk.

The level of mortality associated with electrocution grids has been discussed above under Criterion 1. In summary, TSSC believes that there is good evidence to suggest that the levels of mortality being imposed through this form of crop protection are additive to natural mortality, and are likely to lead to negative population growth and ultimately extinction of the species. The example used above (mortality rate of 30% for all age classes, fecundity rate of 90% for females greater than 2 years old) uses parameters which are conservative in the face of this level of mortality. It predicts that the wet tropics population will halve in nine years, and be extinct within 99 years under this scenario.

Based upon the population modeling, and in the presence of high levels of non-natural mortality, the spectacled flying fox is eligible for listing as vulnerable under this criterion.

4. Conclusion

The population of Spectacled Flying-foxes is likely to undergo in the immediate future a substantial reduction in numbers and faces extinction in the medium term. Mortality caused by the use of electrocution grids to protect fruit crops poses a significant threat to the wet tropics population. The combination of inferred declines and continuing threats justifies listing the species. The species is eligible for listing as vulnerable under criteria 1 and 5.

5. Recommendations

a) TSSC recommends that a review of the conservation status be undertaken in 2003.

b) TSSC recommends that the list referred to in section 178 of the EPBC Act be amended by including in the list in the vulnerable category: *Pteropus conspicillatus* (Spectacled Flying-fox).

Bat Pups Reported

Barbara French [french@batcon.org] has sent the following interesting information.

Bat Pups either received by or reported to Rehabilitators in 2002: First reported date, May 12 through final reported date, August ?

317 pups from Arizona, Arkansas, California, Florida, Georgia, Kansas, Michigan, Missouri, New Jersey, Ohio, Oklahoma, Pennsylvania, Texas, Virginia, Wisconsin.. Species reported include eastern red bats, western red bats, seminole bats, northern yellow bats, hoary bats,

Eastern pipistrelles, evening bats, big brown bats, Mexican free-tailed bats, California myotis, Yuma myotis, and little brown bats.

By species:

Eastern red bats (*Lasiurus borealis*) 164; big brown bats (*Eptesicus fuscus*) 91; Mexican free-tailed bats (*Tadarida brasiliensis*) 27; evening bats (*Nycticeius humeralis*) 9; hoary bats (*Lasiurus cinereus*) 8; seminole bats (*L. seminolus*) 7; yellow bats (*L. intermedius*) 4; California myotis (*Myotis californicus*) 1; Yuma myotis (*M. yumanensis*) 1; western red bat (*L. blossevilli*) 1; eastern pipistrelle (*Pipistrellus subflavus*) 1; little brown bat (*M. lucifugus*) 1; unknown (possibly little brown bats; *M. lucifugus*) 2.

For more details reply to: worldbatline@yahoogroups.com

PRESS RELEASE: Endangered Bat Discovery

The critically endangered Philippine tube-nosed fruit bat (*Nyctimene rabori*) has recently been discovered in the sub-montane forests of the North Negros Forest Reserve (NNFR), Negros Island, Philippines for the first time by a team of research volunteers.

The discovery was made by a team of volunteer conservationists who were undertaking baseline biodiversity surveys as part of the Negros Rainforest Conservation Project (NRCP). The NRCP is a joint program of research, conservation and education between Coral Cay Conservation (a UK based conservation NGO) and the Negros Forests and Ecological Foundation, Inc (NFEFI) in order to develop community driven management recommendations for the NNFR. Previous records of this species from Negros are very limited and this is the first time this species has been recorded in the NNFR.

This tube-nosed fruit bat is endemic to the Philippines and is only known to exist on three islands, Cebu, Sibuyan and Negros. This species was only discovered in 1984, and is currently classified as critically endangered by the World Conservation Union (IUCN Red List). It is thought that numbers of this species are now reduced to about one percent of the original population size. Such a decline is due to their dependency on lowland tropical forest where they feed and roost. These forests have been dramatically cleared in the last fifty years and less than five percent of the original forest remains. It had been suggested that the species could face extinction within the next ten years. Discovery of what could amount to a new population is certainly welcome news.

For further details please contact: Craig Turner, Terrestrial Science Co-ordinator, Coral Cay Conservation, The Tower, 125 High Street, Colliers Wood, London, SW19 2JG, UK

E-mail : ct@coralcay.org web site: <http://www.coralcay.org/>

Bats in Churches: A Novel Approach

Three vicars having coffee together one morning discover that all their churches are infested with bats. "Once I got so cross," says one of them, "I borrowed a shotgun and fired at the creatures. It made some holes in the roof but did nothing to the bats."

"I tried catching them," says the second. "Then I drove 50 miles before releasing them—but they beat me back to the church."

"I haven't had any more problems," says the third. "What did you do?" ask the others, amazed. "I simply baptized and confirmed them," replies the third vicar. "I haven't seen them since." Anonymous.

Book Review

Stokes Beginner's Guide to Bats, Kim Williams, Rob Mies with Donald & Lillian Stokes. 160 pages. \$8.95. Little, Brown, and Company, 2002.

Good things do come in small packages and this handsome new publication is packed full of good information about bats found in the United States and Canada. The introductory chapters are written in a friendly style and cover the usual topics (natural history, public health, common myths, exclusion, attracting bats and bat houses, conservation, etc.) with just enough detail to maintain even the most casual reader's interest. Species descriptions for 45 species include a range map, color photo(s), identification characters (key measurements, color, echolocation frequency), diet, and flight and roosting behavior. Icons for roosting and flight locations are included for each bat. Species pages are organized and color-coded by genera. A section on bat lists by state, province or territory has bats grouped by genus color code with common names presented first. Bats are further divided as to whether species are common, uncommon or of unknown status. This was probably not necessary and beginners may find this arrangement a bit confusing. While the reviewer did not check the accuracy of all state lists the one for Texas was missing two species. Additional helpful information includes a list of places throughout the country to see bats and a compilation of educational resources to learn more about bats. Unfortunately some of the best bat reference books were listed as source materials at the end of the acknowledgments section where they are likely to be missed by most readers. The book is printed in full color and beautifully illustrated with photographs from 13 photographers including some of Scott Altenbach's finest. The book's small size 4.5" by 7" makes it a handy pocket guide for field biologists. Despite some inconsequential omissions or formatting questions this book will be a nice addition to anyone's library of bat books and is a perfect gift for someone who wants to know more about the fascinating bats found in Canada and the United States.

Submitted by Patricia Morton, Texas Parks and Wildlife Department, Suite 100,
3000 Interstate Highway -35, Austin, TX 78704

New Book

Hot off the presses is our new bilingual book "Murciélagos de Costa Rica/Bats" by Richard and Meg LaVal, Apdo 24-5655, Monteverde, Cost Rica

website: www.stellabakery.com published by: Editorial INBIO (Instituto Nacional de Biodiversidad). San Jose, Costa Rica.

The publisher is selling the book on their website for only \$17.

<http://www.inbio.ac.cr/editorial/english/pages/ediprinen.html>

Ed. Note: We are seeking a reviewer for this book. Contact Roy Horst at horstgr@potsgdam.edu

New book on Bats of Japan (not the exact title) by Satoshi Kumagai, Akiko Mikasa, Yushi Osawa and Keiko Osawa Publisher: JINRUI BUNKASHA, Sold by: OHTOH SHOBO
ISBN4-7567-1205-3 Price 2700 yen (about \$ 21.00 U.S.)

My friends, my husband and I have published a book of Japanese bats. It is written in Japanese. So I assume most batliner will not be able to read the book. But in chapter 4 there are descriptions of all 36 bat species in Japan (33 microbats and 3 flying foxes) with scientific names, sizes, radular formulas, distribution maps and redlist ranks. There are two or more photos of most species (some species have only one picture). There are a lot of illustrations and photos. We think you can enjoy this book even if you don't read Japanese.

For more information please contact Keiko Osawa at: fruitbat@mwc.biglobe.ne.jp

Ed. note: there is a very good website on Japanese Fruit Bats by the author at:

<http://www2r.biglobe.ne.jp/~fruitbat/english.htm>

In Memorium, Jim Cope 1924-2002



Earlham College has provided the following material memorializing the passing of an old friend, Jim Cope on March 16, 2002

"If you noticed the rapt attention on the faces of Jim Cope and Bill Buskirk as they sat among the faculty at commencement you would have assumed they were giving their full attention to the ceremonial proceedings, and you would have been wrong. Truth is, the two biologists were competing in a private game, one they had been playing for years. With eyes fixed on the speaker, their ears harkened instead to the various birds flitting about the trees and grounds. Each species, identified by song, counted one point. Immediately after the benediction, Cope and Buskirk would find each other in the milling crowd and compare scores.

"The anecdote is one of countless stories that come to mind around campus this week as the Earlham community absorbed the news of the death of Jim Cope, Saturday, March 16. Jim Cope professor

emeritas and a pillar of Earlham's biology program, died of a heart attack Saturday, March 16, while working at the Cope Environmental Center near Richmond. He was 81 years old. His presence and contributions in the life of Earlham are remarkable. Teacher, field biologist, researcher, museum director, peacebuilder, familyman, and all-around community friend. In his life, where does one start?

Hundreds of former Earlham students from his 40 years on the Earlham faculty may remember Jim Cope foremost as the charismatic professor who illuminated the mysteries of nature. Others will recall him as the re-creator of Joseph Moore Museum from artifacts and specimens that had been stored away after a disastrous fire destroyed the original in 1924. He was an early director of Conner Prairie Pioneer Settlement, a post he accepted in 1977 out of respect for his friend Eli Lilly, who had donated the William Conner house and surrounding grounds to Earlham College."

Susan Lewis, one of Jim's last students to go on and earn a doctorate and follow in Jim's footsteps graciously provided the additional material.

Jim made many critical contributions to the field of bat research. He identified the first maternity roost of *Myotis sodalis* (without the benefit of radiotelemetry) and documented the decline of that species in southern Indiana caves. His work with *M. sodalis* contributed to the species receiving federal protection under the Endangered Species Act. He was working on several additional projects pertaining to the bats of Indiana with John Whitaker at the time of his death. Jim's most important contribution to bat research was through the lives of the students and colleagues he touched. Jim was perhaps one of the first professors in the nation to involve undergraduate students in research. He published 25 papers on bats and birds. Most of these were co-authored by current or former students including Steve Humphrey, Anthony DeBlase, Andreas Richter, Richard Mills, and Jim Fowler. By modeling the value of undergraduate research, his web of influence spread even further, as former students such as John Bowles, Dick Myers, and I went on to spread Jim's enthusiasm for research in the natural sciences through our own teaching. Susan E. Lewis, Ph.D. Associate Professor of Biology, Carroll College, Waukesha, WI 53186

Future Meetings

August, 2002

The 9th European Bat Research Symposium will convene in Le Havre, France.

The Symposium Convenor will be Stephane Aulagnier, I.R.G.M., C.R.A. Toulouse, B.P. 27, 31326 Castenet-Tolosan Cedex, France. Aulagnier's e-mail is: aulagnie@teleirgm.toulouse.inra.fr

November 6-9, 2002

The 32nd Annual North American Symposium on Bat Research will convene in Burlington, Vermont hosted by William Kilpatrick (University of Vermont) and Roy Horst (State University of New York at Potsdam) Arrangements have been made for participants in the symposium to stay at the Radisson Hotel at very reasonable rates. All symposium session, displays, etc., will be in the Radisson which overlooks Lake Champlain only a 5 minute walk away. Just 5 minutes away are historic St. Paul Street and Church Street, both famous for the great number of fine restaurants and the Burlington Brew Pub. Unfortunately the spectacular fall foliage season will be past (which incidentally is why we can get such reasonable room rates).

For details see our web-site at www.nasbr.com

January 29 -to February 1, 2003

2nd Four Corners Regional Bat Conference / 1st Annual Western Bat Working Group Conference for the Management and Conservation of Bats.

We would like to announce this meeting, scheduled to be held in Durango, Colorado, January 29-February 1, 2003. Conference registration information and call for papers will be available soon. Room reservations can be made now at the Doubletree Hotel, 970-259-6580. Ask for the rate for the Four Corners WBWG meetings. Rates will be \$59.00 + tax for 1 king bed, 1 or 2 people, \$69.00 + tax for 2 queen beds, 1/2/3 people. We encourage everyone to reserve a room early to get the reduced room rate. Registration information is now available on the WBWG website (<http://www.batworkinggroups.org/>). Information on Durango can be obtained at www.durango.org. First call for papers is coming soon.

October 8 to 11, 2003

The 33rd Annual North American Symposium on Bat Research is scheduled to be held in Lincoln, Nebraska. Patricia Freeman will be the Convenor and will chair the Local Committee. The venue will be the Cornhusker Hotel in Lincoln, which was our location for the 20th Meeting in 1990. Everyone was pleased with their hospitality. For more details see our website at www.nasbr.com

If you know of other meetings, large or small, concerning any aspect of bat biology please send me the details for publication at: horstgr@potsdam.edu

Employment Opportunities

Director, the Lube Foundation, Inc

The Lube Foundation, Inc, a private facility for captive breeding, education, and research on Old World fruit bats, invites applications for the position of Director. The position requires a Ph. D. With a background in the ecology, behavior, and conservation biology of bats, field research experience, experience in the breeding and management of captive animals, demonstrated administrative skills, and experience in community outreach. The successful applicant will be expected to develop a high profile externally funded research program that includes studies on both captive and free-ranging Old World fruit bats. Office and laboratory space will be provided at the Lube Foundation facilities located near Gainesville, Florida.

We are seeking an individual whose research interests complement and extend existing programs at Lube. The successful candidate will be considered for a courtesy Faculty appointment in the Department of Wildlife Ecology and Conservation at the University of Florida. Salary and benefits are commensurate with experience. Applicants should submit a complete curriculum vitae, three reprints, a statement of research interests, and three letters of recommendation to: Roger D. Haagensen, 800 E. Broward Boulevard, Ft. Lauderdale, FL 33301. Detailed information about the Lube Foundation is available at website: <http://www.Lube.com>. Deadline for application is September 1, 2002.

Field Biologist Position

The position requires field knowledge of hydrology, ecology, and identification of small mammals (especially bats), fishes, macroinvertebrates, reptiles, amphibians, and plants. A strong background with bats and mistnetting techniques required. This position will also require overnight travel using a company vehicle. All travel expenses will be paid on a per diem basis. This position is seasonal. To apply, send a resume to: Palmer Engineering, 273 Shoppers Drive, PO Box 747, Winchester, KY 40392
Attention: Doug Lambert

Bat Conservation International

There is a job opening at Bat Conservation International. For those who are interested, qualifications and application instructions can be viewed at: www.yahogroups.com under "batdata".

Barbara French, Conservation Information Specialist, Bat Conservation International, P.O. Box 162603, Austin, TX 78716

Position Opening

Director, The Lubee Foundaton , Inc.

The Lubee Foundation, Inc, a private facility for captive breeding, education, and research on Old World fruit bats, invites applications for the position of Director. The position requires a Ph. D. With a background in the ecology, behavior, and conservation biology of bats, field research experience, experience in the breeding and management of captive animals, demonstrated administrative skills, and experience in community outreach. The successful applicant will be expected to develop a high profile externally funded research program that includes studies on both captive and free-ranging Old World fruit bats. Office and laboratory space will be provided at the Lubee Foundation facilities located near Gainesville, Florida.

We are seeking an individual whose research interests complement and extend exiting programs at Lubee. The successful candidate will be considered for a courtesy Faculty appointment in the Department of Wildlife Ecology and Conservation at the University of Florida. Salary and benefits are commensurate with experience. Applicants should submit a complete curriculum vitae, three reprints, a statement of research interests, and three letters of recommendation to: Roger D. Haagensen, 800 E. Broward Boulevard, Ft. Lauderdale, FL 33301. Detailed information about the Lubee Foundation is available at website: <http://www.Lubee.com> Deadline for application is September 1, 2002.

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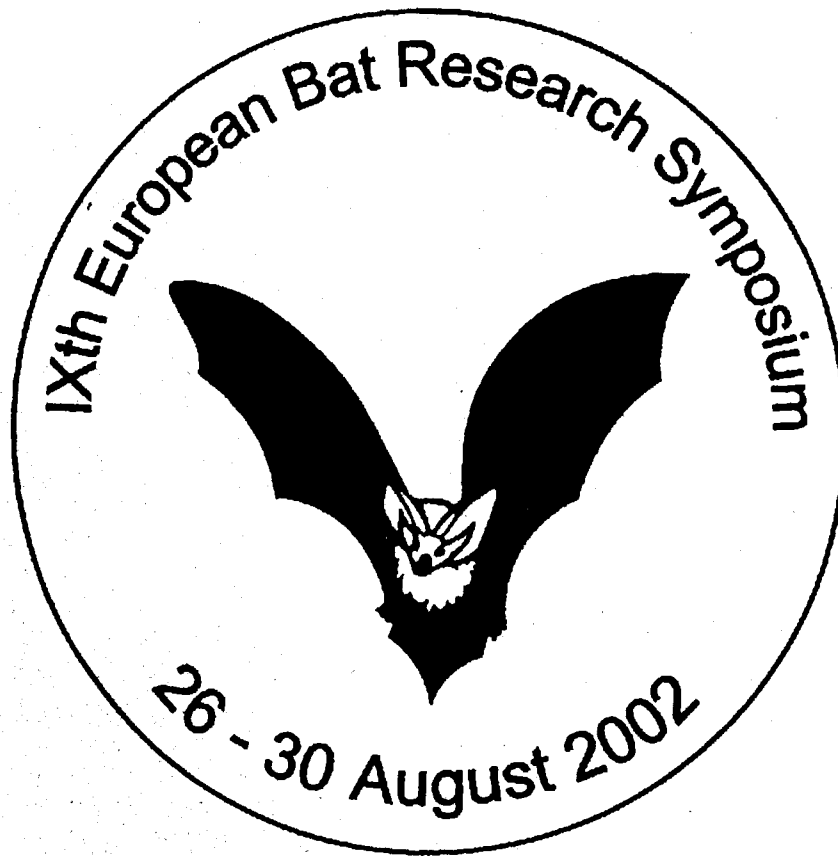
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Front Cover

The front cover illustration was generously provided by Jacqueline J. Belwood from her Book, *The Bats of Ohio*. This artwork was created by Ann E. Geise of the Ohio Bat Survey.

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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- 556-3230, FAX 309-556- 3411
e-mail: tgriff@titan.iwu.edu

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

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FALL 2002

Abstracts of Presentations at the 9th European Bat Research Conference August 26 - 30 at Le Havre, France

These abstracts are listed in alphabetical order by first author. Poster and Oral presentations are listed together. Any errors that may have been introduced in the preparation for publication are inadvertent, our sincere apologies. A great debt of gratitude is due the Scientific Secretariat, Stephane Aulagnier, and his associates, who have assembled these abstracts and forwarded them to us. G.R. Horst, Editor

Bat Migration in Southern Sweden

Ingemar Ahlén, Lothar Bach¹ & Petra Burkhardt¹

¹ Freilandforschung, zool. Gutachten, Gd, D-28357 Bremen, Germany

Visible bat migration was discovered and studied at 14 sites along the Swedish south coast in 1993-1996 (Ahlén 1997). Migration to south and southwest over the sea was observed and marked concentrations of more than ten bat species were found at certain points. Further observations were then collected in 1997-1999 and from 2000 and 2001 migration movements were studied on Southern Gotland and Öland (IA & LB) and at Falsterbo, Skåne (PB & LB). Direct observations with detector and strong visible light were used as well as automatic recording boxes. The studies give data on flyways on land, species composition and which flight directions the bats use when they leave the coast.

Comparison of Aerial Deposition of Cadmium Before and After the Closure of an Oil-fired Power Station in the Vicinity of Two Greater Horseshoe Bat Nursery Roosts

Margaret M. Andrews¹ & Jane Allen

¹ School of Biomolecular Sciences, Byrom Street, Liverpool L3 3AF, England.
m.m.andrews@livjm.ac.uk

Aerial deposition of cadmium has been monitored from 1995 to the present by extraction of cadmium from petroleum jelly coated onto ceramic tiles placed near two nursery roosts and in the foraging area of greater horseshoe bats *Rhinolophus ferrumequinum*. Cadmium levels from aerial deposition recorded in 1995 near the two nursery roosts were in the range 0.08-0.13 mg/Kg. After the oil-fired power station closed during the winter of 1997 subsequent analysis showed a reduction in cadmium precipitation. Cadmium levels from aerial deposition have been compared with cadmium in bat droppings taken from the two nursery roosts and soil samples taken in the foraging areas.

The Number of Greater Horseshoe Bat *Rhinolophus ferrumequinum* Births in South Wales Varies with Winter Temperatures

Peter T. Andrews¹ & Thomas P. McOwat

¹ Oliver Lodge Laboratory, University of Liverpool, Liverpool, L69 7ZE, England

The Greater horseshoe bat *Rhinolophus ferrumequinum* is at the northern limit of its range in Southwest Wales where the number of births in two nursery roosts has been recorded each year since the roosts were discovered in 1978 and 1983. The number of births fell from 1978 to 1988 but has increased since then. The annual changes in the number of births correlates with the winter temperatures and can be well represented by a linear model. The species is known to feed during the winter and the condition of females in April is expected to depend on how often they have been able to feed on warm evenings in the preceding months. The number of pregnant females that eventually come to term is likely to reflect this. >

Winter temperatures in the XIXth century were lower than in the XXth century and calculations using historical temperatures indicate that the species probably colonized the area relatively recently. This is consistent with the low genetic diversity of the species in Southwest Wales.

Comparative Study of the diet of Two Pipistrelle Species, *Pipistrellus pygmaeus* and *P. pipistrellus* in Southwest Germany

Andreas Arnold, Ursel Häussler & Monika Braun

Koordinationsstelle für Fledermausschutz Nordbaden, c/o Staatliches Museum für Naturkunde,
Erbprinzenstrasse 12,
D-76133 Karlsruhe, Germany. MonikaBraun@aol.com

Food composition and ecological parameters as niche width and niche overlap of the sibling species *P. pygmaeus/mediterraneus* and *P. pipistrellus* were investigated by analysis of bat droppings. The study area is situated outside the riparian zone in deciduous forests of hills and slopes adjacent to the Neckar Valley in the vicinity of Heidelberg, Southwest Germany. Throughout the season bat boxes were used by both species with different distributional patterns. The population of *P. pygmaeus/mediterraneus* is dominant in numbers and comprises, according to roost data, spring transient colonies, resident males, and mating groups. However, the numbers of *P. pipistrellus* occurring in the forest are lower and only single bats or small groups could be found. Despite some differences in seasonal variation the food composition was considerably equal. By far the most important prey for both bat species consisted of dipteran suborders Brachycera (incl. Cyclorrhapha) and Nematocera, followed by Hymenoptera, Planipennia and Homoptera. Values for standardized niche width showed a relatively high degree of specialisation, due to the fact that the bats preferred small prey organisms over larger ones. Niche overlap was tending to high values indicating a strong competition concerning the resource "food" on common foraging grounds. According to the results obtained, conclusions were made regarding the food composition and the hunting strategy of *P. pygmaeus/mediterraneus* and *P. pipistrellus* in the area under investigation.

Feeding Ecology of the Central European Bat Community

Michal Andreas

Agency of Nature Conservation and Landscape Protection of the Czech Republic,
Kali_nická 4-6, CZ-130 23 Praha, Czech Republic. andreas@nature.cz

Trophic ecology of 16 bat species living sympatrically in SE Czech Republic was studied by means of faecal analysis of netted animals. Food supply was studied using a light trap, sweeping and beating. The collected material enabled to assess main foraging strategies of bats, detailed seasonal dynamics of trophic niches and their overlaps in sympatry, foraging success of particular species etc. *E. serotimus*, *E. nilssonii*, *M. brandtii*, *M. mystacinus*, *M. daubentonii*, *N. leisleri*, *N. noctula* and *P. pipistrellus* s.l. can be classified as aerial hawkers, while *M. myotis* is a ground gleaner. Some food items (Odonata and Ephemeroptera larvae) in the diet of *M. daubentonii* indicate the use of water-surface gleaning. *M. nattereri*, *M. emarginatus*, *M. bechsteinii*, *P. auritus* and *P. austriacus* are foliage gleaners. Two species do not fit well in any of these groups and their strategies can be called slow hawking (*B. barbastellus*) or slow hawking/hovering/gleaning (*R. hipposideros*). Comparing food supply and the diets of bats, we can state opportunistic foraging of most species in the frame of their morphological and echolocation constraints. On the other hand, a trend of selectivity was found in several species which preferred hunting of relatively big species of *Lepidoptera* in summer, although small species distinctly prevailed in the food supply. Considerable differences were recorded in the foraging success rate, flying activity and weight changes between *P. auritus* and *M. daubentonii* - representatives of the groups applying different foraging strategies - foliage gleaning and aerial hawking. Compared to *M. daubentonii*, *P. auritus* is able to forage more effectively very early in the spring and late in the autumn, it shows higher flying activity during these periods and its weight grows earlier in spring.

Ultrasound Calls Made by Greater Horseshoe Bats *Rhinolophus ferrumequinum* During Their Exit from a Nursery Roost

Margaret M. Andrews

School of Biomolecular Sciences, Byrom Street, Liverpool L3 3AF, England.
m.m.andrews@livjm.ac.uk

Ultrasound calls of greater horseshoe bats *Rhinolophus ferrumequinum* were recorded during the emergence from a nursery roost in the pre and postnatal periods by using a time expansion detector with a microphone extension in the roost. The time expanded calls were recorded on tape for later analysis using the BatSound program. Recordings showed that in addition to the usual echolocation calls there was social interaction between the bats. The time and direction of travel of each bat passing through the roost exit was recorded on a computer when the bat interrupted infra-red beams in an array crossing the exit hole. The relation between the frequency of social calls and simultaneous bat activity during emergence is analysed.

Greater Horseshoe Bat *Rhinolophus ferrumequinum* Conservation in England David Appleton, James R. Diamond & Tony Mitchell-Jones

English Nature, Level Two, Renslade House, Bonhay Road, Exeter. EX4 3AW, England

Greater horseshoe bat *Rhinolophus ferrumequinum* is listed on Annex II of the EC Habitats Directive. Roost destruction and agricultural change in pastoral landscapes have been identified as contributory causes of significant population declines in the United Kingdom. The majority of large maternity and hibernation sites are now protected under domestic legislation and the largest populations in England are now designated as Special Areas of Conservation under European legislation. Since 1998 the Greater Horseshoe Bat Project has been working to support appropriate management of the landscapes around roosts in Southwest England. By March 2002 advice had been provided to over 110 farmers managing in excess of 9300 hectares of land. Management agreements have been used to support landscape enhancements, including hedgerow renovation, extensive grassland management and arable reversion. Monitoring data suggests that greater horseshoe bat populations may be recovering.

SDPVN - What We are All About

Nataša Aupi¹ & Maja Zigmajster²

¹ Svibnik 21, SI-8340 Crnomelj, Slovenia

² S.D.P.V.N.-Slovenian Association for Bat Research and Conservation, UL. Bratov Ucakar 110, SI-1000 Ljubljana, Slovenia

SDPVN - Slovenian Association for Bat Research and Conservation is a non-governmental organisation, involving biology experts, students and all who have interest in bats. Our work began in 1998, as a part of the Biology Students' Society (Section for bat research and conservation), but in June 2001 we started the independent society. Our main goals are to improve the knowledge on distribution, ecology of bats in Slovenia, to recognise threats and recommend proper protection measures. We organize various student research camps and workshops, like for example the "Workshop on identification of bats and localisation of roosts using bat detectors" We participate at international projects like "Central European Miniopterus Protection Programme". So far we organised three European bat nights: in 1999, 2000, 2001. This year a leaflet "Bats - Neighbours in need" will be issued. We co-operate with Public Institution Park *Kočjanske jame* in preparation of the "Learning path on natural and cultural characteristics of Regional Park *Kočjanske jame*". In 2000 we organised a project: "Bats - Animals of the year 2000" in co-operation with the magazine Proteus and Slovenian Natural History Society that involved a large number of schools. We are also active on the field of legislation. Our members attended the Meeting of the Advisory Committee to EUROBATS Agreement and we work together with different NGOs in the preparation of important conservation documents and legislation.

Tunnels as a Possibility to connect Bat Habitats

Lothar Bach¹, Herman J.G.A. Limpens² & Petra Burkhardt¹

¹ Freilandforschung, zool. Gutachten, Gd, D-28357 Bremen, Germany

² Eco Consult & Project Management, Roghorst 99, NL-6708 KD Wageningen, The Netherlands.
liever.limpens@knoware.nl

Fragmentation of landscape is one of the biggest problems for animals with large home ranges and/or different functional habitats within a landscape, such as red deer, wolfs but also bats. Even in the case of undisturbed quality in hunting habitats and roosts, disconnection of flight paths could lead to decline of populations of bats. Tunnels allowing for connection of both sides of a barrier, can be used minimize the impact of e.g. motorways. Results of studies in different parts of Germany show, that nine bats species do use tunnels. Data are analysed with respect to different types of tunnels. The results support the role of tunnels in effective de-fragmentation of landscapes.

Flight Activity and Habitat Use of *Pipistrellus pygmaeus* / *mediterraneus* in the Floodplain Forest

Tomá_ Bartonicka

Katedra zoologie a ekologie, Masarykova Universita, Kotláčská 2, CZ-611 37 Brno, Czech Republic.
bartonic@sci.muni.cz

Seasonal and overnight changes of flying activity were studied in the floodplain area in South Moravia (Czech Republic) during the season 2001 by bat-detectors. The night was divided into thirds, during each one bat activity was recorded in the particular habitats - ecotones, water bodies, meadows and closed forest. The highest activity was recorded at the beginning of the night (first period). During the second period, the flying activity was very low throughout the whole season. An increase in the level of activity after the parturition during the 3th period was found. The seasonal changes of activity had a bimodal character along edges, in forest and over forest paths with the first peak in the spring (May) and the second in the end of the summer (August). On the contrary, foraging activity at the water bodies very varied on a relatively high level. Over the meadows very low activity throughout season was registered. A decline in flying activity was found during late pregnancy. The peak in activity of *Pipistrellus pygmaeus* was found 40 minutes after the sunset. The decrease in activity after this peak was statistically significant. Pipistrelles in the floodplain forest can suddenly forage under the protection of canopies, after their emergence, reducing the predation risk. At the beginning of the night bats preferred the edges of the growths (ecotones). Foraging activity decreased at the ecotones towards midnight. The level of flying activity was recorded well-balanced in the closed forest and over the forest paths. But it was very low, in contrast to stable high activity over the water. The research was supported by the Grant Agency of the Czech Republic No. 206/02/0961.

Myotis dasycneme in Ukraine: Current State and Distribution

Andriy-Taras Bashta

Institute of Ecology of the Carpathians, Koselnytska street 4, UK-79026 Lviv, Ukraine

Pond bat *Myotis dasycneme* is one of the Europe's rare and threatened species. This species is included to Ukrainian Red Book (the 3rd category - rare species). Only single findings of Pond Bat were known up to the last decade in Ukraine. Unknown status of species caused our special investigations of Pond bat distribution. During the period of 1990-2001 years approximately 30 records of *M. dasycneme* are known in Ukraine in general. The main territory of summer distribution of Pond bat involved mainly northern and north-western regions, which have characteristic biotopes for this species: great number of lakes and the dense net of canals and rivers. All our findings of maternity colonies of Pond bat come from there. The colonies are situated in buildings, on attics as well as behind the wood elements of wall. Foraging specimens have been caught by nets also, but only close to rivers and canals. The migration way probably lies across the territory of Western Ukraine that is confirmed by the catching of migration specimens as well as by mass flying inside buildings. All findings in the migration period come from Western Ukraine and were noted in August - of the beginning of September. Pond bat is noticed more rarely in the winter period, but the geography of findings is wider: catacombs near Odessa city - South (letter. inform. O.Fedorchenko),

caves near Kyiv - Central Ukraine (Likhotop, Tkach & Barvinsky 1990), artificial caves in in Kharkiv region - East (Vlashchenko 2001), mines in Podilla - West (Tyshchenko 2002). Our investigations showed that Pond bat is not so catastrophically rare species as it was considered earlier. However, analysis of investigation data and literature on the distribution of Pond Bat suggests that the species could be >1500 specimens on the territory of Ukraine. More detail evaluation of species quantity is very problematic and it needs more investigations. The question: could the Ukrainian population of Pond bats be the part of greater population concentrated on the territory of Eastern Baltic countries and Byelorussia and which exists as one the whole with places of more or less concentration, or could this population (occupying probably the territory of North-Eastern Poland and Byelorussia as well) be spatially relatively isolated ?

Status of *Myotis emarginatus* in Bohemia, Czech Republic: Distribution and Population Trends

Petr Benda¹ & Vladimír Hanák²

¹ Dept. of Zoology, National Museum (Natural History), Václavské nám. 68, CZ-115 79 Praha 1, Czech Republic

² Dept. of Zoology, Charles University, Viničná 7, CZ-128 44 Praha 2, Czech Republic

At the present time, *Myotis emarginatus* reaches in the territory of Bohemia its northernmost regular occurrence in Central Europe (up to 50°50' N). However, this occurrence was considered rare on a margin of distributional range of species, unlike the situation in Moravia and Austria, where *M. emarginatus* is relatively common species. In the last decade, this species was recorded in Bohemia on 43 localities (from these are 27 new, i.e. 56% of all up-to-date known Bohemian localities). During last 20 years, *M. emarginatus* became regularly recorded bat in Bohemia in hibernacula; within last 10 years, it was regularly recorded also in summer shelters and by netting; in 2000, it was for the first time found a nursery colony. In the last quarter of XXth century, *M. emarginatus* was probably spread (1) to Eastern, North-Eastern and Central Bohemia from Northern and Central Moravia, and (2) to southern and South-Western Bohemia from Upper Austria or from Bavaria. Two of winter shelters of *M. emarginatus* in Bohemia (one cave and one artificial space) we can consider as mass hibernacula of the species (highest numbers of hibernated bats was 38 and 70 individuals, respectively); in these hibernacula, numbers of hibernating bats have increased since 1980s and in 1990s. In Bohemia, *M. emarginatus* is inhabitant of middle elevations, with average locality altitude ca. 460m a.s.l. (of winter record ca. 480m a.s.l.; of summer record ca. 430m a.s.l.). As in more to south situated regions of continuous occurrence of *M. emarginatus*, in Bohemia is its distribution in relation to distribution of karst and pseudo-karst phenomena, and it is in positive correlation with the occurrence of relatively commonly distributed *Rhinolophus hipposideros*.

Record of *Hypsugo arabicus* from Baluchistan, Iran, with Remarks on Its Ecology and Systematical Status

Petr Benda¹, Michal Andreas² & Antonín Reiter³

¹ Department of Zoology, National Museum (Natural History), Václavské nám. 68, CZ-115 79 Praha 1, Czech Republic

² Agency for Nature Conservation and Landscape Protection of the Czech Republic, Kališnická 4-6, CZ-130 00 Praha 3, Czech Republic

³ South-Moravian Museum, P_ emyslovc_ 6, CZ-669 45 Znojmo, Czech Republic

Up to now, *Hypsugo arabicus* is a bat species known only from mountains of the North-Eastern Oman, Arabian Peninsula. In the course of a recent expedition to Iran, twelve individuals were netted in Southern Baluchistan; it represents the first record of the species from Iran and from the mainland Asia, respectively. The bats were caught above a rest pool of periodical river, that was surrounded by lowland desert and semi-desert habitats (ca. 130m a.s.l.). Similarly as in other species of eptesicini-pipistrellini clade, *H. arabicus* is an aerial hawk: as the diet analysis has shown, diet of this species consist mostly of Auchenorrhyncha and small representatives of Coleoptera; additionally the diet is composed by Hymenoptera, Blattoidea and some others insect groups. The species *H. arabicus* is considered as a member of the *H. savii* group; together with Saharo-Sindian species *H. bodenheimeri* and *H. ariel*, it is included into *ariel*-subgroup. All three species of this subgroup are considered as possibly conspecific (senior synonym is the name *H. ariel*). Although among these three species significant differences in colouration, external and/or cranial dimensions and dentary constitution are not present, the distinctness has

been found in penial anatomy. The validity of species status of *H. arabicus* has been confirmed; however, *H. bodenheimeri* is suitable to consider conspecific with *H. ariel*.

The Wintering Bats in Selected Historical Monuments of the Gdansk Region , Northern Poland

Aleksandra Benedycka¹, Anna Biala¹ & Krzysztof Kniec²

¹ Dept. of Cytology and Genetics, University of Gdansk, PL-83-110 Gdansk, Poland

² Dept. of Animal Physiology, University of Gdansk, PL-83-110 Gdansk, Poland

The aim of the study was to determine the species composition of wintering bats in Pomeranian region (Poland) and to evaluate the importance of particular shelters for bat populations. The census was done during winters 1989-2002. We checked up 32 potential hibernacula (forts, bunkers, cellars and a natural cave). In the present paper we analysed data from 5 historical monuments of the Gdansk region according to the historical and cultural meaning: forts of Reduta Napoleonska (census since 1989), Wislouwscie Fortress (census since 1994), cellar of the presbytery in Frombork (census since from 1995), Bastion of St. Gertruda (census since 1998) and Teutonic Castle in Malbork (census since 2001). We recorded the presence of the 8 following species: *Myotis myotis*, *M. nattereri*, *M. daubentonii*, *M. dasycneme*, *Eptesicus serotimus*, *Pipistrellus pipistrellus* sensu lato, *Plecotus auritus*, *Barbastella barbastellus*. The highest number of hibernating bats during the study period was recorded in Malbork Castle (maximally 191 individuals, 6 species) and in Wislouwscie Fortress (maximally 115 individuals, 4 species). These objects are the most important bat winter roosts in the Gdansk region. The population trends are different in particular localities, however the total number of bats in all localities is increasing. The protection of the above mentioned objects has to be a compromise, taking into account their natural and historical values.

Flight Activity of Bats at the Entrance of a Natural Cave

Hana Berkova^{1,2}, Jan Zukal¹ & Zdenek Rehak²

¹ Institute of Vertebrate Biology, Academy of Sciences of the Czech Republic, Kvetna'8, CZ-603 65 Brno, Czech Republic

² Department of Zoology and Ecology, Faculty of Science, Masaryk University, CZ-603 65 Brno, Czech Republic

Activity patterns of bats were investigated at the entrance of a natural karstic cave (Katejnská cave, Czech Republic). The activity was recorded automatically with a double infra-red light barrier allowing discrimination between those bats leaving and entering the cave. The five most abundant bat species were *Myotis myotis*, *M. emarginatus*, *M. daubentonii*, *M. nattereri* and *M. bechsteinii*, as revealed by netting. Five periods were defined on the basis of bat flight activity: a) Hibernation period (November - late March), with very low activity. b1) Departure period 1 (late March - mid April), with intensive departure during the first quarter of the night. b2) Departure period 2 (mid April - beginning of June), with departure activity in the first quarter, and a small number of bats entering the cave in the fourth part of the night. The peak of activity was in the second part of the night. c) Summer period (mid June - mid July), with low activity. d) Autumn activity (late July - late October), with very high activity and increasing number of bats entering the cave. The peak of activity was around midnight. There was a positive correlation between the number of bat passes through the entrance and outside ambient temperature and a negative correlation between the number of passes and barometric pressure. Rain had no significant effect on the level of bat activity.

Myotis punicus, Anew Mediterranean Species in Corsica

Grégory Beuneux

Groupe Chiroptères Corse, 7bis rue du Colonel Feracci, F-20250 Corte, France. Gregory.beuneux@free.fr

The presence of the two sibling species *Myotis myotis* and *Myotis blythii* in Mediterranean islands has always been strongly debated. Arlettaz (1995) described these as belonging to the North African form of *Myotis myotis*. Nowadays, owing to recent works in genetics, a new Mediterranean species is identified: *Myotis punicus* (Felten, 1977). *Myotis punicus* is distributed in North Africa and in some

Mediterranean islands (Corsica, Sardinia and Malta). No easy morphological criteria is presently available to distinguish *Myotis punicus* from *Myotis myotis/blythii*. So genetic analysis is required.

The poster presents available information in Corsica concerning the distribution, status and ecology of *Myotis punicus*. *Myotis punicus* is found throughout the island (0 to 1480m) but is weakly represented (ca. 3000 individuals). The presence of this species is recorded in 69 roosts and 29 different biotopes. Four maternity colonies are known (generally mixed colonies with *Miniopterus schreibersii*, *Myotis capaccinii* and *Rhinolophus euryale*) and concerns ca. 500 females of *Myotis punicus*. Two autumnal transit roosts have been identified. No winter roost is known in Corsica. In Corsica, the life cycle of *Myotis punicus* is characterized by an early breeding season (the end of May to the end of June). As soon as the end of July, young can forage and disperse. Mating seems to take place at the beginning of August. *Myotis punicus* prey on 8 distinct arthropod taxa. Open areas and hedgerows seem to be the most appropriate foraging habitat according to this diet.

A Study of the Ecology of the Lesser Horseshoe Colony at the Summer Roost in Co. Clare, Ireland

Sinead Biggane & Jimmy Dunne

National University of Ireland, Department of Zoology, N.U.I., Galway, Ireland.

The Lesser horseshoe bat *Rhinolophus hipposideros* is the only member of the Rhinolophidae to occur in Ireland. It is confined to the western side of the country where it is considered relatively common. This study is based at a maternity roost at Dromore, Co. Clare. The building is an old stables which has been used by the bats for many years. At least three hundred bats occupy the roost during the summer making it internationally important. In 1998 the Heritage Council purchased the building in order to protect the colony. The bats occupy the hayloft portion of the stables, which date back to the 1900's. The colony has been investigated since the 1980s by the zoology department, NUI Galway. The diet and foraging behaviour are currently being studied using faecal analysis and radio-tracking. Eleven females were radio-tracked during the summer of 2001. The radio-tracking revealed the most commonly used commuting routes. Foraging took place in Dromore wood, a predominantly broadleaved woodland adjacent to the roost. Certain areas within the wood were selected over other areas. Two buildings were identified as night roosts and satellite roosts. The results show that the bats use linear landscape features such as stone walls, hedgerows and trees in order to commute to their foraging areas. The radio-tracking is continuing during 2002. The diet consists mainly of Nematoceran Diptera, Lepidoptera, Trichoptera, Coleoptera and Neuroptera. The results will form the basis of a management plan for the conservation of this important roost.

The Roost Preference of *Nyctalus noctula* in Summer and the Ecological Background of Their Urbanization

Zoltán Bihari

University of Debrecen, Böszörményi út 138., H-4032 Debrecen, Hungary.

bihari@helios.date.hu

The paper summarises the investigation of roost-selection of *Nyctalus noctula* (Schreber, 1774) in panel buildings and trees in Hungary. From 1997 September until 1999 July we explored 142 roosts on a 103 ha large housing estate and 21 roosts on a 30 ha large park. In the blocks of flats bats prefer roosts at the height of 6-8 metres (64 % of the roosts) without any seasonal differences. Results show that there are no roosts below the height of 3 metres. The width of used entrance is minimum 19 mm. The position of vegetation and road around the buildings do not influence the roost selection. In the summer 35 % of the roosts are situated on the western walls. The rhythm of temperature fluctuation in that side best corresponds to the daily life cycle of bats. The density is 24 ind./ha, which is higher than in a natural forest, due to the possibility of dense roosts. 594 trees with more than one metre trunk-circle were examined in the Nagyerdő forest. My data suggested that the choice of roosts is not dependant on the species of the tree. The entrances of the roosts can be found at 4-15 meters height. No significant preference may be shown at any height. The direction of the roost entrance shows no significant preference as to the point of the compass. All known roosts have a round openings made by woodpeckers with a diameter of 4-5 cm. Noctule bats tend to choose entrances more or less pointed to the ground. The roosts are situated at the

height of 4-15 metres in case of both housing estates and forests, hence the choosing of roosts is similar in this respect. In housing estates the openings of roosts have the size of 19-50 mm, while in the forests 30-50 mm. There are small, only few centimetres large spaces in the panel crevices and tree-hollows. Both types have entrances on a vertical object (wall, tree). Bats living in forests can inhabit only in shaded hollows. In the housing estates *Noctule* bats prefer the western walls, where the correlation of the temperature fluctuation is the strongest with those in the tree-hollows.

Metapopulation Structure of *Rhinolophus ferrumequinum* in the Carpathian Basin

Zoltán Bihari

University of Debrecen, Böszörményi út 138, H-4032 Debrecen, Hungary. bihari@helios.date.hu

Roost utilisation by *Rhinolophus ferrumequinum* (Schreber, 1774) was investigated between 1984 and 1998 in North-Eastern Hungary. Exploration of summer and winter roosts, monitoring and bat-banding were implemented to find movements between the colonies. Data on roost utilisation by this species in South-Eastern Slovakia, collected in a similar way, were included for comparison. Twenty two marked bats were recaptured. The studied bats created nursery colonies in Hungarian churches and moved to Slovakian mines and caves to hibernate in winter. The population used two main hibernacula, two large nursery roosts and one temporary-roost, but several other roosts were also visited. *R. ferrumequinum* living in SE Slovakia and NE Hungary formed probably a separate population on the northern edge of the species range. This population is a part of the metapopulation of the species existing in the Carpathian Basin. The study population inhabited a well determinable region. The study population now living in an area of 5180 km², consists of 350 individuals, but it increases up to 500 after the juveniles are able to fly. This indicates a bat density of 0.0005 specimens per ha. This low density is explained by the very few underground roost possibilities. This region is suboptimal from the point of view of winter roost availability. The fact that bats migrate from here to longer distances away (60-80 km) than in other regions (20-30 km) also indicate the suboptimality. This leads to the conclusion that greater horseshoe bats living in the investigated region should be treated as a homogeneous unit. Therefore, the efficient protection of the bats can be achieved only by the protection of all known roosts.

The Use of Echolocation Sounds in Southern Africa

Pieter Blondé & Paul Van Daele

Vleermuzienwerkgroep Natuurpuntvzw, Natuurpunt Oost Vlaanderen, Kortrijksepoortstraat, SA-9000 Gent, South Africa. pieterblonde@hotmail.com, pvdaele@zamnet.zm

The IUCN (International Union for Conservation of Nature and Natural Resources) Red List recognises that lack of data is a major problem for the development of conservation plans (Fenton & Rautenbach 1998). The use of echolocation sounds can provide a lot of these data. Recent technology now permits the direct identification of bats by analysing echolocation signals; meaning that capture is not always necessary. In many cases, the analysis of bat calls makes identification easier and often may be the only means available to identify some species. Scientific experiments using bat calls in Southern Africa are scarce and data on echolocation calls of local species is largely lacking (Taylor 1999). The first recordings of African bats came from a study by Fenton & Bell in 1981, in which 23 Zimbabwean bats were analysed. Up to now, just six international articles have been written on identification of Southern African bats, based on time expansion signals. In 1999, Taylor compiled all the available data on the echolocation of 37 Southern African bat species. In 2001, we made the first time expansion recordings of 14 bat species in Zambia, in order to develop field studies on bats without catching them systematically. To make it possible to compare our data with others, we tried to record sounds in as many different situations as possible: from handheld bats, bats emerging from roosts and from bats flying in a tent or room or in the open environment.

Monitoring Bat Activity by Using Band Transects

Kris Boeckx¹, Alex Lefèvre¹, Ludwig De Loose² & Els Martens³

¹ Vleermuizenwerkgroep Natuurpunt, Kardinaal Mercierplein 1, B- 2800 Mechelen, Belgium²
 Vlaamse Landmaatschappij, Gulden-vlieslaan 72, B-1060 Brussels, Belgium³ Ministry of the
 Flemish Community, Nature Division, Koning AlbertII-laan 20 bus 8, B-1000 Brussels, Belgium

During the last decades an intensified agricultural land use and changing of agricultural techniques has had a major impact on many habitats in many countries. The common practice of redistribution of land into larger lots (re-allocation) is suspected to have had a negative impact on the overall species abundance and densities. In order to prevent this in the future the Flemish government ordered Natuurpunt to carry out a study in Herenthout, in the northern part of Belgium. The study includes data on habitat preferences by bats in a mainly agricultural region that is characterised by landscape structures such as woodland edges, hedges, tree lanes and hedgerows. Between May and October 2001 a study was conducted for studying bat activity correlated to the different landscape structures in that area (around 1500 ha). Band transects were used to study bat activity. 10 routes were chosen at random. A band transect consisted of 30 stops with a distance of 50 m between each point, or 1.5 km for a full transect. On each stop, bat activity is recorded during 3 minutes. With a D240 bat-detector, connected to a mini-disc recorder, all activity was recorded in heterodyne as well as in time-expansion. Recordings were analysed by BatSound Pro. Each transect was monitored 3 times during the summer season. On a total of 900 observation points, 348 (38.7 %) had no bat activity; in total 674 bats were recorded and allocated to 5 different species: *Pipistrellus pipistrellus* (599 observations, 89%), *Eptesicus serotimus* (n = 41, 6.1%), *Nyctalus noctula* (n = 8, 1.2%), *Myotis daubentonii* (n = 4, 0.6%), *Myotis mystacinus* vel. *brandtii* (n = 3, 0.5%) and Chiroptera species (n = 19, 2.8%). At the same time, we surveyed the whole region at random, using the same D240 bat detector technique. During 20 evening survey's, 192 bats (belonging to 6 species) were recorded. By using the band transect method, we can clearly indicate where bats are preferentially hunting. We believe this method to be a favourable tool in landscape management and planning.

Results of Long-term Study of Bats in Smolinskaya Cave, Middle Urals, Russia

Vladimir Bol'shakov¹ & Oleg Orlov^{1,2}

¹ Institute of Plant and Animal Ecology, 8 March street. 202, RU-620144 Ekaterinburg, Russia

² Ural State Pedagogical University, 8 March street. 202, RU-620144 Ekaterinburg, Russia

First data about bats in Smolinskaya cave are dated by the end of the XIX century. In 1956 Petr Strelkov reported the presence of 852 bats in this cave: 680 *Myotis dasycneme*, 170 *M. daubentonii*, 2 *M. brandtii*. Our research in Smolinskaya cave started in 1958. In 1950-s - 1960-s the number of wintering animals decreased dramatically because of regular presence of tourist groups in the cave. During winter of 1960-1961 the number of animals decreased 6 times. At the same time we found a great number of bat killed by sticks and stones. In 1964 the number of wintering bats was 80. The studies of bats in Smolinskaya cave resumed in winter 1996-1997. The maximum number of wintering animals was registered in winter 1998-1999: 1730 *M. dasycneme*, 111 *M. daubentonii*, 4 *M. brandtii*, 2 *Eptesicus nilssonii*. Analysis of seasonal dynamics of the colony of bats indicated that disintegration of wintering colony occurs usually in the beginning of May. Males stay in the cave in summer. Many animals inhabit the small grottos and holes in the tress in the surroundings of the cave. The establishment of winter colony begins in September and lasts until the end of November. During the period of wintering animals gradually move to the grottos with the lower temperatures.

Relation between Bats, Climate and Air Microorganisms in a Cave from Romania

Daniela Borda¹ & Cristin Borda²

¹ Speleological Institute "Emil Racovitza", Clinicilor 5, RO-3400 Cluj-Napoca, Romania

² University of Agricultural Sciences and Veterinary Medicine, Faculty of Veterinary Medicine, Hygiene Department, Manastur 3-5, RO-3400 Cluj-Napoca, Romania

A survey of bats dynamics, and of the temperature and humidity was undertaken monthly during a one year period in a Romanian cave. Some air microorganisms were also seasonally determined. The cave investigated is in the Somesan Plateau (N-W Romania), a limestone area, at 319 m a.s.l.. In the vicinity of

the cave there are potatoes and maize cultures, meadows, plum orchards and also forests, being thus an excellent hunting and feeding habitat for bats. Minimum 4 species of bats populate this cave. The most abundant is *Myotis myotis*, which represents a permanent inhabitant with nursery and winter colony; the second one is *Miniopterus schreibersii* who visits the cave in autumn, and forms a mating colony. *Rhinolophus ferrumequinum* and *Rhinolophus hipposideros* were recorded singly next to the greater mouse-eared bat colony, sometimes in winter. Near the bats colonies the temperature varies between 1°C and 11.6°C (6.3°C close to the hibernating bats) and the relative humidity was high all over the year (80% - 100%), the lowest values being registered in winter. The location of the colonies in the cave was determined by these two physical factors and also by the structure of walls and the ventilation system. Concerning the air microorganisms our investigations showed the direct relation with bats in the cave, the most pronounced air infestation being near the nursery colony, in the summer period. The total count plate mesophylic aerobes was very high (11317), followed by Fungi (3929 cfu/m³), *Staphylococcus* spp (1152 cfu/m³), *Streptococcus* spp. (1152 cfu/m³) and Gram negative bacteria (209 cfu/m³).

A Study of Bats in Barn Conversions in Hertfordshire

Patty Briggs

Hertfordshire Biological Records Centre and Hertfordshire County Council, Claybury Cottage,
8 Sparrows Herne, Bushey, WD23 1FU Hertfordshire, England

Many timber framed barns are used by bats that roost in mortice joints within the timber structures. Most of these barns are now redundant and are being converted into dwellings. Attempts have been made to give advice on how to accommodate bats in these conversions. This paper examines what has happened to the bats following conversion of twenty-nine of the forty barns where bats have been previously recorded. Bat roosts have been lost at twenty of the twenty-nine developed sites. Eleven barns remain undeveloped; all have bats still present. Only two of the eleven developed Natterer's sites were found to have bats still present. These two sites had been provided with recessed entrances which allow the bats access to several mortice joints. Bats have been found to accept a reduction in the number of available mortice joints. However, breeding has not yet been proved so this type of provision may not be maintaining the colony at a favourable conservation status. Bat lofts have not been successful for this species; they prefer an open flight path into barns which can be maintained by the use of recessed entrances. Care needs to be taken to ensure that the recessed area for the bats does not suffer from light pollution. Brown long-eared bats (*Plecotus auritus*) are using twenty-five sites. Twenty have been developed. Bats were absent in fourteen and present in only two. Bats were still present at all of the undeveloped sites. The provision of a bat loft for Brown long-eared bats *Plecotus auritus* has been found to be an almost complete failure. Pipistrelle *Pipistrellus* sp roosts were found at eleven sites. Six have been developed and bats were absent from all but one. All five undeveloped sites still had bats present. Early action at the planning stage prior to development is most likely to result in a conversion that is sympathetic to bat usage.

Bats of Natural and Artificial Caves of Georgia

Alexander Bukhnikashvili, Joseph Natradze & Andrei Kandaurov
Institute of Zoology of Georgian Academy of Science, 380062 Tbilisi, Georgia

From 32 bat species living in Caucasus, in caves are registered 17. 9 species of them inhabit Georgia, in particular: *Rhinolophus ferrumequinum*, *R. hipposideros*, *R. euryale*, *R. mehelyi*, *Myotis blythii*, *M. mystacinus*, *Pipistrellus pipistrellus*, *Plecotus austriacus*, *Miniopterus schreibersii*. In Georgia are about 2000 caves. From the data gathered by laymans, it is known, that in 68 natural caves there were earlier bats, in some caves there were even large congestions. Artificial caves investigated worse, the data were available only from two items, David Gareji and Vardzia. Since 1998 we start regular researches the caves. More than 200 caves was investigated. In 11 natural and 11 artificial caves, bats were found. The most often inhabitants of caves are *R. ferrumequinum*, *R. hipposideros*, *M. blythii*, *M. schreibersii*. Nowadays *M. schreibersii* meets less often, than earlier. Nursery colony of *R. ferrumequinum* 900-1100 spec., *M. blythii* 500-600 spec. (largests in Georgia); and wintering colony of *R. ferrumequinum*, *R. hipposideros*, *M. schreibersii*, *R. euryale* was marked. Also was found constant colony *R. euryale* 200 spec. this year. *R. mehelyi* is not found yet by us. As result of all our investigation, previously we offer the following

conservation status: *R. ferrumequinum* NT, *R. hipposideros* NT, *R. euryale* EN, *R. mehelyi* CR, *M. blythii* NT, *M. mystacinus* DD, *P. pipistrellus* LC, *P. austriacus* DD, *M. schreibersii* EN.

The UK's National Bat Monitoring Programme (NBMP)

Colin Catto

The Bat Conservation Trust, 15 Cloisters house, 8 Battersea Park Road, SW8 4BG London, England

The UK Bat Monitoring programme began in 1997 and is run by the Bat Conservation Trust with the Joint Nature Conservancy Council the main governmental funder. Summer colony, field and hibernation surveys form the main monitoring methods. Heterodyne/frequency division detectors were introduced onto field surveys in 2002 allowing a more objective assessment of species identification. Power statistics demonstrate a 90% confidence in meeting RUCN 'Alert' targets for population declines based on present annual data collection levels for most species/surveys. Population indices are constructed for each species/survey. The programme delivers c. 11,000 hours of volunteer effort throughout the UK annually and volunteer management is identified as critical to the success of the programme. Volunteer turnover requires constant recruitment to maintain present survey levels. In 2002 the pilot 'Sunrise Survey', requiring no equipment/previous bat experience for participation, opened the programme to novice surveyors. Workshops are run throughout the UK to increase existing surveyor effectiveness, especially on detector-based field surveys.

Spatial Structure of a Bat Community and Dynamics of Bat Activity in a Forest-Agriculture Landscape of Reda Valley, Northethn Poland

Mateusz Ciechanowski & Tomasz Zajac

Department of Vertebrate Ecology and Zoology, University of Gdansk,
al. Legionów 9, PL-80-441 Gda_sk, Poland. matciech@kki.net.pl

The aim of this study is to describe changes in community structure, feeding ground preferences and activity of co-occurring bat species, all the year round, except the hibernation period. Bat calls (echolocation and social) were recorded with an ultrasound detector (Pettersson D-230) and a tape recorder, once per decade from April to October. We made recordings in three, closely located water bodies every night. We also captured bats in mist nets, measured water and air temperature, wind speed and (using the sticky traps) insect abundance. Ten bat species were recorded in the study area. Over the river in a forest ecotone *Myotis daubentonii* and *Nyctalus noctula* dominated, over the pond in an open pasture - *N. noctula* and *Pipistrellus nathusii* (with a significant share of *Eptesicus serotinus*), while over the pond in an alder tree stand - *P. pipistrellus* and *M. daubentonii*. Three co-occurring species of pipistrelles preferred different feeding grounds (*P. nathusii* - the pasture pond, *P. pipistrellus* and *P. pygmaeus* - the forest pond and the river). In the autumn and early spring, when migratory *P. nathusii* left the area, *P. pipistrellus* utilized also the pasture pond. We found a significant correlation between air temperature and bat activity, however it differed in particular species. *N. noctula* was the most thermophilous (Spearman rank correlation, $r = 0.50$, $p = 0.002$), *M. daubentonii* was the least thermophilous ($r = 0.35$, $p = 0.05$; it foraged also in sub-zero temperatures in early spring). We recorded a distinct increase of *M. daubentonii* activity in September, what could be associated with pre-hibernation fat accumulation. The similar autumn peaks of activity of *P. pipistrellus* and *P. pygmaeus* were connected with their mating period. The long-distance migrant *N. noctula* showed the distinct decrease of activity in August, probably associated with its departure. Night dynamics of particular species' activity varied between localities and changed during the season. *M. daubentonii* was captured in mist nets mainly less than 1 meter above the water surface, while *Pipistrellus* spp. - more than 1 meter above it ($\chi^2 = 25.11$, $p < 0.0001$). The insect abundance was significantly higher near the water surface than 4 meters above (Mann-Whitney test, $U = 11.5$, $p < 0.02$).

Phylogeography of the Longfingered Bat *Myotis capaccinii* in the North-Mediterranean Area: Two Genetic Structures and Probably Two Histories

Emmanuel Cosson, Josiane Aubert, Marie Zimmerman, Henri Descimon & Eric Faure
EA Biodiversité, Université de Provence, Case 5, place Victor Hugo, F-13331 Marseille cedex 03, France.
Cosson@up.univ-mrs.fr

The Long fingered bat *Myotis capaccinii* (Bonaparte, 1887) is a rare cave-dwelling bat which hunts above water of lakes and rivers. In Europe, it lives around Mediterranean sea with an extension in the low Danube basin. It also lives from near-east regions to the western margins of central Asia. In this study, we tried to reveal the genetic links between the groups of reproduction in the north part of the Mediterranean sea. The Long fingered bat is known as an phylogenetically "old" species. The samples come from Eastern Spain with Balearic Islands, Southern France including Corsica, Northern Italia, Sardinia, Monte-Negro, Serbia, Central and Southern Bulgaria. Unfortunately, the samples from Algeria and Israel didn't give any results when extracting DNA. We sequenced parts of two mitochondrial genes: cytochrome b (420 bp) and control region (380 bp). Analysis give trees obtained by several methods as distance methods (NJ, MSN), parcimony. The two genes show a clear bipartition of the Mediterranean basin with an eastern group composed by North Italia and Monte-Negro in a clade, and Serbia, Bulgaria and Greece (one cyt b sequence from Gene Bank) in a second one. The western group is composed by the other samples. The two groups differed by the genetic structuration. The eastern group is clearly structured with high bootstrapping values on nodes. The clades of this group are consistent with the geography of the region geographically separated by mountains. The western group is not as well clearly structured, and many clades are not well supported by bootstrapping values. The branching of the insular populations is frequently confused. Generally, all the individuals of a same colony are grouped together in trees. This is probably due to a phylopatric behaviour of the species. Compared with other bat species, the long fingered bat seem to be lied to an localised area where reproductive conditions are favourable. The females, studied by the mean of mitochondrial DNA, seems to be mostly sedentary and must return year after year in the same cave. These observations are important for the conservation strategy of this rare species in Europe.

Mouse-eared Bats *Myotis myotis* and Orchards: Ways to Coexistence?

Christian Drescher & Oskar Niederfriniger
South Tyrolean Nature Museum, Bindergasse 1, I-39100 Bozen, Italia

Mouse eared bats are at the same time reliant on man (for shelters) and adversely affected by him (e.g. landscape destruction). This is a common situation for most of the Central-european bat species. In South Tyrol however large maternity colonies of mouse eared bats are often situated amidst zones of intensive apple growing and they are usually thriving well. A telemetry study conducted in the months of July and August of the last two years shows strong foraging activity in the orchards. Beside this, the greater mouse eared bats also used deciduous shrub forests, a more traditional habitat. Mature forests, meadows and pastures were scarcely used. Arlettaz (1995) showed that greater mouse-eared bats prefer intensive to traditional orchards. But intensification in apple growing is an ongoing process. So it is crucial to know if the bats can keep pace with it. At present, we have only hints, which suggest that mouse eared bats use more often orchard plots with high grown apple trees (more traditional) than ones with small trees (intensive orchards). Should this hints become proofs, it should be necessary to convince farmers that hunting bats in their orchards are beneficial to them. This should be based on the following two arguments: a) bats (in general) are beneficial organisms; b) bats sell: growing apples bat-friendly can be a valuable selling argument.

Arlettaz R., 1995. Ecology of the sibling mouse-eared bats (*Myotis myotis* and *Myotis blythii*). Horus Publ. Martigny, 223p.

Foraging Activity of Serotine Bats *Eptesicus serotinus* in Different Foraging Sites

Elbieta Fuszara

Dept. of Behavioural and Evolutionary Ecology, Institute of Ecology,
Polish Academy of Sciences, PL-05-092 _omianki, Poland. e_fuszara@poczta.onet.pl

The poster presents results of a study of the foraging activity of serotine bats. All-night recordings of echolocation activity were taken and insect samples were collected at sites located in different habitat types within 3 km from a known maternity roost of the species. Each site was visited 8 times, i.e. once every two weeks between 15 May and 15 September. The amount of time spent by bats at different foraging sites and the number of feeding buzzes were compared, and their dependence upon the abundance of prey, time of night and time of the season was examined. Differences were found between habitat types, between different sites in the same habitat type, and also between different visits to the same site.

Body Weight Changes in Adult Male Daubenton's Bat *Myotis daubentonii* during Summer

Jorge Encarnação, Markus Dietz & Uwe Kierdorf

Department of Animal Ecology, Justus-Liebig-University of Giessen,
Heinrich-Buff-Ring 26-32, D-35392 Giessen, Germany

Body weight changes of adult and juvenile male Daubenton's bat during summer were studied in a summer habitat in Hesse (Germany) in the years 1998 - 2001. Animals from the resident population were regularly captured along the flightpath from April to October, and body weight was determined using a digital balance. Median values of body weight of adult individuals differed significantly between fortnightly periods (Kruskal-Wallis-ANOVA by ranks: $H = 141.75$, $p < 0.001$). Median body weight increased from 7.0 g in the second half of April to 7.8 g in the first half of May (U-Test with Bonferroni correction: $p < 0.001$). Between the second half of May and the first half of August, median body weights fluctuated between 7.8 g and 8.3 g. From the first half of August to the second half of September, median body weight significantly increased from 8.0 g to 9.3 g (U-Test with Bonferroni correction: $p < 0.01$). Highest median body weight (9.6 g) was recorded in the second half of October. Thus, whereas body weight of adult males remained fairly constant during early and mid summer, a pronounced increase occurred in late summer/early autumn. Median body weight of juvenile males ranged between 6.5 g in the first half of July and 8.5 g in the second half of October. Differences in median body weights over the studied period were significant (Kruskal-Wallis-ANOVA by ranks: $H = 21.70$, $p < 0.01$). During the month July, August, and September, median body weight of adult males was always significantly higher than that of juveniles (U-Test with Bonferroni correction: $p < 0.001$), whereas in October the difference was no longer significant.

Significance of Water Bodies for Insectivorous Bats in a Semi-humid Tropical Forest in the Yucatan, Mexico

Mary Carmen García Escalona, Enrique Escobedo Cabrera & Sophie Calmé

El Colegio de la Frontera Sur, Carr. Chetumal-Bacalar km 2, 77000 Chetumal, Quintana Roo,
México. natalusstramineus@yahoo.com

The region of the Calakmul Biosphere Reserve is characterized by a dry season during which water is restricted to natural rain collectors called locally "aguadas". These conditions offer the opportunity to determine the importance of "aguadas" as open areas and water sources for bats. During the dry season of 2002, we compared species richness and activity of insectivorous bats in "aguadas", forest gaps and continuous forest (control) in the Calakmul region. We called a unit a combination "aguada"-gap-control, and four of these units were established. The mean distance between each element of a unit was 100 m. We realized five samplings of each unit from March to May. For a given unit, sampling was simultaneous, and lasted for 1.5 h using the ANABAT II system. We evaluated bat activity with the acoustic activity index (AAI) proposed by Miller (2001). For both species richness and AAI, we found a striking difference between "aguadas", gaps and controls. Species richness (N) and AAI were significantly higher in "aguadas" ($N=10$; $AAI=120$), followed by gaps ($N=4$; $AAI=22$), and finally controls ($N=1$; $AAI=1$). These differences

might be due to the differential disponibility of insects, though it remains to be demonstrated. Our results highlight the importance of "aguadas" in areas where water is discretely distributed over the landscape.

Miller B.W., 2001. A method for determining relative activity of free flying bats using a new activity index for acoustic monitoring. *Acta Quiropterológica*, 3(1):93-105.

The Status of Forest Bats in the Bükk Mountains, Northeast Hungary

Péter Estók

University of Debrecen, Dept. of Ecology, Egyetem tér 1, H-4032 Debrecen, Hungary.

The Bükk mountains, situated in North-East of Hungary are one of the richest regions in bat species in the country. The poster is reporting on the results of a bat research programme, that has been running here since 1994 aiming mostly at forest bats. 23 of the 27 Hungarian bat species were mist netted during nearly 200 nights. The observations took place in different habitats: Aegopodio-Alnetum, Aconito-Fagetum, Melittio-Fagetum, Querco-petrae-Carpinetum, Quercetum petraeae-cerris, and in an urban environment, a 14 hectare park in the city of Eger. The most common species were: *Nyctalus leisleri*, *Myotis myotis*, *M. bechsteinii*. Substantial numbers of *Barbastella barbastellus*, *Plecotus auritus*, *Pipistrellus pipistrellus*, *Myotis brandtii*, *M. mystacinus* and the recently described *Myotis alcahoë* were mist netted at different sites. Several faunistical rarities were observed like *Hypsugo savii*, *Pipistrellus kuhlii*, *Nyctalus lasiopterus* and *Vespertilo murinus*. Specific seasonal changes in the sex ratio of *Myotis daubentonii* and *M. dasycneme* were found. Several species showed a conspecific occurrence arising from similar habitat preference. Data obtained from research help us to establish the effective strategies of bat protection.

Conclusions of Successful Settlements in Bat Houses

Csaba Endre Fehér

White Raven Nature Conservation Association,
Csabagyongye u. 50/A, H-8360 Keszthely, Hungary

From December of 1997 to April of 1998 in the 140 km² marshy territory of Small-Balaton bird's reserve 100 small and 70 large bat houses were installed. During the preceding research on bat fauna of this region of the Balaton Uplands National Park 10 bat species were found. Typical house-dwelling species, such as *E. serotinus*, *P. austriacus*, *M. myotis*, occurred in the outer areas. Non-typical house-dwelling (settling in tree-holes, too) species were *P. pipistrellus*, *P. pygmaeus*, *P. nathusii*, *N. noctula*, while rare species were *V. murinus*, *M. nattereri* and *P. auritus*. The lack of roost was conspicuous especially in the case of *P. nathusii*, because its specimens often occurred even between wooden planks of high-stands, which were exposed to harsh weather and disturbance as well. Most of our bat houses were constructed to meet the needs of this small-bodied species. During the first year in the installed small bat houses generally one or two settled *P. nathusii* were observed, but in the large ones, only two months after the installation, two nursery colonies (approx. 300 specimens) of *P. nathusii* were found. Since 1998 the number of successful settlements in bat houses has been growing continuously, in addition to *P. nathusii*, *P. pipistrellus*, *P. pygmaeus* and *N. noctula* nursery colonies have also settled. In spring of 2002 the occupation ratio of bat houses is 81,4%.

Mating Behaviour of the Brown Long-eared Bat *Plecotus Auritus*

Joanna Furmankiewicz

Department of Avian Ecology, Institute of Zoology, University of Wrocław,
Sienkiewicza 21, PL-50-335 Wrocław, Poland. asiaraj@biol.uni.wroc.pl

In 2000-2002 mating behaviour of brown long-eared bat was studied in the city park in Wrocław and in two abandoned mining shafts in Sudety Mts. (SW Poland). Bats were netted, sexed and weighted, and the shape and colour of cauda epididymides was used to assess their reproductive status. 164 bats were banded using aluminium rings. The recapture rate was 24.4%. Social calls were recorded with the DAT recorder connected to the bat detector. In autumn 2001 and spring 2002 seven males and two females were radio-tracked using 0.52 g radiotransmitters. In early spring (March, April) and autumn (September-October) bats were swarming and emitting species-specific social calls near their hibernacula. Four dif-

ferent types of social calls were emitted during songflights, while chasing and from the sites situated on the tree branches and walls inside one of the shafts. The vocal activity in early spring was ten times higher than in autumn. In spring the proportion of males with distended caudae epididymides was 84,8 % (n=92), while in autumn was 73,5 % (n=121). The radio-tracking data, collected at one of the shafts, showed that in spring and autumn bats foraged and roosted in daily shelters in the vicinity of the swarming site in the mine. They visited it on average 1,2 times during 4,3 days of observation. Some males covered up to 7 km to spend a few hours in the shaft, and the same night they flew back to their roosting places. These results demonstrated the importance of swarming sites in the studied species in spring and autumn, which are considered the mating period of brown long-eared bat. Thus the observed behaviour could be associated with mating. It also suggests that spring could be the main mating period for this species. The radio-telemetry project was financed by the State Committee for Scientific Research - grant KBN 6P04C 112 21.

Changes in the Number of Bats in a Colony and the Timing of Evening Emergence

Maciej Fuszara

Department of Population Ecology, Institute of Ecology, Polish Academy of Sciences,
PL-05-092 _omianki, Poland. maciek_fuszara@poczta.onet.pl

The poster presents changes in the number of bats occupying a maternity roost during the summer season. Three consecutive seasons are compared and the influence of weather on the colony's dispersal is briefly discussed. The timing of the evening emergence of bats and its dependence on temperature, cloudiness, wind speed, precipitation, time of sunset and the number of bats in the colony are also presented.

Ecomorphology of *Myotis daubentonii* and *M. lucifugus*: A comparison

Jiri Gaisler & Jan Zukal

Institute of Vertebrate Biology, Masaryk University, Kotlarska 2, CZ-61137 Brno, Czech Republic

The Palearctic Daubenton's and the Nearctic little brown bats are very similar in their ecology and morphology and have traditionally been included into the subgenus *Leuconoe*. Recent molecular genetic analysis by Ruedi & Mayer (2001), however, did not support this division of *Myotis* into subgenera and placed *M. daubentonii* into quite another cluster than *M. lucifugus*. The present paper is based on an analysis of eight external and 12 cranial characters in a sample of 158 *M. d. daubentonii* and 113 *M. l. lucifugus*. Significant sexual dimorphism was found in eight of the characters in *M. d. daubentonii* and in three in *M. l. lucifugus*, hence in further analyses, males were separated from females. The two species were compared by ANOVA. Significant differences were found in all but five characters in males and in all but four characters in females; of them, mastoid and maxillary widths were common to both sexes. PCA was performed separately for external and cranial characters. Only 48 and 52 % variability was found on the first two PC axes in external characters, probably due to differences in individual measurements (the values were adopted from specimens' labels). In cranial dimensions (taken invariably by the first author) the first three axes explained 70 % of variability in both sexes. The ANOVA test on the factor scores did not reveal differences in the first axis (influenced mainly by length variables) but did so in the further two. These two axes were influenced by breadth and height of braincase, and interorbital constriction respectively. We conclude that the two species differ in the shape of neurocranium but do not differ in the shaping of viscerocranium, namely the maxillary, mandibular and dental variables. This development could have resulted from adaptation to analogous foraging strategies and diets.

The Role of Vitamin C in the Hand Rearing of Insectivorous European Bats

Donatella Gelli & S. Romagnoli

Department of Veterinary Clinical Sciences, University of Padova, Via del Bosco 11, I-50020
Montespertoli, Firenze, Italia

Authors describe clinical pathological signs observed in some hand reared European orphaned bats belonging mainly to the species *Pipistrellus pipistrellus*, *Pipistrellus kuhlii* and *Hypsugo savii*. These diseases appeared during artificial nursing, at different ages of the bats, and involved especially the skin,

the cartilaginous joints and the digestive system. All symptoms observed in these bats led the authors to suspect an ascorbic acid deficiency. The diagnostic of scurvy was only based on clinical signs as laboratory tests and radiographic findings could not be used because of the small size of these patients. However, a positive response to treatment is often the best of confirmation of the diagnostic. After addition of vitamin C to the diet of the orphaned bats, the authors obtained the complete recovery from the diseases in those patients whereas the lesions did not compromise the ability to climb and fly. After collecting the observations described in this work, authors hypothesise that ascorbic acid is essential for the growth and the development of insectivorous bats.

Evidence of Sperm Storage in *Pipistrellus kuhlii* in Western Iran

Rostam Ghorbani¹, Mozafar Sharifi², Zeinab Hemmati² & Parasto Rahimi²

¹ School of Medicine, Kermanshah Medical Science University, Iran.

² Department of Biology, Faculty of Science, Shahid Beheshti University, Kermanshah, Iran.

We documented endometrial sperm storage in the uterus of two female *Pipistrellus kuhlii* at the time (mid-December) unrelated to imminent ovulation. Packing and perpendicular orientation of spermatozoa toward the endometrium, and unsuitability of the time of copulation are used to infer that *P. kuhlii* stores sperm in Western Iran.

Habitat Changes: The Mediterranean Horseshoe Bat *Rhinolophus euryale* in Peril

Urtzi Goiti, Jose Ramon Aihartza & Inazio Garin

Department of Zoology and Animal Cell Dynamics, University of the Basque Country, 644 p.k., E-48080 Bilbao, Spain

In order to ascertain whether human-related habitat changes could be involved in the current decline of the Mediterranean horseshoe bat *Rhinolophus euryale*, we carried out two radio-tracking experiments in contrasting colonies of the Basque Country. During May 2000 nine bats of a spring colony located in a highly afforested area, where exotic plantations of pine and eucalyptus predominated, were radiotracked. Likewise, during May 2001 fourteen bats of the largest known breeding colony of the Northern Iberian Peninsula were tracked. This colony inhabited an Atlantic seminatural landscape. Results showed that the spatial foraging pattern and the habitat selection differed between both colonies. The maximum distance a bat travelled from the roost to its feeding grounds more than doubled in the first colony (10 vs. 4.8 km), mean distance being 4 times longer (5.5 vs. 1.4 km). Mean surface of foraging areas of the first colony also two-fold that of the second (94.9 vs 41.2 ha). Overlap between foraging bats was negligible in the first colony whereas it was extensive in the second. Additionally, most of bat foraging activity in the first colony occurred in exotic plantations, while this habitat was avoided in the second one, where foraging concentrated in native deciduous woodland. We think that the differences in landscape composition were responsible for the different spatial foraging behaviour found in the two colonies. The larger distances travelled to large foraging areas in the first colony suggest that it offers poorer feeding opportunities and is probably a suboptimal habitat for *R. euryale*. The spreading of the exotic plantations occurred in recent decades in the Basque Country may explain the disappearance of the species from a number of caves.

Diet Selection of *Rhinolophus euryale* in Spring

Urtzi Goiti, Inazio Garin & Jose Ramon Aihartza

Department of Zoology and Animal Cell Dynamics, University of the Basque Country,
644 p.k., E-48080 Bilbao, Spain

During May 2001 we collected faeces from 25 bats of a colony located in a seminatural Atlantic landscape in the Basque Country. Simultaneously we used Malaise traps to determine differential prey availability in the available habitats and radiotracked 13 bats to ascertain habitat use. Prey availability was recalculated weighing it according to the registered habitat use. Main consumed prey were by far small size lepidopterans (5-11 mm long), followed by scarabaeid beetles (genus *Rhizotrogus*) and Tipulidae. The selection analysis showed that bats foraged selectively precisely on lepidopterans and scarabaeids. Longterm diet studies, however, should be implemented to assess possible temporal variability.

Population Development and Present Distribution of the Most Endangered Bat *Rhinolophus hipposideros* in Southern Bavaria, Germany

Ines Hager¹, Patrizia Weiner² & Andreas Zahn³

¹ Eschenstrasse 1, D-85464 Neufinsing, Germany

² Wirtstrasse 1, D-84552 Geratskirchen, Germany

³ Hermann-Löns-Strasse 4, D-84478 Waldkraiburg, Germany

In Bavaria (Germany) the population of *Rhinolophus hipposideros* (Bechstein, 1800) declined dramatically after 1950. Between 1991 and 2000 only one reproducing colony was known. This colony, which settles in a castle on the island, Herrenchiemsee“ in Lake Chiemsee (Upper Bavaria) increased from 12 adults in 1991 to 56 in 2001. In the year 2000 however, two further smaller maternity colonies of this species were discovered. Therefore a special conservation program was financed in the same year by the Bavarian State Office for Environmental Protection. The program included systematic controls of potential roosts (e.g. churches and castles) in South-Eastern Bavaria and public relation work about this bat species. To favour the establishment of new colonies, suggestions were made to optimize roosts in the surrounding of the existing nurseries. In 2000 and 2001 altogether 110 buildings in an area of about 2000 km² were controlled. New colonies could not be detected. In 6 roosts solitary individuals or fresh faeces were observed indicating that the population was not limited to the known colony sites. In 6 other buildings old faeces indicated former roosts. In 4 roosts, that were occupied before 1990, neither bats nor fresh faeces were found. In 2002 local batworkers shall participate the conservation work to optimize roosts nearby the 3 colonies.

Aspects of the Ecology of Serotine Bats *Eptesicus serotinus* in Contrasting Landscapes

Christine Harbusch^{1,2} & Paul A. Racey²

¹ Orscholzerstrasse 15, 66706 Perl-Kesslingen, Germany

² Department of Zoology, University of Aberdeen, Aberdeen AB24 2TZ, Scotland

Two maternity colonies of serotine bats were studied in contrasting landscapes in Saarland, Southwest Germany, and in the Grand Duchy of Luxembourg. The surroundings of the first colony were characterized by mixed woodlands, the second by fields and grassland. Part of the study aimed to assess possible differences in habitat use and selection of both colonies, as well as the diet and prey selection of one colony. The main methods used for studying the activity of bats were radio-tracking of adult female and juvenile serotine bats and ultrasound detector survey in foraging habitats. The average individual home range sizes and maximum distances traveled were similar for both colonies. There was a tendency for juvenile serotines to have larger home ranges than adult females, but early volant juveniles used foraging sites significantly closer to the maternity roost than older juveniles. Radio-tracked bats of both colonies spent on average 90 % of their foraging time at distances below 1.7 km from their maternity roost. Habitat use and selection were similar for both colonies, although habitat availability was different. Habitat selection ranks as follows for the main habitat types: settlement area > woodland edges > grassland. Arable land was significantly avoided. During five years of study, faecal pellets were collected in one maternity roost and analysed. Although 18 insect families were identified, three insect orders form the key prey taxa: Coleoptera: Scarabaeidae: *Aphodius*, *Amphimallon*, *Melolontha*; Diptera: Tipulidae; Hemiptera: Pentatomidae: *Pentatoma*. During two subsequent years, detailed insect studies were carried out in the colonial home range of the studied colony. The comparison between available arthropods in the field and those identified from faecal analyses resulted in a consistent prey selection during both years. The following prey taxa were preferred: Scarabaeidae, Carabidae, Tipulidae, Pentatomidae and Ophioninae. Lepidoptera were always avoided.

Radiotelemetric Study of the Lesser Horseshoe Bat *Rhinolophus hipposideros* in Southern Bavaria, Germany

Jenny Holzhaider, Angela Kayikcioglu, Eva Kriner & Andreas Zahn

Department Biologie II, Universität München, Luisenstrasse 14, D-80333 München, Germany

Seven adult *Rhinolophus hipposideros* females were the subject of a radiotelemetric study made in 2000 and 2001. Six came from a colony at Herreninsel, a 230 ha island on Lake Chiemsee (Upper Bavaria), and the other from a smaller colony near Aschau, about twelve km northwest of the lake. The animals were tracked for up to six nights in a row. This monitoring revealed that between 44% and 71% of the nights were spent flying, and that a minimum of two and a maximum of seven different foraging areas were used. The maximum distance from the respective roosts to the hunting areas was 1.3 km (Herreninsel) and 3.6 km (Aschau). The bats foraged in all available forest types, varying from young mainly deciduous woods to mature, semi-natural beech-spruce-fir woodlands and spruce-dominated monocultures. The Aschau individual visited night roosts to take a rest, whereas the island bats always returned to their main roost to rest and presumably feed their young. Two bats surprisingly left the island, returning either later the same night or not returning until the following night. These bats did not choose the closest distance to the shore to cross the lake but flew for at least 1.5 km above the open water.

Monitoring Bats in Underground Hibernacula of the Czech Republic: 33 Years of Study

Ivan Horáček

Department of Zoology, Charles University, Vinicna 7, CZ 128 44 Praha, Czech Republic.
horacek@natur.cuni.

A greatly standardized monitoring of bat hibernacula (one control per winter only, at the first decade of February each year, visual accounts without disturbing bats) is regularly performed in Czech Republic since 1969 when the project started with 23 localities. Recently, the regular census covers more than 300 hibernacula. The data on population development in the localities monitored over 30 year period supplemented with data from further 177 localities for which the continuous sequences longer than 10 year are available enabled us to compare patterns of abundance changes in individuals species and estimate the major trends in population development of mid-European bats over last 30 years. Among other, a considerable increase in abundance of several species (particularly *Myotis myotis*) during the last 15 years is worth mentioning.

Early *Myotis*: Comments on the Fossil Record

Ivan Horáček

Department of Zoology, Charles University, Vinicna 7, CZ-128 44 Praha, Czech Republic

Recent molecular studies on phylogeny of the genus *Myotis* (Ruedi & Mayer 2002) show a considerable discrepancy between the late divergence data predicted based on molecular evidence and a fact that most of the Miocene and Oligocene records of vespertilionid bats is identified just as *Myotis*. The present paper reports results of a revision of the Early Miocene and Oligocene material of these forms, and an extensive material of them obtained from the N-Bohemian MN3 site Ahníkov- Merkur -north. It is demonstrated that almost all European early *Myotis* actually do not belong to that genus but represent ancestral grades of the other vespertilionid clades. Two new genera (*Hanakia*, *Quinetia*) are described and their possible relations are discussed. The fossil forms which for sure can be identified as *Myotis* appear first in Vallesian, i.e. just in the period that is in quite a good agreement with predictions by molecular clock.

DNA from Faecal Pellets Used to Assess Relationships within and between Colonies of Serotine Bats *Eptesicus serotinus*

Anthony M. Hutson

Winkfield, Station Road, Plumpton Green BN7 3BU, East Sussex, England.

Bat DNA extracted from faecal pellets of colonies of Serotine bat (*Eptesicus serotinus*) in South-East England and Belgium was analysed to demonstrate the relatedness of bats within a colony and between colonies and hence likely levels of recruitment of individuals to non-natal colonies. Faecal pellets were collected by leaving sheets under maternity colony roost sites or outside under access points and the resultant faeces collected on subsequent days. The recovery rate of DNA was affected by the length of time between placement of the sheet and the collection of the faeces, and by the time between collection and extraction. In the best circumstances DNA could be retrieved from 80% of the faeces in a sample. The techniques used, some preliminary results and future plans will be discussed.

First Results in Radio-tracking Geoffroy's Bats *Myotis emarginatus* in Centre Region, France

Régis Huet¹, Michèle Lemaire², Laurent Arthur² & Nadia Del Giudice

¹ 5 rue de l'Eglise, Namps-au-Mont, F-80290 Namps-Maisnil, France.

² Muséum d'Histoire Naturelle, Parc Saint Paul, F-18000 Bourges, France.

The study concerns a colony of 80 bats located 15 km from Bourges in the Cher department, central France. The landscape around the roost is mostly constituted by monocultural fields. Nine females were captured and fitted with transmitters from summer 2000 to summer 2002: six were not-lactating, two were lactating and one was post-lactating. Twenty-two hunting zones were identified. For the six non-lactating females, hunting zones were inside woods and wood borders with dense undergrowth, forest allees and along tree lines near a river. For the lactating and the post-lactating females, the hunting areas were mostly hedges with big trees bordering meadows. Just after take off, the no-lactating females first hunted in woody zones near the roost. Then they flew to nearby woods and then to a further forest, located between 7 and 12.5 km from the roost, where they spent most of the night. While returning back to the roost they usually foraged shortly over one or two area already visited in the beginning of the night. For one lactating female, which did not return in the roost during the night, and for the post-lactating, the principal hunting areas were also far from the roost. For the second lactating female, hunting zones were closer, only 3 km from the roost, the bat returned to the roost in the middle of the night to suckle her young. Transit trails between each hunting zone usually follow linear structural landscapes but *Myotis emarginatus* is able to cross large monocultural fields pointing directly to a distant wood. In this case, the flight is fast. In some cases they may forage shortly in a wooded area. The average speed was around 20 and 25 km/h in open field zone, and 8 km/h when wooded area exists. Hunting periods are long (around 6 hours each night); when the weather was good, bats only paused for a few minutes. Other data collected during this study will be published later on. (infrared video monitoring inside the roost, solitary male hunting zones...).

Mega- and Microchiroptera: Old Clades and New Views

Pavel Hulva & Ivan Horáček

Department of Zoology, Charles University, Vinicna 7, CZ-128 44 Praha, Czech Republic.
hulva@natur.cuni.cz

Extensive discussions on mutual relations of the two traditional suborders of Chiroptera, vivid in nineties, turned recently to another topics: monophyly of Microchiroptera and reality and actual content of Yungipterid and Yinopodidae. The strong molecular evidence, recently published, suggests that Rhinolophoidea is a sister group of Pteropodidae. We try to reexamine this topic in details, particularly with considerable enlarging of a spectrum of rhinolophoid and pteropod clades taken in account. Here we report results of a phylogenetic analysis based on cytochrome b sequence data both published and those we obtained from several critical taxa not yet investigated (including *Craseonycteris*, three *Rhinopoma* spp., *Megaderma*, *Nycteris*, *Emballonura* etc.) which we analysed with aid of several techniques of phylogenetic analysis (MP, ML, spectral analyses etc.). The results mostly confirmed close relations between Pteropodidae and Rhinolophoidea (including Craseonycteridae) except for Nycteridae which was found a

sister group of Emballonuridae. Within Rhinolophoidea, a close relation of Rhinolophidae and Megadermatidae is suggested, while Hipposideridae - a sister group of Creseonycteridae, appear to be not directly related to that clade similarly as Rhinopomatidae. Further phylogenetic inferences and their possible consequences in classification are also discussed.

The Eastern Limits of Distribution of Migratory Bat Species in the South Urals

Vladimir Iliyn¹, Dmitriy Smirnov¹ & Nailya Yanyaeva

¹ The Chair of Zoology, Lermontova Street 37, RU-440602 Penza, Russia

The territory of the South Urals and Preduralye, within limit 50-56°N and 52-60°E. is inhabited by 15 bat species. Migratory species from this to group are: *Nyctalus lasiopterus*, *N. noctula*, *N. leisleri*, *Pipistrellus pipistrellus*, *P. nathusii* and *Vespertilio murinus*. In this region they meet only in warm period of a year. As an exception single individuals of *V. murinus* can remain here and stay for the winter (Kirykov 1954). The South Urals are the east limit of distribution of such species: *P. nathusii*, *N. lasiopterus* and *N. leisleri*. The extreme points of detection of *P. nathusii* are fixed in flood - lands of river Large Cumak, near of settlements Udarnik (51°20'N, 58°48'E) and Novoorsk (51°22'N, 58°55'E) (Orenburg provise). A find of this species to the north are known from reserve "Ilmensky" (55°00'N, 60°11'E) (Snitko 2001). The *N. leisleri* is caught by us in the village Spasskoe by Orenburg province (52°01'N, 56°35'E). Earlier it inhabitation in the Orenburg steppes mentioned by E. Eversmann (1850). Also single specimen known from Bashkir reserve (53°02'N, 57°03'E) (Tkachenko 1971). About east boundary *N. lasiopterus* it is known thanks to unique find, made in the beginning XXth century in the Busulucsky forest (52°56'N, 52°03'E) (Ognev 1925). The territory of South Urals is a northeast limit of distribution european subspecies *N. noctula* and *P. pipistrellus*. The extreme east points of find *N. n. noctula* known near of settlements Idyash in Bashkir (51°47'N, 57°06'E). The *P. p. pipistrellus* marked in average current river White (52°55'N, 55°55'E) (Marvin 1969).

The Occurrence of the Parti-Coloured Bat *Vespertilio murinus* in the Netherlands: A Change of Status

Eric Jansen

Vermeulen straat 167, NL-3572 WT Utrecht, The Netherlands

In the Netherlands the parti-coloured bat was unrecorded from 1900 until 1976. From 1977 onwards, almost yearly, a few individuals were found. The number of records show a marked increase from 1991 onwards. In 1993, 1998, 2000 and 2001 more than 5 individuals were found. This increase in findings may have been explained by migrants from a growth in the bat population in Scandinavia and partly by larger numbers of Dutch bat workers. Most parti-coloured bats were found in poor condition, often in the months September, October and November, close to high buildings and less than 25 km from the coastline. The species is easily recognizable and unlikely to have been overlooked before 1977. The Dutch-Bat-Survey 1986-1993 did produce only a few records of stranded bats, except one calling male along the coast. This led many others to the conclusion that, this species was in the Netherlands, a rare vagrant from the northeast of Europe. Totally unexpectedly, a colony of 22 parti-coloured bats was found in 1998 in Maarssenbroek, close to Utrecht. The colony was at least present from 1996 onwards. The status as a nursery colony was confirmed in 1999 with the finding of two youngsters, 5-6 and 10-11 days old. The yearly maximum emergence counts gradually increased from 22 individuals in 1998 to 56 in 2002. The present status of this species in the Netherlands should now be regarded as a rare bat with a (very) small number of nursery colonies. It should be considered vulnerable because of the small number of individuals and the isolated location of the nursery roost.

Control Region Variability of the Mitochondrial DNA of *Pipistrellus nathusii* : First Results of Population Genetic Study

Tomasz Jarzembowski, _ukasz Naumiuk & Mateusz Ciechanowski

Department of Ecology and Zoology of Vertebrates, University of Gda _sk, Al Legionów 9, PL-80-441
Gda _sk, Poland. doktj@univ.gda.pl, matciech@kki.net.pl

Distribution of wintering places and breeding areas of bat *Pipistrellus nathusii* in Europe may suggest that there are several different populations of this species with different migration routes and migration strategies. The aim of this project is to check if genetic variability between individuals from Baltic States and Northern Poland allows to divide these bats into different populations.

Study of population genetics of *Nathusius pipistrelle* was done using control region of mitochondrial DNA extracted from hair samples. They were collected on breeding areas of *P. nathusii*: Kuronian Split, Kaunas (Lithuania), Vistula Split, Sobieszewo Island and Dar _lubska Forest (Poland). Comparison of the genetic structure was carried out with use of two techniques: amplification of mtDNA control region (PCR) and RLFP (Restriction Fragment Length Polymorphism) analysis of PCR product. The size of PCR product varied from 1000 to 1070 bp. *RsaI* was used to digest a PCR product. The length of two restriction fragments varied from 190-250 to 690-750 bp. Comparison of amplified DNA fragment shows higher similarity among samples from Lithuania than between samples from Kuronian and Vistula Splits. On the other hand, analysis of RLFP of all samples allows to distinguish four genogroups: A (consisted of samples from Kuronian and Vistula Splits), B (consisted of individuals from Dar _lubska Forest, Vistula Split, Sobieszewo Island and Kaunas region), C (consisted of individuals from Vistula split only), D (consisted of individuals from Kaunas region and Vistula split).

First Data of *Pipistrellus pygmaeus/mediterraneus* in Belgium

Géraldine Kapfer¹, Marc Van de Sijpe², Bob Vandendriessche³ & Els Martens⁴

¹ Royal Institute of Natural Sciences of Belgium, Rue Vautier 29, B-1000 Brussels, Belgium.

Kapfer.geraldine@caramail.com

² Vleermuizenwerkgroep Natuurpunt v.z.w., Kezelberg 23, B-8560, Moorsele, Belgium.

mv.ritec@wanadoo.be

³ Vleermuizenwerkgroep Natuurpunt, Kardinaal Mercierplein 1, B-2800 Mechelen Belgium.

bobvdd@hotmail.com

⁴ Ministry of the Flemish Community, Nature Division, Koning Albert II-laan 20, box 8, B-1000 Brussels, Belgium

The distribution and habitat use of *Pipistrellus pygmaeus/mediterraneus* (the 55 kHz phonic type *Pipistrelle*) are still unclear. This species was discovered by chance for the first time in Belgium only four years ago. The very first time expansion recording came from a location in the Flemish Region, Ieper (May 1998) at the vicinity of trees on the bank of a large moat. The bat has only been identified in March 2000. Two other recordings were conducted in Flanders at a later date. In Moen (June 1999), *Pipistrellus pygmaeus/mediterraneus* was recorded from a bridge over a canal and in Beernem (May 2000), the bat was hunting around the tops of a castle ruin. Despite repeated survey sessions, Soprano *Pipistrelles* have never been observed twice in the same place. The last two records to date, have been from the Brussels' Region, in Boitsfort (April 2002). Both recordings were taken at exactly the same place, very near the pond's bank (Domaine des Silex). The animal's behaviour has been observed while hunting at very close range.

Main and Satellite Roosts of a *Rhinolophus hipposideros* Colony in Southern Bavaria, Germany

Angela Kayikcioglu & Andreas Zahn

Dept. Biologie II, Universität München, Luisenstrasse 14, D-80333 München, Germany

In 2001, a study was conducted to observe main and satellite roost use in a nursery colony of 40 adult *Rhinolophus hipposideros*. Three different buildings and a cave were in use as roosts, whereby the buildings were frequented from May to September and the cave was in use throughout the year. The main roost was located at an old power station, namely in a small attic warmed by the heat of the engines. A cooler, neighbouring room was used regularly by a few individuals, and when the temperature in the main

roost exceeded 34°C by the majority of the colony. Two attics in buildings located 30 m and 400 m away respectively from the power station were used by single individuals or small groups of up to eight bats including unfledged juveniles. Inspections made of the cave every two weeks from April to September revealed that it was being used as a day roost by up to eight individuals. Horseshoe bats were also observed using it as a night roost, juveniles were never observed in the cave. Only one or two hibernating individuals were seen in the cave in winter, indicating that most of the bats leave the area for hibernation.

Strategy for the Conservation of Bats and Their Habitats in the French Overseas Territories

Ronan A. Kirsch

Laboratoire Zoologie Mammifères & Oiseaux, Muséum National d'Histoire Naturelle, 55 rue Buffon, F-75005 Paris, France. kirsch@mnhn.fr

France administers a certain number of overseas territories located mainly in the tropical regions of the world, most of them being archipelagos of geologically and biogeographically highly diverse histories that bear remarkable endemic floras and faunas. This situation implies a strong responsibility for the French authorities to preserve the biodiversity of exceptional tropical island ecosystems and related species which depends on their management. These territories include Guadeloupe archipelago and Martinique Island in the Caribbeans, French Guiana within the neotropical Guiana belt, Réunion and Mayotte Islands in the Indian Ocean, Wallis and Futuna Islands and the New Caledonia archipelago in the South-West Pacific. The chiroptero fauna of these territories forms the largest group of mammals, represented by 10 families, 62 genus and 132 species, amongst which 15 are at risk of extinction and 17 near threatened according to the latest IUCN conservation status (IUCN 1992 & 2001). The French Mammals Society, through its Overseas territories Bat Conservation Specialist Group has initiated a joint programme with local and national wildlife management agencies, national parks and protected areas, and local NGOs to develop a coherent conservation programme for bats in each of the French Overseas Territories. This strategy running for 5 years include a revision of species systematics, the completion of distribution maps using bioacoustic and capture inventories, a process for setting species-oriented and habitats-oriented priorities with the input of atlas data into a conservation GIS and the synthesis of results into recommendations. The programme is also emphasizing conservation education and local capacity building for bat conservation, and is aimed at participating with regional programmes developed through the Chiroptera Specialists Group of the IUCN Species Survival Commission.

Habitat Selection and Mass Dynamics of Daubenton's Bats *Myotis daubentonii* Hibernating in Natural Conditions in W. Poland

Tomasz Kokurewicz

Agricultural University of Wrocław, Department of Zoology and Ecology, Cybulskiego 20,
PL-50 205 Wrocław, Poland. kokur@ozi.ar.wroc.pl

The black chin spot, an unique age criterion, allowing to distinguish individuals in their first year of life from bats older than one year, made possible to study the age related hibernation strategies during hibernation in natural conditions. Due to the localisation of the winter colony on elevation of 800m a.s.l., in severe mountains climate, the winter feeding and winter migrations could be excluded in population under study. Restriction of disturbance to two inspections per season and individual marking allowed to investigate the relationship between the body mass in the beginning and in the end of hibernation (November and March) and difference in overwinter mass loss between adult and sub-adult Daubenton's bats *Myotis daubentonii*. In course of observation period the median hibernation temperature and the distance of hibernating bats from the cave entrance were significantly declining, while the frequency of animals roosting in crevices was increasing. The selection of optimal hibernation temperature by bats was possible by changing the distance from the cave entrance ($r_s = 0.73$, $n = 615$, $P < 0.001$) and the height of hibernation place ($r_s = 0.16$, $P < 0.01$), while selection of high relative humidity, by roosting in low temperature ($r_s = -0.26$, $P < 0.001$) and/or by selecting hibernation places situated lower on the cave walls ($r_s = -0.26$, $P < 0.001$). The lack of records of sub-adult individuals in January and February and substantial decline of number of males Daubenton's bat, suggests that some individuals having smaller fat reserves

were hibernating in the rubble on the bottom of the cave. In such micro-habitats, they could probably find low temperature and high relative humidity, which allow them to minimise the arousal frequency. Sub-adult bats were found hibernating in significantly lower temperature ($Z = -3,1$, $P < 0.01$), in places situated lower on the cave walls ($Z = -2.2$, $P < 0.05$) and in March were using crevices more frequently ($\chi^2 = 5.4$, $P < 0.05$) than bats older than one year.

Seasonal Dynamics of Bat Numbers in two Caves in Southeastern Slovenia

Klemen Koselj

S.D.P.V.N. - Slovenian Association for Bat Research and Conservation, Pre_ernova 20,
SI-1000 Ljubljana, Slovenia. klemen.koselj@amis.net

During the years 1997, 1998 and the first half of 1999, the numbers of bats in two caves were monitored on the same days at least once a month. Ajdovska jama pri Nemkivasi is a small cave in the hills west of Kr_ko in South-Eastern Slovenia. It harbours the largest maternity colony of Mediterranean horseshoe bat (up to 300 individuals) in the country. A number of these bats was also present in the cave during the mating season together with a few greater *R. ferrumequinum* and lesser horseshoe bats *R. hipposideros*. The latter two species also hibernated in the cave. A single hibernating barbastelle *Barbastella barbastellus* was observed during February 1999. Kostanjevi_ka jama is a large tourist cave situated 12 km south of Ajdovska jama pri Nem_ki vasi at the foot of Gorjanci hills, near the Croatian border. We monitored the numbers of all three horseshoe bats in arbitrary chosen fixed areas in tourist and non-tourist part of the cave. The largest numbers of each species occurred during the hibernation, but some individuals also roosted in the cave during the summer. The Lesser horseshoe bat was the least and the Mediterranean horseshoe bat the most gregarious species. The Greater horseshoe bat changed the position, whereas the group of Mediterranean horseshoe bats was almost always in the same hall in the non-tourist part. They appeared to be mildly torpid throughout, and were aroused easily. However, the greater and the lesser horseshoe bats, which roosted in the tourist part, tolerated well the presence of visitors, sometimes no more than 10 cm away from their position.

The Mediterranean Horseshoe Bat *Rhinolophus euryale* in Slovenia: Status Distribution and Conservation

Klemen Koselj, Andrej Hudoklin & Primo_Presetnik

S.D.P.V.N. - Slovenian Association for Bat Research and Conservation, Pre_ernova 20,
SI-1000 Ljubljana, Slovenia. klemen.koselj@amis.net

The Mediterranean horseshoe bat *Rhinolophus euryale* is the rarest of the three rhinolophid species currently living in Slovenia (*R. blasii* is considered extinct). The Slovenian population is also on the northern border of the distribution of the species. During the increased chiropterological work in the past few years a number of roosts has been discovered and additional ecological data have been gathered. The Mediterranean horseshoe bat has been found exclusively in caves throughout the year. The species reproduces in Slovenia. The largest maternity colony composed of ca. 300 individuals was found in the cave Ajdovska jama pri Nem_ki vasi, where a number of Mediterranean horseshoe bats can be also found during the mating season. Another interesting maternity site was found in the water cave Spodnja Klevev_ka jama, where thermal springs are present. The most important hibernaculum is in the tourist cave Kostanjevi_ka jama, which lies 12 km south of Ajdovska jama pri Nem_ki vasi, and harbours approximately the same number of bats. The colonies are most probably linked. The Mediterranean horseshoe bat is a gregarious species, dependent on traditional underground roost sites. We found the species to be sensitive to disturbance. Due to specialized diet consisting mainly of moths, light pollution, intensive agriculture and destruction of woodland also present a threat to this species. A metal walkway, which has been constructed in Ajdovska jama pri Nem_ki vasi and the plans to build a presentation of archaeological findings are seriously threatening the existence of the maternity colony inhabiting this small cave.

Subspecific Structure of *Myotis daubentonii* and Composition of the "*daubentonii*" Species Group

Sergei V. Kruskop

Theriological Department, Zoological Museum of Moscow M. V. Lomonosov State University, Ul. Bolshaya Nikitskaya 6, RU-103009 Moscow, Russia

Myotis daubentonii is one of the most widely distributed bat species, which synonymy includes at least 11 valid names. According to our investigations this species can be divided into two groups of forms, conditionally Western and Eastern. The oldest name for the second one is *M. d. petax* Hollister, 1912. Both groups differ in several measurements (first of all - cranial and dental) and in some details of dentition. Border between groups passes westwards from that it was traditionally interpreted, and animals from the South of Central Siberia belong to the eastern complex. However, there is some geographic variability inside each group. We did not find any difference between Central European specimens and animals from European Russia. Meantime, animals from Western Siberia and, probably Ural Mts., slightly differ and may represent distinct subspecies. In eastern complex we can suppose three forms: Sayan-Transbaikalian, Amur-Mantjurian (*loukashkini* ?=*chosanensis*) and Ussurian (*ussuriensis*). However, Altayan population ("*petax*") highly variable and includes animals similar to all three forms. The whole *daubentonii* species group include at least 7 Eurasian species (listing newly described Vietnamese endemic *M. annamiticus*), plus 4 forms of uncertain taxonomic position. Amongst these species, small mountainous forms: *M. longipes*, *M. csorbai* and *M. annamiticus* with low rostrum and deep fronto-nasal flexure, can be divided into their own subgroup or group. *Myotis lucifugus* as well as other nearctic species provisionally excluded from *daubentonii* group, which thus has transeurasian distribution pattern.

First Elements for Field Identification of Neotropical Bats in French Guiana Using Heterodyne and Time Expansion Detectors

Frédéric Leblanc¹ & Ronan Kirsh²

¹ SFPEM / GMHL, 33 rue Christophe Duverger, F-87100 Limoges, France

² Muséum National d'Histoire Naturelle, Laboratoire Mammifères et Oiseaux, 55 rue Buffon, F-75005 Paris, France

During our stay in French Guiana in Autumn 2001, we caught and recorded 44 species of bats which originated from families *Emballonuridae*, *Phyllostomidae* and *Vespertilionidae*. Out of 465 recordings (that is 6 hours 30 minutes), only 80 or 90 have turned out to be usable for research on the identification criteria of recorded species. Thus out of 44 captured species, we only characterized 31 species or groups of species. The first elements which have been collected permit to differentiate some species or to characterize some families in a conclusive way; a number of acoustic convergences with the European species permit to make hypothesis of the hunting habitats or on the nutrition specificities. After these encouraging results, complementary campaigns are thus necessary to go on with the researches or the acoustic identification of the 105 species of Chiroptera reported from French Guiana (or even more widely in American Neotropical Rainforest).

The Importance of Small Cellars to Bat Hibernation in Poland

Grzegorz Lesinski¹, Marek Kowalski², Jaroslaw Domalski³,
Radoslaw Dzilciolowski⁴ & Krystyna Laskowska⁴

¹ Polish Society for Bat Protection, Institute of Ecology PAS, PL-05-092 Lomianki, Poland.
verticol@poczta.onet.pl

² Mazovian Society for Fauna Protection, Jagielly 11, PL-08-110 Siedlce, Poland. mtof@ap.siedlce.pl

³ Department of Didactics in Biology and Biodiversity Studies, University of Lodz, Banacha 1/3, PL-90-237 Lodz, Poland. woody@biol.uni.lodz.pl

⁴ Polish Society for Nature Protection "Salamandra", Szamarzewskiego 11/6, PL-60-514 Poznan, Poland.
biuro@salamandra.org.pl

The aim of this study was to determine the importance of small underground hibernacula to bats in Poland. Cellars located outside buildings and basements were inspected in many regions of the country (from north-east to west). Among nine species recorded in over 500 sites, *Plecotus auritus* was the most

frequent and abundant. In many cellars only single individuals were found but the highest density was 0.6 individuals per m³ of space inside a roost. Regional differences in species composition of bats hibernating in cellars depended mostly on the structure of local bat communities. *Myotis daubentonii* was much more abundant in north-eastern part of the country, while *Plecotus austriacus* in the south. On the other hand, some species seemed to avoid (e.g. *Myotis myotis*) or prefer (*Plecotus spp.*) this type of winter roost. Species diversity was highest in cellars of North-Eastern Poland (the coldest region) where they are very important hibernation sites. Despite the fact that less than 10% of inspected cellars are inhabited by bats, these roosts are of great importance at least to such species as: *Plecotus auritus*, *P. austriacus* and *Myotis daubentonii*. Calculations made for Central and North-Eastern Poland - 1/5 part of the country, ca. 60 000 km² - (Lesiński & Kowalski 2001) showed that small cellars could be winter roosts for minimum 10 000-15 000 individuals of bats yearly.

Lesiński G. & Kowalski M., 2001. The importance of small cellars to hibernation of bats in central and north-eastern Poland. *Nietoperze*, 2: 43-52.

Bat Detector Workshops in Eastern and Southern European Countries: Building a Network for Bat Conservation

Herman J.G.A. Limpens

Society for Study and Conservation of Mammals - Eco Consult & Project Management,
Roghorst 99, NL-6708 Wageningen KD The Netherlands. herman.limpens@vzz.nl

In the framework of the 'European Bats Agreement a series of training workshops for bat experts and colleagues in eastern and south eastern European countries was initiated in 1999. The project was made possible by the German Ministry of Environment - Federal Agency of Nature Conservation. The aims of the workshops were the introduction to and training of the use of bat detectors as an additional tool to the survey methods already established; providing equipment; assessment of the possibilities of a systematic approach to the assessment of distribution, and a round table discussion on the possibilities and needs for bat conservation in the countries. Between 1999 and 2001 10 workshops could be held in Bulgaria, Croatia, Ukraine, Georgia, Slovenia, Romania, Moldova, Lithuania - Baltic Region, Slovakia, Yugoslavia. The workshops generated interest and participation from all corners of the countries, and where possible also participants from neighbouring countries were welcomed. The new survey technique revealed many new data, observations and experiences, including first species records, and first roost records of species. The workshops served as a strong impulse to the development of working groups addressing bat research and conservation and stimulated development of links and co-operation between individuals and organisations across Europe. They contributed to the building of a network for bat workers and bat conservation in Europe. The results on the biological as well as the organisational level demonstrate the effectiveness of the approach and call for new initiatives.

Influence of Temperature in the Selection of Roosts by the Soprano Pipistrelle *Pipistrellus pygmaeus*: Relavance for the Design of Bat Boxes

Sofia I. Lourenço¹, Diana Bell¹ & Jorge M. Palmeirim²

¹ School of Biological Sciences, University of East Anglia, NR4 7TJ Norwich, England

² Centro de Biologia Ambiental, Faculdade de Ciências da Universidade de Lisboa, P-1749-016 Lisboa, Portugal

The Soprano pipistrelle *Pipistrellus pygmaeus* (55 kHz) is a house-dwelling species, frequently affected by exclusion from buildings. Bat boxes try to address this problem, functioning as alternative roosts. However, they are often ineffective, probably because they fail to meet the species requirements. Temperature is certainly one of the most important factors influencing roost suitability. Consequently, in order to improve the design of bat boxes for pipistrelles, it is important to understand the thermal conditions of its roosts in buildings. We studied roost microclimates and bat's thermal preferences within roosts in buildings. In addition, we monitored bat boxes of different colours to find which of these had similar thermal characteristics to roosts in buildings, and which were occupied. Roosts in buildings were characterised by high temperatures and wide temperature ranges. Bats were found to select warm places within the roosts, but avoiding extreme high temperatures. The black (warmest) bat boxes were always occupied, exhibiting similar temperatures to the roosts in buildings. However, due to their limited temp-

erature range compared to that of roosts in buildings, these were not suitable when environmental temperatures were very high. Modifying the design of these bat boxes to provide them with a wider internal temperature range, may increase the success of the relocation of pipistrelle colonies.

A Long Term Study of Population of Daubenton's Bat *Myotis daubentonii*

Radek Lu_an¹ & Vladimír Hanák²

¹ Dept. of Zoology, Faculty of Biological Sciences, University of South Bohemia,
Brani_ovská 31, CZ-370 05 eské Bud_ovice, Czech Republic

² Dept. of Zoology, Charles University, Vini_ná 7, CZ-128 43, Praha 2, Czech Republic

A population of Daubenton's bat was studied in the Northern part of T_ebo_ basin (S-Bohemia, Czech Republic) during period 1969 - 2001. Netting and banding bats were applied together with controls in their day-time roosts (tree cavities, one building) and bat detectoring in the foraging places. In total, 3122 records of 1643 individuals was obtained. Significantly higher representation of females of all age classes was found in the sample. The sex ratio changed during a season with higher proportion of males (up to 44 %) in spring and autumn period, while females prevailed during the late spring and early summer when nursery colonies were present in the area. Survival analysis did not reveal differences in survival probabilities between both sexes. Mean longevity was assessed on 4,5 years (being actually higher, of course). Mean group size in roosts has changed throughout the season with a peak before parturitions while considerable decrease was observed during the lactation period, apparently due to different female energetic strategies for the late gestation and lactation periods, respectively. A variation in degree of sex segregation throughout the reproduction season and possible bias of non random sampling on sex ratio in the sample are discussed.

Bat Distribution and Phenological Data in Matzeikiai District in 1999 - 2002

Deividas Makavicius & Nomeda Velaviciene

Lithuanian Society for Bat Conservation Renavas Palace, Renavas Kaimas, 5500 Mazeikiai District,
Lithuania

Mazeikiai district is in the Northwest part of the Lithuania. It takes 1220 km_ area. Episodic researches are carrying out in this territory from 1995, but detailed studies of bats fauna are organized from 1999. Then was the beginning of collecting detailed information about bats distribution in this area, abundance of individuals and populations, phenological data. Totally there are 12 bat species founded in Mazeikiai district: *Myotis daubentonii*, *M. dasycneme*, *M. brandtii*, *M. nattereri*, *Plecotus auritus*, *Nyctalus noctula*, *N. leisleri*, *Pipistrellus nathusii*, *P. pipistrellus*, *Eptesicus nilsonii*, *E. serotinus*, *Vespertilio murinus*. Renavas park is very important as a breeding territory of *N. noctula* (35-50 ind.), *P. nathusii* (40-60 ind.), *E. nilsonii* (till 30 ind.). In breeding period there are observed several *M. brandtii* (usually observe them in Lithuania only during wintering time) and *M. dasycneme*. Totally there are detected 11 bat species during breeding period. There are big breeding colonies of *M. daubentonii* (about 80 ind.) and single individuals of *N. leisleri* in Plinkisiai park. 10 bat species are observed in Plinkisiai surroundings during breeding period. Numerous breeding colonies of *P. nathusii* (total 200 ind.) and *P. pipistrellus* (100-150 ind.) are in the Seda, Vieksniai and Krakiai settlements. *E. nilsonii* is common species and several individuals of *V. murinus* are usual in these towns. Totally there are living 7 bat species. The most abundant species are: *M. daubentonii*, *P. auritus*, *P. nathusii*, *E. nilsonii*. *N. leisleri*, *M. dasycneme* and *V. murinus* is a rare or very rare species in Mazeikiai district.

Females of *Pteropus giganteus* are Protected by Members of the Colony during Pregnancy and Lactation

Utkarsha Manish, Shantaj Deshbhratar & Vinod Narayane

Srishtiaasthaa, 102, Shri Ganesh, Plot 13, Sector 11, Kharghar, 410 210 New Mumbai, India.

srishtiaasthaa@email.com,

utkarshamanish@email.com

Bats are unique mammals, well known for their behavioural characteristics. They are relatively smaller in size and have low fecundity rate. They have high survivorship. They have relatively long period of infant dependency and late sexual maturity. Interspecific behaviour is of higher order in most of the species of

bats. Indian flying foxes, *Pteropus giganteus*, exhibit one of the best behavioural features, which show colonial and social attributes of suborder Megachiroptera. Today, some of the most successful bats are those that form huge colonies, and *Pteropus giganteus* is one of such species. Some of the behavioural aspects of this species have already been noted. Present study focuses on the few other aspects, which are being reported for the first time. These are 'protection' and 'attention' given to the expecting mothers by other female members of the colony, etc.

The Results of Testing the Route Counting Method to Monitor Boreal Bats

Matti Masing¹ & Kaja Lotman²

¹ Sicista Development Centre, Box 111, Tartu 50002, Estonia. matti@ut.ee;

² Matsalu Nature Reserve, Penijõe 90305, Läänemaa, Estonia. kaja@matsalu.ee.

Using the route counting method (RCM, Masing *et al.* 1998) and the Skye SBR-1200 heterodyne detectors bat counts were carried out on the same routes during one summer. On two routes situated in different parts of Estonia two observers counted bats (K. Lotman at Matsalu and M. Masing at Värskä) during three nights in similar weather conditions in June, July and August 1998. Analysis of these data shows that significant differences in bat numbers occur between months, not between the dates of a short observation period within a certain month. This result supports the hypothesis that in Estonia bat counting can be carried out in the second half of June without a big difference in the number of bats counted on the same routes on different dates. This means that the counting work carried out under the national bat monitoring programme in Estonia since 1994 is reliable for population estimates, however, depending on the number of routes/counts and the quality of the counting work.

Masing M., Lutsar L. & Lotman K. 1998. Monitoring bats with bat detectors in Estonia. *Myotis*,

The Improved Route Counting Method to Monitor Boreal Bats

Matti Masing¹, Lauri Lutsar² & Kaja Lotman³

¹ Sicista Development Centre, Box 111, Tartu 50002, Estonia. matti@ut.ee;

² Estonian Fund for Nature, Box 245, Tartu 50002, Estonia. lauri@elfond.ee;

³ Matsalu Nature Reserve, Penijõe 90305, Läänemaa, Estonia. kaja@matsalu.ee.

In 2000-2001 the improved route counting method (RCM-2) was developed in Estonia to monitor foraging bats in boreal region. This is a modification of the route counting method (RCM) in which two counting methods, line counting (sub-method LC) and point counting (sub-method PC) are combined to make bat counting more powerful (Masing *et al.* 1998). In RCM-2 both sub-methods are separated, thus enabling to consider their results separately. RCM-2 includes the following aspects: 1) line counting (LC) and point counting (PC) are separated; 2) bats are recorded and their species identified using a sensitive heterodyne detector and visual observation; 3) bat counting starts 1-1.5 hours after sunset depending on light conditions; 4) only suitable weather conditions (temperature at least +10 C, no rain, no strong wind) are recommended for counting bats in the purpose of monitoring their populations; 5) in LC route length is between 3-5km, while bats (maximum number of every species heard or seen) are counted per 50m segments of the route; 6) in PC bats are counted in nine 5-min waiting points, situated either on or near the LC route, in three points in each main habitat type (at the edge of water-body, in forest or park, near houses with trees); 7) the counting is completed during 2.5-3 hours (including 45 min for nine PC waiting points); 8) the results of LC and PC are given in inds/10 km (or inds/100 km) and inds/100 points, respectively; 9) to characterize bat populations in a larger area the results of several routes are summarized. Compared to LC, PC enables to record more effectively bat species which emit quiet sounds (e.g. *Plecotus* and small *Myotis*) while foraging close to vegetation, because the observer is not moving. The results of PC characterize certain habitat types while the results of LC apply to the whole landscape where the counting route passes. While testing RCM-2 on eight routes during 22 hours in midsummer 2001, ten species of bat were found out of eleven species known to occur in Estonia. If only one sub-method is used, some species may be missed.

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Matti Masing¹ & Kaja Lotman²

¹ Sicista Development Centre, Box 111, Tartu 50002, Estonia. matti@ut.ee;

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Masing M., Lutsar L. & Lotman K. 1998. Monitoring bats with bat detectors in Estonia. *Myotis*, 36: 167-176.

Implementing the Bat Action Plan

Simon Mickleburgh¹, Tony Hutson² & Paul Racey³

¹ Fauna & Flora International, Great Eastern House, Tenison Road, Cambridge CB1 2TT, England

² Winkfield, Station Road, Plumpton green BN7 3BU, East Sussex, England

³ Department of Zoology, University of Aberdeen, Tillydrone Avenue, Aberdeen, AB24 2TZ, Scotland

There are 1,001 species of bats, almost a quarter of which are globally threatened. The Chiroptera Specialist Group of IUCN's Species Survival Commission has produced two Action Plans examining conservation issues for all species and detailing recommendations for action to conserve the most threatened species and habitats. These Plans are aimed principally at key decision makers as well as organisations and individuals who are promoting bat conservation issues. The underlying threat to bats is pressure on resources from increasing human populations that leads to the loss or modification of foraging habitats and roosts. Bats frequently have a negative public image and this influences the response to the problem of rabies and vampire bats in Latin America and bats and commercial fruit growers in other areas of the world. In some areas, bats are persecuted because of an ignorance of their life history and role in ecosystems, while in others they are overexploited for food. There is also a general lack of information about the distribution, status, biology and ecology of many species. This presentation examines some of the more general issues relating to bat conservation. It highlights the priority areas where action is needed immediately at a global, regional and national level. It highlights in particular the global importance of islands and caves for bats.

Implementation of the Point counting Method to Monitor Foraging Bats in Southern Tartumaa, Estonia

Tia Möller¹ & Matti Masing²

¹ Tuulevarju talu, Melliste, Tartumaa 62301, Estonia. vihmapiiisake@mail.com

² Sicista Development Centre, Box 111, Tartu 50002, Estonia. matti@ut.ee

From August till September 2001 and from April till July 2002 the point counting method (PC) was used to count foraging bats in a countryside landscape at Melliste and Poka in Southern Tartumaa. The Petterson D-200 heterodyne detector was used to record bats. The task was to identify bats, estimate their numbers and compare the results of 5- and 10-minute counting periods. Two main habitats (edges of lakes with trees; and forest edges, sometimes in the vicinity of buildings) were chosen for the counts, six points in each habitat. The counts were carried out twice a month, always with suitable weather. Counting results are presented as maximum number of animals of each species recorded during either 5- or 10-minute periods in the chosen points, computed per 100 points (Masing *et al.* 2002, 5th European Bat Detector Workshop Abstracts, Tronçais, France). By September 2001 the following preliminary results were

received. First, considerably more animals and more species were foraging near water (four species and 111 animals per 100 points) compared to the sites away from water (one species and 14 animals per 100 points). Second, the 10-minute counting period gave a slightly larger number of animals ($n=72$) per 100 points, but the same number of species (four) as compared to the 5-minute counting period ($n=60$ animals).

Ectoparasites of Cave Dwelling and Forest Bats

Alexandru Movila & Sergiu Andreev

Group Fauna, State University of Moldova, P.O. Box 409, MD-2004 Chisinau, Moldova

The current work is the result of investigation on ectoparasites of dendrophilous and cave dwelling bats. The dendrophilous bats were studied in Talmaz forest during August, 2000; while cave dwelling - in the caves near village Bicok, during February, 2001. Spare methods were used for material collection. Searching of the bats and their shelters in the forest was carried out with the bat detector. For bat catching, the mist net was used. Parasite collection from the cave dwelling bats was carried out preferably from slipping animals. In Talmaz forest 86 specimens of *Nyctalus noctula* bat species were investigated from which 4 species of ectoparasites were collected: *Spinturnix vespertilionis* (occurrence frequency (OF) = 100%; infection intensity (II) = 4,4; abundance index (AI) = 4,4; *Argas vespertilionis* (OF) = 2%; (II) = 1,5; (AI) = 0,03, *Ichnopsyllus elongatus* (OF) = 5%; (II) = 1,3; (AI) = 1,5, *Cimex lectularius* (OF) = 2%; (II) = 1,5; (AI) = 0,03.

Investigations on the ecology of cave dwelling bats in the caves near village Biciok revealed the following species of bats: *Plecotus austriacus*, *Eptesicus serotinus*, *Myotis daubentonii*, *Myotis mystacinus*, from which were collected 5 ectoparasites species: *Trombicula sp.*, *Spinturnix vespertilionis*, *Argas vespertilionis*, *Ichnopsyllus petropolitamus*, *Ichnopsyllus hexactenus*. Most infected with ectoparasites was *Eptesicus serotinus* that was probably related to the formation of big colonies of this species during hibernation that could provide suitable conditions for ectoparasites. It is important to mention the finding of *Argas vespertilionis* on dendrophilous bats. This species usually feed on cave dwelling and synantropic bats species. The results of investigations on cave dwelling bats did not reveal any specimens of *Ixodes vespertilionis*. However, some findings exist on the occurrence of this species on bat species from caves of vg. Bicioc.

The Largest Hibernaculum in Europe

L. Zoltán Nagy & László Szántó

Transylvanian Museum Association, Op. 1, Cp. 191, RO-3400 Cluj, Romania.

bigze@personal.ro

The Western Carpathians, Romania's largest limestone area, provides many suitable underground roosts for bats. One of them is the Huda lui Papara cave, which hosts - during wintertime - a unique bat aggregation. The cave is situated at 567m a.s.l., has a total length of 2,022 m, an entrance up to 25m high, large chambers and corridors. During our visits we recorded a temperature variation between -0.5 and 4.7°C, and a relative humidity of 82-96%, close to saturation, caused by the river, which crosses the cave. The survey of the cave was done during the winter months, yearly, starting from 2000. 10 bat species - sharing the roost - were identified: *Rhinolophus ferrumequinum*, *R. hipposideros*, *Myotis myotis*, *M. blythii*, *M. daubentonii*, *Pipistrellus pipistrellus*, *Nyctalus noctula*, *Vespertilio murinus*, *Barbastella barbastellus* and *Miniopterus schreibersii*. The total number of bats in the cave is about 53,000-56,000 specimens. The number of individuals alters yearly. More than half of the aggregation is composed of *Miniopterus schreibersii* (about 32,000-33,000 specimens). Estimated at 2,000 bats/m², for the moment they represent 90% of the actually known hibernating individuals in Romania. The second largest number of specimens is represented by the pipistrelle bats, with a total number of 15,000-17,000 individuals, estimated at 3,150 bats/m². The *Myotis myotis* and *M. blythii* species are represented by 4,340 bats, the *N. noctula* with up to 1,000 specimens, the *R. ferrumequinum* with cca. 570 individuals, the *R. hipposideros* with 40 bats, the *B. barbastellus* with about 50 bats, the *M. daubentonii* with 5 specimens, and there is only one record of *V. murinus*. Huda lui Papara cave legally is not protected, and is frequently used by tourists. The lack of an active roost protection legacy makes vulnerable the long-term existence of the species and the hibernaculum. Increasing the value of this site represented by the bat diversity, one could increase the value

of all karstic areas in Central-Eastern Europe. A regional conservation and management plan for these underground bat habitats would be clearly of a high priority.

Neuromorphological Traits and Phylogeny of Bats

Pavel Nemeč, Marcela Lucová & Ivan Horáček

Department of Zoology, Charles University, Vinicna 7, CZ-128 44 Praha, Czech Republic

Neuromorphological traits constitute the main body of evidence supporting chiropteran diphyly hypothesis. Indeed, early Pettigrew's papers challenging the monophyletic origin of bats have been based almost entirely on the neural traits. However, the heat of the monophyly/diphyly controversy resulted in the comprehensive revision of their heuristic value for phylogenetic reconstruction. Virtually none of the strongest pieces of evidence supporting the diphyletic scenario can withstand the critical analysis in the light of more recent re-investigations. First, the megachiropteran retinotopic organization of the superior colliculus is not primate-like, but follows the general mammalian scheme (Thiele *et al.* 1991). Second, the megachiropteran lamination pattern in the lateral geniculate nucleus is distinctive and differs from that of primates (Kaas & Preuss 1993). Third, the microchiropteran visual system exhibits regressive features indicative of secondary reductions; a poorly differentiated visual system of insectivorous bats cannot therefore be considered a plesiomorphic state (own unpublished data). Fourth, gross morphology, cyto- and myeloarchitectonic organization of the spinal cord do not differ significantly between Mega- and Microchiroptera; commonly discussed differences do not refer to any disparate quality or characters with discrete states but to continuous quantitative variables scaled by body size and the degree of the neocortex development (Nemeč *et al.* 2000; unpublished data). Finally, quantitative brain characters, when analyzed using an appropriate statistical framework, do support the monophyletic origin of bats (Lapointe *et al.* 1999).

An International Co-operation in Bat Protection: The Southern France Co-ordination

Mélanie Némoz

Mission Chiroptères Grand Sud, Institut de Recherche sur les Grands Mammifères, B.P.
27, 31326 Castanet Tolosan, France. nemoz@toulouse.inra.fr

The French Mammal Society (Société Française pour l'Etude et la Protection des Mammifères, S.F.E.P.M.) includes a working group devoted to bat study and protection. This national network tightly collaborates with local associations of the 22 French regions. In 1995, an overall census of roosts protected or to be protected (Roué 1995) highlighted the outstanding potentialities of Southern France for bat populations. At the same time this work highlighted that in this part of the country bat protection was less active than in most other parts. In order to promote and coordinate such activity in the 5 most southern regions (Aquitaine, Corse, Languedoc-Roussillon, Midi-Pyrénées and Provence-Alpes-Côte d'Azur) a project officer was appointed in 1999. Four missions were assigned to this position: encouraging an inter-regional co-operation; developing relations with national and local administrative structures; helping regions to prepare and draft protection documents and supporting implementation of the national "Plan de Restauration des Chiroptères". Thanks to the dynamism of batworkers, to regional groups' experience and to co-ordinator's work, bat study and protection dramatically increased during the last two years. Results are very promising and more ambitious plans (as a LIFE-Nature project) can be scheduled now.

Roué S.Y., 1995. *Inventaire des sites protégés ou à protéger à Chiroptères en France métropolitaine*.
Muséum National d'Histoire Naturelle, Paris, 142p.

Variability in Echolocation Call Design of Swiss Bat Species: Consequences for Automated Field Identification with a Synergetic Pattern Recognition Approach

Martin K. Obrist, Peter F. Flückiger & Ruedi Boesch

Swiss Federal Research Institute W.S.L., Zurcherstrasse 111, CH-8903 Birmensdorf,
Switzerland

Pattern recognition algorithms offer a promising approach to recognizing bat species by their echolocation calls. Automated systems like synergetic classifiers may contribute significantly to expert-independent species identification in the field. However, it necessitates the assembling of an appropriate database of reference calls, a task far from trivial. We present data on species specific flexibility in call parameters of all Swiss bat species (except *Nyctalus lasiopterus*). The selection of 'learn-calls' for the classifier significantly influences species identification success. We discuss this in the context of echolocation call variability differing between species and its consequences for the implementation of an automated, species specific bat activity monitoring system.

Recognizing *Myotis* Species by Their Echolocation Calls: Limits and Options for Visual Pattern Recognition

Martin K. Obrist, Ruedi Boesch & Peter F. Flückiger

Swiss Federal Research Institute W.S.L., Zurcherstrasse 111, CH-8903 Birmensdorf,
Switzerland

In the bat genus *Myotis*, today, recognition of species by their echolocation calls is virtually impossible in the field. Spectral and temporal offline-analysis of recordings and subsequent statistical treatment may allow to separate some species by the frequency content or temporal characteristics of their orientation calls. However, in some species, spectrographic analysis reveals 'signatures' in the course of the frequency-time-sweeps, which are not discernible by simple parametric measurements, but which could be species specific, and in some cases even individually specific. We test the hypotheses of individuality and species specificity by comparing identification success rate of a synergetic pattern recognition algorithm with the results from discriminant component analysis.

Fauna of Bats in Northern Urals, Russia

Oleg Orlov

Institute of Plant and Animal Ecology, 8 March St. 202, RU-620144 Ekaterinburg, Russia

Northern Urals is known to be a part of Urals mountain chain between 64° n. l. in the north and 59° n. l. in south with the adjoining territories of Russian plain (Pre-Urals) in the west and West Siberian Plain (Trans-Urals) in the east. Analysis of literature data and our research indicate that most common species in the bats' fauna of Northern Urals are such species as *Myotis dasycneme*, *M. daubentonii*, *M. brandtii*, *Eptesicus nilsonii*. The presence of these species is determined mainly by the presence of numerous wintering places in caves of mountains and foothills parts of the region (the biggest groups of wintering animals were found in Divja cave - in total more than 1000 individuals) Considered species differ in their pattern of distribution in Northern Urals. The most northern records were made *E. nilsonii*. *M. brandtii* is the most common, often most abundant species in all parts of region, excluding the northern ones. *M. dasycneme* is much more rare, while *M. daubentonii* was found only in plains of western part of Northern Urals. Such species as *M. mystacinus* and *Plecotus auritus* also inhabit the territory of Northern Urals however they are much less common than the mentioned above species. The former was found in the south of western part of Northern Urals, while the latter inhabits both the eastern and western slope of Ural mountains in the southern part of region. All mentioned above species are non-migrating. Migrating bats in Northern Urals are presented by *Vespertilio murinus*. In the western part of Northern Urals species is distributed further to north than in the eastern part of it. Absence of other migrating species is determined by the lack of typical habitats, providing them with shelters (broadleaves forests) and the remoteness of Northern Urals from their places of wintering.

Estimation of Dispersal Rates in Bats: Differences between Males and Females

Eric Petit

UMR 6552 "Ethologie-Evolution-Ecologie", Campus de Beaulieu, Université de Rennes I, F-35042 Rennes cedex, France

Male-biased dispersal characterises most mammalian species, and bats are no exception to this rule. However, this pattern covers different situations, and these differences have profound implications for the evolution and conservation of bat populations. Because dispersal mediates gene flow between populations, it is possible to estimate dispersal rates by using differences in allele frequencies between populations. If, moreover, the genetic markers that are typed have sexually contrasted inheritance, differences between male and female dispersal rates can be quantified. We analysed the maternally inherited mitochondrial DNA and biparentally inherited microsatellites to characterize the degree of sex-bias in dispersal in two European bat species. We find in both species, the noctule bat *Nyctalus noctula* and the Bechstein's bat *Myotis bechsteinii*, that the genetic data are compatible with complete male dispersal. By contrast, females are strictly philopatric in one species (the Bechstein's bat) whereas they disperse at a high rate in the other species (the noctule bat). In light of recent theoretical treatment of dispersal evolution, possible ultimate causes for these two different patterns will be discussed. This will help to understand some differences in conservation strategies that could be applied to the two species. Finally, weaknesses of the population genetic analysis of sex-biased dispersal in bats will be underlined and a comparison with recently published studies will show that our understanding of bat population biology is limited due to a lack of knowledge of bat mating systems.

Comparison of Roost Emergence and Return Activity in Maternity Colonies of *Pipistrellus pipistrellus* and *P. pygmaeus*

Klara J. Petrzalkova^{1,2,3}, Nicholas C. Downs¹ & Paul A. Racey¹

¹ Department of Zoology, University of Aberdeen, Tillydrone Avenue, Aberdeen AB24 2TZ, Scotland.
petrzal@sci.muni.cz

² Department of Zoology and Ecology, Masaryk University, Kotlarska 2, Brno CZ-61137, Czech Republic

³ Institute of Vertebrate Biology, Academy of Sciences of the Czech Republic, Kvetna 8, Brno CZ- 60365, Czech Republic

Bats are thought to be more vulnerable to predation during evening roost emergence and morning return. A great deal of research has been carried out on emergence behaviour, but less attention has been focused on a period of morning return. Early emergence increases exposure to raptorial birds, but emerging late results in missing of peak abundance of aerial insect. We studied both emergence and return activity in six maternity colonies of pipistrelle bats (*Pipistrellus pipistrellus* and *P. pygmaeus*) in N.E. Scotland, focusing on light conditions and time parameters (with respect to sunset/sunrise). Return activity generally occurred at lower light intensities than emergence. Therefore the time between dawn return and sunrise was generally longer than that between sunset and dusk emergence. However this trend was not clear at all colonies. These differences could be explained by variety of factors such as surroundings of the roosts, foraging opportunities and different risk of predation among colonies. Bats seem sometimes prolonged their activity and exploited a morning peak of insect abundance. Nevertheless, the general trend during morning return is rather to reduce the risk of predation and came back to the roost earlier.

Data on the Distribution of Bat Summer Colonies in the Surrounding of the Moravia Karstic Area

Martin Pokorny^{1,2}, Hana Berkova^{1,2} & Jan Zukal¹

¹ Institute of Vertebrate Biology, Academy of Sciences of the Czech Republic, Kvetna 8, CZ-60365 Brno, Czech Republic

² Department of Zoology and Ecology, Masaryk University, Kotlarska 2, CZ-61137 Brno, Czech Republic

Moravian Karst, Czech Republic, is an important central European hibernaculum, where thousands of hibernating bats have been found every year. However, summer shelters and their distances to the hibernation places of these bats are poorly known. Between May and August 2001 an area of 2826 km² (a circle of 30 km around the hibernaculum) was surveyed for the occurrence of bat colonies. In total 187

buildings of various types (mainly churches) have been checked, 64 % of them were at least temporarily used by bats (bat droppings), 51 shelters (27%) were inhabited by a colony of bats (more than 3 specimens). About 5500 specimens of 6 bat species were found. In the most abundant species, *Myotis myotis*, the population of adult females living in the area under study was estimated to be 3700 individuals. This number more than twice exceeded the number of *M. myotis* hibernating in Moravian Karst. Data about winter - summer movements of this species indicates no preferable direction of dispersal and quite high rate of intercolonial movements.

Changes in Number and Composition of Bat Fauna and Conservation Problems of the Castle Gradna Gorockem, Northeastern Slovakia

Primoz Presetnik

Tolstojeva 9/b, SI-1113 Ljubljana, Slovenia. primoz.presetnik@s5.net

The castle Gradna Gorockem lies on the western hilly margins of the Pannonian basin. Its cellars provide a unique underground habitat, which are rare in the surrounding region. The cellars were found to shelter a small colony of *Miniopterus schreibersii*, *Rhinolophus hipposideros*, *Myotis myotis*, and occasionally at least four additional bat species. This is the most northeastern location of *Miniopterus schreibersii* in Slovenia. Approximately one hundred individuals of this species use the cellars from spring to autumn. In late autumn *Miniopterus schreibersii* migrates most probably to Austrian caves, where they hibernate till the next spring. The castle cellars are also the most northeastern location of *Rhinolophus hipposideros*, which is the most abundant bat species in these cellars during winter. *Myotis myotis* uses the castle mostly as the autumnal mating quarters. The most serious threat to bats, besides vandalism, is an imminent collapse of the castle wing above the cellars with the highest concentration of bats. Some conservation measures are already being implemented. The crucial element of the conservation of the bats, with special emphasis on *Miniopterus schreibersii*, is the correct renovation of the castle cellars.

The Role of Fruit Bats in Maintaining Biodiversity in Malagasy Forests

Paul A. Racey^{1*}

¹ Department of Zoology, University of Aberdeen, Aberdeen AB24 2TZ, Scotland. p.racey@abdn.ac.uk

² Department of Animal Biology, University of Antananarivo, Antananarivo, Madagascar

³ Department of Plant Biology, University of Tulear, Tulear, Madagascar

The objectives of this project were : 1. To survey the roosts of the three Malagasy Megachiroptera *Pteropus rufus*, *Eidolon dupreanum* and *Rousettus madagascariensis* all of which are endemic; 2. To study their feeding ecology by analysis of faeces and ejecta; 3. To evaluate the effects of hunting; 4. To produce a National Action Plan for their conservation. *Pteropus* roosts are found mainly on the coastal lowlands. Twenty six of the hundred and thirty three *Pteropus* roosts surveyed have become deserted within the last ten years, often as a result of hunting with guns and there were only two examples of *Pteropus* establishing new roosts. *Eidolon* roosts in clefts in rock faces and although little forest remains on the central high plateau, it still roosts there. Eighteen out of the forty one *Eidolon* roosts surveyed have become deserted because of hunting. There were thirty five plants species in the diet of *Eidolon* and thirty eight in the diet of *Pteropus* and a total of fifty different plant species in all, only twenty three of which were consumed by both bat species. Approximately two thirds of the plant species in the diet were fruit and one third was pollen or parts of flowers. Over half the species in *Eidolon*'s diet were endemics. The germination rate of seeds passing through bats differed little from that of seeds taken from ripe fruit but is significantly greater than that recovered from the faeces of frugivorous birds. *Eidolon* visits the rare baobab *Adansonia suarezensis* and is likely to be its main pollinator.

Bats in the Forest Areas of Different Levels of Air Pollution

Alek Rachwald¹, Karolina Wodecka² & Leszek Kluzi_ski³

¹ Department. Ecology & Nature Protection, Forest Research Institute, 3 Bitwy Warszawskiej str

² Department of Ecology, University of Warsaw, Knakowskie Przedmieocie

³ Department of Forest Monitoring, Forest Research Institute, 3 Bitwy Warszawskiej str,
all above from Warszawa, Poland

These studies concern the comparison of bat occurrence between the five mixed coniferous forest areas, of the different impact of air pollutions. Forest age at every study plot were 70-100 years old. The main census method were the detecting of ultrasounds along line transects. There were found a significant difference in bats diversity and activity between these areas. Median flight activity varied between 21 flights/1 control (Biebrza Valley) and 1 flight/1 control (Upper Silesia). The largest bats diversity was found in the less disturbed and polluted forests in Bia owie a Primeval Forest and Biebrza Valley. The lowest bat diversity was found in the Upper Silesia region, South-West Poland, the area of highest impact of heavy industry. The possible reasons of these results are analyzed and discussed.

Foraging Patterns of the European Free-tailed Bat *Tadarida teniotus* Studied by Radio-tracking

Ana Rainho¹, Tiago Marques², Mafalda Carapuço³, Paulo Oliveira⁴ & Jorge M. Palmeirim⁵

¹ Instituto da Conservação da Natureza, Rua Filipe Folque, 46-1º, P-1050-114 Lisboa, Portugal

² Rua Central Quinta da Asseca, 14, P-2950-426 Palmela, Portugal

³ Laboratório Marítimo da Guia, Instituto do Mar, Estrada do Guincho, P-2750-642 Cascais, Portugal

⁴ Rua Cidade de Cádiz, 13-2º Dto, P-1500-156 Lisboa, Portugal

⁵ Centro de Biologia Ambiental, Faculdade de Ciências da Universidade de Lisboa, P-1749-016 Lisboa, Portugal

Autumnal foraging behaviour of *Tadarida teniotis* was studied in Southern Portugal from September to November 2001. Four females and 6 males were successfully followed over multiple nights by radio tracking, from fixed and mobile stations. On most nights the bats left the roosts about one hour after sunset, but the time of return to the roosts varied greatly. They only made one foraging trip in each night. In the early evening almost all the bats were foraging, but their numbers declined steadily through the night; one hour before sunrise over 80% of the animals were back in the roost. Bats kept flying even during rain, but there was an apparent decline in activity on colder nights. Most animals flew straight to a previously identified foraging site, but some made slower indirect flights, suggesting that they were searching for profitable foraging areas. Upon arriving to a foraging site most bats remained there for the rest of the foraging trip. The median size of these foraging sites was just over 100 ha. The range of the colony had a radius of over 30 km, but this area was not used uniformly; most foraging sites were concentrated in a mountain region located about 5 km north of the roost. *T. teniotis* proved to be a strong flyer, reaching speeds of over 50 km/h, and flying for up to 10 hours without any obvious resting periods. Forested areas, such as pine plantations, cork oak woodlands, and olive groves, were used more than expected from availability. They foraged both on alluvial plains and in a mountainous area, but in the later clearly concentrated their activity along the valleys.

Optimizing the Thermal Behaviour of Bat-Boxes

Hugo Rebelo¹, Maria J. Ramos Pereira¹, Luisa Rodrigues¹ & Jorge M. Palmeirim²

¹ Instituto da Conservação da Natureza, Rua Filipe Folque, 46, 1º, P-1050-114 Lisboa, Portugal.
hugoreb@hotmail.com

² Centro de Biologia Ambiental, Departamento de Zoologia e Antropologia, Faculdade de Ciências, Universidade de Lisboa, P-1749-016 Lisboa, Portugal. hugoreb@hotmail.com

Bat-boxes are often used to replace roosts in buildings. However, they often fail to attract bats, which may be caused by inadequate thermal conditions. Bats are likely to select roosts in which they can minimize metabolic costs, only possible within certain temperature ranges. There is no good universal bat-box design, because internal temperatures are determined by environmental temperature and radiation, which vary geographically. Consequently, their design has to be adapted to the climate of the region in which they will be set up. Our objective was to quantify the thermal consequences of various manipulations of the structure and colour of boxes, and exemplify how to adapt them to different climates. We used as a reference a grey "BCI" nursery box, and evaluated the thermal impact of 15 design changes. Experiments were carried out simultaneously to avoid the confounding effect of day-to-day climatic variations. The mean daily high during the experiments was 22,3°C. The changes that were most successful at keeping the boxes cool were painting the box white (just 9°C above the environmental temperature), installing a double roof (+16°C), and a wide roof ledge that shadowed the walls of the box

(+18°C). We consider that the two later designs were more successful because they lower the temperature while keeping a relatively broad range of temperatures available within the box. The highest temperatures were reached by painting the upper half of the box black (+ 27°C above environmental temperature), painting the box black (+27°C), and covering the front of the house with a glass (+ 48°C). The black box, however, had a lower range of internal temperatures available. The capacity to manipulate box temperatures with design changes is tremendous; at mid-day the range of temperatures among our 15 boxes was about 40°C. We assume that the best bat-boxes remain at comfortable temperatures for long periods, while keeping a broad range of internal temperatures available. We will exemplify how these conditions can be met in different climates using the results of this study.

The Importance of Woodland for Lesser Horseshoe Bat *Rhinolophus hipposideros* in Austria

Guido Reiter

Institute of Zoology, University of Salzburg, Hellbrunnerstrasse 34, A-5020 Salzburg, Austria.
guido.reiter@sbg.ac.at

Earlier radio tracking studies have shown that woodlands are key foraging habitats for lesser horseshoe bats. Hence, the location of maternity roosts should be influenced by the availability of woodland. I studied the distribution of maternity roosts in Austria with respect to the availability of woodland measured at different scales. Based on digital maps I compared the percentages of woodland cover within a radius of 0.5 and 2.5 km around maternity roosts with those of randomly selected churches and castles. I also measured the distance from maternity roosts to the nearest patch of woodland. Comparing different provinces of Austria, the number of maternity roosts was greater in provinces with greater cover by woodland. Woodland was more abundant around existing maternity roosts than around randomly selected churches and castles. These patterns were found within 0.5 km in both, Carinthia and Salzburg, and within 2.5 km only in Salzburg. Furthermore, the distance to the nearest patch of woodland was shorter at existing maternity roosts than at randomly sampled churches and castles in Salzburg. The colony size was positively correlated with the proportion of surrounding woodland: small areas of woodland only made for small colonies, bigger colonies were only possible in the vicinity of larger proportions of woodland. I conclude that woodlands are an important factor explaining the distribution and selection of maternity roosts and should therefore strongly be considered when conservation measures for this species are required, designed and put into action.

Implementation of the Improved Route counting Method to Monitor Foraging Bats in Tartu, Estonia

Eve Roos¹ & Matti Masing²

¹ Nõmme 1, Tartu 50303, Estonia. evy@ut.ee;

² Sicista Development Centre, Box 111, Tartu 50002, Estonia. matti@ut.ee.

From June till August 2001 and from April till July 2002 a new modification of the route counting method (RCM-2) was implemented to count foraging bats on two routes (3.6 km and 4.7 km) at Raadi in Tartu. The Pettersson D-200 heterodyne detector was used. The task was to identify bats, estimate their numbers and determine the value of different habitats for foraging bats. Two sub-methods of RCM-2, including line counting (LC) and point counting (PC), were used simultaneously (Masing *et al.* 2002, 5th European Bat Detector Workshop. Abstracts. Tronçais, France). By the end of August 2001 the following preliminary results were received. First, LC and PC gave similar results: 7 species and 131 ind., and 7 species and 227 ind., respectively (total result of eight counts). Second, 6 species of bat were observed foraging at River Emajõgi, 5 species were recorded in the streets and around houses, and 4 species were recorded in parks. Third, a total of eight species were recorded on the routes in Tartu, incl. *M. dasycneme*, *M. daubentonii*, *P. auritus*, *P. nathusii*, *P. pipistrellus*, *E. nilssonii*, *V. murinus* and *N. noctula*. Fourth, the largest numbers of foraging bats were found either near or over River Emajõgi, especially in the vicinity of old trees.

Evolution of Migration and Geneflow in *Myotis myotis*: A molecular Perspective

Manuel Ruedi¹ & Vincent Castella²

¹ Muséum d'Histoire Naturelle de Genève, Case postale 6434, CH-1211 Geneva 6, Switzerland

² Laboratoire de Génétique Forensique, C.H.U.V., CH-1005 Lausanne, Switzerland

Analyses of mitochondrial (mtDNA) control region polymorphism and of variation at 10 nuclear microsatellite loci are used to investigate the mechanisms and genetic consequences of the postglacial migration of *Myotis myotis* in Europe. Overall, the 24 European nurseries tested (= 480 bats analysed) show contrasted patterns of mtDNA and nuclear (nDNA) structure, with the former being 20 times more pronounced than the latter. Such discrepancy is in agreement with a strong male-bias dispersal, whereby females remain philopatric. Nevertheless, both markers indicate the existence of major genetic subdivisions across the continent. Accordingly, the phylogeography based on mtDNA sequences reveals the presence of contact zones between haplogroups that have probably diverged in separate glacial refugia. Such zones of secondary contact are found near the Alps and near the Rhodopes. Due to the mixing of divergent haplogroups in these mountain ranges, the predicted northward decline of genetic variation stemming from successive founder events is poorly supported by both mtDNA and nDNA data sets. Contrastingly, when analyses are restricted to a subset of 15 nurseries originating from a single Iberian refugium, a strong northward decrease of mtDNA polymorphism is evidenced, but nothing comparable has been found at nuclear markers. Thus movements of males over large areas have been sufficient to preclude the expected northward decrease of nDNA variation. Results from contrasting patterns of genetic differentiation at nuclear and mitochondrial markers are also used to infer possible modes of colony foundation during the recolonization process of Europe by *M. myotis*.

Factors Influencing the Selection of Roost Cavities by Bats in the Bialowieza Primeval Forest, Eastern Poland

Ireneusz Ruczylski¹ & Wieslaw Bogdanowicz²

¹ Mammal Research Institute, Polish Academy of Sciences, ul. Waszkiewicza 1, PL-17-230 Bialowieza, Poland

² Museum and Institute of Zoology, Polish Academy of Sciences, ul. Wilcza 64, PL-00-679 Warszawa, Poland

Relationships between cavity structure and roosting choice by bats were investigated in two habitats of the Bialowieza Primeval Forest, Eastern Poland. The two habitats included (1) the natural forest stands of the Bialowieza National Park (Biosphere Reserve) and (2) managed forest. 73 roosts of six bat species (*Nyctalus noctula*, *N. leislerii*, *Myotis daubentonii*, *M. brandtii*, *Plecotus auritus*, *Vespertilio murinus*) were inspected in the study area, and 12 features measured. Tree hollows occupied by bats were significantly higher above ground level and at longer distance to the nearest tree than random ones. The bats preferred hollows with narrow entrances and long safety distance (maximum distance from entrance to the farthest point of the hollow). They appeared to be selecting against wet, shallow, and extremely large cavities.

Ectoparasite Load in European Vespertilionid Bats

Doris Rupp & Andreas Zahn

Department Biologie II, Universität München, Luisenstrasse 14, D-80333 München, Germany

Between 1998 and 2000, a study was conducted on the parasite load of eight European bat species (*Myotis daubentonii*, *Myotis emarginatus*, *Myotis myotis*, *Myotis mystacinus*, *Myotis nattereri*, *Nyctalus noctula*, *Pipistrellus pipistrellus*, *Plecotus auritus*) to compare the parasite densities of different bat populations, sexes and ages and to determine whether a relationship existed between high parasite load and poor physical condition. Considerable variations in load were observed according to host species, age and sex, and are attributable to roosting conditions and behavioural differences. Male bats, which roost relatively often alone, had the fewest parasites. Parasite population development was found to differ considerably according to year and site. There was no particular evidence of an increase in parasite load in relationship to deteriorating physical condition. High parasite numbers in weak bats did not appear to be a cause but rather a symptom of poor condition.

Roost Selection by *Barbastella barbastellus* in Apennine Woodlands (Central Italy) and its Implication for Bat Conservation in Forest Management

Daniilo Russo^{1,2}, Luca Cistrone³ & Gareth Jones¹

¹ School of Biological Sciences, University of Bristol, Woodland Road., Bristol BS8 1UG, England

² Centro Studi Ecologici Appenninici, Parco Nazionale d'Abruzzo, Lazio e Molise, viale Santa Lucia, I-67032, Pescasseroli (AQ), Italy. danrusso@tim.it

³ Di.S.A.F.Ri., Università della Tuscia, via San Camillo de Lellis, I-01100 Viterbo, Italy

This project aims to determine roost selection by Italian barbastelles (*Barbastella barbastellus*). The study is in progress at the Abruzzo, Lazio and Molise National Park (Central Italy). In Italy, a major threat to the survival of this tree-dwelling species is represented by the critical loss of roosts due to inadequate woodland management and fires. Hence, information on roost selection is necessary to develop guidelines for woodland management that will specifically take into account protection of this endangered bat species. The bats are mist-netted at drinking sites and fitted with 0.5 g radio-tags. Roosts are located by radio-tracking. Structural features of roost-trees are assessed and compared to those of randomly selected trees from the study area to identify the factors which determine roost choice in barbastelles. In July-August 2001, we identified 19 roosts used by 7 lactating and post-lactating females. Roosts were located at 1280-1630 m a.s.l. All of the roosts were in *Fagus sylvatica* trees, most of which dead or dying trees. The bats were often observed roosting in the space under loose bark. Some of the roosts were used by maternity colonies. Roost switching was shown by some individuals. Our preliminary results show that dead trees are important to *B. barbastellus* in the study area and should be carefully protected. We identified an area of primary importance for barbastelles which deserves special protection. We are indebted to the Nando Peretti Foundation and the Ente Autonomo Parco Nazionale d'Abruzzo, Lazio and Molise for funding this study.

Sexual Segregation in Italian Daubenton's Bat *Myotis daubentonii*

Daniilo Russo

School of Biol. Sciences, University of Bristol, Woodland Road., Bristol BS8 1UG, England
Centro Studi Ecologici Appenninici, Parco Nazionale d'Abruzzo, Lazio e Molise, viale Santa Lucia, I-67032, Pescasseroli (AQ), Italy. danrusso@tim.it

In 2000-2001 I investigated sexual segregation in *Myotis daubentonii* from the Abruzzo (Central Italy) population. I mist-netted 133 bats at sites respectively below 880 and above 970 m a.s.l. Females only occurred below 880 m, while males were observed at all sites but were less frequent than expected below 880 m a.s.l. and occurred more than expected above 970 m a.s.l. Of four day-roosts examined, the one above 970 m a.s.l. was occupied by males only, while bats from both sexes were captured at those at lower altitudes. A few bats from both sexes were captured at a night-roost below 880 m a.s.l. The % Body Condition Index (BCI) was compared between adult males from below 880 m and above 970 m a.s.l. In April-June males from low-elevation sites showed a higher BCI, but no difference occurred in August. The upper elevational limit for females in Italy lies at a higher altitude (ca. 900-950 m a.s.l.) than that recorded in Northern Europe. The possible mechanisms (physiological constraints and competition between sexes) leading to sexual segregation in *M. daubentonii* and in other bat species are discussed.

Summer Roost Sites of *Myotis brandtii* in Eastern Poland

Konrad Sachanowicz¹ & Ireneusz Ruczyński²

¹ Polish Society for the Protection of Birds, Po. Box. 335, PL-80-958 Gdańsk 50, Poland

² Mammal Research Institute, Polish Academy of Sciences, ul. Wąszkiewicza 1, PL-17-230 Białowieża, Poland

We investigated the occurrence of rare *Myotis brandtii* in buildings of forest settlements and bat boxes in the Mazowsze and Podlasie Lowland (Central-Eastern Poland). Altogether, 15 summer roosts of *M. brandtii* were recorded: 10 were situated in houses, 3 in Issel type bat boxes and 2 in natural tree hollows. All roosts were situated in the forest or on its edges. Window shutters in houses were used more frequent than the attics. Buildings were occupied either by single individuals or by small groups up to 6 bats, including lactating females with their juveniles. One nursery colony shared an attic with three other species.

Adult bats (both sexes) were detected in houses and wooden bat boxes in August and possibly used them for mating. In the Łuków Forest, *M. brandtii* belonged to the group of bats the most frequently recorded in buildings during summer along with: *Plecotus auritus* and *Eptesicus serotimus*. In the Bia_owie_a Primeval Forest 2 colonies were found to use natural hollows in two large oaks *Quercus robur*.

Genetics and Conservation of the Azorean Bat *Nyctalus azoreum*

Patricia Salgueiro¹, Maria Manuela Coelho¹, Jorge Palmeirim¹ & Manuel Ruedi²

¹ Centro de Biologia Ambiental Departamento de Zoologia e Antropologia,
Faculdade de Ciências da Universidade de Lisboa, P-1749-016 Lisboa, Portugal.

² Muséum d'Histoire Naturelle de Genève, Case postale 6434, CH-1211 Genève 6, Switzerland

The Azorean bat *Nyctalus azoreum* is the only endemic mammal from the archipelago of Azores. It is thought to have evolved from a continental ancestor related to *N. leisleri* but it is morphologically distinct from the later (with a smaller size and darker pelage). This species is considered threatened due to its isolation and very limited geographic range. To analyse genetic diversity and the colonisation history of *N. azoreum*, 21 breeding colonies from six islands of the Azores were sampled. Mitochondrial DNA variation was examined by amplification of D-loop sequences of 161 individuals. Within the Azores, 15 distinct haplotypes were identified, but only two were common to both central and eastern groups of islands. The largest and eastern island of S. Miguel showed the highest diversity with eight haplotypes, six of them were unique to this island. Four haplotypes from islands of the central group showed a unique insertion of 22 bp that was not found elsewhere. This pattern of haplotype distribution suggests very few current population exchanges between eastern and central island groups, although such exchanges seem to be more frequent among neighbouring islands within the central group. These results allowed to estimate female gene flow between island populations, which will provide a solid framework for the future conservation of this endemic species.

Ecology and Conservation Problems of Bats in Bangladesh

Sohrab Uddin Sarker, Noor Jahan Sarker, M. Feroj Jaman & Taslima Akter

Dept. Zoology, University of Dhaka, 1000 Dhaka, Bangladesh. arker@udhaka.net -
du@citechco.net

Present study is based on direct field observation in woodland, forests of rural and urban areas in the country and laboratory research since 1968. Thirty-two species of bats have so far been reported from Bangladesh including a large horseshoe bat (*Microtis hipposideros*) a newly recorded species from a cave in the hilly forest. Of these, ecological and conservation problems were studied on Fruit bats (*Pteropus giganteus*) false vampire (*Megaderma lyra*), greater yellow bat (*Scotophilus heathi*) and lesser yellow bat (*S. kuhlii*), and pipistrelles (*Pipistrellus coromandra* and *P. mimus*) including horseshoe bat. Yellow bats and pipistrelles were common and had wider in distribution all over the country. Fruit bats were fairly common in the plain woodlands than hilly and mangrove forests. Fruit bats roosted in colony in the woodland of the rural and urban areas. False vampire and other bats usually roosted in small colonies in hidden places like ruined buildings, crevices, tree holes and leaves of palm trees. Large horseshoe bats live in colony in the cave of hilly forests. Bats did not change their habitats until they were heavily disturbed or destroyed. In recent decades population particularly of the fruit bat and false vampire decline rapidly due to reducing roosting, feeding facilities and human disturbances. Main problems of conservation of these bats are destruction of their roosting and feeding habitats, shortage of food due to increasing human population, agricultural expansion, development activities and uses of agrochemicals in the fruit gardens. Awareness, protection of woodlands, plantation of fruiting trees, national conservation action plan and international cooperation would assist the conservation of bats of Bangladesh.

Geographic Variation in *Myotis blythii* in Western Zagros Mts., Iran

Mozafar Sharifi & Zeinab Hemmati

Dept. Biology, Faculty of Science, Razi University, Baghabrisham 67149, Kermanshah, Iran

Information obtained from 74 specimens of *Myotis blythii* (Tomes, 1857) collected from 6 caves along Western Zagros Mts. (in Western Iran) together with 22 specimens described from the same area in the

literature has been used to demonstrate geographic variation in this species. Results of this investigation reveal that an overall clinal increase in size exists in this species from the north to the south across the Zagros Range. These differences in external features and cranial characters are best shown in two separated samples coming from the Zivieh and Kilasefid caves located at the north and the south of the western part of the Zagros Range in Iran respectively. Size differences appear to exist in these specimens as bigger (individuals with bigger forearms) specimens are reported from the southern parts of the range and smaller ones from the northern parts of the range. The specimens from northern part of the country appear to have more "reddish" coloration than those from the southern localities which are paler.

Postnatal Growth in the Lesser Mouse-eared Bat *Myotis blythii* in a Maternity Roost in Western Iran

Mozafar Sharifi¹, B. Kiabi² & K. Faizolahi²

¹ Dept. Biology, Faculty of Science, Razi University, Baghabrisham 67149, Kermanshah, Iran

² Dept. Biology, faculty of Science, Shahid Beheshti University, Tehran, Iran

Length of forearm, body mass and length of total gap of the fourth metacarpal-phalangeal joint were measured in order to develop empirical growth curves for a free-ranging population of the lesser mouse-eared bat *Myotis blythii* in a maternity colony in Western Iran. Length of forearm and body mass followed a linear pattern of growth until day 14 and subsequently leveled off to reach to a stable condition. The length of the total gap of the metacarpal-phalangeal joint showed an increase up to 10 days and decreased when it closed at over 70 days. Initiation of flight occurred 3-4 weeks after birth. During the first two weeks of post-natal growth, the body mass and the length of forearm of pups increased linearly at mean rates of 0.43 g/day and 0.8 mm/day, respectively. A method of estimation of age was derived from values of length of forearm and the total gap of the four metacarpal-phalangeal joint during the preflight and post flight periods.

The Genus *Plecotus* in Austria

Friederike Spitzenberger¹, Elisabeth Haring¹ & Nikola Tvrtkovic²

¹ Natural History Museum in Vienna, P.O. Box 417, A-1014 Wien, Austria

² Natural History Museum Zagreb, Demetrova 1, HR-10 000 Zagreb, Croatia

Austria is inhabited by three species of the genus *Plecotus*: *P. austriacus*, *P. auritus* and *P. microdontus* (or *P. alpinus*). External and cranial characters as well as distribution maps are presented. *Plecotus austriacus* is mainly confined to the extra-alpine lowlands where it lives in regions characterized by small-scaled agriculture dominated by arable land in low altitudes. It enters also cities. Maternity roosts are situated mainly in lofts, hibernacula in cellars of buildings. *Plecotus auritus* is widely distributed in wooded areas of the Alps and in the Bohemian Massif, for hibernation it migrates also to low-lying planes east of the Alps. Maternity roosts are situated in trees as well as in lofts of buildings up to 1640m. a.s.l. For hibernation it prefers caves to buildings. The highest hibernaculum was found in 1960 m a.s.l. *Plecotus microdontus* (or *P. alpinus*) was found in some parts of the Alps in altitudes between 550 and 1220m a.s.l.. All maternity roosts were situated in lofts of churches.

Molecular Systematics of the Piscivorous Bat *Myotis (pizonix) vivesi*

Benoît Stadelmann^{1,2}, Gerardo Herrera³, Joaquín Arroyo-Cabrales⁴ & Manuel Ruedi¹

¹ Natural History Museum, P.O. Box 6434, CH-1211 Geneva 6, Switzerland

² Department of Zoology & Animal Biology, Molecular Systematics Group, University of Geneva, 154 route de Malagnou, CH-1224 Chêne-Bougeries, Switzerland

³ Instituto de Biología, U.N.A.M., Departamento de Zoología, Apartado Postal 70-153, 04510 Mexico D.F.

⁴ Laboratorio de Paleozoología, I.N.A.H., Moneda # 16, Col. Centro, 06060 Mexico D.F., Mexico

Previous phylogenetic reconstructions based on molecular data showed recurrent morphological convergences during the evolution of the speciose genus *Myotis*. This illustrates that the evolution of species or groups of species with similar feeding strategies occurred independently several times, but led to remarkable similarities in their external morphology. In this context, we investigated the rather contested

phylogenetic position of one of the only two piscivorous species of bat in the world, *Myotis vivesi* Menegaux, 1901, which was missing in the earlier study. This bat is endemic to the coasts and islands of the Gulf of California, Mexico. Because of its distinctive morphology, it was long classified in its own genus, *Pizonyx*. In order to reconstruct its phylogenetic origins relative to other *Myotis*, we sequenced the mitochondrial cytochrome-*b* of two *M. vivesi* and related vespertilionid bats. These outgroups included *Pipistrellus subflavus*, a member of the subgenus *Perimyotis*, sometimes classified within the genus *Myotis*. Unexpectedly, all reconstructions placed *vivesi* unambiguously within a strongly supported clade including more "conventional" Neotropical and Nearctic *Myotis*. This supports the existence of an endemic radiation of American *Myotis*. Other *Myotis* species with similar adaptations to gaffing preys from the water surface present no close phylogenetic relationships with *M. vivesi*, indicating that such adaptations result from morphological convergences. On the other hand, "*Pipistrellus*" *subflavus* is genetically as distant from the genus *Myotis*, as from other true "*Pipistrellus*", suggesting separate, full generic rank to *Perimyotis*.

Selecting Special Areas of Conservation for Bats in the Czech Republic

Michal Andreas & Eva Suhomelová

Agency of Nature Conservation and Landscape Protection of the Czech Republic,
Kali_nická 4-6, CZ-130 23 Praha, Czech Republic

The poster summarises results of a status analysis of bat populations in the Czech Republic carried out in 2000-2001. The study was aimed at the populations of bat species included in Annex II of the Habitats Directive (*Rhinolophus ferrumequinum*, *R. hipposideros*, *Myotis emarginatus*, *M. blythii*, *M. myotis*, *M. dasycneme*, *M. bechsteinii* and *Barbastella barbastellus*). At the first step, 3-5 most numerous hibernacula and nursery colonies in the country were selected in each species. Second, the national population of each species has been classified, more or less objectively, into several sub-populations with respect to geographical segmentation and landscape features important for bat populations (e.g. karstic regions). 3-5 most numerous nursery colonies and 3-5 hibernacula have been then chosen in the particular sub-populations. Selection of the SACs based on this approach should ensure survival of the particular sub-populations in a relative welfare. Moreover, special attention has been paid to isolated and marginal populations of bats. Recent results of bat monitoring show an increase of population size at least in some species and the studies of feeding ecology of bats indicate that these animals are not an endangered group in the patchy Central-European landscape as far as their trophic resources are concerned. Therefore, effective conservation of bats in the Czech Republic should be aimed at eliminating factors that may threaten their roosts.

Gleaning Behaviour in two European Bat Species, *Myotis nattereri* & *Plecotus auritus*

Susan M. Swift & Paul A. Racey

Dept. of Zoology, University of Aberdeen, Tillydrone Avenue, Aberdeen AB24 2TZ, Scotland

Two species which glean prey directly from plant surfaces, Natterer's bat, *Myotis nattereri* and the Brown long-eared bat, *Plecotus auritus*, are sympatric in Scotland. However, they eat different arthropods, possibly due to differences in prey perception. In a study carried out in a flight room, aimed to elucidate these methods of prey perception, *M. nattereri* continued to emit echolocation calls throughout gleaning attacks both on mealworms and on arthropods found in their natural diet, and made little use of prey-generated sound as a cue to locate them. Feeding buzzes were recorded in most attacks. In contrast, *P. auritus* in similar experiments stopped echolocating during the hovering phase of gleaning attacks, did not emit feeding buzzes and used prey-generated sound as a cue to find food. In uncluttered foraging situations, *M. nattereri* were able to locate prey by echolocation alone, but in clutter they may have combined it with associative learning, and may also have gleaned prey after being attracted to food sources by feeding buzzes of conspecifics. Both species used a sequence of low searching flight and hovering, Natterer's bats used the tail membrane for most aerial captures, and both were able to land and pursue prey by quadrupedal locomotion. In an area where both species had summer roosts, moths constituted 31.8% of the diet of *P. auritus* in the wild, but only 4.2% of that of *M. nattereri*. It is suggested that Natterer's bats do not hunt moths selectively because they cannot switch off echolocation during gleaning and cannot therefore avoid alerting tympanate moths to their presence.

Preliminary Data Regarding the Evolution of the Occurrence of Cave Dwelling Bats in Southern and Western Carpathians, Romania

László Szántó¹; L. Zoltán Nagy¹ & Farkas Szodoray-Parádi²

¹ Transylvanian Museum Association, Op. 1, Cp. 191, RO-3400 Cluj, Romania. szantolaci@yahoo.com

² Romanian Bat Protection Association, Str. Ion Budai Deleanu 2, RO-3900 Satu Mare, Romania

The last global report on the bats' status in Romania was conducted in the '50s. Since then no comprehensive study was published. We initiated a new research of the region in 1999, and compared our data with those found in literature. We realised an overview of 60 underground sites inhabited by bats. *Miniopterus schreibersii* is quoted as a common cave species in Romania, which often form colonies of several 10,000 individuals. Nowadays they present much smaller nursery colonies, with less than 5,000 specimens, or disappeared completely from the 36 quoted sites. 90% of the currently known winter aggregations, more than 30,000 specimens, are hosted during hibernation by a single cave. *Rhinolophus ferrumequinum* is quoted on 39 locations of the region, and was found by us on 32 locations. The species forms only small nursery colonies in caves, up to 50 individuals, although large hibernating colonies were recorded, with hundreds of individuals. This discrepancy is due to the preference of the species for forming nursery colonies in buildings. A connection of such a nursery colony with several caves was proved. *Rhinolophus hipposideros* is quoted on over 50 locations, although it was found only in a small number, not more than 50 specimens, mainly during hibernation. *Myotis myotis* / *blythii* were also common species for caves; nowadays they form mixed colonies in the region, with up to 5,000 individuals. The presence of *Pipistrellus pipistrellus* and *Nyctalus noctula* in caves during hibernation is remarkable. The first one forms colonies of several 10,000 individuals, the latest one of ca. 1,000 specimens. *R. euryale* and *M. capaccinii* form colonies up to 200 specimens. The other 13 species, *R. blasii*, *M. bechsteinii*, *M. brandtii*, *M. mystacinus*, *M. daubentonii*, *M. dasycneme*, *M. emarginatus*, *M. nattereri*, *Eptesicus serotinus*, *Plecotus auritus*, *P. austriacus*, *Barbastella barbastellus* and *Vespertilio murinus*, were recorded only accidentally; they do not form large colonies in caves. Even though it seems that some species are not endangered, the literature data is lacunar or missing. One can suppose that the colonies found by us are only the remain of the former populations, which were drastically reduced by human interference.

Foraging Strategy of Daubenton's Bat *Myotis daubentonii* in Relation to Invertebrate Availability

Victoria L.G. Turner, Dean A. Waters & Claudia Vollrath

School of Biology, University of Leeds, Leeds LS2 9JT, England

Non-volant and volant invertebrates fall into rivers where they may be gaffed off the surface by foraging *Myotis daubentonii*. This species also aerial hawks volant insects and we suggest that the proportion of surface gaffs and aerial hawks should be related to water surface and aerial invertebrate density respectively. To test this hypothesis, free-living *M. daubentonii* were filmed throughout the night at two sampling locations. Simultaneous invertebrate availability was measured by aerial sweep netting and river surface drift nets. At both sites, surface invertebrate density was two orders of magnitude greater than aerial insect density but the overall foraging strategy was aerial hawking (85.7%) with only 14.3 % gaffs. However, at one site, bats preferentially aerial hawked (> 84 %) in the hour after sunset when mean aerial insect density was highest (0.3 insects/m³). Bats predominantly gaffed for three hours in the middle of the night when the mean surface invertebrate density peaked at 17 individuals m⁻³ and mean aerial insects were minimal (0-0.04 insects/m³). At the second site, aerial hawking dominated all night (79-96 %) regardless of surface invertebrate density. Results are discussed in terms of energetic constraints of foraging strategies and food availability.

Link Between the Summer Distribution of the Pond Bat *Myotis dasycneme* and the Water Quality of Broad Watercourses in the Province of West Flanders, Belgium

Marc Van De Sijpe¹, Bob Vandendriessche¹, Paul Voet¹, Joost Vandenberghe¹, Johan Duyck¹, Ivan Duyck¹, Erik Naeyaert¹, Mario Manhaeve¹ & Els Martens²

¹ Vleermuizenwerkgroep Natuurpunt, Kardinaal Mercierplein 1, B-2800 Mechelen, Belgium

² Ministry of the Flemish Community, Nature Division, Koning Albert II-laan 20 bus 8, B-1000 Brussels, Belgium

During the period 1998 to 2001 bat detector surveys were carried out throughout the province West-Vlaanderen with special attention to the extensive network of watercourses. During this survey, the rare pond bat was discovered. Pond bats are known to forage on chironomid midges, moths and caddis flies over large, open water surfaces of ponds, rivers and canals. Although there are many large watercourses in the province, only three are listed to have a good water quality: the upstream half of the canal Ieper-IJzer (near Ieper), the entire canal Damme-Sluis and the downstream half of the canal Bossuit-Kortrijk (near Kortrijk). Three areas with concentrations of pond bats were found: the surroundings of Ieper, the area around Damme and the area south of Kortrijk. The first maternity roost of the pond bat in Flanders was found north of Ieper, in a brewery near a canal strip with good water quality, where they have been observed hunting frequently. The Ieper town moats have a gradually improving water quality from the south-west end, where a polluted brook enters the moats, to the northeast end thanks to the long retention time of the almost stagnant water. With an image intensifier pond bats have been seen foraging on mothlike insects above the north-eastern moat, the strip with the best water quality. In these parts of the moats caddis fly larvae have been found. Pond bats seldom forage over the more polluted south-western moats. South of Kortrijk, pond bats were observed commuting over the heavy polluted river Schelde, but flight paths of this group partially lead to the canal Bossuit-Kortrijk where a good water quality exists. According to our observations, the pond bat seems to select - at least in the west of Flanders - those areas where large open water surfaces where good water quality is available.

Survey of Historic Data and Present Status of *Barbastella barbastellus* in the Northern Region of Belgium (Flanders)

Bob Vandendriessche¹, Paul Voet¹, Joost Vandenberghe¹, Rudy Van Torre¹, Marc Van De Sijpe¹ & Els Martens²

¹ Bat Working group Flanders, Natuurpunt vzw, Kardinaal Mercierplein 1, B-2800 Mechelen, Belgium

² Ministry of the Flemish Community, Nature Division, Koning Albert II-laan 20, Bus 8, B-1000 Brussels, Belgium

One of the species which status has been described in the Flemish Red Data List of Mammals as 'probably extinct' is the barbastelle (Criel *et al.* 1994). During the last two decades, several observations have proven the opposite, and it is not unlikely that the barbastelle is still present, probably in critically low numbers, in some forested areas of Flanders. At the Belgian level, the main distribution is presumed to be South of the rivers Sambre and Meuse (Wallonia). Our survey presents a summary and some comment on historic and recent data. During the eighties, observations are limited to the finding of a skull at the fortress of Oudenaarde in 1981 (Minnaert *et al.* 1990) and two observations of hibernating animals, one near Brussels (winter '84-'85) and one in a fortress of the well-known 'Antwerp cluster of fortresses' for the consecutive winters from '87-'88 until '90-'91. Observations of at least 5 hibernating barbastelles were equally made between '81 and '94 at a site of ruins at the town of Sluis (The Netherlands), less than two miles from the Flemish border. September '92 a barbastelle was seen in a barn in that same area, this time at a stone's throw of the border. During the 1990-ies, apart from an unverifiable bat-detector observation in the 'Forêt des Soignes' near Brussels, observations in Flanders are limited to one site at the coastal province of Western Flanders, only fifteen miles away from the Dutch site: during the winter of '96-'97 one barbastelle was found hibernating in an ice-cellar at a private woodland at the city of beernem. At this site, sound recordings of hunting barbastelles were made and analysed for the first time in October '98. A first summer observation was made the 30th of may 1999. The last verifiable observation at that site was made on July 2000. Since then further intensive attempts to observe barbastelles at this site have failed. The following winter, a remarkable observation of a hibernating barbastelle was done at a well surveyed hibernation-site in the province of Eastern Flanders, less than seven miles away from the former site. It

seems not unlikely that all or some of the animals of the small Dutch population in Sluis have migrated along canals that make a known migration route for at least nine other species of bats.

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Do Bats Select Tree Cavities for Reasons of Microclimate: An Experimental Study

Ben Van der Wijden^{1,2}, Sven Verkem¹, L. De Bruyn^{1,3} & R. Verhagen¹

¹ Evolutionary Biology Research Group, University of Antwerp RUCA, Groenenborgerlaan 171, B-2020 Antwerpen, Belgium

² Brussels Institute for Environmental Management, Gulledele 100, B-1200 Brussels, Belgium

³ Institute for Nature Conservation, Kliniekstraat 25, B-1070 Brussels, Belgium

The availability of suitable roost sites is essential for the survival of bats. Selection of specific roost sites by breeding female bats has consequences for survival and reproductive success. However, factors that influence roost site selection by bats under natural conditions are poorly understood. The influence of microclimate on the selection of roost sites is not clear. For bats roosting in buildings it has been shown that temperature is one of the most important factors. In forest-dwelling bats, however, this was never investigated. During previous research we found that roost site selection of the tree cavity dwelling species *Myotis daubentonii*, *M. nattereri* and *Plecotus auritus* is based exclusively on cavity parameters. Bats showed a marked preference for narrow cavities with high ceilings. The study of cavity thermoclimate in the field is extremely difficult due to the lack of control over several variables and the absence of suitable replications. Therefore, we chose to use an experimental approach. The goals of this study are 1) the creation of artificial tree cavities with a thermal régime approximating the thermal characteristics of natural tree cavities and 2) to test the influence of individual cavity parameters on the internal thermal régime. The influence of entrance tunnel length, entrance diameter, number and position of entrances, internal height, internal diameter and wall thickness of the cavity was tested. The results yield that there is a relationship between several cavity parameters selected for by bats and the thermal régime of the cavity. It may therefore be possible that bats select tree cavities for reasons of microclimate and that the preferences found in the field for certain cavity types merely reflect a selection for certain thermal régimes. This should, however, be further investigated.

The Influence of Artificial Light on the Emerging Time of Geoffroy's Bat *Myotis emarginatus*

Sven Verkem & Tine Moermans

Flanders Bat Group Natuurpunt, Kardinaal Mercierplein 1, B-2800 Mechelen, Belgium.

sven.verkem@natuurpunt.be

In Flanders Geoffroy's bats roost in church attics. For architectural and estetic reasons a major part of the churches are illuminated during night with spotlights. We investigated the effect of this light on the emerging behaviour of the bats at 4 roosts. In 3 cases the number of bats and their behaviour was observed during 2 days in absence of spotlights (normal conditions), the following 2 days a spotlight was installed, and finally we observed again 2 days in absence of lights. At one roost the reverse was done: normally there was a spotlight, and it was switched off for two days and then turned on again. Furthermore we investigated the light intensity around the roost and compared this with the flightpath. In normal conditions the bats flightpath was in close relation with the light intensity around the roost with an obvious preference for the darkest places. The results of the experiment revealed that the first day when spotlights were installed bats showed an obvious change in behaviour (changing flightpath, using other exits, flying back into the roost) and emergence was delayed ($36,7 \pm 3,34$ minutes). The second day behaviour was less disturbed but bats even remained longer in the roost (extra $8,62 \pm 1,45$ minutes). At the roost were the experiment was reversed, the bats showed exactly the opposite behaviour. During the experiment we also gained evidence that the installation of spotlights actually increases the predation pressure on emerging bats by birds of prey.

Activity Patterns of a colony of Greater Mouse-eared Bats *Myotis myotis* in a Motorway Bridge

Bernd Walther

Behavioural Ecology, Group Institute of Ecology, Friedrich-Schiller-University Jena,
Dornburger Strasse 159, D-07743 Jena, Germany

The investigated colony of about 250 Greater mouse eared bats live in a motorway bridge near Mellingen, 7 km SO of Weimar (Germany). Prior to reconstruction and redevelopment of the bridge several studies for the protection of this colony were carried out between the end of March and the middle of November 1997. During this time the bats used the bridge as a nursery roost and for reproduction. The flight activity of the colony in the shelter was recorded by an automatic recording system using the bats ultrasound. Additional observations of outflying bats completed the study of temporal activity in the roost. A small window at the western bridge was the main transit scope for the colony. For hunting the bats leave their roost about 27 min after astronomical sunrise. The colony needed between 45 and 60 min for outflying but rainfalls prolonged the outflying phase. The normal outflight course was unimodal. When rain starts in the night the bats returned earlier from hunting. The flight activity inside the bridge increased between 0,5 and 1,5 hours after rainfall in comparison with the same time the night before and after. Normally the colony showed a nocturnal flight activity pattern with three peaks inside the bridge. In addition to the peaks at outflight and inflight there was a lower peak around midnight due to some bats who came back for a rest. In the middle of July fledged juveniles exhibited a high flight activity in the shelter the whole night through. The study showed that the Greater mouse eared bats used this uncommon nursery roost in a motorway bridge for the whole summer season, not only for day roosting but also during the night.

Diet of a Motorway Bridge Indwelling Colony of Greater Mouse-eared Bats *Myotis myotis*

Bernd Walther

Behavioural Ecology, Group Institute of Ecology, Friedrich-Schiller-University Jena,
Dornburger Strasse 159, D-07743 Jena, Germany

The observed colony of Greater mouse eared bats *Myotis myotis* count about 250 individuals. The bats use a motorway bridge near Mellingen, 7 km SO of Weimar (Germany) as a nursery roost and for reproduction. To determine the diet of the colony 180 faecal pellets were collected between the end of March and the middle of November 1997. The seasonal differences in the composition of diet were established by a frequency analysis. For this analysis only the discovering of a taxon in a pellet was counted, but not its volume. Carabids were the main taxon found. Large Carabids of the order *Carabus* were mainly eaten in spring and autumn. The middle-sized taxon Pterostichinae showed a peak in summer. Especially from July until September Scarabeids and Tipulids became an important element of diet. Considering the habits of the prey species, the bats probably hunted in forests but also on meadows. Their use of foraging habitats changed through the season. The hunting of arthropods that live primarily on the soil surface, and the general prey size confirmed a size-selective and ground-gleaning foraging strategy of Greater mouse eared bats as already known and accepted. However, the discovering of numbers of the small beetle *Aphodius fimentarius* in August suggested that abundance and availability of prey items are more important than the prey size at certain times. It seems that Greater mouse eared bats use Carabids as a basic prey resource which is available the whole summer season. The bats may react quickly on high abundances of other prey taxons and change their hunting habitats and strategies individually.

Hedgerow Architecture and its Use by Bats

Ruth D. Warren

English Nature, Bullring House Northgate, Wakefield, West Yorkshire, WF1 3BJ, England

Anecdotal evidence suggests that bats often associate with linear features. However, relatively few studies have looked at how the architecture of these linear features affects the distribution of bats. A study to investigate this was undertaken in 1998 and 1999 in Wales. Twenty-six transects along linear features in

agricultural land were walked and bats identified using time-expanded recordings. The association of each bat with different features of the hedges was recorded. Hedges were categorised into one of three height categories and into one of three density categories. The latter were dense hedge, thin hedge, and gappy hedge. Hard landscape features such as fences, gates and walls were also recorded and transects took in areas of open field as a control. In total, 48.6 kilometres were surveyed with 486 bats recorded. Chi-squared analysis in combination with Bonferroni confidence intervals were used to investigate habitat preference. All species of bat selected against open fields and hard landscaping features but selected for at least one hedge type. In general, bats selected for taller, denser hedges.

Echolocation Performance and Call Structure in the Megachiropteran Fruit Bat *Rousettus aegyptiacus*

Dean A. Waters & Claudia Vollrath

School of Biology, University of Leeds, Leeds, LS2 9JT, England.

The call structure of the echolocating fruit bat *Rousettus aegyptiacus* was investigated. Calls are impulsive clicks with an exponential decay lasting 250 μ s, with most energy occurring during the first 100 μ s, much shorter in duration than previously recorded. Calls closely resemble Gabor functions and are similar in structure to those used by dolphins. The ability of *R. aegyptiacus* to detect and avoid obstacles was tested in both the light and total darkness. Bats were able to detect and avoid 6 mm diameter wires significantly more often than 1.3 mm diameter wires when tested in the light. In the dark, the same relationship held, with no decrease in the ability to detect and avoid the obstacles. Bats used echolocation in both the light and the dark conditions. The simple impulsive clicks used in echolocation by this species are thus able to detect wires of at least 6 mm in diameter, providing confirmation that this species may have a more sophisticated echolocation system than previously thought. The detection problems associated with very short duration signals is discussed. The possession of both a good visual system, and a good echolocation system has implications for the evolution of echolocation in bats.

The Bat Population of the Meerdaal Forest, Flanders, Belgium

Wout Willems¹, Bart Roelandt², Alex Lefèvre¹ & Ludo Holsbeek³

¹ Bat Working Group Flanders, Natuurpunt vzw, Kardinaal Mercierplein 1, B-2800 Mechelen, Belgium

² Ministry of the Flemish Community, Forest and Green Areas Division,
Koning Albert II-laan 20, Bus 8, B-1000 Brussels, Belgium

³ Free University of Brussels (VUB), Biology Dept., Pleinlaan 2, B-1050 Brussels, Belgium.

During 2001, a full scale project was launched on the occurrence of bats in small and large scale forest areas throughout the Region of Flanders, Belgium. The project is co-ordinated by the Flemish Forest and Green Areas Division; the field work is carried out by the Bat Working Group within Natuurpunt vzw. One of the pilot study areas is the Forest of Meerdaal, in the Province of Vlaams-Brabant, covering a total area of \pm 1300 ha. As a first step, an species inventory list is; a second phase aims to identify foraging habitats, flight paths and roosting sites. Activities are recorded using Pettersson D240 bat-detectors and Batbox-3s, connected to a Sony Minidisc recorder. Surveys were undertaken during early evening or at night; some surveys were carried out early mornings in order to better locate flight paths as well as colonies. All sound recordings were analysed using the BatSound Pro programme. The first results indicate that the Meerdaal Forest is an important habitat for a considerable number of bat species: Daubenton's bat *Myotis daubentonii*, pipistrelle *Pipistrellus pipistrellus*, Nathusius' bat *Pipistrellus nathusii* (first observation in the larger area surrounding the study site), serotine *Eptesicus serotinus*, noctule *Nyctalus noctula* and long-eared bats *Plecotus sp.* A flight path was discovered with at least 13 *Myotis* species, most probably whiskered bats *Myotis mystacinus/brandtii*. Surprisingly, 2 encounters were recorded for Leisler's bat *Nyctalus leisleri*, being the 2nd and 3rd confirmed and recent observations in Flanders. A single encounter only was recorded of a hunting pond bat *Myotis dasycneme*; first record for this part of Belgium since 1945.

The ABC (Atlas of Bats of the Carpathians) Project

Bronislaw W. Woloszyn

Chiropterological Information Center, Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, ul. S17, PL-31-016 Kraków, Poland

Carpathians territory is of considerable significance to analyse ranges of bats in Europe. Several bat species are restricted to different parts of the mountains and, as the ranges of these species have not been thoroughly studied, the boundaries of their distribution in Europe have been freely interpolated. Changes in the geopolitical situation stimulated the development of new ideas and plans of international co-operation in this area. A proposal for conducting joint research aimed to recognize the present state of the bat fauna of the Carpathians was presented as the ABC Project (Atlas of Bats of the Carpathians) during the 1st International Conference on the Carpathians Bats, organized by the Chiropterological Information Center in Kraków (Poland) on 14-15 December 1996. The main goals of the ABC Project are: 1- obtaining the most accurate knowledge of species and their distribution over the Carpathian Region; 2- recording the status of the bat fauna in a definite time interval, as a starting point for tracing further evolution and as an indicator of environmental changes; 3- filling the gaps in our knowledge of ranges of bats in the Carpathian Region. The final form of the atlas will be divided into two main parts. The first part will gather descriptions of each region as independent chapters prepared by teams from respective countries appointed by national coordinators. The second part will contain maps of the distribution of all bat species currently occurring in the Carpathians as well as biogeographical analyses. Additional maps in different scale will present the regional distribution of certain species.

The ABC Team is managed by a Project Coordinator - Bronislaw W. Woloszyn, and National Coordinators: Czech Republic - Zdenek Rehak, Hungary - Zoltan Bihari, Romania - Dumitru Murariu & Zoltan Nagy, Slovakia - Marcel Uhrin, Ukraine - Andrij Taras Bashta & Vasyl Pokynchereda, Poland - Tomasz Postawa & Krzysztof Piksa.

Miniopterus schreibersii in Slovenia - Status, Distribution and Conservation

Maja Zagmajster, Klemen Koselj, Primož Presetnik & Nataša Aupič

S.D.P.V.N. - Slovenian Association for Bat Research and Conservation, Prešernova 20, SI-1000 Ljubljana, Slovenia. maja.zagmajster@uni-lj.si

In the past few years, intensive work has been carried out to assess the status and distribution of Schreiber's bat in Slovenia. Most of the fieldwork was done in 1999 and 2000, as a part of the international project Central European *Miniopterus* Protection Programme, but it continued also later. Caves and other potential roosting places were searched and monthly monitoring was introduced to the most important shelters. Schreiber's bats or their bony remnants have been found on fifteen localities in Slovenia, but larger concentrations of bats occur on five localities only. Kocjanske jame cave (SW Slovenia) is a large cave system, used by Schreiber's bats throughout the year. In winter 1999/2000 about 10.000 bats were counted there. Predjama cave system (SW Slovenia) and Huda luknja cave (N Slovenia) are being used as hibernation and mating site for Schreiber's bats, though in Huda luknja a small summer colony could also be observed. Planinska jama (SW Slovenia) appears to be an autumn transitory roost. In the cellars of the castle Grad na Goriškem (NE Slovenia) about one hundred Schreiber's bats, including the young, were observed during the summer time. Schreiber's bat has been classified Endangered in the Slovenian Red List of Animal and Plant species and is legally protected. Recommendations for the protection of some underground sites were given to the Conservation Authorities. Most of the roosts are tourist caves, so the tourism in some of them should be at least partly restricted. In the case of the castle Grad, besides human vandalism the collapsing of walls in the cellars presents an even bigger problem. Conservation of the species in Slovenia for now depends completely on the protection of roosts, since little is known about other threats.

Study of a Cave-dwelling Colony of *Myotis daubentonii* in Bavaria, Germany

Andreas Zahn & Ines Hager

Department Biologie II, Universität München, Luisenstrasse 14, D-80333 München, Germany

A study was made between 1999 and 2002 of a small cave in Garching a.d. Alz, Bavaria (Germany), used by a colony of *Myotis daubentonii*. It was observed that the cave, which had been modified into a cellar, was employed as a summer roost from April till October, but was abandoned in winter except by single hibernating individuals. In 1999, the cave was used as a nursery; the following years, the pregnant females left shortly before giving birth, leaving behind males and females without offspring. Fledged juveniles arrive at the cave in July and their numbers increased until August, whereas those of adults gradually decreased. The number of adults (mainly males) rose again in September, but by October only a few individuals, mainly juveniles, were left. The bats roosted together in a cluster at the top of the cave except in winter. The study shows that bats occasionally reproduce in Central European caves. It also indicates that even caves that are small and not important as hibernation roosts can play an important role as roosts for males in summer, and for all ages and sexes in the period between fledging and hibernation.

RECENT LITERATURE

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Book Reviews

Atlas des chauves-souris de Guyane, (*Atlas of The Bats of Guyana*) by Charles-Dominique P., Brosset A., Jouard S., Patrimoines Naturels, 49: 172 pages.

This new book, published in French, presents a synthesis of current knowledge, mostly from recent years, on the main aspects of bat biology in Guyana. Although it is a scientifically rigorous work, the authors have done a good job of summarizing and making the results of scientific studies on the bats of Guyana widely accessible. Accordingly, this book should appeal to both laymen and natural science experts. It begins with a brief survey of research on the bats of Guyana. A map of French Guyana indicates the sites of the main bat studies. The lack of contrast and different colours makes the map quite difficult to read, however, especially in terms of the major ecological divisions of the country. Each of these divisions (coastal savannah, primary forest, cleared land, secondary forest, swamp, watercourse and urban areas) is dealt with individually to indicate the distribution of bat species. Moreover, there is an appendix listing some of the 100 species of bats in French Guyana, grouped by family and habitat.

The authors describe the tremendous diversity of bats in Guyana. They devote a number of pages to summarizing the different bat diets (insectivorous, nectarivorous/ pollinivorous, frugivorous, carnivorous, piscivorous and sanguivorous). There is a full description of the different diurnal shelters and the bat species associated with each (underground environments, hollow trees, termite nests, foliage, terminal buds, tents, man-made structures). This chapter will be very useful for naturalists interested in observing bats in their natural environment. A short chapter on predation is included, although the authors consider this issue to be poorly documented in Guyana. A chapter on the relationship between humans and bats does a good job of explaining the positive and negative aspects of these relations. The authors objectively discuss problems relating to human disturbance, public health issues and domestic animals. They do a good job of explaining the general ecological role played by bats and the dynamics of ecosystems in Guyana. They discuss various points relating to co-evolution of the tropical forest and chiroptera. In this regard, there is an excellent description of the role of bats in fertilizing flowers and especially in dispersing seeds for forest regeneration. A number of figures make it easy to visualize and understand the plant-animal interactions involved in forest regeneration.

Only one page is devoted to the conservation of bats in Guyana, despite the fact that human activities continue to have a major impact on these animals. It would have been interesting had the authors further elaborated on their opinion on bat conservation in Guyana. To illustrate the methodology of chiroptera field studies and the associated constraints, the authors review the most commonly used research methods: capture (mist nets, harp traps), handling, radiotelemetry and ultrasonic detectors. Although the text is accessible to laymen, the authors do occasionally use some fairly complex terminology. A glossary would have been useful. In some cases, definitions of complicated terms are inserted in parentheses within the text. Good-quality colour plates are included for more than half (57) of the 100 bat species inventoried in Guyana, with most of these plates showing the tremendous diversity of bat faces. Although it is not indicated, the photographs are presented by family (Emballonuridae, Noctilionidae, Mormoopidae, etc.). Nearly one third of the book (52 pages) is dedicated to identifying the bats of French Guyana. The family and genus keys, as well as the illustrated species key, are based on a fairly limited number of external bat features. Some important anatomical features, including length of forearm, length of noseleaf, length of ear and tragus and wing anatomy, are illustrated and discussed to facilitate species identification. There are excellent illustrations of the main anatomical features that support species identification. In many cases, dental features are illustrated. All the captions, figures and appendices are translated into English. The book contains five appendices, one of which is particularly useful, as it lists the main biological characteristics of the bats of French Guyana (body weight, abundance index, diet, roosting sites). This book is a unique

source of information on the bats of Guyana. It is always worth making the results of scientific research studies available to a wider audience. This book is a good tool for raising public awareness and promoting a better understanding of bats around the world.

Submitted by Michel Delorme, Montreal Biodôme, 4777 Pierre-De Coubertin Avenue, Montreal, Quebec, Canada, H1V 1B3 mdelorme@ville.montreal.qc.ca

Murciélagos de Costa Rica, by Richard LaVal and Bernal Rodríguez-H. Illustrations by Olga Vivian Sistachs, Alina Suárez C., Francisco J. Quesada. Photographs by Marco Tschapka 320 pp. INBIO (Instituto Nacional de Biodiversidad). San Jose, Costa Rica.

Before I went to Costa Rica, I'd heard that mammalogists became entranced by the bats and soon lost interest in terrestrial creatures. Determined not to fall into this trap, I arrived at La Selva prepared to find every other animal in the forest: my steely resolve lasted three days. Bats would have been the first thing on my agenda rather than the last if this book had existed then.

This is an excellent field guide to the 109 bat species currently known from Costa Rica that will be useful to anyone interested in bats throughout Central America. The fine color paintings of each species and many photographs will be an enormous aid in identifying the often confusing species. Much of the information given in the book is from Richard Laval's years of careful and detailed fieldwork.

The introductory chapters give basic information on classification, anatomy, evolution, ecology, and conservation. Technical terms are clearly diagramed or listed in the glossary. A brief section speaks of the authors current research using echolocation calls to document rare species; they expect to increase the number of bat reported in Costa Rica, and to expand the known distribution of other species.

The bulk of the book is the 109 species accounts, arranged taxonomically. A description of each family is followed by pages of excellent color photographs by Marco Tschapka, including glossophagines hovering at flowers, emballonurids disguised as tree-trunks, and facial close-ups of many species. Family, subfamily genus, species, and common names are given at the top each page making it easy to quickly search through the book. To keep the taxonomic debate alive and well, bats in the stenodermine genus or subgenus of *Dermanura* are listed here as *Artibeus*. Each account has a physical description, distribution, natural history notes, and a clear, detailed color painting on the page facing the text. The color paintings are very good quality with useful details. For example, a key to distinguishing between conspecific *Carollia* species is the 4-color banded fur of *C. brevicauda*, hard to explain in words but easy to understand from the picture. Physical descriptions include forearm measurements, dental characteristics, and other identification tips. As Costa Rica is often a vertical country, altitudinal range is included in the distribution.

Much of the natural history information has been drawn from the authors observations within Costa Rica with additional information from outside of Costa Rica and by other authors. References are not cited in the text and I frequently wondered at the source of the information. I was disappointed at the small amount of information given for some well studied species. The bibliography is selective and gives citations for only some of the papers and books that were used. Its unfortunate that a more complete list of sources wasn't provided as it gives the impression that much less research has been done than is the case.

For the biologist trying to identify bats in the field, the book will make an excellent companion to the Field key to the bats of Costa Rica by Timm and LaVal. The book is part of a series of Spanish-English field guides produced by INBIO, the Costa Rican National Institute of Biodiversity. At US \$17 it's a bargain that shouldn't be missed. The INBIO web site, <http://www.inbio.ac.cr>, is easy to use and I received my order promptly.

Submitted by Anne Brooke, P.O. Box 102, Newfields, NH 03856
abrooke.nh.ultranet@rcn.com

Important New Book!

The University of Arizona Press is pleased to announce the publication of :

Columnar Cacti and Their Mutualists

Evolution, Ecology, and Conservation

Edited by Theodore H. Fleming and Alfonso Valiente-Banuet

Ranging from the Sonoran Desert to the northern Andes, these studies explore aspects of geology and evolution that have forged the relationship between cacti and their vertebrate pollinators, review findings in anatomy and physiology, and discuss recent research in population and community ecology.

The contributors review Phylogenetic relationships between cacti and nectar-feeding bats in an effort to understand how bat-plant interactions have influenced the evolution and diversity of both. Because of the number of migratory pollinators feeding on columnar cacti, the authors make conservation recommendations aimed at preserving functional ecosystems in arid portions of the New World tropics and subtropics.

"An important contribution to the literature on species interactions and mutualisms, as well as one of the most significant works ever published on the two topics of columnar cacti and nectar feeding bats"- Peter E. Scott

371 pp., 91 illustrations, \$65.00.

For additional information go to: www.upress.arizona.edu/books/bid1466.htm

The University of Arizona Press, 355 Euclid Ave.#103, Tucson AZ

857191-800-426-3797 www.uapress.arizona.edu

Future Meetings

November 6-9, 2002

The **32nd Annual North American Symposium on Bat Research** will convene in Burlington, Vermont hosted by William Kilpatrick (University of Vermont) and Roy Horst (State University of New York at Potsdam). Arrangements have been made for participants in the symposium to stay at the Radisson Hotel at very reasonable rates. All symposium sessions, displays, etc., will be in the Radisson which overlooks Lake Champlain only a 5 minute walk away. Just 5 minutes away are historic St. Paul Street and Church Street, both famous for the great number of fine restaurants and the Burlington Brew Pub. Unfortunately the spectacular fall foliage season will be past (which incidentally is why we can get such reasonable room rates).

For all details see our web-site at: www.nasbr.com

January 29 -to February 1, 2003

2nd Four Corners Regional Bat Conference / 1st Annual Western Bat Working Group Conference for the Management and Conservation of Bats.

We would like to announce this meeting, scheduled to be held in Durango, Colorado, January 29-February 1, 2003. Conference registration information and call for papers will be available soon. Room reservations can be made now at the Doubletree Hotel, 970-259-6580. Ask for the rate for the Four Corners WBWG meetings. Rates will be \$59.00 + tax for 1 king bed, 1 or 2 people, \$69.00 + tax for 2 queen beds, 1/2/3 people. We encourage everyone to reserve a room early to get the reduced room rate. Be sure to mention that you are with the Four corners Regional Bat conference. Registration information is now available on the WBWG website (<http://batworkinggroups.org/>)

Information on the city of Durango can be obtained at (www.durango.org) This first call for papers is now official. You can do everything by e-mail or FAX. Please contact Michael Herder at michael.herder@blm.gov or Laura E. Ellison at: laura.ellison@usgs.gov

October 8 to 11, 2003

The **33rd Annual North American Symposium on Bat Research** is scheduled to be held in Lincoln, Nebraska. Patricia Freeman will be the Convenor and will chair the Local Committee. The venue will be the Cornhusker Hotel in Lincoln, which was our location for the 20th Meeting in 1990. Everyone who attended that meeting was very pleased with their hospitality. For more details see our website at www.nasbr.com

If you know of other meetings, large or small, concerning any aspect of bat biology, please send me the details for publication at:

horstgr@potsgdam.edu

Notes

Successful Breeding of *Chrotopterus auritus* IN CAPTIVITY.

Chrotopterus auritus is a carnivorous Phyllostomid bat not maintained in captivity. This bat feeds in large insects, amphibians, reptiles, birds and small mammals and lives in couples and small groups.

Since 1997 I have made several attempts to keep small group of this species, obtaining animals from several localities. To date seven bats have been netted and brought to the laboratory. Of these, one died after 24 months in captivity; six others are still living after 55 months. The bats are maintained as paired couples, or two to three males in wire screened cages with 0.90 x 0.60 x 0.80m. The cages remained in a room with ambient temperature (17 to 31 degrees C) and humidity (60 to 80%). The photoperiod was increased to 14 hours with artificial illumination during the spring and summer. The animals were initially fed with fragments of young mice that were replaced gradually by recently killed adult mice. We use one gram of insect flour (Cedé™) on a daily basis to avoid fur loss. Some times a day old chickens were offered.

A female netted on 06/14/01 in a cave and kept isolated from others bats gave birth to a female 143 days later. A second birth was observed by a female captured in 02/24/00 and paired with a male since its arrival. The pregnancy was confirmed by the ventral dilatation 40 days before the birth of male young, at 11/24/01. At age 26 days the male young measured 69.84 mm of forearm length and 64.5 grams and the female at 43 days old showed 82.88 mm of forearm length and 74.5 grams.

The young stayed with the females for four to five weeks. After this period the young hung by the claws to the roof of the cage. At birth the newborn presents the body covered with dark fur. With six weeks the fur is similar to adults. At nine weeks of age the young bats began to accept parts of mice, sharing the food with the mother. Within 90 days after birth adult size was reached and the young readily accept food, immediately after it is offered.

New copulations were observed in June 2002, representing 11 and 12 months after the births. No aggressive behavior was observed between the adult male and the yearlings.

Submitted by Carlos Esbérard, Projeto Morcegos Urbanos, Fundação RIOZOO, Brazil

cesberard@ieg.com.br

A Rare White Red Bat

I work with Chuck Trimarchi and he suggested that I mention this to others. We get a very large number of bats sent to the rabies diagnostic laboratory. I have been here 28 years and I have never seen one of these, neither has Chuck, and he has even more experience than I! We received a red bat yesterday. Usually this is a nice experience because they are rare to see and are so beautiful. This specimen however was white! The fur on the dorsal side of the interfemoral membrane was brownish, but, all of the fur anterior to this was white. The wing membranes are whitish/pink. Has anyone else seen such a specimen? Submitted by Bob Rudd, Director, Rabies Diagnostic and Research Lab., York State Health Dept., Albany, NY

Grants in Aid of Research

EQUIPMENT GRANTS PROGRAM

Sandpiper Technologies, Inc. announced its STI Equipment Grant program for the 2003 field season. The company specializes in video equipment for wildlife research and offers free use of rental fleet to undergraduate and post graduate students. Implemented in 1997, this program includes equipment grants to students in the U.S. and Canada, and equipment discounts and cash grants to students and universities worldwide. Sandpiper has granted free equipment rentals valued at over \$350,000 over the past six years.

AVAILABLE EQUIPMENT

TreeTop Peeper Video System; Color or black and white camera; Poles range in height from 16, 35 or 50 feet; Battery interface; Basic Sentinel Video System; Time-lapse VCR; Auto-color camera; 25m

cable; Camera set-up kit(Batteries not included); Burrow Video Probe; Head mounted video display; Battery pack- 2.3-inch dia.; Two gooseneck probe options: 2.3-inch diameter, 3-meter gooseneck (Peeper Video Probe) or 1.0-inch dia., 3-meter gooseneck (Peep-A-Roo)

Equipment specifications can be found at: <http://www.Sandpipertech.com>

HOW TO APPLY

Applications are accepted year-round, but students needing equipment for the 2003 spring/summer season should apply by December 1, 2002.

Applicants must:

- 1) Describe their project and how they plan to use the equipment. Include the title of your paper.
- 2) Describe the size of the critter to be studied and the habitat.
- 3) Specify the length of the field season, and the preferred equipment schedule.
- 4) Include complete contact information for yourself and your advisor.

E-mailed proposals are acceptable. Please do not request equipment that is not in the list of available equipment, or specifications that are not listed. Please do not request more than one system in your proposal.

DEADLINE: December 1, 2002 for the 2003 field season.

Decisions are based on the proposal, field survey schedules and equipment availability.

Contact Ann Christensen, Sandpiper Technologies, Inc.

535 W. Yosemite Ave. , Manteca, CA 95337 (209) 239-7460

e-mail: Ann@Sandpipertech.com

STUDENT SCHOLARSHIPS AVAILABLE for BAT CONSERVATION RESEARCH

Bat Conservation International hereby announces the availability of student research scholarships.

Approximately 15 grants ranging from \$500 to \$2,500 will be made in 2003. Grants will go to research that best helps document the roosting and feeding habitat requirements of bats, their ecological or economic roles, or their conservation needs. Students enrolled in any college or university worldwide are eligible to apply. Projects must have bat conservation relevance. The application **deadline** for 2003 scholarships is **16 December 2002**. All application information and forms are available on our web page at <http://www.batcon.org/schol/schol.html>, by writing to: Bat Conservation International, Student Scholarship Program, P.O. Box 162603, Austin, TX 78716-2603, or by emailing apuntch@batcon.org. Any questions or concerns, please feel free to contact Andrew Puntch

Administrative/Program Assistant, Bat Conservation International. PO Box 162603 Austin, TX 78716 apuntch@batcon.org Tel. 512.327.9721 ext. 19 FAX 512.327.9724

FIELD EXPERIENCE OPPORTUNITY

You are always asking for stuff to put in BRN. We need volunteers for a research project and it seems like the Fall issue might be a good place to 'advertise'. I should have sent something earlier.

Dates: 11-24 November 2002 and 15 February - 1 March 2003.

Project Location: Disney Wilderness Preserve, Osceola/Polk county in south central Florida

Both experienced volunteers (techs) and not-so experienced volunteers (assistants, training is available) are needed to help track SE big-eared. This is a great opportunity for professionals to get out of the office and in the field, or for students and others to get some radio tracking experience. Housing is available. Contact me directly for more information.

More>

Fly By Night, Inc. is a 501(c)3 organization (all donations are tax deductible!) entirely dedicated to bat conservation. Our conservation efforts include field research (i.e. species diversity surveys, habitat use, roost preference, experimental roosts), population management (i.e. eviction and exclusion of 'nuisance' bat colonies, installation of bat houses), public education programs (complete with live bats) and rehabilitation of orphaned or injured bats. Most of our work is in the SE, primarily in FL and GA. We work closely with Bat Conservation International, I am the Coordinator of BCI's Bats in Buildings Program. We always need volunteers and may even be hiring soon, if we find the right person.

An addition: We recently participated in a couple of unusual events: look for us on Dogs with Jobs, episode 35 (National Geographic Channel) and the Pet Psychic (Animal Planet). The Pet Psychic was purely for fun, it's OK to snicker; but Dogs With Jobs summarizes the use of a great tool (despite the fact that it was highly staged and scripted, I think they did a pretty good job). The DWJ episode will provide an update for those who remember meeting Bruce at the Miami NASBR (with his PR seeking trainer). We haven't had the time or funding to get him in the field for any scientific-quality tests, but our observations are that he is VERY good at his job.

Laura S. Finn, Director, Fly By Night, Inc., P.O. Box 562, Osteen, FL 32764-0562
phone/FAX: 407-324-0647 cell: 407-414-2142 www.flybynightinc.org

ERRATUM:

This is somewhat minor, but on the off chance that it might be important to someone's research in the future, I would like to submit the following correction to our note, "Hibernating behavior of a Silver-haired Bat (*Lasionycteris noctivagans*)", published in BRN, Vol 43 (1), pp 5-6. In the sixth line from the end of the note, substitute min for h: "...activity was 64.2 ± 45.3 (30-145) min".

Thank you. Joel Maruniak, 218 Lefevre Hall, Biological Sciences
Univ Missouri, Columbia, MO 65211 573-882-2725

NEW FIELD VEHICLE FOR SALE:

The "Murcielago" (for those with unspent grant funds)

Lamborghini used to be one of the sexiest, swankest names on the road. But I can't remember the last time I actually saw one. After hitting the skids financially, the legendary race car rides again with the first new model in ten years, the *Murciélago*. My first look left me breathless, and so did the price tag-\$273,000!

Actually you can feel where the money's gone in this car. It accelerates like no other, and rides like it's on rails. I took tight twisty turns at 60 mph and didn't once feel the car slip. It's scary-fast. But the speed seems natural, even safe, riding on big fat tires. That's good. Here's the bad news: there's a substantial blind spot off the rear passenger side. And racing-inspired seats- which hug the body around the waste, hips and thighs- are built for bony Italian racing bots that for amply-hipped Americans. Who cares? This car is poetry in motion. And I needed to go on a diet anyway.

It has a 6-speed transmission; 580 hp V-12 engine with all wheel drive; and 205 mph top speed. Surprisingly easy to drive; polite street manners in a true race car.

For more go to www.lamborghini.com

BIG SALE !

Back Issues of Bat Research News

We are regularly receiving requests for back issues of BRN. We have a large supply of back issues dating back to volume 22, 1981. Storing these requires more space than the department here has available since I retired, and they have requested that I store these back issues elsewhere. At present these back issues (approximately 75 separate issues) occupy just under 50 linear feet of shelf space(my wife refuses to let me store them in our living room!) so I need to drastically reduce this collection. They are packaged in single volume sets of 3 or 4 quarterly issues, and can be purchased for \$10.00 per volume, or \$25.00 for any 4 volumes. Single issues are in short supply and can be purchased for \$5.00 each while the supply lasts. These prices included mailing. There is no tax on this material.

Proceeds from this sale will be placed in the Student Awards Fund to assist students who attend our Annual Symposium.

Payment from US and Canada can be made by check to Bat Research News and mailed to:

Bat Research News
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Potsdam, NY 13676

You can also pay by credit card by sending your card company (Visa, MasterCard, or American Express); your 16 digit account number; the date of expiration; and your name as it appears on the card. [If you are concerned with e-mail security you can send your information in two separate messages].

After January 1, 2003 the size of our stocks will need to be substantially reduced even if it means the paper shredder. Please help solve this problem. I look forward to hearing from all of you! Thank you. Roy

Please address all inquiries and orders to:
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BAT RESEARCH NEWS

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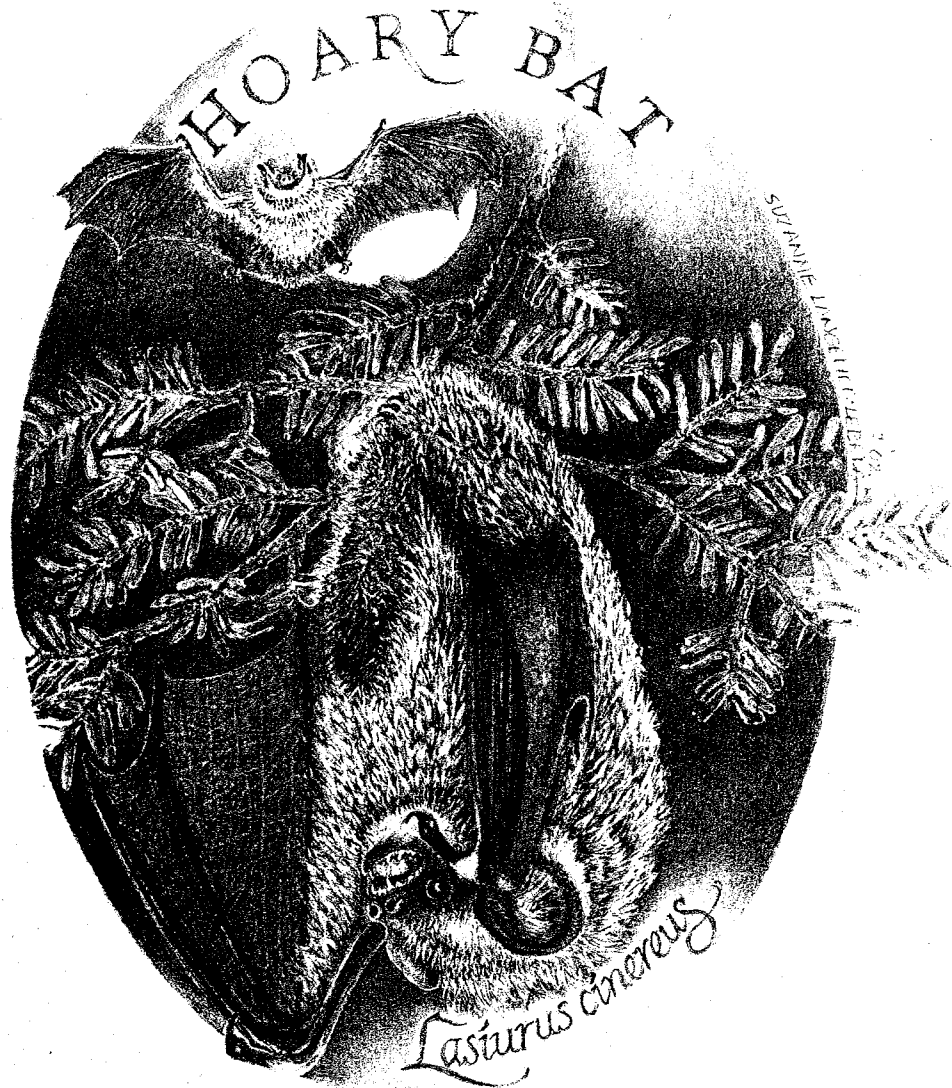
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FRONT COVER

Our cover this issue is the logo from the
IVth European Bat Research Symposium, Le Havre, France

We prefer to use sharp black and white photos or line drawings of bats or great bat sites, so would you please send your favorite illustration. If your illustration is accepted as a future cover, you will receive one free banquet ticket at the next North American Symposium. Send your copy to: horstgr@potsdam.edu

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: Thomas A. Griffiths, Dept. of Biology, Illinois Wesleyan University, Bloomington, IL 61702 Tel. 309-556-3230, FAX 309-556-3411
e-mail: tgriff@titan.iwu.edu

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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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 subscription for volume 44: 2003. The details of this conversion, at a substantial saving, will be given when invoices for renewal are mailed. 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
Pat Morton, Editor, Conservation Education
Tom and Margaret Griffiths, Editors, Recent Literature
Allen Kurta, Editor, Feature Articles & Letters to the Editor

horstgr@potdam.edu
patricia.morton@tpwd.tx.us
tgriff@titan.iwu.edu
bio_kurta@onlinc.emich.edu

**Abstracts of Papers Presented at the
32nd Annual North American Symposium on Bat Research
Held November 6-9, 2002, in Burlington, Vermont**

The abstracts are listed in alphabetical order by first author.

* designates student award-winning papers.

**Use Patterns, Roost Parameters, and Human Impacts at Two Townsend's
Big-eared Bat Maternity Sites**

Adams, Rick, Toni Piaggio, and Cary Richardson
University of Northern Colorado, Greeley, CO, University of Colorado, Boulder, CO;
City of Boulder Open Space and Mountain Parks Dept., Boulder, CO

In Spring 2002 we initiated a study of two cave sites used by *Corynorhinus townsendii* outside of Boulder, Colorado. In 1997, Harmon Cave was gated to protect a maternity colony of about 25 *C. townsendii*. The other site, Mallory Cave, has had in place for two years a "seasonal closure" making the site legally off-limits to the public from April 1 until October 31. The closure was put in place to protect a colony of approximately 15 *C. townsendii* from human disturbance. The goal of the project was to quantify the amount of human impact at these sites after protective measures were in place, to assess usage patterns of the colonies of each site, and to compare the climatic conditions with each cave relative to the known preference of *C. townsendii* published in the literature. We placed two Lucet Instruments, Temperature/Humidity data loggers at each end of the larger cavern, Mallory Cave, and a single data logger in the smaller cavern, Harmon Cave. We placed pressure-sensitive footpads to measure disturbance at both caves, and we documented the presence and absence of the colonies bi-weekly. Results indicate that Mallory Cave, the ungated site, fits the climatic profile associated with this species' preferences for roost sites. Temperature on average was 11° C lower at Mallory than at Harmon and humidity was on average 15% higher at Mallory than at Harmon. There was also variation within Mallory, with the north end of the cave having the lowest average temperature and highest average humidity which corresponded to where the colony was usually hanging. As for human disturbance, few visits by humans occurred at the gated Harmon Cave, and since the seasonal closure was instigated at Mallory, few bats have been observed at Harmon as well. At Mallory Cave, apparently the preferred site for Townsend's bats, the seasonal closure was successful in deterring human impact. For example, before the closure was in effect, the foot-pad counter inside Mallory Cave registered 428 passes between 3/29 and 4/12, whereas after the closure, the most passes registered was 28 between 7/7 and 7/23. This is a reduction of approximately 93.5% of passes into and out of the cave. It appears from our data that seasonal closures can be an effective and affordable means for colony protection when funds are not available for gating procedures. However, because the closure did not deter all incursions by humans into the cave, the colony is still considered "at-risk."

Molecular Systematics of the Genus *Eumops*

Ammerman, Loren K. and Rogelio M. Rodriguez, Angelo State University, San Angelo, TX

The family Molossidae includes at least 13 genera and 86 species of free-tailed bats. There are at least 8 species in the new world genus *Eumops* (bonneted bats). This genus is more variable (both morphologically and karyotypically) than most other genera of molossids. *Eumops* species range in forearm size from 37 to 83 mm and there are few well-defined synapomorphies for this genus. *Eumops* species also exhibit both ancestral and derived karyotypes. A robust hypothesis of *Eumops* species relationships will provide a framework on which to interpret karyotypic evolution and morphological changes within this group. The objective of our study was to use molecular data to test the relationships among *Eumops* species that have been proposed by mor-

phometric data. We included 8 species of *Eumops* and 4 outgroups (*Tadarida*, *Nyctinomops*, *Promops*, and *Molossus*) in our analysis. We analyzed DNA sequence from both the mitochondrial and nuclear genomes. A total of approximately 2500 bp from the ND1 gene and beta-fibrinogen intron 7 was collected. Preliminary phylogenetic analyses of both individual data sets and combined data sets were conducted using parsimony and maximum-likelihood analysis. Our results will be examined for congruence with previous branching patterns proposed for this genus.

The Assessment and Monitoring of a Neotropical Bat Community in the Context of an Undergraduate Field Course

Audet, Doris, Augustana University College, Camrose, AB

We initiated a multi-taxa biodiversity survey in a private forest reserve of northwestern Costa Rica, as part of an undergraduate field course on tropical ecology and conservation. Bats constitute one of our focal groups in that course which largely follows the methods of Rapid Biodiversity Assessments (RAPs). In 14 nights of sampling with mist-nets at ground level, we captured 15 bat species from four families and as many trophic groups. This represents 23% of the species known to occur in the broader geographic region. Our sampling efficiency approaches that of published RAP surveys. The relative abundance of bat species at our site resembles that of moderately disturbed areas and our samples included two species of phyllostomine bats, infrequently captured at highly disturbed sites. Further sampling in the forest reserve will provide the data base necessary to use species accumulation models to estimate bat species richness and allow us to better interpret the species abundance patterns. The RAP methodology provides an effective structure to the design of field projects for the students and allows us to make the information on biological diversity that we gather during the course available to those interested in the conservation and sustainable development of the region.

Habitat Use by Insectivorous Bats in a Mega-urban Environment

Avila-Flores, Rafael, York University, Toronto, ON

I analyzed the patterns of summer bat activity in Mexico City, one the most complex and chaotic cities of the world. To test the hypotheses that bat activity is not equal along the urban mosaic, and that species are not equally tolerant to urbanization, I compared activity of insectivorous species producing high intensity echolocation calls in four urban spatial features: large parks (> 100 ha), small parks (< 10 ha), well-illuminated open areas, and well-urbanized residential zones. A Petterson D980 bat detector was used to monitor bat activity twice a night every fifteen days in 12 sites per habitat, between late May and late August 2002. Additionally 12 sites located in a close natural pine-oak forest were monitored for comparison. A total of 3,600 one-minute sequences (720 minutes per habitat) were recorded and analyzed. Total bat activity was significantly higher ($H = 16.7$, $d.f. = 4$, $P = 0.002$) in large parks (45% of the total number of bat passes) and open illuminated areas (30% of passes), being even higher than activity in natural forests (18%). Small parks were slightly used (8%), and residential areas were almost not used (1%). The feeding buzzes/bat passes ratio suggest that large parks were used more as foraging areas by insectivorous bats (ratio = 0.19). Illuminated areas (0.07) and natural forest (0.10) had ratios similar to others previously reported, but small parks and residential zones were not used at all for foraging. At least 11 "sono-species" were detected in the Mexico City area, probably corresponding to 3-6 true species. Based on multiple quantitative call analysis, and considering the commonest species captured in Mexico City, I assigned these sono-species to three taxa: *Tadarida brasiliensis*, *Nyctinomops macrotis* and *Myotis* spp. *T. brasiliensis* and *N. macrotis* were mostly detected in urban habitats (95% and 82% of the passes, respectively), more frequently in large parks and open illuminated areas. Large parks were the only urban habitat actively exploited by *Myotis* spp. (50% of the passes), in the same proportion than the natural

forest. Our results support the idea that concentrations of insects around street-lamps are more often exploited by fast-flying species such as molossids, and also confirm that *Myotis* species are highly sensitive to urbanization. Ecological, functional and technical reasons are discussed to account for these patterns. As this work demonstrates, urban green areas are essential to maintain a more complete bat fauna in the cities.

Importance of Slope Position and Bark Type in Selection of Day Roosts by Female *Myotis volans*

Baker, Michael D. and Michael J. Lacki, University of Kentucky, Lexington, KY

We radio-tracked 58 female *Myotis volans* to day roosts on the Wenatchee National Forest in south-central Washington in 2001 and 2002. Female *M. volans* roosted in 133 trees, primarily snags, of six species of trees and periodically roosted in rock crevices. We used Chi-squared tests of independence on the number of bat roost-days among reproductive condition classes to identify patterns related to slope position of the roost tree (upslope versus stream bottom), bark type (loose versus tight bark), and size of flyouts observed from the roost tree (≥ 10 bats or large flyouts versus < 10 bats or small flyouts). Female *M. volans* frequently switched roosts with individual bats returning to the same roost tree for an average of 2.98 ± 0.19 days. Roost trees used by female *M. volans* were nearly evenly distributed with regard to slope position, with 52.6% of roosts situated upslope and 47.4% of roosts located in stream bottoms. Loose bark trees, *Pinus ponderosa*, comprised 45.1% of roost trees, whereas tight bark trees, primarily *Abies grandis*, comprised 54.9%. Most roost trees (78.2%) had flyouts of < 10 bats. Fewer bat roost-days of pregnant females occurred in trees situated on upper slopes than expected, whereas more bat roost-days of lactating and post-lactating females occurred in trees on upper slopes than expected ($\chi^2 = 33.4$, $d.f. = 3$, $p < 0.0001$). Fewer bat roost-days of pregnant females and more bat roost-days of lactating females occurred in loose bark trees than expected ($\chi^2 = 33.4$, $d.f. = 3$, $p < 0.0001$). More bat roost-days of lactating females occurred in trees with large flyouts ($\chi^2 = 27.3$, $d.f. = 3$, $p < 0.0001$). We hypothesize that shifts in the selection of roost trees by slope position by female *M. volans* from pregnancy through lactation and post-lactation, may be related to differences in available roosting temperatures among trees in different slope positions. Moreover, the bark of dead *P. ponderosa* typically exfoliates from the bole of the tree in relatively large plates that create more roosting space. In contrast, the bark of *Abies grandis*, *Pseudotsuga menziesii*, and other tight bark tree species, exfoliates in relatively smaller sections. Our data indicate that female *M. volans* may become more communal during lactation than during pregnancy, and select *P. ponderosa* during lactation because of the greater availability of roosting space beneath the large plates of exfoliating bark.

The Gleaning Bat's Dilemma - Listening to Prey-generated Sounds and Echoes at the Same Time: Behavioral Evidence from *Antrozous pallidus*

Barber, Jesse, Khaleel Abdulrazak, and Zoltan Fuzessery, Wake Forest University, Winston-Salem NC; University of Wyoming, Laramie WY

Most bats use echolocation to image both environment and prey. However, echolocation has limitations when used to locate prey amongst clutter. In response to this sensory problem, some gleaning bats listen passively to localize prey-generated sounds. This adaptation most likely results in situations where the bat receives prey-generated and echolocation information within short time intervals. Human research on auditory scene analysis suggests that only one acoustic stream can be processed at a time. This hypothesis was tested in the pallid bat, an obligate gleaner, which listens to prey-generated, low-frequency (1-30 kHz) noise transients to obtain food, while reserving echolocation (30-60 kHz) to avoid obstacles. Pallid bats were trained to

localize the source of a brief noise burst from an array of 15 speakers while echolocating an array of vertical wires. The performance of the bat while performing both tasks was compared to single task controls. Results show that sound localization accuracy decreased when the bat was forced to listen to noise and avoid obstacles. However, obstacle avoidance acuity demonstrated little change. Interestingly, the pallid bat increases the time between emitted pulses when performing both auditory tasks in a small time window. This behavioral strategy may indicate a central processing limitation, as the bat appears to be maximizing the amount of time available between returning echoes to process noise.

Variation in the Reproductive Rates of Bats: Correlations and Life-history Implications

Barclay, Robert M. R., Joel Ulmer, Cameron J. A. MacKenzie, Megan S. Thompson, Leif Olson, Julianne McCool, Elvie Cropley, and Graeme Poll, University of Calgary, Calgary, AB

The life histories of bats are unusual for small mammals in that they involve small litters, slow growth and maturation, and relatively long lifespans. One aspect of the life history of bats that has not been examined is the proportion of females that reproduce during any particular breeding season (i.e. reproductive rate or fecundity). To address this gap in our knowledge and test predictions based on life history theory, we collected data from the literature, unpublished reports, and unpublished data. We obtained information for 76 species of bats in 8 families. Over all studies, an average of 85% of adult females reproduced in a breeding season. This rate varied significantly with latitude and family. As we predicted based on variation in seasonality and energy constraints, reproductive rate declined with latitude: mean rate among species near the equator was 87.5%, but only 74% at latitudes between 46° and 51°. When this effect was controlled for, species of emballonurids and phyllostomatids had significantly lower reproductive rates than did hipposiderids or vespertilionids. There was no effect of bat mass or diet. There were significant year-to-year variations in reproductive rate within populations at the same location, especially at higher latitudes; in some years less than 50% of females reproduced. We suggest that as with other aspects of their life history, female bats are similar to females of large mammals and forego reproduction when conditions are unfavourable. This is in accordance with life history theory for species, such as bats, in which adults have a low risk of mortality from external factors while juveniles have a higher rate of mortality. Under such conditions, adult females should invest in self maintenance to increase their chance of survival and future reproduction, rather than investing in offspring that have a low chance of survival.

The Great Smoky Mountains Bat Blitz of 2002

Belwood, Jacqueline J., Cincinnati Nature Center, Milford, OH

In 1998, the Great Smoky Mountains National Park (GSMNP) began an All Taxa Biodiversity Inventory (ATBI). The goal of this 15-year project (www.discoverlife.org), which is a model for research in biodiversity, is to inventory every living thing in the Park. Most ATBI surveying and inventorying takes place during taxon-specific "bio-blitzes" that allow large numbers of biologists and volunteers to converge on the Park for three to five days of collecting activities. Past blitzes have focused on beetles, ferns, snails, moths and butterflies, protists, millipedes, and slime molds, among others. At an annual ATBI meeting in December 2001, non-bat biologists noted difficulties inherent in obtaining live bats from which ectoparasites, endoparasites, and other associated organisms and specimens can be obtained. This has resulted in bat-related gaps in ATBI inventories. In response to this concern, a "Bat Blitz" was organized and took place at the GSMNP between 17 and 20 June 2002. During this time, 26 biologists from nine institutions mist-netted or trapped 205 bats in 12 locations in the Park. Members of seven bat species were captured and examined, including endangered Indiana Bats and a Rafinesque's big-eared bat. No new bat records were added to the ATBI inventory, but large numbers of other organisms and samples were obtained for study by biologists at an additional five institutions.

Samples collected include: ectoparasites, feces (for endoparasitic scans and Archaea), blood (for blood parasites), and tissue and fur (for genetic analysis). Bat guano, containing large numbers of free-living invertebrates, was also obtained from a well-established little brown bat roost. As part of the Blitz, a lactating Indiana Bat was radio-tracked to a dead pine tree containing 15 additional bats. In addition to providing material for the ATBI, the Great Smoky Mountains Bat Blitz of 2002 provided an opportunity for a large number of bat biologists to work together in the field, some for the first time, and exchange ideas and information as well as tips on field techniques and equipment. It was also the impetus for the presentation of several educational programs to local high school students in residence at the University of Tennessee for the summer. The Blitz received considerable media attention and generated several newspaper articles favorable to bats. More Bat Blitzes are planned for the future.

Do Echolocation Calls Provide a Good Indication about which Species of Bats Occur in an Area?

Biscardi, Stefania and Jazmine Orprecio, York University, Toronto, ON

Some bats produce high intensity echolocation calls with low variability in call parameters, allowing some species to be correctly identified by their calls. However, for many species the combination of call variability and local high diversity of species could make such identification problematic. The objective of this study was to investigate the efficiency of analyzing high intensity echolocation calls as a tool for identifying species of molossids (3) and emballonurids (5) at sites in Belize, the Brazilian Amazonia, and Mexico City. Calls were recorded with a Pettersson D980 bat detector connected to a laptop computer running Bat Sound Pro software through a filter and an Ines DAQ i508 high-speed card. For 27 sequences we analyzed 10 calls from each sequence. We measured the frequency with most energy (kHz), the highest and the lowest frequencies (kHz) and call durations (ms) and noted the presence or absence of harmonics. A MANOVA indicated significant differences between species, particularly in duration, and lowest frequency. We then used a Discriminant Function Analysis (DFA) to test species identification by call features. Our data show that some species can consistently be identified by their calls while others show geographic variation in diagnostic call features. Still other species produce a variety of calls making the task of identification much more difficult.

A Comparison of Foraging Behavior Between Adult and Juvenile Little Brown Bats (*Myotis lucifugus*). Evidence for Learning Behavior?

Bonney, Caitlin E., Jason W. Horn, and Thomas H. Kunz, Boston University, Boston, MA

The little brown bat (*Myotis lucifugus*) is among the insectivorous bat species that form summer maternity colonies. It has been suggested that favorable conditions for gestation and location, information transfer, and proximity to food resources are key reasons for this communal behavior. It is unclear, however, if learning behavior between mothers and pups influences the formation of these maternity colonies. We hypothesized that patterns of nightly foraging behavior might provide an opportunity for learning between adults and juveniles within a maternity colony. We used radio telemetry to monitor the nightly activity of nine *M. lucifugus* from a maternity colony of approximately 800 individuals in southern New Hampshire. Three adult females, three juvenile females, and three juvenile males were tracked simultaneously for six consecutive nights in late July 2002. We radio-tracked all nine individuals from two fixed locations for 2.5 hours after evening emergence, and again for 2.5 hours in the early morning. Using passive integrated transponders (PITs), we also recorded the emergence and return behavior of approximately 400 bats, including the nine radio-tagged individuals. Preliminary observations suggest that individuals were habitual in their use of nightly activity areas and duration of foraging bouts. Juvenile males continued to forage in the same areas even after dispersing from maternity colony to roost elsewhere during the day. PIT records provide a larger

sample for comparison of adult and juvenile male and female activity budgets. Males appear to become solitary soon after weaning, suggesting a reduced role for colonial behavior in juvenile learning. Learning by females may contribute to the formation of maternity colonies, or learning may be a consequence of colonial behavior.

Intensity Compensation in Daubenton's bats *Myotis daubentonii*

Boonman, Arjan and Gareth Jones

University of Tübingen, Tuebingen, Germany; University of Bristol, Bristol, UK

Most echolocating bats use intensity compensation when they approach a prey. *Eptesicus fuscus* and *Noctilio leporinus* lower the intensity of consecutive emissions by 6 dB per halving of target distance (Hartley et al., 1989; Hartley, 1992). In our study we found that *Myotis daubentonii* uses an intensity compensation of 4 dB per halving of target distance [Journal of Experimental Biology, 205 (18)]. Reflected intensity from a target is not used by *Myotis daubentonii* to trigger intensity compensation behavior. Target strength was found to be irrelevant for the distance at which the bats initiated intensity compensation behavior. Reflected intensity from the target is also not used to fine tune the intensity compensation behavior between and within flights. Bats did not raise their intensity when attacking weakly reflecting targets. We were unable to find convincing evidence that the erratic intensity compensation over time matched the changing distance from bat to target, which would indicate a feedback of positional information to regulate intensity compensation. Therefore, neither the triggering nor the execution of intensity compensation behavior appears to occur in harmony with changing intensity in the bat's environment. No evidence thus far exists for the hypothesis that FM bats use the reflected intensity of the environment (in our case prey) to guide their flight.

Spring Roosting Ecology of Female Indiana Bats (*Myotis sodalis*) in the Northeastern United States

Britzke, Eric R., Alan C. Hicks, S. von Oettingen, and Scott R. Darling

Tennessee Technological Univ., Cookeville, TN; N Y Dept. of Environmental Conservation, Albany, NY; US Fish and Wildlife Service, Concord, NH; Vermont Fish and Wildlife Department, Pittsford, VT

With the development of radio transmitters suited for the study of bats, extensive effort has been directed towards their roosting ecology. In the eastern United States much emphasis has been placed on the federally endangered Indiana bat (*Myotis sodalis*). After spending up to 6 months in hibernation, female Indiana bats migrate up to 500 km from hibernacula to maternity range. However, little attention has been paid to roosting ecology during this migratory period, when only depleted energy reserves are available. In April 2002, we captured Indiana bats at their hibernacula in northern New York prior to emergence. Bats were sexed, weighed, measured, and banded with an aluminum band. We also attached 0.50 gram radio transmitters (Holohil Systems, Ltd.) to the backs of 19 female bats using surgical glue. An airplane was used to determine the approximate location of transmitted bats. Each bat was then tracked from the ground to locate the specific roost occupied. Bats were tracked for a total of 232 bats days (1 bat located for one day). Thirty-nine roost trees were discovered at 15 sites in northeastern New York and western Vermont. Of the 11 species of trees utilized, the shagbark hickory (*Carya ovata*) was the most commonly used (33% of all trees). Exit counts ranged from 1- 43 bats. This study documents an extensive investigation into the roosting ecology of female Indiana bats during the spring migration period.

Thermally Challenging Roosts: Evidence for Daily Dehydration Effects in the Angolan Free-tailed Bat, *Mops condylurus*

Buffenstein, Rochelle, Shane K. Maloney, Rodney Bally, and Gary N. Bronner, City College of New York, NY; University of Western Australia, Aus.; University of Fort Hare, South Africa; University of Cape Town, South Africa

The Angolan free-tailed bat (*Mops condylurus*) uses roosts that often exceed 40°C, an ambient temperature lethal to many microchiropterans. We measured urine and plasma concentrations, fecal water content and hematocrits in free-ranging free-tailed bats as well as rates of evaporative cooling at high ambient temperatures. Samples were collected in both autumn and summer from bats caught emerging from roosts before feeding (pre-feeding), and those returning after foraging (post-prandial). Fecal water content was unchanged with season. Evaporative water loss was moderate at 45°C with both panting and sweating evident. Post-prandial bats exhibited higher body fluid concentrations, but lower hematocrits, than individuals caught prior to feeding. This is indicative of raised excretory mineral and nitrogenous loads and replenished body water pools as a result of nocturnal foraging. In autumn, urine/plasma (U/P) ratios increased from 7.4 to 9.0 with feeding, while in summer U/P ratios showed a smaller increment (7.9 to 8.4) owing to greater urine and plasma concentrations in bats caught emerging from their roosts before feeding. Pre-feeding summer urine osmolalities, and post-prandial urine concentrations in both autumn (2997.65 + 647.00 mMol/kg; n = 12) and summer (2705.21 + 577.33 mMol/kg; n = 8), exceeded the maximum (2634 mMol/kg) predicted from renal morphology. This reflects the pronounced dehydration stresses within hotter roost microclimates, and a moderate kidney concentrating ability in this species. Faced with a thermally-challenging roost milieu on a daily basis, free-tailed bats compensate for an only moderate kidney concentrating ability through behavioral means, physiological mechanisms such as adaptive hyperthermia and tolerance of daily changes in plasma concentration and hematocrit. Although tolerant of cyclic dehydration and rehydration during feeding, these bats may lack the physiological resilience to sustain water balance should more debilitating conditions prevail, or if prevented from feeding. It therefore seems likely that Angolan free-tailed bats may need to forage regularly not only for energetic reasons, but also to meet the daily water needs associated with the hot roost microclimate.

Identifying Bats Using Computerized Analysis and Artificial Neural Networks

Burnett, Stephen C. and W. Mitchell Masters

Clayton College & State University, Morrow, GA, The Ohio State University, Columbus, OH

There is continued interest in censusing bat populations in the least invasive way possible, a desire that is hampered by the ecology of chiropterans. Our previous work suggested that artificial neural networks (ANN's) might be capable of censusing big brown bats (*Eptesicus fuscus*) based solely on their echolocation calls. This initial work used recordings made under laboratory conditions, a fact that limits our ability to extrapolate these results to field conditions. Advances in ultrasonic recording equipment have made it possible to record bats under field conditions and automatically extract and analyze those calls with minimal intervention by the researcher. This allowed us to record calls in more natural situations, allowing us to extend the results to conditions researchers are most likely to encounter. We used calls recorded from big brown bats in central Ohio to test the ability of a self-organizing map (SOM) ANN to count the number of bats. Results with field recordings were superior to those obtained with laboratory recordings, suggesting that this technique might be useful for censusing bats under field conditions. In addition, we attempted to ascertain whether individual signatures in echolocation calls of *E. fuscus* might persist for extended periods of time. We examined laboratory recordings from bats recorded on repeated occasions at intervals between one month and five years to test the ability of ANN's and discriminant function analysis to assign calls to the correct bat. Our

results suggest that it might be possible to identify a bat from recordings made within the previous few months, but longer intervals between recordings resulted in calls that could not be distinguished from unfamiliar animals.

Surveying the Behavior of Bats Crossing a Two-lane Highway and an Open Field

Butchkoski, Calvin M., Pennsylvania Game Commission, Petersburg, PA

A maternity roost, inclusive of 50-banded Indiana bats (*Myotis sodalis*) and a large colony (estimated at 20,000) of little brown bats (*Myotis lucifugus*), is located in the attic of an old wood frame country church at Canoe Creek State Park, Blair County, PA. This church is located about 0.5 km north of a major (>9,000 vehicles per day) U.S. highway, Route 22. Trees and brush border both sides of this road. Bats exiting the trees on the north side of the road have to cross a 20 m wide opening before they enter the trees on the south side of the road. Previous radio-telemetry and visual observations documented numerous bats crossing this road. All transmitted Indiana bats crossed this road to access a major foraging area southwest of the church. One monitored Indiana bat female crossed the highway at least 8 times in one night to forage, nurse, and roost in the church attic. These observations precipitated surveys of bat flight behavior as bats traveled across the road, and of road-killed bats. On ten evenings between 15 May and 26 July 2001, surveyors, positioned along a 150-meter length of highway where most bats were crossing, counted bats by crossing height category. Evening counts ranged from 1,636 to 3,351 bat crosses during a 40-minute period. Results indicated that the height of the tree canopy on each side of the road influenced the crossing heights of bats. Where the canopy is high (>20m), bats cross well above the traffic; where the canopy is low (~15m), the bats cross closer to the traffic. Bats avoided crossing where the canopy was the lowest (< 8 m). Between 15 May and 14 September 2001, on 36 days, searches for road-killed bats were conducted at the 150-meter long major bat road crossing. Fifteen little brown bats and one unidentifiable bat were found. On 29 July 2001, the highway was searched 2.8 kilometers to the west resulting in finds of eight little brown bats and one Indiana bat. The next day 1.6 kilometers were searched to the east and resulted in finds of four little brown bats. Initiated by a planned highway upgrade that would increase the width of the highway opening from 20 meters to ~55 meters, researchers were engaged by the Pennsylvania Department of Highways to assess the impacts of this road improvement on traveling Indiana bats. For this study, little brown bats were used as behavioral surrogates for Indiana bats. A second colony of little brown bats was found in Huntingdon county about 50 km east of the Canoe Creek colony. These bats traveled across a 55 meter mowed field to get from day roost to foraging site. Bats at this site exit bat boxes 8 meters high on a building, travel 45 meters along the side of the building flying less than 4 meters high and enter a 15 m high tree line. They then exit the tree line and cross a 55 meter mowed field to a 14 m high tree line on the other side. Counts of crossing bats and flight heights were conducted two evenings (31 July and 8 Aug. 2002) in the middle of the mowed field. On respective evenings, 453 and 1,346 bats were counted with the following flight heights and percentages: 0 to 1m - 56.07%, 31.05%; >1m to 2m - 23.4%, 45.54%; >2m to 4m - 17.0%, 19.02%; >4m to 6m - 3.31%, 3.27%; >6m to 8m - 0.22%, 0.67%; >8m - 0.0%, 0.45%. Over 90% of the bats were flying lower than 4 meters as they crossed this opening. If this were a highway, most of these bats would be in harm's way.

Green Bats? Green Algae

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

The color of mammal fur usually includes neutral blacks, browns, greys, and whites - sometimes tinged with red and gold. These colors are caused by a few classes of pigment granules deposited in the medulla and/or cortex of the hair shaft. With a few exceptions, it is the pattern of the different colors rather than the colors themselves that catches our eye, for example,

Pteropus conspicillatus, the spectacled flying fox; *Euderma maculatum*, the North American spotted bat, and *Melonycteris melanops*, the black-bellied bat. The members of the Pteropodid genera *Dobsonia* and *Nyctimene* wear the usual black, brown, and grey pelage, in interesting patterns. However, some of these species also sport striking green and yellow fur. As I have reported previously, distinguishing among species in both of these genera relies on problematic characters such as geographic range, tooth morphology, body size, and fur color, which may vary with the age and sex of an individual. Though some *Dobsonia* species are thought to be distinguishable by the green-ness of their fur (e. g., *D. viridis* in Flannery 1995), it has been observed that the green fur color of *Nyctimene* and *Dobsonia* can fade to greyish brown in museum specimens. In this paper I will present evidence that the origin of the green fur color of the *Nyctimene* and *Dobsonia* of New Britain is a symbiotic green algae that live in the fur of these animals. Starch tests indicate that green algae live within the hollow medulla of the hair shafts of some *Nyctimene*, and are associated with the fur of *Dobsonia* as well. The taxonomy of algae is even less well understood than that of these bats, and molecular evidence is needed to distinguish the species of algae before questions about the specificity of the algae-bat associations can be answered.

Long Term Spatial Relationships of Indiana Bats: A conceptual model?

Carter, Timothy and Eric R. Britzke

Southern Illinois Univ., Carbondale, IL; Tennessee Technological Univ., Cookeville, TN

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. These colonies used dead or dying trees that are ephemeral roost sites. As a result of natural circumstances, 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.

Habitat Usage by Bats in the Western Ozark National Forest, Arkansas

Caviness, Michelle L and Douglas A. James, University of Arkansas, Fayetteville, AR

In the summers of 2000 and 2001, bats were netted in repeat sessions over 20 ponds and streams at two sites in the western Ozark National Forest, Arkansas. A suite of vegetational characteristics and other environmental features were measured at each pond or stream. Principal components analysis of the habitat features used by the bats (six species, 198 individuals caught) showed that little brown bats (*Myotis lucifugus*) and eastern pipistrelles (*Pipistrellus subflavus*) frequented streams with larger trees and less percent forest in one of the forest units. Eastern pipistrelles show the same trend at the other site, however, there is some usage of ponds associated with smaller trees and more open canopy. Red bats (*Lasiurus borealis*) used both ponds and streams, but where canopy was rather open. Evening bats (*Nycticeius humeralis*) trended toward ponds in younger forests with lower canopy and few snags. Northern long-eared bats (*Myotis septentrionalis*) occurred at ponds in more mature forests with a high number of snags and a low closed canopy. Big brown bats (*Eptesicus fuscus*) used only ponds associated with

small trees and a younger forest and open canopy. Discriminant function analysis identified species differences with respect to specific habitat factors within the overall patterns described above.

Conservation Takes Flight: Sharing the Importance of Bat Conservation with our Guests at Disney's Animal Kingdom

Chag, Mark A., Jr., Animal Keeper, Disney's Animal Kingdom

Bat conservation is not a new image on the horizon. People from all levels in the zoological field have dedicated themselves to this concept for years, teaching people about bats, stressing their importance to the ecology, and trying to dismiss the destructive myths bats have carried for as long as they have been flying. Zoo educational programs invite children to the classrooms, bat rehabilitators take their messages (and even their bats) to the schools, and researchers spend long dark hours deep in the woods, documenting that small plots of land are habitats crucial to species survival. Together we try to shine a little appreciating light on an animal so important to us all, yet traditionally so neglected, exploited, and feared. At Disney's Animal Kingdom we're working at various levels to emphasize the importance of bats and their habitats. With the bat exhibit, staff training, classes, EcoWeb, and through the Disney Wildlife Conservation Fund, we hope to spread the wings of bat conservation a little further.

Roost Fidelity in the Tent-making Bat *Artibeus watsoni*

Chaverri, Gloriana, Boston University, Boston, MA

Roost fidelity in bats varies widely among species, and has traditionally been associated with roost permanency and abundance. Some species may use the same roost for several years, whereas others may change sites daily. Bats that modify leaves, so-called tent-making bats, appear to use roosts restricted to relatively small areas, and use each tent for several days before changing to another. The objective of this study was to characterize roost fidelity and dynamics of tent use in *Artibeus watsoni*. Bats were radio-tracked at two sites: Golfito Wildlife refuge and Corcovado National Park, both located in the lowlands of southwestern Costa Rica. Bats were trapped during the day at their roost using hand nets, and were captured at night using mist nets. A total of 11 individuals were tracked for a period of four to twelve days (for a total of 1,034 radiotracked days). The sample included non-reproductively active adult females and males, reproductively active males and females, and juvenile and sub-adult females. Roost fidelity in this tent-making species was highly variable; some bats changed roosts daily, whereas others remained in the same tent for as long as six days. Most individuals used tents intermittently, changing between tents located in a relatively small area. Sometimes they used more than one tent located in the same plant on different days. No significant differences were observed in tent fidelity between males or females, or by sexually active or inactive individuals. Degree of gregariousness did not appear to predict faithfulness to a roost, and bats that remained for longer periods of time in one tent were usually alone and sexually inactive. Reasons for short-term roost use may be associated with tent quality, roost availability, parasite avoidance, and investigator disturbance.

Logging Systems and Bat Diversity in Trinidad's Evergreen Seasonal Forests

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

Human activities are increasingly altering tropical forests leading to a reduction in biodiversity. Timber extraction often results in substantial disturbance to tropical forests leading to the local extirpation of wildlife. Recently new systems of natural forest management for timber extraction have been developed that are proposed to be sustainable and compatible with the maintenance of biodiversity. Neotropical bat communities of tropical forests are species rich

and tropically diverse, with many species playing key ecological roles including pollination, seed dispersal, and the regulation of insect populations. There is some evidence that tropical bats may be good indicators of forest health responding in predictable ways to forest disturbance. Here the result of two years of field-work in Trinidad is presented in which i) the effect of two different logging systems on bat community organisation and diversity was determined and ii) the hypothesis that Neotropical bats are good indicators of forest health was tested. Trinidad has a well-documented, rich, bat fauna of c. 65 species. Part of the Victoria-Mayaro Forest Reserve in the southeast is logged using two systems of natural forest management. The Open Range management is a selection system with girth limits for selected timber species in common with many of the logging systems used throughout the tropics. Lack of adequate control in operating this method has led to over-exploitation of these forests. More recently, the Periodic Block system has been developed in Trinidad. The Periodic Block is a polycyclic selection system that incorporates a set of ecologically sensitive extraction procedures supposed to benefit wildlife.

Effects of Bat Detector Position and Orientation

Corben, Chris, William E. Rainey, Elizabeth D. Pierson, and Leslie S. Chow
University of California, Berkeley, CA; Berkeley, CA; U.S. Geological Survey, El Portal, CA

When passively monitoring bat activity, it is convenient, and therefore common practice, to place bat detectors on the ground facing up at about 45 degrees. Several investigators have reported higher detection rates with transducers placed above ground level. We examined how detector angle and height above the ground affected detection rates for different feeding guilds. We used Anabat detectors calibrated to operate at the same sensitivity, and deployed these in arrays so they would simultaneously monitor bat activity from several heights and angles to the horizontal. We analyzed the resulting data with automated identification software, classifying bat calls either to species or to small groups of acoustically similar species. Within the bat assemblage examined, acoustically similar species commonly flew at similar heights and shared similar hunting styles. We found that different guilds are better detected by different detector placements, and that any single detector placement represents a compromise. We discuss how to place detectors to best meet different survey goals.

Preliminary Results on Bat Distribution in Relation to Habitat Structure in an Urban Environment

Côté, Fabienne, Daniel Gagnon, and Michel Delorme
Université du Québec à Montréal, Montréal, Québec; Biodôme de Montréal, Montréal, Québec

Loss of habitat is considered a major cause of bat decline. In Quebec, where four out of eight species of bats have been listed as potential threatened or vulnerable species, no studies have been done to identify and describe the habitat used by microchiroptera. The results of a network of acoustic bat inventories, begun in 2000 by the Biodôme de Montréal and the Société de la faune et des parc du Québec have been combined with the geographic information system technology (GIS) in order to analyze the distribution of bats in relation to habitat structure in the Québec province. The network of acoustic bat inventories operates with the help of trained volunteers who record bat calls along 20 km long pre-selected listening routes, in various regions of Quebec, using a tape recorder connected to an Anabat II echolocation detector. Locations of recorded calls are determined with a GPS. Inventoried routes and bat call locations are transferred onto computerized topographic maps installed on the GIS. To describe each route, habitat variables such as area of wooded zones, fields, open areas, water, buildings, and roads as well as the position of street lamps are generated by the GIS. Habitat data produced by the GIS will be used to build predictive models of bat abundance. Preliminary analyses have been conducted only on a single route located in an urban area in the city of Laval, North of Montreal. Pearson (product-moment) correlations show a significant positive relation between the area of water and the

abundance of big brown bats *Eptesicus fuscus* ($p = 0.001$) and of the silver bat *Lasionycteris noctivagans* ($p = 0.001$). Additionally, a negative correlation is found between the abundance of *E. fuscus* and the area of buildings ($p = 0.05$). Although analyses were conducted for a single route this year, data from ten different routes, which are part of the network of acoustic bat inventories, will be available in 2002 and from 14 different routes in 2003. These data will offer a great potential for increasing our knowledge of bat habitat in Quebec.

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

Cruz, Wilmarie and Armando Rodriguez-Durán

Inter American University-San Germán, PR; Inter American University-Bayamón, PR

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. Preliminary 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 is known from the island.

*** The Unequal Division of Labor: Sex Differences in the Thermoregulation and Water Loss of Migratory Hoary Bats (*Lasiurus cinereus*)**

Cryan, Paul M., USGS Arid Lands Field Station/University of New Mexico, Albuquerque, NM

Male and female hoary bats, *Lasiurus cinereus*, differ in distribution on a continental scale in North America during spring and summer. Dispersing from wintering grounds in Mexico and California, females apparently travel further than males into more eastern regions. Reasons for these disparate distributions and movements are unclear, but may partially involve different energy and water needs. I measured the resting metabolic rate and evaporative water loss of wild-captured hoary bats over a range of temperatures (0-40° C) using flow-through respirometry. The majority of females studied ($n = 82$) were pregnant, whereas males ($n = 59$) showed no visible signs of reproductive activity. The mass-specific metabolic rate for normothermic (body temperature 34-39° C) individuals was lowest between air temperatures of 30-35° C. All but one of the females remained normothermic at low air temperatures (< 25° C) by increasing metabolic heat production, whereas 74% of males became heterothermic (body temp < 34° C) at such temperatures. Metabolic rates of normothermic bats exposed to 0° C increased 3-fold above baseline values. At ambient temperatures > 35° C, both sexes showed signs of hyperthermia and experienced high levels of evaporative water loss. Differences between sexes in warm-season distribution likely relate to the reluctance of pregnant females to enter torpor, the high cost of metabolic heat production, and elevated rates of water loss experienced under hot and dry conditions.

* Paul Cryan received the *Bat Research News* Award for this presentation.

Starting a Bat Population Monitoring Project with K-12 Students for Bats on the Guadalupe River Watershed

Curtis, Laura and Dave Johnston, Santa Clara University, Santa Clara, CA

Other than monitoring bat populations in caves and known roosts, few long-term population studies have been conducted for bats in North America. Because monitoring for bats is labor intensive, most of the needed time for the project will need to comprise organized volunteers. We designed a curriculum for an educational program for elementary and high schools located along the Guadalupe River in Santa Clara County, California. Our program includes a PowerPoint presentation highlighting the natural history of bats, species distribution and an explanation of our project this summer. We emphasize the importance of the scientific method, as well as an explanation of the methods used in our bat study of the Guadalupe River watershed (e.g., our methods for the dietary analysis and the macro-invertebrate sampling). The second part of the program includes a "night in the field" when students and their teachers are taught how to use a bat detector to document foraging calls and bats emerging from roosts. Water Quality analysis is also a part of the fieldwork. After spending an evening in the field, interested students and members of the community are recruited to help continue monitoring for bats at designated sites along the watershed. We hope that by establishing a long-term population study of the Yuma bat (*Myotis yumanensis*) with relatively few financial resources, we can provide a working model for other communities.

A Total Evidence Phylogenetic Hypothesis for the Relationships among Short-faced Bats (Phyllostomidae: Stenodermatina)

Dávalos, Liliana M. and Valeria da C. Tavares

Columbia University; City University and American Museum of Natural History, New York

The phyllostomid subtribe Stenodermatina comprises eight monotypic genera ranging from Cuba and tropical Mexico to central Brazil. The relationships among phyllostomids, including all Stenodermatinae or short-faced bats have recently been studied using morphological and nuclear DNA characters. Despite these analyses, support values for particular branching arrangements are low and provide little confidence for testing ecological, behavioral, and biogeographic hypotheses. We present a novel phylogenetic hypothesis for short-faced bats based on analyses of mitochondrial and nuclear DNA, and a matrix of 101 unpublished morphological characters. The "total evidence" phylogeny is consistent with the monophyly of Stenodermatinae, and the sister relationship between *Ardops* and *Ariteus* found by previous studies. Our results, however, differ in the structure and support for internal nodes. All continental short-faced bats are grouped in a well-supported clade, and *Phyllops* is sister to *Stenoderma* with high support values. Our extensive data set comprising more than 2500 characters resolves the basal relationships among short-faced bats albeit with low support values.

Bioacoustics and the Nasal Cavity of *Hypsignathus monstrosus*

Dawson, Alta E. and Elizabeth R. Dumont, University of Massachusetts, Amherst, MA

Male hammer-headed fruit bats (*Hypsignathus monstrosus*, Megachiroptera: Pteropodidae) have exaggerated muzzles that appear to encase greatly enlarged nasal cavities. Here we investigate the potential role of the nasal cavity in the acoustical system of this species. Using three-dimensional reconstruction of serial images for twenty-nine pteropodid species and recorded calls, we test the hypothesis that the nasal cavity influences the sounds emitted by these animals. We demonstrate that nasal cavity volume is related to vocal tract length, an important variable determining acoustical performance. The presence of formants in sound spectrograms from recorded calls of *Hypsignathus monstrosus* suggests that the vocal tract alters calls. The inflated nasal cavities and associated paranasal spaces of *Hypsignathus monstrosus* appear effectively to lengthen the vocal tract and thus influence the sounds produced by this species. We

suggest that the unusual calls of these animals and the associated morphology may be related to the evolution of lek mating behavior in these bats.

The Effects of Gape Angle and Bite Point on Feeding Performance in Bats

Dumont, Elizabeth R. and Anthony Herrel

University of Massachusetts, Amherst, MA; University of Antwerp, Antwerp, Belgium

Models of the mammalian masticatory apparatus predict that bite force is affected by variation in both gape angle and bite point (the location along the toothrow where force is transferred to a food item). For generalized mammals like bats, bite force is predicted to decrease as gape angle increases and bite points shift anteriorly. Despite the widespread dependence on these models and predictions in comparative analyses of mammalian craniofacial morphology and feeding, there are relatively few data on bite force in mammals. Here we use three separate data sets collected from plant-visiting bats to investigate the dual impacts of gape angle and bite point on bite force. In accordance with existing models, we found a significant negative relationship between bite force and gape angle both within and between species. Bite force was universally highest at the most posterior bite points, but was unexpectedly low during unilateral canine biting. Overall, models predicting bite force were supported, but there are minor differences among species that probably reflect variation in details of musculoskeletal architecture.

Thermal Characteristics of Bat Houses

Edwards, James and Michael Scott, Lincoln University, Jefferson City, MO

Artificial bat roosts (houses) are one component in encouraging the proliferation of insect-eating bats. Bat house design and placement are two of the characteristics that are known to influence the thermal properties of bat houses. We are reporting the first year data from a project that will compare thermal properties among four bat house designs placed on two different substrates. Two of the bat house designs are modeled from the BCI "Large Economy" style and constructed from western red cedar or painted plywood. The third design is modeled on the minimum recommendations from the BCI "Bat Approved" bat house design and constructed from western red cedar. The fourth design is modeled after "typical" commercially available bat houses and constructed of western red cedar. Three houses of each design were placed in the same orientation (magnetic south) on two different substrates; individually mounted on metal poles and the side of a metal barn. Temperatures were recorded over a three-month time period in the twenty-four bat houses using HOBO data loggers. We will report comparisons addressing several study objectives. These comparisons will include the effect of the vertical position of the temperature sensor inside the bat house, external surface temperatures compared to internal temperatures, the effect of color on temperatures in houses of the same design, the effect of design on houses of the same color, and the effect of substrate on houses of the same design and color.

Northern Bats (*Eptesicus nilssonii*) Use Vision but Not Flutter-detection When Searching for Large Prey in Clutter

Eklöf, Johan, A. Monica Svensson, and Jens Rydell, Göteborg University, Göteborg, Sweden

We investigated the detection cues used by the aerial-hawking bat *Eptesicus nilssonii* foraging in a cluttered environment. The bats can detect and attack rapidly moving targets within the clutter, i.e. below grass panicles, by using prey motion as a cue. Stationary objects are attacked only above the grass, but still within the clutter overlap zone. To test if the bats were guided by flutter from moth wings or by vision when searching for stationary targets, they were presented with male ghost swifts (*Hepialus humuli*) mounted on top of steel wires.

There was no difference in attack frequency on live, fluttering moths compared to dead and spread ones. However, when comparing white and dark moths, we found a significantly higher attack frequency on white ones. This suggests use of vision. When we reduced the size of the spread moths by cutting the wings, and presented the bats with 6, 5, 4 and 3 cm large moths, the preference for white individuals disappeared at 4 cm, indicating that this is the bats' visual acuity threshold. As the attacks always were guided by echolocation calls, even in the case of large (> 4 cm) moths, we hypothesize that northern bats, at least in the initial search phase, use visual cues as a complement to detect stationary ghost swifts.

Fragmented Tropical Forests and Seed-dispersing Bats

Evelyn, Michelle J. and David A. Stiles, University of British Columbia, Vancouver, BC

Throughout the earth's tropics, large continuous tracts of forest are increasingly being reduced to small forest fragments within diverse matrices of human-dominated land uses. The impact of such profound landscape changes on frugivorous bats is of vital concern given their important ecological role as seed dispersers. Between 1996 and 2000, we investigated patterns of habitat use and seed dispersal by frugivorous bats in a tropical forest fragmented by slash-and-burn agriculture in southern Mexico. We used a variety of techniques. First, to assess foraging habitat associations, we conducted mist net surveys in 30 sites of 5 different vegetation types (mature forest, small forest fragments, riparian forest corridors, young secondary forest, and agricultural clearings). Second, to assess roosting habitat selection, we used radio telemetry to locate 55 day roosts of 2 representative species (*Sturnira lilium* and *Artibeus intermedius*) and conducted vegetation surveys to compare chosen roosts with random comparisons. Finally, to assess seed dispersal patterns, we sampled seed rain using 375 seed traps located in closed-canopy forest, treefall gaps, and within agricultural clearings at 1m, 5m, and 20m from the forest edge. We found that, although frugivorous bats were broadly able to use all available vegetation types while foraging, the 2 focal species required large trees and mature forest for roosts. *Sturnira lilium* roosted almost exclusively in tree cavities in mature forest and selected roost trees 50 percent larger in diameter than random trees. *Artibeus intermedius* roosted externally among tree foliage and selected roost trees in close proximity to taller trees. Although male *Artibeus intermedius* often roosted in secondary forest, females preferred mature forest. Our seed surveys indicate that frugivorous bats play a key role in natural restoration of cleared areas, accounting for up to 92 percent of all animal-dispersed seeds within agricultural clearings. These results illustrate an important mutually dependent relationship: bats depend upon tropical forests for roosts and tropical forests depend upon bats for seed dispersal. To maintain this useful and unique dependency, we must work to protect sufficient amounts of forest to provide roosts for bats within human-dominated tropical landscapes.

A Model for Individual Dynamics of Bats

Federico, Paula, Thomas G. Hallam, Thomas H. Kunz, and Gary F. McCracken, University of Tennessee, Knoxville, TN; Boston University, Boston, MA

Temperate zone bats are subject to serious energetic constraints due to their high surface area to volume relations, the cost of temperature regulation, the high metabolic cost of flight, and the seasonality of their resources. Calcium has been suggested to be another critical factor for offspring skeletal growth and demands can cause significant structural changes in the bones during lactation and hibernation periods. Calcium availability is low in the diet of many insectivorous bats and could be insufficient to meet the requirements during pregnancy and lactation. To our knowledge, there are no individual-based mathematical models for any bat species. The model being developed here for a female bat is primarily based on life history and energetics. It describes the growth of an individual female bat through the dynamics of two main compartments, storage (lipids and proteins) and structure (proteins and calcium). The model is

developed for the little brown bat, *Myotis lucifugus*, because of information available on energy budgets and changes in body mass throughout its life history. However, with appropriate modifications the conceptualization might be applied to other species of bats with similar life histories. The individual model integrated into a dynamic population model can assist in many areas such as to improve understanding of the strategies used by bats to meet their energy requirements, generate population dynamics leading to the development of management techniques and conservation strategies, and to investigate stress effects like loss of suitable habitat or chemical insults.

Seasonal Use of Bridge Roosts in Louisiana

Ferrara, Francesca J. and Paul L. Leberg, University of Louisiana at Lafayette, Lafayette, LA

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. From January to September 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 bridges (12) and double T concrete bridges (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 roost site selection. I also assessed whether frequent visits by survey workers affected bat use of roost sites. I compared variation in roost use for bridges that were monitored everyday for a week to bridges that were monitored at the beginning and end of the survey period. There were no significant differences among the treatments, suggesting surveys do not cause bats to abandon roosts.

Bat Activity and Mortality at Buffalo Mountain Windfarm, Eastern Tennessee

Fiedler, Jenny K., Charles P. Nicholson, Niki S. Nicholas, David A. Buehler, Gary McCracken, and Kathy H. Braden, University of Tennessee, Knoxville, TN; Tennessee Valley Authority, Norris, TN

The development of wind power increased dramatically as an alternative power source in recent decades. The effect of wind resource areas (WRA) on bats has not been well studied and is becoming a critical issue as the wind industry continues to grow. Preliminary studies at existing WRA's show the greatest number of mortalities occur from mid-July through August with a national average of approximately 2.5 bats per turbine per year. It is not known what specific behaviors or WRA site features may contribute most to mortality. To start answering these questions, bat mortality and activity of bats were monitored at Tennessee Valley Authority's Buffalo Mountain Windfarm in eastern Tennessee. This site is of particular interest as it is the only WRA in the southeastern United States and possible regional differences have not been established. Bat mortalities documented in 2001 and 2002 included five species (*Lasiurus borealis*, *L. cinereus*, *Pipistrellus subflavus*, *Eptesicus fuscus*, and *Lasionycteris noctivagans*); the majority of mortalities were of *Lasiurus* spp. Species found on site but not among the mortalities include *Myotis septentrionalis* and *M. lucifugus*. The mortality rate for 2001 was 10.33 bats per turbine per year. The current mortality rate for 2002 is slightly higher than in 2001. Activity patterns of bats on and off turbine sites, near and away from areas containing water, and at several altitudes were compared using an Activity Index, and correlated with bat mortalities. Preliminary results show a period of in-

activity from mid-July through August, coinciding with the period of greatest mortality.

Species Diversity and Conservation of Bats in Laos PDR, Asia

Francis, Charles M., National Wildlife Research Centre, Canadian Wildlife Service, Ottawa, ON

With the discovery of several previously undescribed large mammals in Laos and adjacent Vietnam within the past decade, it is not surprising that the bat fauna was, until recently, also poorly known. A review of south-east Asian mammals in 1992 gave records for no more than 35 species of bats confirmed from Laos. Surveys starting in 1995 by myself and others, using a variety of techniques such as harp traps, mist nets, and cave searches, have brought the currently known total to nearly 90 species. Considering that only limited portions of the country have been surveyed, it seems likely that the true total is well over 100 species. Although many of these new records are of species previously reported from adjacent countries, they also include several new or previously unrecognized species. These include at least 5 round-leaf bats (*Hipposideros*), 3 tube-nosed bats (*Murina*), and 1 or more *Myotis* species. Some of these are highly distinctive species, while others are relatively cryptic, and were only detected because of differences in echolocation calls. Unfortunately, many bats in Laos are potentially at risk, particularly from habitat loss and exploitation. Natural habitats are being lost to a variety of causes including logging, hydroelectric dams (especially to provide electricity Thailand), and clearance for agriculture. In addition, nearly any species of bat, including small insectivorous species, may be captured for food. Species that roost in large concentrations in caves are particularly vulnerable, and many large colonies have been eradicated through trapping. Efforts are under way to provide educational materials on the need to conserve bats.

Virtual Bats and Real Insects: Effects of Echolocation on the Reproductive Behavior of the Corn Earworm Moth, *Helicoverpa zea*

Gillam, Erin H., Gary F. McCracken, John K. Westbrook, and Paul G. Schleider
University of Tennessee, Knoxville, TN; U.S. Department of Agriculture, College Station, TX

Noctuid moths have evolved the ability to detect echolocation calls of bats and respond to these calls by performing evasive maneuvers and limiting flight activity. Previous studies of Noctuidae and other insects have also determined that a simple ultrasonic signal causes insects to modify or cease mating and oviposition activities as part of an evolved tradeoff between reproduction and the risk of predation. Although the neurophysiological and behavioral reactions have been documented, demographical implications for reproduction and growth of insect populations have not been investigated. Corn earworm moths, *Helicoverpa zea* (Noctuidae), are a major crop pest in the United States and are heavily preyed upon by Mexican free-tailed bats, *Tadarida brasiliensis mexicana*. It has been demonstrated that ears of corn earworm moths are tuned to echolocation call frequencies of Mexican free-tailed bats. Using corn earworms as a model, the goals of this research are 1) to examine mating and oviposition behavior of free-flying *H. zea* in the presence of simulated echolocation, 2) to investigate population-level effects of echolocation on *H. zea*. "Virtual bats" are electronic units that emit a continuous mixture of search, approach, and feeding calls highly representative of the echolocation of *T. b. mexicana*. Preliminary studies were conducted in areas of Texas with low and high bat density. The high bat density site is within 10 miles of Frio Cave, where several million Mexican free-tailed bats roost in the summer months. Tests of mating behavior included behavioral observations in field cages (6'x6'x6'), field observations and collections of *H. zea* in treatment and control plots, pheromone trapping, and use of mating tables. Large field cages (18'x6'x6') were used to investigate oviposition behavior of corn earworm moths in the presence of simulated echolocation. A population-level experiment was performed by introducing adult moths into control and treatment field cages and after 4 - 5 weeks counting the pupae and adults in each cage composing the field cages and after 4 - 5 weeks counting the pupae and adults in each cage composing the second

generation. Moths used for these studies were collected as larvae and pupae in the field and reared to adulthood in the laboratory. Research in summer 2002 was confounded by inclement weather, insecticide sprays and the extreme temporal and spatial variability in this highly perturbed agricultural system. Future studies will be modified based on the experiences of the last summer.

Variability of Feeding Buzzes

Griffin, Donald R. and Gregory J. Auger, Harvard University, Bedford, MA

When *Myotis lucifugus* are hunting actively in the early evening search phase signals are easily detected by heterodyne bat detectors. Feeding or terminal buzzes are sometimes also detected, especially if the bat detector is tuned to about 35 kHz, but on other evenings when all conditions appeared comparable we detected no approach phase or buzz with Pettersson D-100 detectors. Video obtained with a Canon XLI camcorder with ITT Pocketscope model 6010B light intensifier, using near infrared light from the side, sometimes showed both the larger insects and the bats that caught them. Examples of these video records of insect catching will be shown. With two camcorders aimed from different directions we could also locate catches in three dimensions and determine the bat's approximate distance to the microphone. When this distance was several meters no buzz was detected before some of the catches; but at 0.5 to 2.5 meters at least a faint buzz was always detected when the bat was flying roughly toward the microphone and was located reasonably close to the microphone axis where its sensitivity was maximum. In some cases the usual approach phase with gradual reduction of interpulse interval was not evident even when a faint buzz was recorded. It therefore seems that buzzes are present during insect capture but that the approach and terminal phase signals vary widely in intensity relative to the search phase. Microphone sensitivity sets a lower intensity limit to signals that can be detected; and sometimes in the final and critical interception maneuvers signal levels are detectable only at close range.

Assessment of Bat Community Structure and Habitat Preferences for the Hoary Bat (*Lasiurus cinereus*) Near Foote Creek Rim, Wyoming

Gruver, Jeffery C., University of Wyoming, Laramie, WY

Windturbines cause mortalities to some species of bats, primarily lasiurines, but it is unclear if mortalities occur in proportion to relative abundance. Reports indicate that the hoary bat was the most commonly found bat during mortality searches at a windpower facility in south-central Wyoming. A better understanding of roosting habitat for the hoary bat can inform mitigation strategies at windfarms. The goals of my study were twofold: to examine the community structure of bats and quantify roosting habitat for the hoary bat proximate to the windpower facility. Community structure data were used to determine if mortalities were proportionate to relative abundance. Bats were surveyed with mist-nets and ultrasonic detectors in 2000 and 2001. The little-brown and long-legged myotis were the most commonly encountered species. The hoary bat was the fourth most abundant species, but may be transient in the study area. The number of hoary bat mortalities was more than four times as great as the number captured indicating mortalities befall this species more frequently than the other species in the study area. Most day roosts for the hoary bat were in lodgepole pine trees and were located nearly 7 km from the windfarm. 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. Migratory lasiurines appear to comprise most bat mortalities at windfarms in the U.S., but the reasons for this phenomenon are not well understood. Potential explanations include reduced use of echolocation by migrating species, misinformation about structures based on echo-morphology, increased densities of insects in the lee of windturbines, and 'flocking' behavior by migrating species.

Physiologically-based Models of Bat Population Dynamics

Hallam, Thomas G., Paula Federico, Thomas H. Kunz, Gary F. McCracken, and Amy Russell
University of Tennessee, Knoxville, TN; Boston University, Boston, MA

Data sufficient for determining the dynamics of bat populations are, at best, sparse. A modeling approach is employed to represent the two processes, birth and death, that govern dynamics of a closed population. Each of these population level processes is controlled by individuals and is determined by the physio-chemical environment together with biological and ecological constraints. Based upon life history, physiology and energetics, an individual-based approach, which appears to be generic in that it should be applicable to many bat species, is formulated to investigate population dynamics. An individual bat is modeled with compartments representing storage and structure follows lipids, proteins, carbohydrates and calcium. The life history of an individual is represented by coupled ordinary differential equations representing the dynamics of storage and structure. Aggregates of individuals are tracked by partial differential equations and the simulations of the solutions provide an indication of the bat population dynamics. The utility of the methodology is illustrated for the dynamics of the Indiana bat, *Myotis sodalis*, but individual parameters are selected primarily from a surrogate, the little brown bat *M. lucifugus*.

Improvements in Using Aircraft to Track Indiana Bats *Myotis sodalis* from Their Hibernacula to Summer Range

Hicks, Alan C., Kurt C. Swartz, George M. Greene, and Susanna L. von Oettingen
New York State Department of Environmental Conservation, Albany, NY;
New York State Police, Albany, NY; U.S. Fish and Wildlife Service, Concord, NH

During 2001 we demonstrated that it was possible to radio track *Myotis sodalis* during their migration from their hibernacula to their summer range using aircraft. We located three of five radio-tagged bats, all of which had migrated from their hibernacula at the Barton Hill Mines, Essex County, NY to the Champlain Valley of VT. During the spring of 2002 the process was repeated at the same site but modified to make more efficient use of resources, to sample animals from the beginning of emergence instead of the end, and to provide a larger sample of animals for more meaningful results. Nineteen animals were radio tagged and released on the night of April 16, the second consecutive night of substantial bat activity that spring. To determine their direction of travel, the first ten animals were monitored from the air from the moment of release. As animals were released, staff continually circled 4.8 km from the release point in a fixed-wing aircraft. One onboard G.P.S. system allowed staff to plot where on the circle staff detected the strongest signals, which provided us the direction of the bat's flight but not distance traveled. A second system allowed the pilot to maintain a constant course around the release point. The following day (April 17) staff in two airplanes began the search in the direction suggested from the previous night's results. Starting at roughly 24 km from the release point one flew toward, the other away, in concentric arcs 3.2 km apart. The first plane had located eight animals within three hours. Fifteen were located by the end of the first day after having searched roughly 4,500 sq. kilometers. There were four more flights, all of which checked previously located animals for dispersal, and then searched outlying areas for additional animals. In total we searched roughly 12,000 sq. km and located 16 of 19 animals released; all were within 38 km of the release point.

The Use of Alternate Resources by Nectar-feeding Bats in the Absence of Agaves: Bat Poo Revealed!

Hinman, Katy, Arizona Game and Fish Department, Phoenix, AZ

Temporal or spatial separation between mutualists necessitates the usage of alternate resources by one or both partners. In the case of nectar-feeding bats and *Agave palmeri* in

southeastern Arizona, there is considerable asynchrony between the blooming period of the agaves and the residency of the bats in the area. Exclusion experiments performed on *Agave palmeri* demonstrated that, although the agaves set the most fruit when bats visited, they were able to set some fruit with just diurnal pollinators, and even when pollinators were excluded. As well, vegetative reproduction may also be an effective guard against the absence of primary pollinators. However, the two species of nectar-feeding bats in the area, *Choeronycteris mexicana* and *Leptonycteris curasoae*, are present both before and after the agaves have bloomed. There are no other known bat-visited plants in the area. It has been shown that both of these species of bats readily visit hummingbird feeders, and that these feeders may represent a significant source of energy for the bats both in the presence and absence of blooming agaves. During the agave bloom, both species of bats continue to visit agaves even while visiting feeders, as evidenced by the presence of agave pollen on their fur and in their feces. However, when the agaves are not blooming, the bats must find alternate sources of protein. Examination of samples taken from the bats' fur as well as of fecal samples reveals the usage of alternate protein sources, including pollen from other plant species and, in some cases, insects. The extent to which bats rely on these sources and their significance to explaining temporal asynchrony between the bats and agaves are examined. Although further study in this area may reveal an even broader resource base for the bats, there is not yet enough evidence to support changes in management strategies for these species, especially *L. curasoae*, which is federally endangered. However, this study does reveal the difficulties inherent in generalizing about behavior and feeding habits across populations and geographic areas.

An mtDNA Perspective of the Dynamics of a Chromosomal Hybrid Zone in *Uroderma*

Hoffmann, Federico G., James G. Owen, and Robert J. Baker
Texas Tech University Lubbock, TX; Universidad Salvadorena San Salvador, El Salvador

We sequenced the 1140 base pairs of the *cytochrome-b* gene for 57 specimens of *Uroderma bilobatum* to estimate aspects of the population biology associated with the three chromosomal races in Peters' tent-making bat, *Uroderma bilobatum*. Within species of bats, chromosomal races are uncommon. Chromosomal races in *U. bilobatum* provide an opportunity to understand the population biology associated with intraspecific chromosomal evolution. The three chromosomal races include a $2n=42$ race restricted to South America, east of the Andes, a $2n=38$ race distributed from western South America to eastern Mexico, and a $2n=44$ race distributed on the Pacific versant of Honduras, El Salvador, Guatemala and Mexico. The phylogenetic relationships of the three races cannot be statistically resolved with the *cytochrome-b* gene sequence data, however, the monophyly of the $2n=38$ race and $2n=44$ race is supported by the gene tree. The deepest nodes (3.0%) within the *cytochrome-b* gene trees are within the $2n=42$ race and we hypothesize that this chromosomal race is the oldest of the three. The least amount of sequence divergence (0.5%) is present in the $2n=44$ race whereas within the $2n=38$ race, the average divergence is 0.9%. Intraspecific sequence variation in the *cytochrome-b* gene is partitioned as follows; 70% among chromosome races, 6% among populations within races and 24% within individuals in a single population. The number of captures of the *cytochrome-b* gene across the hybrid zone in Honduras is 1 in 28 for the $2n=38$ race and 1 in 18 for the $2n=44$ race. The integrity of the genome of the three races appears to be maintained. The number of unique haplotypes is 46 for the 57 specimens examined. The cline of the *cytochrome-b* gene data matches the clines previously generated for chromosomal and allozyme data. These results are most compatible with the predictions of a zone originating from a secondary contact. Assuming a 2% per million years rate of evolution, then the $2n=38$ and $2n=44$ division occurred about a million years ago and the last common ancestor for the $2n=44$ race occurred within the last 500,000 years. We found no evidence for geographic subdivision within either the $2n=38$ or the $2n=44$ races which suggests that the within race movement of individuals is substantial.

Intra-race movement among females is further supported by the low number of shared haplotypes within a single population.

*** Patterns in Batfly Morphology and Host-Site Preference on Neotropical Bats**

Hofstede, Hannah ter, York University, Toronto, ON

The purpose of this study was to look at host specificity and host-site preferences in batflies (Streblidae and Nycteribiidae) collected from Neotropical bats. Bats were captured in a forested reserve in Belize using mistnets from April-August, 2001. All visible ectoparasites were removed using forceps and placed in 70% ethanol. Locations of the ectoparasites were recorded as one of 7 categories: ventral wing, dorsal wing, ventral uropatagium, dorsal uropatagium, ventral fur, dorsal fur and head. I captured 455 bats belonging to 32 species in 6 families and collected batflies from 23 species of bats in 5 families. Most species of bat had only one species of batfly (15 out of 23) and many batfly species (18 out of 27) were found on just one host species. From the bats sampled, vespertilionids only had nycteribiids and phyllostomids only had streblids. The morphology of many batflies appears to be linked to the host-site preference. Batflies found mostly in the fur tend to have long legs compared to their body. Batflies with a ctenidium were found in the fur, but not all fur-dwelling batflies had ctenidia. The presence or absence of functional wings did not influence the host-site preference of the batfly, but on bats with more than one species of batfly, all the species either had or lacked functional wings. Bats harbouring more than one batfly species tend to have one fur-dwelling and one membrane-dwelling species, suggesting resource partitioning due to competition. This relationship was not as clear with batflies with functional wings, possibly due to increased mobility.

*Hannah ter Hofstede received the **Basically Bats Wildlife Conservation Society Award**.

The Importance of Estimating the Statistical Power for Endangered Bat Monitoring Programs

Hohmann, Matthew G., Jean M. Mengelkoch, and Tracey E. Hickox
U.S. Army Corps of Engineers, ERDC-CERL, Champaign, IL

Documenting the abundance of threatened and endangered species (T&ES) and tracking changes in their populations over time are important aspects of T&ES management. Typically, data on T&ES abundance are collected as part of site specific or regional monitoring programs designed to detect changes (positive or negative) in T&ES populations. However, when monitoring programs are not designed to provide sufficient statistical power, analyses of population change will be compromised and often misinterpreted. To ensure that adequate data are collected, monitoring programs should be designed a priori with regard to statistical power. This presentation summarizes the use of power analysis for the design of statistically defensible and cost efficient T&ES monitoring programs. Specifically, we use realistic data on Indiana bat primary roost counts to demonstrate how population size, population variation, and sampling plan design all affect one's ability to accurately detect a persistent population decline.

Are You What You Eat? Developmental Changes in Thermoregulation and Influence of Diet on Torpor Use by Big Brown Bats

Hollis, Lydia, University of Calgary, Calgary, AB

Although there are several advantages to torpor use for adult bats (e.g., large energy savings during inclement weather/food shortages), the disadvantages of torpor may outweigh the benefits for juveniles. During torpor, juveniles experience slowed growth and may lose out on opportunities to feed when their mothers return to the roost from foraging. The purpose of my study is to investigate the changes in thermoregulation with age and examine the effects of diet on torpor use by big brown bats, *Eptesicus fuscus*. To determine if thermoregulatory abilities of bats

change during different life stages, I measured body temperature (indirectly as skin temperature) and metabolic rates (indirectly as oxygen consumption) of 4-9 captive big browns at 6 different ambient temperatures (10, 15, 20, 25, 30, and 35 °C) for four different age classes (early prevolant, late prevolant, volant juveniles, and adults). Early prevolant bats were the most thermolabile group, with body temperatures closely matching ambient temperatures. Early prevolant individuals did not stay warm at 10, 15 or 20 °C, whereas some late prevolant bats maintained an active body temperature at these temperatures. Similarly, some volant juveniles and adults maintained an active body temperature and some became torpid at ambient temperatures between 10 and 30 °C. Because the amount of dietary polyunsaturated fatty acids (PUFAs) influences the ability to enter torpor in some other mammals, I investigated the effect of diet on torpor use by big brown bats. To test this, 15 subadult *E. fuscus* (5 bats per treatment) were fed one of three diets: (1) mealworms raised on bran, as the control diet, (2) mealworms injected with 10% addition by weight of sunflower oil, as the "unsaturated diet" [high in PUFAs], and (3) mealworms injected with 5% addition by weight of sheep fat, as the "saturated diet" [low in PUFAs]. After a 2-week feeding period on the various diets, I monitored use of torpor by the bats using temperature-sensitive transmitters. Bats were held in a cold chamber at 10 °C for two days, followed by 5 °C for one week, and length and depth of torpor bouts were determined.

Nutritional Limitations on Lactation in the Big Brown Bat, *Eptesicus fuscus*

Hood, Wendy, Olav Oftedal, and Thomas Kunz

Coastal Carolina University, Conway, SC; National Zoological Park, Washington, DC; Boston University, Boston, MA

Nutritional limitations during lactation were examined in the big brown bat, *Eptesicus fuscus*, by characterizing total nutrients consumed, total nutrients exported as milk, changes in body composition, and energy expenditure in lactating females. Proximate nutrients and minerals transferred between mother and offspring were determined based on patterns of milk composition and production. Concentrations of most nutrients varied considerably. Total energy expenditure was greater than predicted for animals with comparable body size. Prey items were primarily coleopterans. Lactating females consume up to the equivalent of their body mass each night in insects. Analyses of the nutritional content of insects consumed and estimates of total amount consumed suggest that intake alone is insufficient to support the calcium requirements of females throughout lactation and energy requirements during late lactation. Concentrations of body fat and phosphorus in lactating females were markedly lower during mid-lactation, while calcium was marginally lower, suggesting that resorption of bone and mobilization of body fat may be necessary to support nutritional demands. Our findings suggest that lactating females were probably in negative calcium balance throughout lactation and negative energy balance during late lactation. With large fluctuations in dietary intake, energy expenditure, milk output, and milk composition, females appear to adopt a variable strategy for meeting their nutritional needs.

Behavioral Dynamics of Large-scale Nightly Emergences and Dispersal of Brazilian Free-tailed Bats (*Tadarida brasiliensis*)

Horn, Jason W., Raymond Dezzani, and Thomas H. Kunz, Boston University, Boston, MA

The value of abundant and widely distributed non-game species is often overlooked, although they may provide important ecosystem services to human societies. The Brazilian free-tailed bat (*Tadarida brasiliensis*) may play such a role by preying upon migrating pest insects that damage important agricultural crops such as corn and cotton. Because *T. brasiliensis* forages at altitudes higher and at distances further from roosts than most insectivorous species, we have only a cursory understanding of their foraging behavior, including where and when these bats encounter insects over a large foraging area. New tools for observing and quantifying high-altitude foraging

behavior are needed to help evaluate the ecosystem services that these bats potentially provide. We designed our study to quantify the variation in the patterns of nightly emergence and dispersal at five of the largest known maternity colonies of *T. brasiliensis* in south-central Texas. We hypothesized that the information present in NEXRAD Doppler radar images contains patterns of bat movements that could improve our understanding of nightly foraging behavior. We used base reflectivity data at 15-minute intervals to quantify the relative magnitude, direction and speed of nightly dispersal of groups of emerging free-tailed bats using GIS-based spatial analysis. Using circular statistical models, we observed non-random angular directions of dispersion and significant variation in magnitude in nightly activity. We also used a Markov random field model for characterizing the dynamics of nightly dispersal activity. The presence of migrating insect populations during the warm months may influence the nightly widespread dispersion of millions of Brazilian free-tailed bats over the Texas landscape. If so, these behavioral patterns may have implications for pesticide application and conservation and management efforts.

*** Predator-Prey Interactions: A New Analysis of the Bat-Moth Arms Race**

Hristov, Nickolay I. and William E. Conner, Wake Forest University, Winston-Salem, NC

The acoustic interaction between insectivorous bats and tiger moths (Lepidoptera: Arctiidae), has puzzled behavioral biologists for over three decades. When approached by hunting bats, tiger moths answer with a series of intense ultrasonic clicks that stimulate the bat to abort its attack. Although it is generally agreed that the generation of ultrasonic clicks is a defensive strategy employed by arctiid moths against bats, there is disagreement about the mechanism through which the clicks exert their effect. Three hypothesis have been proposed to account for this behavior: that the clicks startle the bats, that they jam the sophisticated sonar of bats, or that they serve as an acoustic warning to the bats that the moths are not palatable food items. This work addresses the bat-tiger moth acoustic interaction from a new perspective by analyzing the learning behavior of naive bats when interacting with tiger moths. In a series of experiments big brown bats (*Eptesicus fuscus*) were pitted against different groups of tiger moths according to the lack or presence of a chemical defense (C-) or (C+) and ability or inability to produce sound (S+) or (S-) resulting in four experimental categories (C+S+), (C+S-), (C-S+) and (C-S-). The responses of the bats were recorded over time and learning curves were constructed and compared. The results of these experiments will be analyzed to shed light on the three hypotheses concerning bat-tiger moth interactions.

* Nickolay Hristov received the **Bat Conservation International Award**.

A Study of Infant Rearing and Mating Behaviors in a Captive Group of Straw-colored Fruit Bats, *Eidolon helvum*

Hull, Rebekah, Jan Zinck, and Debbie Duffield

Portland State University and the Oregon Zoo, Portland, OR

Captive groups of straw-colored fruit bats, *Eidolon helvum*, were observed for over 300 hours during two birthing and subsequent mating seasons. Communal care and infant behaviors were recorded from birth through independence/weaning. Previous genetic analyses of this captive population of *E. helvum* have shown evidence of possible baby swapping, allo-nursing, and/or babysitting behaviors. No evidence of baby swapping or allo-nursing was recorded; however, babysitting care behaviors were observed for specific 'helpers'. This study confirmed previous genetic analyses that suggested this type of care was not kinship dependent. A helper was also involved in a particularly difficult birth. Some evidence of differential rearing of male and female young was noted. Males are left alone in the group huddle earlier than females; however, this does not correlate to males being weaned earlier. Weaning appears to be related to the experience of the mother and/or individual differences in parenting style. Previous genetic analyses of this population and behavioral observations in the wild have suggested indiscriminate

mating; however, this study showed that there are a number of more subtle male and female mating behaviors. The mating season began after the young were mostly independent. At this time, what was one large group huddle broke down into smaller huddles consisting of one male and one to several adult females. A marked change in male behavior took place, with males becoming more aggressive, defending territories, females and food. Male-male interactions consisted of aggressive and dominance displays, and the marking of territories. Most of these interactions were seen between the adult males and a sub-adult male. Territorial marking consisted of males licking the area being claimed. Females as well as males sniffed these marks. Most females tended to stay in one male territory; however, 'roving' females were observed (particularly during feeding). Males also occasionally visited another males' huddle when the attending male was off feeding; this resulted in copulations between the females of the huddle and the visiting male. Once a female was mated, she became a focal interest to all males, suggesting some type of olfactory cue. For this reason, males typically 'guarded' the female just after mating, a behavior that consisted of a very distinct display and guttural vocalizations. These observations lend support to the idea of sperm competition in this species.

Species Consumed by Fruit Bats in the Subtropical Cloud Forest of the Sierra de Manantlán Biosphere Reserve, Mexico

Iñiguez, Luis I., and Jorge Schondübe, Universidad de Guadalajara, Jalisco, Mexico

Interaction between fruit bats and plants is mutualistic, due to the benefits that both species get from it. An initial step to study this interaction in a specific community is to identify the species of both taxa involved. In tropical forests have been recorded a high number of fruit species consumed by bats. Some bats, like *Carollia perspicillata* or *Artibeus jamaicensis*, are well known in their feeding habits in the tropics. However, the diet information for many species is marginal or isolated, or simply does not exist. In the subtropical cloud forest of the Sierra de Manantlán Biosphere Reserve, twelve frugivorous bat species have been identified. Eight of them feed mainly on fruits whereas the other four are nectarivorous that can switch to fruits seasonally. However, up to now there is not an evaluation of their food habits in this subtropical vegetation type. The objective of this work is to know which fruit species are consumed by some of the bat species in the subtropical cloud forest in western Mexico. To get a general overview of the fruits eaten by bats, we take three different approaches. First was to obtain seeds from captured bats' feces. Second, we conduct some feeding experiments in captivity. Third, we realized observations of fruit removal from plants in natural conditions. As result of this work, we present a list of nine consumed species, highlighting as the most important species *Solanum nigricans* (Solanaceae) and *Conostegia volcanalis* (Melastomataceae). This list is not exhaustive, but we consider that it points out the main food items of the fruit-eating bats in the study area. Family Rhamnaceae (*Rhamnus hintonii*) is reported by the first time as consumed by frugivorous bats.

Effects of Wildlife Stand Improvements and Prescribed Burning on Bat Communities on the Buffalo Ranger District, Ozark National Forest, AR

Jackson, Jeremy L., Shane R. Prescott, and J. D. Wilhide
Arkansas State University, State University, AR

Beginning in the year of 2001 managers of the Buffalo Ranger District (BRD) in the Ozark National Forest, Arkansas (Boston Mountains, of north central Arkansas) began using wildlife stand improvements (WSI) and prescribed burning (PB) as part of their management strategy in selected portions of the forest. One result of these management procedures is to alter the forest stands, from forests that contain many crowded, similarly aged trees to a considerably more open forest. We predicted that both the abundance of bats and the number of bat species would increase after a WSI that included PBs, since more open woodlands contain more potential

foraging and movement areas for bats. To test this prediction, we compared bat abundance and species diversity between two intensively managed areas and two reference areas. Specifically, a WSI and PB were administered on a watershed located on the northwestern portion of the BRD during the fall of 2001 and spring of 2002. Similar management practices occurred in 1998 at treatment site two located on the eastern portion of the district. We selected two areas within the BRD, where little or no forest management has occurred in recent years to serve as reference areas. All four sites were approximately 5000 ha in size. Mist netting was conducted at a variety of water sources to assess bat abundance and diversity. We mist netted each area for an average of 23 nights (range 12-34 nights) in the summer of both 2001 and 2002 (one reference site was only sampled in 2002). Both bat species diversity and abundance was higher on the managed areas as compared to our reference sites. In addition a relationship was found between the number of bats captured and the density of trees (basal area). In general, more bats were captured in more open areas. These data suggest that forest management strategies incorporating WSI and PB may be beneficial to bat communities.

A Comparison of Various Capture Versus Acoustic Techniques for the Surveying of Bats in Belize

Johnston, Dave S., Fiona Reid, Cullen Geiselman, and Sybill Amelon
Santa Clara University, Santa Clara, CA; Royal Ontario Museum, Toronto, Ontario; Bat Conservation
International, Austin, TX; University of Missouri, Columbia, MO

To evaluate the effectiveness of various capture methods and acoustic techniques for the purpose of surveying for bats in Belize, we captured bats using small mist nets (7 ft. x 8 ft. and 18 ft., and 10 ft. x 30 ft. and 42 ft.), a macro mist net (25 ft. x 100 ft.), canopy nets, Austbat harp traps, hand nets, and for acoustic surveying we used the ANAbat 6 system. We sampled at eight locations using both methods each survey night and compared the results between methods and among nets. Using both methods we recorded 37 species representing seven families from 311 captures and 220 acoustic detections. Of the four species of Emballonuridae only one species was detected by both methods. Additionally, one species of Noctilionidae was caught with a small mist net, and the two species representing Mormoopidae were recorded by both methods. However, of the 18 species of Phyllostomidae, none were detected by the acoustic method. Bats > 50 gm were caught in the macro net in higher numbers than in the equivalent unit area of the small nets or the canopy nets. The Macro net caught five phyllostomid species not captured by other methods, and the canopy nets caught one phyllostomid species not captured by other means. Of the seven species of Vespertilionidae, four species were caught by various capture methods and six were detected by the acoustic method. Of the five species in the Molossidae family, two species were captured at a known roost by a modified net/hand technique, and four species were detected by acoustic means. The one species representing Thyropteridae was recorded only by capture. Our data indicate that the biology and foraging behavior of bats at the family level determines the survey method required, and that the most complete inventories of bats in neotropical areas are accomplished though the use of several capture methods as well as by acoustic means.

A Description of the Structure and Distribution of Buccal Cavity Characters in the Chiroptera

Knapp, Michelle C., Harvard University, Cambridge, MA

Phylogenetic relationships amongst bats are controversial. In recent years, the monophyly of genera, families, and even the order has been called into question. In light of this debate, any information that can be gained by molecular or morphological data may be helpful. While pelage and dentition are well-described, soft mouthpart morphology has been largely ignored. I looked at structures occurring in the buccal cavity between the gums and the lips of members of several

families of bats; two structures found in several taxa are papillae on the insides of the lips and a ridge between the lips and the teeth. The structures are described and their distributions among taxa are noted.

Social Preferences and Sociability of the Solitary Little Golden-mantled Flying Fox (*Pteropus pumilus*) and the Social Island Flying Fox (*P. hypomelanus*)

Kosteczko, Nicole S., DeeAnn M. Reeder, and Thomas H. Kunz
University of Scranton, Scranton, PA; Boston University, Boston, MA

A comparative study of social preferences was conducted using the solitary little golden-mantled flying fox (*Pteropus pumilus*) and the highly social island flying fox (*P. hypomelanus*). Eight males and eight females of each species were tested at the Lube Foundation in a 6m x 3m x 3m x 2m high triangular cage that contained two smaller cages (0.6m x 0.75m x 0.9 m) for housing stimulus animals. The behaviors of each bat were recorded for 10 minutes in each of the following conditions: 1) habituation trial — stimulus cages empty; 2) same sex stranger in one cage vs. an empty cage; 3) opposite sex stranger in one cage vs. an empty cage; and 4) same sex stranger vs. opposite sex stranger. Each 10-minute behavioral trial was divided into forty 15 sec intervals, with the latency to chose a stimulus animal recorded in seconds and other behaviors recorded if they occurred during each interval. Both male and female *P. hypomelanus* were more likely to approach stimulus animals than were individual *P. pumilus*, although these differences were not significant. Additionally, there were no differences between the behaviors of males vs. females nor between trial types for both species. Despite the lack of overt social preferences for same or opposite sex strangers, significant differences between species and between sexes were found in other behaviors. For example, females of *P. hypomelanus* were more aroused by the novel environment and novel stimulus of other bats than were females and males of the same species or both sexes of *P. pumilus*, as indicated by significantly higher levels of shivering behavior. Greater overall arousal and/or curiosity in *P. hypomelanus* vs. *P. pumilus* was also suggested by significantly higher rates of locomotion during the trials in both sexes. *P. hypomelanus* also exhibited significantly higher levels of investigatory behavior in all trial types than did *P. pumilus*. Although individuals of *P. pumilus* were less inclined to investigate, they demonstrated a significantly higher level of threat behavior (wing threats and wing flicks, open mouth staring, etc.) than did *P. hypomelanus* (threatening in 69.6% of all trial intervals vs. 8.75%). These results suggest that the two species differ considerably in temperament in ways that reflect their differences in sociality. The more social *P. hypomelanus* responded to the novel situation and to novel animals with curiosity and increased levels of activity, whereas the relatively asocial *P. pumilus* appeared threatened by these conditions.

Proposed Forest Management Changes in Southern Appalachian Mountain National Forests Should Benefit Bat Conservation

Krusac, Dennis L., USDA Forest Service, Atlanta, GA

Currently, there are five national forests in the southern Appalachian Mountains of the eastern United States that are revising their forest management plans. The proposed management changes are a significant step forward in the U.S. Forest Service's effort to conserve biological diversity. The management direction to benefit bats is a huge change from the direction in the early forest plans they are replacing. The current planning effort is an attempt to get consistent management direction in place across national forest lands stretching from northern Virginia to northern Alabama. Cliffline habitat, important to Virginia big-eared bat *Corynorhinus townsendii virginianus*, Rafinesque's big-eared bat *C. rafinesquii*, and eastern small-footed bat *Myotis leibii* will be protected with a 100 foot buffer above and a 200 foot buffer below the cliff face. The only management that will occur in the buffer zone will be done to benefit cliffline dependent species. All caves and mines are assumed to be used by federally threatened or endangered bats

and protective measures are put in place until it is proven these sites are not important to listed bats or large concentrations of any bat species. Buffer zones ranging from one-quarter mile to five miles are placed around caves and mines depending on species present and season of the year. For example, prescribed fire is prohibited within a five-mile buffer of Indiana bat *M. sodalis* hibernacula during the fall swarm to protect and avoid disturbing roosting bats. Gates or other structures are constructed and maintained at entrances to caves and mines occupied by federally listed species, rare species or significant populations of other species to minimize human disturbance. Before old buildings and other man-made structures are modified or demolished, they are surveyed for bats. If significant bat roosting is found within such structures, these structures will be maintained or alternate roosts suitable for the species and colony size will be provided before their adverse modification or destruction. Forested corridors are maintained along watercourses including channeled ephemeral drains. All immediately suitable roost trees are retained in timber harvest activities. Proposed management direction will be discussed in detail. The draft forest plan revisions will be available for public review and comment early in 2003. I encourage you to review these plans and provide your comments.

Reproductive Energetics of Free-ranging Brazilian Free-tailed Bats (*Tadarida brasiliensis*)

Kunz, Thomas H., Boston University, Boston, MA

Estimates of daily energy budgets in free-ranging animals can provide important information for assessing their ecological and economic role in both natural and human-altered ecosystems. Such assessments require accurate and reliable estimates of population density and the amount of food consumed. Realistic estimates of the amount of food consumed should be based on energy budgets derived from both the amount of energy expenditure and exported. One of the goals of the present study was to use compartment models and empirically-derived field data on time budgets (based on radiotelemetry), field metabolic rate, FMR (based on doubly labeled water), stage of lactation (based on age of growing pups), milk energy output (based on daily water flux in pups and proximate composition of milk), and variation in roost temperatures (recorded with remote recording devices) to estimate the daily energy budget of *Tadarida brasiliensis* during lactation. Data from radiotelemetry indicate that lactating females have two discrete foraging periods during lactation, with the amount of time spent on the wing averaging eight hours per night. Females spend the balance of a 24-hour period occupying day and night roosts--exposed to contrasting thermal conditions and exhibiting different activity levels. The average daily energy expenditure of *T. brasiliensis* at peak lactation, based on field metabolic rate (FMR) is 31.6 kJ/day. Of this amount, a total of 22.8 kJ/day (72.1%) is allocated to flight (commuting and foraging) and 8.8 kJ/day (27.9%) is allocated to day- and night-roost activities. In addition, a total of 26.0 kJ/day is exported as milk during peak lactation. Thus, the total energy budget (FMR + milk export) of a female *T. brasiliensis* at peak lactation is 57.5 kJ/day. A lactating female may allocate as much as 45.1% of its nightly energy intake to milk export. Using these estimates, the predicted energy equivalent of an insect diet (mostly beetles and moths), and assuming an 88% assimilation efficiency, an 11.5 g female *T. brasiliensis* at peak lactation would consume ca. 8 g of insects each night (ca. 70% of its body mass). Based on these estimates, a colony of 10 million lactating Brazilian free-tailed bats would consume the equivalent of ca. 72 metric tons of insects nightly. Obviously, differences in the types of insects eaten (e.g., beetles, moths, etc.) will influence a bat's assimilation efficiency and quantity of insects consumed.

Ecological Aspects of Indiana Bats (*Myotis sodalis*) in Michigan

Kurta, Allen and Heidi Rice, Eastern Michigan University, Ypsilanti, MI

The Indiana bat (*Myotis sodalis*) is the only mammal on the federal list of endangered species that consistently breeds in Michigan. We have captured over 100 Indiana bats in the state since 1990, and we combined these captures with previous records to analyze geographic, seasonal, and reproductive patterns. Most Indiana bats from Michigan winter in southern Indiana or Kentucky, but a few hibernate at Tippy Dam in northern Lower Michigan; warm-season records (April-October), in contrast, exist for 12 counties in southern Lower Michigan. Births typically occur in mid-to-late June, and lactation lasts 3-5 weeks. Eighty-nine percent of adult females are reproductive (pregnant, lactating, or postlactating), and 11% of all adults are male. We suggest that other researchers analyze their accumulated data to determine whether reproductive rates are consistent across the range or low in areas associated with population declines.

Montserrat Redux-Recovery: Role of Reproduction in Plant-visiting Bats

Kwiecinski, Gary G. and Scott C. Pedersen

University of Scranton, Scranton, PA; South Dakota State University, Brookings, SD

Hurricanes and volcanoes are large scale, high intensity perturbations that impact the structure and function of tropical ecosystems. Bats are key agents of pollination and seed dispersal in the tropics but little is known about their response to and recovery from such natural disasters. Frugivorous and nectarivorous bats make a significant contribution to tropical forest succession (e.g., seed dispersal, flower pollination) and have a large impact on the distributional and genetic structure of the tropical plant community, and are therefore important to ecosystem recovery from traumatic events. Among the islands of the Lesser Antilles, Montserrat is unique because it has recently experienced the trauma of both hurricanes and volcanic activity. Census of plant-visiting bat populations before and after the most recent pyroclastic event have indicated an increase in plant-visiting bat numbers, due primarily to an increase in captures of *Artibeus jamaicensis* and *Monophyllus plethodon*, two of the four plant-visiting species present (see Pedersen and Kwiecinski). For *Ardops nichollsi* and *Brachyphylla cavernarum*, our census data correlate well with literature accounts; they follow the general tropical pattern of a single, population-wide reproductive effort at the time of maximum food availability. For *Monophyllus plethodon*, the literature hints at a distinct breeding season, but the census data indicate a seasonally bimodal pattern. More information is needed for this species to verify its reproductive pattern. *Artibeus jamaicensis* is known to be polyestrous and seasonally bimodal. Data from captive *Artibeus jamaicensis* indicate individuals can produce three young per year if there is no delayed development. Our census data confirm polyestry, but more data are needed to determine if the population is synchronized and bimodal. The effect of recent perturbations on demographic patterns of plant-visiting bats can be estimated by examining the proportion of captured individuals that are juveniles. This proportion measures recent reproductive success and is an index of potential for an increase in population density in the near future. For *Artibeus jamaicensis*, juveniles were not captured during the time of major pyroclastic events (1995-1997) but were 16.8-20.6% during the recent recovery period (2000-2002). This is a significant difference in demographic structure and together with their reproductive potential, can account for the dominance of *Artibeus* captures. Furthermore, the increase in numbers and proportion of juveniles provide an index of post-perturbation recovery.

A Survey of the Bats of New Boston Air Force Station in South-central New Hampshire

LaGory, Kirk E., D. Scott Reynolds, and Stephen Najjar, Argonne National Laboratory, Argonne, IL;
North East Ecological Services, Concord, NH; New Boston Air Force Station, NH

A survey of bats was conducted in June and July 2002 at New Boston Air Force Station (NBAFS), Hillsborough County, in south-central New Hampshire. The objectives of the survey were to determine the species present to inform natural resource management and planning on the station. Endangered bats, specifically the state-listed eastern small-footed bat (*Myotis leibii*) and the federally listed Indiana bat (*Myotis sodalis*), were of particular interest. NBAFS, a satellite-tracking station, is mostly undeveloped and consists of a mosaic of deciduous, coniferous, and mixed forests of various seral stages. Wetland habitats, open areas, rock outcroppings, and cliff habitats are scattered throughout the station. Ten locations were sampled for a total of 648 net-nights with a combination of horizontal, stack, and canopy nets. Acoustic sampling of these locations was also conducted using Anabat detectors (20 detector-nights). Although relatively few bats were captured (29 individuals), diversity was high (6 species), and several species that are rarely captured in New England were found. Species captured included: little brown bat (*Myotis lucifugus*, N=11), big brown bat (*Eptesicus fuscus*, N=10), northern long-eared bat (*Myotis septentrionalis*, N=2), hoary bat (*Lasiurus cinereus*, N=2), red bat (*Lasiurus borealis*, N=2), and eastern small-footed bat (*Myotis leibii*, N=2). A total of 2,225 calls from seven species was recorded with Anabat equipment. In general, the acoustic sampling results agreed with those from mist nets. Additional species detected, but not netted, were eastern pipistrelle bat (*Pipistrellus subflavus*) and silver-haired bat (*Lasionycteris noctivagans*) bringing the total number of species found on NBAFS to eight.

Muscle Fiber Types in the Abdominal Walls of Two Bats (Microchiroptera)

Lancaster, Winston C. and O. W. Henson, Jr.

California State University, Sacramento, CA; University of North Carolina at Chapel Hill, NC

The physical properties of skeletal muscles can be characterized by the staining characteristics of muscle cells for the enzyme myofibrillar adenosinetriphosphatase. Using these characteristics, muscle cells have been classified as slow-contracting (Type I), fast-contracting oxidative/glycolytic (Type II a) and fast-contracting glycolytic (Type II b). We examined muscle fiber types in the lateral abdominal wall muscles and rectus abdominis in two bats, *Pteronotus parnellii* and *Macrotus waterhousii*. In five individuals, the rectus abdominis of *P. parnellii* had an average of 30% Type I, 30% Type II a and 40% Type II b fibers. This contrasts with the lateral abdominal wall in which the proportions (in three bats) were 7%, 18% and 75%, respectively. In one individual of *M. waterhousii*, the rectus abdominis had 19% Type I fibers, 69% Type II a fibers and 13% Type II b, in comparison to proportions of 0%, 45% and 55% (respectively) in the muscles of the lateral abdominal wall. By Chi-squared analysis, we found the proportions of muscle fibers to be significantly different between the muscles within each species ($\chi^2_{0.05, 2} = 62.1$; $p < 0.0001$), and found each of the muscles to be significantly different between the two species (*P. parnellii*, $\chi^2_{0.05, 2} = 1089.2$; $p < 0.0001$; *M. waterhousii*, $\chi^2_{0.05, 2} = 62.0$; $p < 0.0001$). The lateral abdominal wall and the rectus abdominis have functional differences that are reflected in these differences in physiological properties. The lateral abdominal wall is adapted for rapid forceful contractions needed to power echolocative calls; the rectus abdominis retains a significant proportion of slow-contracting fibers indicating postural functions. The differences in the muscles in *M. waterhousii* are more difficult to interpret in that slow-contracting fibers are absent in the lateral abdominal wall, and are less than 20% of fibers in the rectus abdominis. These data indicate the need of further examination of the function of the abdominal wall muscles in *M. waterhousii*. Supported by USPHS grant NIDC DC 00114 to O.W. Henson, Jr.

Bat Surveys on Fort Knox, KY, 2002

Lance, Richard F., Chester O. Martin, Bruce M. Sabol, David K. Delaney, and Larry L. Pater
U.S. Army Engineer Research and Development Center, Environmental Lab, Vicksburg, MS;
Construction Engineering Research Lab, Champaign, IL

The bat community on Fort Knox, KY was surveyed in 2002 as part of a larger effort to investigate potential impacts of high-caliber weapons fire on bats. Three sampling efforts, totaling twelve nights, were completed between April and August of 2002. Creeks, lakes, and forest edges were sampled using mist-nets and Anabat II bat detectors. Because of range safety considerations, central and eastern portions of the installation within firing range impact areas were not surveyed. Sites within the northern portion were mist-netted in 1999-2000 as part of unrelated studies. Sites near heavy caliber weapons ranges in the southern portion of the installation were the focus of much the sampling. However, as opportunity presented, sites within the central and western portions were surveyed. In total, 116 bats were netted, with *Pipistrellus subflavus* and *Lasiurus borealis* comprising the bulk of captures. The endangered species *Myotis grisescens* and *M. sodalis* are known to occur on the installation, but only *M. grisescens* was netted during our surveys. Some species of bats were tentatively identified using bat detectors, but were not captured during mist-netting. Ultrasonic calls recorded during bat detector surveys were identified to species using a discriminant function analysis and a large library of "known" calls developed by E. Britzke (Tennessee Tech University) for Southeastern bat species. Surveys will be ongoing through 2004.

Associations of Lunar-correlated Activity Rhythms of Neotropical Katydid with Activity Patterns of the Gleaning Insectivorous Round-eared Bat, *Tonatia silvicola*

Lang, Alexander B., Elisabeth K. V. Kalko, Dina K. N. Dechmann, and Cécile Bockholdt
Karl-Franzens-University Graz, Austria; University of Ulm, Germany; Smithsonian Tropical Research Institute, Panama; University of Zurich, Switzerland

For a range of animals, a correlation of varying environmental light conditions during the lunar period and with activity patterns has been observed. However, the effects of moonlight on insect activity are still controversial and thus also the effects behavioural changes may have on their predators. Studies reported variable results depending on the methods being used (Hardwick, 1972; Williams & Singh, 1951; Brown & Taylor, 1971). Several insect species showed a significantly lower abundance during full moon periods. Similar avoidance of bright moonlight conditions has also been reported for several groups of nocturnal mammals, such as rodents (Bowers, 1988, 1990), lagomorphs (Butynski, 1984) and bats (Erkert, 1974; Fenton et al., 1977; Morrison, 1978). Nocturnal Neotropical katydids are a major protein source for many insectivorous bats on Barro Colorado Island, Panama (Belwood & Morris, 1987; Kalko, 1996). One species that is well known in its behaviour and dietary choice is the perch hunting bat *Tonatia silvicola*. It catches katydids and other insects in the forest under story by using acoustic cues produced by its prey (Belwood, 1988; Servatius & Kalko, 1997). The nocturnal activity of Neotropical katydids on Barro Colorado Island, Panama, varies significantly within the lunar cycle. Two different sampling methods, either by systematically collecting katydids manually at the lights of the lab buildings, or with systematic searches in the dark forest, showed a decrease in the number of captured individuals close to full moon. In addition, long term recordings of the background noise level in the forest varied with the moon phase – the sound pressure level was significantly higher around new moon. Calling crickets and katydids contribute predominantly to the background noise, thus the reduced noise level during full moon corroborates the abundance of potential prey for the bats during this time (Lang et al, in press). To link the observed changes in katydid activity level with possible changes in predator behaviour, we analyzed the activity pattern of *T. silvicola* using telemetry and infrared video recordings at their roosts. The results demonstrate a significant effect of moonlight intensity on bat behavior. During the full moon phase, the bats drastically reduced their activity level and stayed for most of the night in their

roost. Therefore, we suggest that the observed lunar phobia of *T. silvicola* may be mainly a result of low prey availability during the full moon phase rather than of predation pressure on the bats itself as it has been suggested for other bat species such as the canopy frugivore *Artibeus jamaicensis* (Morrison, 1978). Further evidence and discussions on this behavior pattern will be presented.

Capture Rates of Four Species of Fruitbats on Montserrat

Larsen, Peter A. and Scott C. Pedersen, South Dakota State University, Brookings, SD

The mist net capture times of over 200 fruitbats were recorded on the island of Montserrat during late July and early August of 2002. Seventeen sites were sampled with an average of 5.8 mist nets at each site. Captures occurred between the hours of 18:50 and 23:20. Analysis of these times revealed an interesting pattern of foraging activity amongst four species of Phyllostomid bats: *Artibeus jamaicensis*, *Monophyllus plethodon*, *Ardops nicholli*, and *Brachyphylla cavernarum*. Capture times for *Artibeus* and *Monophyllus* were similar; the earliest netting of both species occurred at 18:50 hrs, and both shared a peak capture rate (18 *Artibeus* and 12 *Monophyllus* per 10-minute interval) between 19:00 hrs and 19:30 hrs. During this sampling period, *Ardops* was first netted at 19:20 hrs, appearing 20 minutes after the earliest *Artibeus* and *Monophyllus* captures. A somewhat constant capture rate for *Ardops* existed throughout the sampling time frame, with an average of 0.8 captured every 10 min between the hours of 19:20 and 22:10. *Brachyphylla* appeared relatively late during the sampling period; its earliest capture being at 20:10 hrs. The late appearance by *Brachyphylla* coincided with a decline in the capture rate of *Artibeus*, suggesting a possible competitive interaction between the species. Early capture times of *Artibeus*, *Monophyllus*, and *Ardops* could be attributed to the relative close proximity of their roosts to their foraging locations (short transit time). The late arrival by *Brachyphylla* at each site may be due to: 1) *Brachyphylla* has been observed emerging from their cave roosts well after sunset and 20 min. after the emergence of *Artibeus* (Nellis and Ehle 1977), and 2) *Brachyphylla* would have a somewhat longer transit time to its foraging sites from coastal caves averaging 1.90 km from the sampled locations.

Thermoregulation and Microclimate in Maternity Colonies of *Eptesicus fuscus*: The Consequences of Roost Structure

Lausen, Cori L., University of Calgary, Calgary, AB

Roost microclimate has been identified as an important factor influencing roost choice by bats and can affect the costs of thermoregulation as well as growth rate. I studied a maternity colony of big brown bats (*Eptesicus fuscus*) roosting in natural rock crevices along the South Saskatchewan River in Alberta, Canada and compared patterns of thermoregulation by pregnant and lactating females to those of females roosting in a nearby building (ESS; Hamilton & Barclay 1994). The frequency of torpor use (% of bat-days) was the same for the two locations, but building-roosting bats used deep torpor more frequently during pregnancy, and had lower mean minimum body temperatures (T_b) throughout the reproductive season. I compared microclimate in ESS and one other *E. fuscus* building-roost (ECH) with that of the rock-crevice roosts. Both buildings offered warmer conditions day and night, creating conditions more conducive to juvenile growth. Bats roosting in warm building conditions and using deep torpor to a greater extent, would realize greater energy savings than those roosting in cooler rock crevices and maintaining higher T_b when torpid. I suggest that rock-roosting bats maintain higher T_b despite colder roosting conditions to remain vigilant. Roosting in buildings may provide a three-fold advantage over roosting in rock crevices: lower predation risk, higher juvenile growth rates, and increased energy savings. From a conservation standpoint, these results highlight the importance of building-roosts to some species of concern for which thermoregulatory studies have not been

done, and thermal roosting needs are not understood. It is possible that colonies in buildings experience greatest reproductive success, and may be capable of re-colonizing surrounding natural areas. These results also suggest that studies of thermoregulatory behavior and life history traits of bats in human-made structures may give false impressions of these characteristics in natural roosting situations.

Individual Marking of Captive Flying Foxes for Behavioral Observations

LeBlanc, Dana M., DeeAnn M. Reeder, and Nicole S. Kosteczko

The Lube Foundation, Gainesville, FL; Boston University, Boston, MA; University of Scranton, Scranton, PA

Traditional marking of captive flying foxes in captivity with stainless steel thumb bands or electromagnetic transponders only facilitate individual identification while in close proximity. Plastic thumb bands offer better visual identification over a short distance, but bands are not available for larger bats and some individuals are adept at removing these easy-to-use bands. Chemiluminescent tags offer excellent individual identification at night, but fade over a period of hours. A combination of two temporary marking methods, colored tubing necklaces and fur bleaching, may offer better long distance identification and facilitate behavioral observations during the day and at night. Forty-eight Malayan flying foxes (*Pteropus vampyrus*) at the Lube Foundation, Inc. were marked with 1) necklaces using beaded chain inserted into 1/4" vinyl tubing with Rexlace® [plastic lacing] threaded through the tube and 2) bleached fur on both their abdomen and their back using a mixture of Clairol Professional® Pure White [30 Volume Crème developer] and BW2 a dust-free lightening concentrate. Both marking methods were accomplished during approximately 15 minutes of anesthesia and complimented each other for accurate visual identification. Fur bleaching on both the ventral and dorsal aspects provided the best identification from a distance from any angle. Because this marking method was temporary, large conspicuous symbols or numbers could be used. The necklaces provided short distance identification and identify confirmation when the bleached symbols were similar or when they were not visible due to the bat's position or body posture. Several collars have been lost, potentially due to crimping of the chain prior to being put on the bat. One collar was removed when a laceration was found on half the circumference of the neck. The cost of both of these techniques is minimal at less than a dollar per bat. These techniques could be used both in captive and field settings.

What's Your Zone?

Determining the Implications of Variation in the Zone of Reception

Livengood, Kimberly, Ronald Drobney, Chris Corben, and Richard Clawson

Missouri Cooperative Fish and Wildlife Research Unit, University of Missouri, Columbia, MO;
Missouri Department of Conservation, Columbia, MO

The zone of reception (the volume of space being sampled by a bat detector) is dependant on many factors including: the characteristics of the bat call (frequency and intensity), transmission of the call through the atmosphere (varying with temperature, humidity, and barometric pressure), and bat detector characteristics (microphone and amplifier response characteristics, sensitivity setting, battery voltage, and variation between units). Weather data were collected to assess the range of atmospheric conditions likely to be experienced in the field while recording bat calls, and the sensitivity characteristics of seventy-two new Anabat detectors were measured to determine the inherent variability among bat detectors. These data were collated to determine the practical significance of each factor on the Anabat's zone of reception for 40kHz bat calls. The implications of these findings are discussed, and recommendations for reducing variability are made.

Effects of Forest Thinning and Prescribed Burning on Bat Activity in the Piedmont of South Carolina

Loeb, Susan C., Thomas A. Waldrop, and David W. Leput, USDA Forest Service, Southern Research Station, Clemson, SC; Department of Forest Resources, Clemson University, Clemson, SC

Based on morphological and acoustical considerations, several investigators have predicted that structurally complex environments, such as dense forests, will not be used by many species of bats. Thus, forest management practices that decrease clutter may increase the suitability of many forested stands for bats. We tested this hypothesis using two common forest management practices that decrease stand density: thinning and prescribed burning. The study was conducted on twelve 14-ha plots on the Clemson Experimental Forest in the Upper Piedmont of South Carolina. The plots were located in 17–50 year-old pine-hardwood stands. The study design consisted of three replicates of four treatments: Control, Thin, Burn, Thin+Burn. From May–August 2002 we mist-netted in the vicinity of the plots to determine the composition of the bat community. We used AnabatII bat detectors to sample bat activity on each plot during two nights each month from May through August 2001 and 2002. Bat detectors were placed at two random grid points for the first night and moved to new points on the second night. One detector was placed at the top of a 10 m extendable pole and the other was placed at approximately 1 m above ground. Red bats (*Lasiurus borealis*), big brown bats (*Eptesicus fuscus*), eastern pipistrelles (*Pipistrellus subflavus*), and evening bats (*Nycticeius humeralis*) were the most common bats captured; we also captured one silver-haired bat (*Lasionycteris noctivagans*) and one seminole bat (*L. seminolus*). Bat activity was significantly lower in 2002 than in 2001, and in both years, we recorded significantly higher activity from detectors mounted on 10-m poles than from detectors close to the ground. Bat activity also varied significantly among treatments. In 2001, bat activity was significantly higher in Thin and Thin+Burn plots than in Control or Burn plots. In 2002, bat activity was significantly higher in Thin, Burn, and Thin+Burn plots than in Control plots. Thus, in the short-term, forest management practices that decrease tree density increase habitat suitability for bats. Other benefits of these practices, such as increased tree growth resulting in larger trees and snags, should favor bats in the long-term.

Influence of Forest Ecosystem Type on Bat Habitat Use in the Northern Skagit Watershed, British Columbia

Luszcz, Tanya M. J., University of Calgary, Calgary, AB

In forest ecosystems, several factors, such as species composition, age, spatial complexity and elevation, may influence bat habitat use. The majority of British Columbia's bat species are key residents of forest habitats, and understanding their habitat needs is important, especially when landscapes are being artificially altered. The objectives of this study are to compare habitat use of bats in forests of different ecosystem types in the Skagit watershed and ultimately apply this information to a forest management perspective. I measured activity levels of forest dwelling bats by placing remote AnaBat II detector systems in young, medium and old forests of four different ecosystem types. Detectors were placed in natural forest gaps within a contiguous habitat type. Following ecomorphology theory, habitat use by bats can be predicted by differences in their wing morphology, body size and other characteristics that influence their maneuverability. I am determining habitat use by species or species groups using Anlook call analysis software and discriminant function analysis. Reference calls were collected locally from hand-releases of captured bats. The results from this analysis will be presented and related to predictions of habitat use based on ecomorphology theory.

Application of Ultrasonic Sound Detection and Passive Thermal Infrared Imaging Technology for Monitoring Bat Activity Associated with Military Noise on Department of Defense Installations

Martin, Chester O., Richard F. Lance, Bruce M. Sabol, David K. Delaney, and Larry L. Pater Environmental Laboratory, U.S. Army Engineer Research and Development Center (ERDC), Vicksburg, MS; Construction Engineering Research Laboratory, ERDC, Champaign, IL

The Department of Defense (DOD) manages natural resources on numerous installations that support populations of sensitive bat species, including the federally endangered gray bat (*Myotis grisescens*) and Indiana bat (*M. sodalis*). A U. S. Army basic research study was initiated in 2002 to investigate the impacts of military training noise, primarily high-caliber weapons fire, on the foraging and roosting behaviors of bats. Most field sites were located on Fort Knox, Kentucky; some preliminary tests were conducted at Meridian Naval Air Station, Mississippi. Study tasks included development of protocols for using ultrasonic sound detection, thermal infrared imaging, and radio telemetry. Standard mist netting procedures and ultrasonic sound detection systems (Anabat II) were used to determine the presence of bats in selected study areas. Ultrasonic sound detectors and thermal infrared cameras were used simultaneously to monitor bat activity at sites subjected to various military noise sources, including high-caliber weapons fire, rocket fire, and helicopter noise. Additional field studies to monitor bat activity and measure various noise sources on DOD installations will continue in 2003 and 2004. Data obtained during the 2002 field season are currently being analyzed and will be used to focus study efforts in following years.

Food Habits of the Free-tailed Bats *Nyctinomops femorosaccus* and *Tadarida brasiliensis* from Big Bend National Park, Texas

Matthews, Amanda K. and Loren K. Ammerman, Angelo State University, San Angelo, TX

Studies in community ecology are often concerned with the partitioning of resources among similar coexisting species. Dietary composition of two morphologically similar, closely related free-tailed bats, the pocketed free-tailed bat (*Nyctinomops femorosaccus*) and Mexican free-tailed (*Tadarida brasiliensis*), was determined to evaluate differences in food resource use in an area of sympatry. Foods eaten by *N. femorosaccus* and *T. brasiliensis* were determined from fecal samples collected (May-July, September 2000, March 2002) from individual bats captured in mist nets at two sites in Big Bend National Park, Texas. Insects present in fecal pellets were identified to ordinal (and often familial) level using reference guides and/or by comparison to specimens collected in light traps at netting sites. Proportion of each food item was visually estimated (to the nearest 1%) and percent frequency was calculated. Fecal pellets from 65 *N. femorosaccus* and 95 *T. brasiliensis* were analyzed, with remains of Lepidoptera (moths), Hemiptera (true bugs), Coleoptera (beetles), Homoptera (hoppers), and Hymenoptera (ants) found in both species. Remains of Diptera (flies) and Orthoptera (crickets) were present only in *N. femorosaccus*. Comparisons in dietary composition and temporal activity (based on nightly capture rates) between these two species will be discussed.

Flight Frequencies and Durations and Exit/Entry Sequences of Pregnant and Lactating Big Brown Bats at a Summer Roost

Mayrberger, Sheri, Dennis Viele, Eugene Studier, and Victor Mayrberger
University of Michigan at Flint, Flint, MI

Beyond sunset emergence patterns, little is known about the entry/exit patterns of big brown bats, *Eptesicus fuscus* from summer roosts. At the single small entrance/exit portal of a summer roost, activities of all bats were continuously taped using an infrared camera, beginning in the

evening of 4 May 2002 and continuing nightly through September. Precise (to the second) exit/entry times for all bats using that roost were determined from a clock mounted in the camera's field of view. Around sunrise on 4 May 2002, thirteen (12 female:1 male) bats were marked with key chain necklaces bearing unique symbol tags. This report deals only with activities of those marked bats during pregnancy and lactation. Three females were seen for fewer than five nights, but the remaining ten bats were observed repeatedly for the next several months. Data analyzed thus far indicate no absolute exit/entry sequence, however, certain individuals exhibit a loose exit/entry pattern. Nightly flight frequency and total duration by marked bats were highly variable (range is 0 to 6 flights/night, typically 1 to 3; and 0 to <8 hours/night). During pregnancy, activities are highly depressed by adverse weather conditions. Flight duration increased during lactation. Certain marked individuals exhibited consistent unusual behavior patterns such as typically exiting the portal sideways or entering upside-down. While most marked bats used this roost nightly, some marked individuals were absent for periods of up to a week. One marked lactating bat carried a baby from the roost, returned the following night without the baby, when she carried a second baby from the roost.

Virtual Bats: Manipulating the Activities of Bats and Insects as a Practical Application for Integrated Pest Control

McCracken, Gary F., John K. Westbrook, Paul G. Schleider, Erin H. Gillam, Xu Cui, and Monika Rhodes, University of Tennessee, Knoxville, TN; USDA-ARS-SPARC, College Station, TX; Griffith University, Nathan, QLD, Australia

Many insects, including many agricultural pests, respond to the ultrasonic calls of bats by taking evasive action and curtailing flight activity. Earlier attempts to exploit this co-evolved relationship using artificial ultrasound to inhibit insect activity for crop protection (Belton and Kempster 1962) showed promise, but were not pursued because insects quickly habituated to the monotonous ultrasonic pulses that were used in that study. Bats that forage in groups are also known to be attracted to the feeding calls of other bats, leading to enhanced foraging activity in areas where other bats are feeding. We have developed "virtual bats", or electronic pulse simulators, that are programmable to emit continuously varying arrays of ultrasonic pulses that closely mimic the complexity of search, approach, and feeding calls of real bats. Virtual bats programmed to mimic the calls of Mexican free-tailed bats (*Tadarida brasiliensis mexicana*) were field-tested in experimental (virtual bat present) and control plots (no virtual bat) in large fields of corn and cotton in South Central Texas, at a site near Frio Cave, seasonal home to several million Mexican free-tailed bats. Experiments were conducted during the time that corn earworm moths (*Helicoverpa zea*: Noctuidae) emerge in large numbers from senescent corn and infest fruiting cotton. Moth flight activity monitored using infrared (IR) video at the center of each plot was 27% lower in the experimental plot of corn and 37% less in the experimental plot of cotton than in the respective control plots of each crop type. IR video counts of bat passes were 18 times higher in the experimental cotton plot and 119 times higher in the experimental corn plot than counts in the respective control plots. Bat foraging activity measured as the total numbers of echolocation pulses recorded by bat detectors in the center of each plot were almost three times greater in the corn experimental plot and over two times greater in the cotton experimental plot than in the respective control plots of each crop type. This research documents the effects of the variable pulses emitted by virtual bats, both in reducing moth flight activity and enhancing bat foraging activity over crops. Data analysis will be expanded by the time this paper is presented. On-going research is evaluating the agronomic potential of virtual bats as an application for environmentally benign crop protection. Extension of this application for use with other bat assemblages, and for use in high-value row and orchard crops will be considered.

Effects of Elevation on the Distribution and Sex Ratio Of Bats in the Lake Tahoe Basin

McKenzie, Michelle M., Patricia N. Manley, and Theodore J. Weller, Pacific Southwest Research Station, USDA Forest Service

Understanding of landscape-scale habitat use, and species distributions continue to be an important objective for bat research. In particular, knowledge of the use of high elevation sites by bats is poorly known. Species accounts typically supply an elevational range for the species, but it is not always clear as to what portion of the range this applies and whether it applies equally to both sexes. It is generally understood that males and females segregate by elevation with females using lower elevation sites. We evaluated these assertions for eleven species in the Sierra Nevada using 217 mist net surveys of 66 sites in 2001 and 2002, and preliminary results of 2001 acoustic survey data. These surveys were conducted around Lake Tahoe as part of a developing systematic landscape approach to monitoring bats and for acquisition of baseline information. High elevation data will be compared to data from low elevation surveys, conducted over the same time period, to address two primary questions: which species distributions are most affected by elevation, and which show the most pronounced sexual segregation with elevation. Questions specific to certain species will also be presented.

Effects of Sex Steroids & Temperature on Mating Behavior in Male Big Brown Bats

Mendonça, Mary T., Auburn University, Auburn, AL

Male and female big brown bats exhibit a dissociated pattern of reproduction. They mate in the late fall and throughout the winter upon periodic arousal from hibernation when plasma steroid levels are basal and gonads are inactive. For the past several years, we have been categorizing the various reproductive behaviors exhibited by the bats and the factors controlling their expression. In previous experiments, males and females mated even when gonadectomized (GX) 6-12 months before the beginning of the mating season but the behavior is potentiated by an exposure to 5 C for 7 d and with a return to 22 C (a typical temperature fluctuation in this Alabama population). We have continued to vary temperature and hormone regimens throughout the mating season. Males and females will exhibit sexual behavior when exposed to either constant 22 C (CONSTANT), repeated exposures of 5 C for 7 d (LONG), and repeated exposures to 5 C for 1 d (PULSE) with returns to 22 C for 4 d, regardless of hormone treatment (e.g. GX, GX+steroid replacement, GX+steroid antagonist) in almost all cases. However, exposure to low temperature can significantly increase mating intensity. After 2 months of CONSTANT exposure, these bats were given a LONG exposure and, in response, animals from all steroid treatment groups exhibited significantly higher levels of mating.

The Effect of Canine Tooth Wear on the Diet of Big Brown Bats

Mensing-Solick, Y. Renee and Robert M. R. Barclay, University of Calgary, Calgary, AB

The purpose of this study was to determine whether canine wear influences the diet of big brown bats (*Eptesicus fuscus*). We hypothesized that tooth wear reduces the ability to consume hard-bodied insects, such as beetles, and that older *E. fuscus* would thus include fewer beetles in their diet than younger individuals do. We examined 599 fecal pellets collected from 60 female bats captured at a single maternity colony in southeastern Alberta, Canada. The diets of two age groups (2-3 years old and >7 years old) were similar in composition, despite considerable differences in canine wear. Diets were dominated by beetles (Coleoptera), which accounted for 30 to 40% of the identifiable food items. Younger bats included more beetles in their diet, although the difference was not statistically significant. The results suggest that older bats are still able to use their worn canines to effectively puncture hard exoskeleton, perhaps because of

the angular shape of the worn teeth. However, tooth wear may still influence the diet of bats as food particle size may influence the amount of energy available to insectivorous bats during the later stages in life.

Conservation of Co-roosting Philippine Flying Foxes: What's Happening to the Endemics?

Mildenstein, Tammy L., Sam C. Stier, C. E. Nuevo-Diego, Apolinario B. Carino, and L. Scott Mills,
University of Montana, Missoula, MT; University of the Philippines, Los Banos, Philippines; Silliman
University, Dumaguete City, Negros Or., Philippines

Large flying foxes in insular Southeast Asia are the most threatened of Old World fruit bats due to high levels of deforestation and hunting, and effectively little local conservation commitment. Endemic bats in this region are of most concern, because of their limited distribution and sensitivity as habitat specialists. Subic Bay, Philippines, has a large colony of two species of co-roosting fruit bats. The Philippine giant fruit bat (*Pteropus vampyrus lanensis*) is a subspecific member of a species distributed through Southeast Asia, and the endangered golden-crowned flying fox (*Acerodon jubatus*) is a Philippine endemic. These large flying foxes are optimal for conservation focus as keystone, flagship, and umbrella species, which are also important to Subic Bay's economy and indigenous cultures. Our project goal was to promote conservation of these bats, especially of the endemic *Acerodon jubatus*. Habitat selection information helps streamline management efforts. We used radio telemetry to describe the bats' nighttime use of habitat on two ecological scales: vegetation and microhabitat. The recorded bat locations ranged between 0.4 km and 12 km from the roost. By comparing the bats' use to the availability of habitat types, we found they showed a preference for undisturbed lowland, mangrove, and beach forests over the disturbed and agricultural areas. Bat locations also indicated selection for fruiting/flowering bat trees and a strong preference for riparian areas. From these results we recommend that management focus their flying fox conservation efforts on protecting undisturbed forest and, especially, riparian areas. *Acerodon jubatus* needs special conservation attention, since it is an endemic and likely a forest specialist. Our habitat selection research showed they spent much more time in the forested study area than collared *Pteropus vampyrus*. As a follow up study, we surveyed the largest remaining roosts in the country thought to have *Acerodon jubatus*. Such roosting populations historically numbered in the 100,000's and were found on every major island. Now, over 93% of the Philippines is deforested, and what is left is fragmented. We, therefore, hypothesized that remaining roosts contain more of the generalist, *Pteropus vampyrus* than the endemic *Acerodon jubatus*. The largest roost we surveyed had over 23,000 fruit bats, but most had fewer than 5000. Many of the roosts did not have *Acerodon jubatus* at all, and those that did were over 90% *Pteropus vampyrus*. These data suggest conservation efforts for *Acerodon jubatus* will be crucial to their persistence.

Tree-roost Characteristics of Female and Male Evening Bats (*Nycticeius humeralis*) in Loblolly Pine and Longleaf Pine Forests of 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

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 day-roosts in managed loblolly pine and natural longleaf pine landscapes. The study

was conducted on two study sites in the Gulf Coastal Plain of Georgia. The Joseph W. Jones Ecological Research Center (Ichauway), Baker County, Georgia is a second growth mature longleaf pine ecological reserve managed with a two year fire rotation. The Aultman Tract, Worth County, Georgia is managed by Weyerhaeuser Company for loblolly pine sawtimber and pulpwood production with a 30-year clearcut rotation. During summer 2002, we radiotracked 15 females and 15 males to 32 and 28 day-roosts on Ichauway, and 11 females and 12 males to 11 and 18 day-roosts on The Aultman Tract (n = 53 bats and 89 day-roosts). Pines (*Pinus* spp.) were the most common roosts of both sexes (69% overall), with the remaining roosts in hardwood trees. Females used snags (37%) more than males (7%) on Ichauway, but snags were used by females and males in similar proportions on The Aultman Tract (27% and 22%, 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 Ichauway that contained approximately 490 individuals. Differences in roost tree and site characteristics will be discussed.

Habitat Management for Forest-roosting Bats of North America: A Critical Review of Habitat Studies

Miller, Darren A., Edward B. Arnett, and Michael J. Lacki, Weyerhaeuser Company, Columbus, MS;
Oregon State University, Corvallis, OR; University of Kentucky, Lexington, KY

Public and private land managers increasingly are being asked to consider habitat needs of bats when planning forest management activities. However, reliability of current data on which to base management of forest-roosting bats is uncertain. Therefore, we surveyed peer-reviewed manuscripts pertaining to habitat ecology of forest-roosting bats for the period 1980–2001. We found that there are limited data to support science-based habitat management for forest-roosting bats because there have been relatively few studies (56) conducted during this 21-year period. Additionally most of these studies have occurred primarily in older-aged forests with little to no active forest management, and current research has primarily focused on roost site selection to infer habitat relationships and response to habitat change. Limited sample sizes and pseudoreplication were prevalent and management recommendations often were made without regard to inferential bounds of collected data. We contend that studies using bat detectors have limited ability to infer habitat selection, *per se*, and recommend that studies incorporating detectors define more appropriate objectives regarding habitat associations. The best use of bat detectors may be generation of hypotheses of habitat selection to be tested with more appropriate techniques. There also is a need to conduct more long-term, holistic, experimentally designed research and to expand habitat research to include a wider diversity of forest types and management regimes. We suggest development of cooperative research efforts to secure sufficient funding and logistical support for such studies. We also recommend authors clearly state the objectives of their study, its sampling assumptions and limitations, define the inferential space, ensure results are interpreted within inferential bounds of their data, especially at the proper spatial scale, and use consistent terminology when articulating concepts and results of their work.

Discriminating Between Schreibers' Long-fingered Bat (*Miniopterus schreibersii*) and the Morphologically Similar Lesser Long-fingered Bat (*M. fraterculus*) in the Field, and Confirmation of Population Substructuring in *M. schreibersii* in South Africa

Miller-Butterworth, Cassandra M., David S. Jacobs, Samantha Stoffberg, and Eric H. Harley
University of Cape Town, South Africa

Miniopterus schreibersii and *M. fraterculus* are morphologically similar species that frequently share roosts. Distinguishing between them in the field is complicated by overlap in the ranges of forearm and mass. However, there are characteristic genetic differences in microsatellite allele frequencies and mitochondrial DNA (mtDNA) haplotype sequences between

the two species. Cranial and morphological measurements from museum specimens were compared using Principal Component and Discriminant Function Analyses, to find morphological variables that could distinguish between them in the field. Length of hind foot (HF) and total body length (TL) were responsible for most of the variation between the species. A function generated from standardized canonical variables, $(HF \times 0.279417) - (TL \times 0.989306) + 100$, generated negative function scores for *M. schreibersii* and positive scores for *M. fraterculus*. This function was used successfully to assign 20 individuals (identified as *M. fraterculus* or *M. schreibersii* from their mtDNA sequences) to their respective species, and thus provides a useful tool for discriminating between the species in the field. Schreibers' long-fingered bat, *Miniopterus schreibersii* migrates seasonally between hibernacula and maternity colonies in South Africa. Previous behavioural studies suggested roost fidelity is well developed and juvenile dispersal may be limited, possibly in both sexes. Strong philopatry may lead to restricted gene flow among colonies, resulting in genetically distinct breeding subpopulations. Microsatellite analysis of ~300 individuals, sampled from ten colonies throughout South Africa, indicated that significant genetic heterogeneity exists in the *M. schreibersii* population, such that it can be subdivided into three partially discrete breeding subpopulations, the locations of which correspond to four biomes. This suggests the bats may be adapted to local environmental conditions, and is supported by Principal Component Analysis of morphological parameters, which indicates that bats from different subpopulations differ significantly in wing morphology, particularly aspect ratio. To determine whether male and female *M. schreibersii* exhibit similar levels of philopatry, population substructure was also examined using maternally-inherited mtDNA. Approximately 530 bp of the control region was sequenced in 80 individuals. Phylogeographic clustering of mitochondrial haplotypes correlates closely with the nuclear results. Both markers indicate little differentiation exists among colonies within the three subpopulations, but different subpopulations are strongly differentiated, and gene flow among them is restricted. Such extensive population substructuring is unusual for volant, migratory species, which generally show limited population differentiation, particularly at the nuclear level. Furthermore, the close correlation between mitochondrial and nuclear results suggests males as well as females exhibit strong philopatry, which is unusual in mammals.

A Collaborative Effort to Restore Feeding Areas for Nectar-feeding Bats in Tamaulipas, Mexico

Moreno, Arnulfo, Aaron Terrazas, and Steve Walker

Instituto Tecnológico de Cd. Victoria, Tamaulipas, México; Dirección General de Vida Silvestre, Cd. Victoria, Tamaulipas, México; Bat Conservation International, Inc., Austin, TX

The Mexican state of Tamaulipas is located in northeastern Mexico. It shares its border with Texas. Five species of nectar-feeding bats (*Glossophaga soricina*, *Anoura geoffroyi*, *Choeronycteris mexicana*, *Leptonycteris curasoae* and *L. nivalis*) have been reported from this State. Three of these species (*Choeronycteris mexicana*, *Leptonycteris curasoae* and *L. nivalis*) are protected by both Mexican and United States laws. Habitat degradation and illegal exploitation of wild agaves are considered the primary threats to these species. In the last five years these threats have intensified due to increased soil erosion, wild fires and demand for Mescal and Tequila. A recent (2000) study reveals that more than 90% of Tamaulipas has severe soil erosion. From 1998 to 2001, wildfires destroyed about 23,970 hectares of forest in this state alone. Also, a significant increase in demand for Mescal and Tequila dramatically diminished the availability of cultivated agaves, forcing producers to harvest wild agaves. This is significant because wild agaves are the main food source for these bat species in northeastern Mexico. In an attempt to address this growing threat, in 2000 we started a program to plant wild agaves in highly eroded areas and areas affected by wildfires in Tamaulipas. To date, we have collaborated with people in local communities to plant 22,000 wild agaves in priority habitat for these bat

species. Despite these efforts, the rate of habitat degradation exceeds the rate of habitat restoration. For this reason, we are investigating more cost-efficient techniques to propagate and plant wild agaves.

Morphological Variation Between Two Cryptic Species of Paleotropical Bats (*Hipposideros bicolor*)

Murray, Susan W. and Tigga Kingston, Boston University, Boston, MA

Tropical bat assemblages are the most diverse among mammals, with local species richness exceeding 60 species at some Neotropical and Paleotropical locations. Many bat assemblages contain species that are tightly packed in ecological and morphological space. Questions have inevitably arisen as to whether these species-rich assemblages are structured in any way and if they are, whether stochastic or deterministic processes are responsible for the observed patterns. Although a number of ecomorphological studies have described patterns in the structure of bat assemblages and attributed these patterns to resource partitioning, the role of competition in structuring bat assemblages remains equivocal. By studying cryptic species in sympatry, we can begin to address questions such as, how different species must be morphologically and ecologically to coexist. This preliminary study addressed this question by examining the morphological differences between two acoustically divergent but morphologically cryptic populations of *Hipposideros bicolor* in Peninsular Malaysia. Although these populations occurred sympatrically and occupied the same caves, they were genetically distinct. The echolocation calls of the two phonic types had different frequencies of maximum energy, 131 kHz versus 142 kHz. Several measures of body size (body mass and lengths of forearm and tibia), noseleaf morphology (height and width of posterior, intermediate, and anterior noseleaves), and ear size (height and width) were measured for bats captured in four-bank harp traps set along trails and at cave openings. These same measurements were taken on voucher specimens to more accurately quantify external morphology and to assess whether measurements taken on live animals were reliable. Phonic types were distinguished by determining frequency of the CF portion of echolocation calls (131 kHz versus 142 kHz) of hand-held individuals using a Pettersson D-980 ultrasound detector and SonoBat for call analysis. To examine possible differences in feeding ecology, cranial morphology was quantified and compared between the two phonic types. Finally, baculum morphology was compared among *H. bicolor*. Predictions about the ecology of the two phonic types are discussed as well as possible hypotheses for their evolution.

A Technique for Obtaining a Library of Naturalistic Echolocation Calls from a Known Individual

Nawojchik, Laura, Joe Wernet, and W. Mitch Masters, Ohio State University, Columbus, OH

It is difficult to obtain a large number or wide range of naturalistic echolocation calls from a known individual, such as a laboratory bat or one captured in the field. Our lab has an interest in recognizing individual bats using echolocation calls, for which obtaining extensive call libraries from known individuals is essential. To address this problem, we developed a technique of flying bats at the end of a light-weight fishing line using a spin-casting rod and reel. The bat is secured with a slip-knotted noose of elastic thread around its neck. A small glowstick attached to the line near the bat permits visual tracking. The fishing line can either be played out freely as the bat flies away, or locked to restrict the bat's flight. Field trials using big brown bats (*Eptesicus fuscus*) have allowed us to obtain many and varied sonar calls from heights up to >30 m and distances >40 m. This technique should therefore be helpful for echolocation researchers wishing to obtain calls in varied locations over long distances and high altitudes, and yet recover the bat. We were concerned, however, that the noose, glowstick, and tether line might cause the bat to produce unnatural calls. As a first step in investigating this question, we constructed an 8.6 x 4.3

x 3.6 m (length x width x height) flight cage of light netting. Big brown bats were recorded flying either with or without noose and glowstick. Calls were collected digitally and analyzed by an automatic analysis program (Burnett and Masters, 2000, NASBR abstracts). Using discriminant function analysis (DFA) on the principle components of each bat's data set, we found a slight, but statistically significant, difference between calls with and without noose and glowstick. Call differences, however, were subtle and were detectable only because we had available a large number of high-quality calls for each bat. The question remains, then, whether these slight differences are truly important, either to the bats themselves or to biologists seeking naturalistic calls. Our analyses to date suggest that DFA developed on calls recorded with noose and glowstick can still successfully recognize calls of those individuals when it is given calls recorded without any such hindrances, suggesting the differences may be of minor concern.

Migration and Population Structure in the Lesser Long-nosed Bat, *Leptonycteris curasoae yerbabuena*

Newton, Lyndsay R., Theodore H. Fleming, and Rodrigo Medellín
University of Miami, Coral Gables, FL; Universidad Nacional Autónoma de México, Mexico City

The lesser long-nosed bat, *Leptonycteris curasoae* (Phyllostomidae, Glossophaginae), is a migratory bat found in Mexico and the southwestern United States; a second subspecies occurs in northern South America. In South America the species has only one reproductive event per year; babies are born in the spring. In North America, *L. curasoae* has at least two distinct reproductive events; spring-birth females occupy northern maternity roosts and winter-birth females occupy maternity roosts in southern Mexico. Individual females give birth only once a year. We tested the hypothesis that differences in reproductive timing are a barrier to effective dispersal in Mexico. We also re-examined the Wilkinson-Fleming (W-F) hypothesis, which predicts that females migrating north to maternity roosts follow either a coastal lowland or inland montane route. We sequenced nearly 300 bp of control region mitochondrial DNA from 102 bats sampled from 18 locations throughout Mexico and southern Arizona. Our analyses indicate that movement is restricted between reproductive demes in females but not in males; however, no significant population subdivision was detected between reproductive demes. Our results also indicate that migrating females are more likely to move within a corridor than between corridors, providing further support for the W-F hypothesis. We suggest that, although no reproductive isolation is evident, adequate habitat should be maintained in both northern migratory corridors and winter-birth migratory locations to conserve *L. curasoae* populations and their role as pollinators and potential seed dispersers in arid ecosystems.

Canine Dimorphism in Phyllostomid Bats

Nicolay, Christopher W., University of North Carolina -Asheville, Asheville, NC

Large canine teeth occur in many species of phyllostomid bats, even species that differ markedly in dietary habits. Beyond their obvious role in feeding, canine teeth are crucial to many mammals for intraspecific competition (e.g. fighting, threat gestures). In many mammals (such as carnivores and primates), the degree of canine dimorphism reflects mating strategies. The largest canines are typically observed in species where males maintain harems, while lesser degrees of dimorphism characterize monogamous species and those living in multi-male multi-female groups. Sexual dimorphism in skull and canine size was examined for 41 species representing Phyllostomidae, and *Pteronotus parnellii* and *Mormoops megalophylla* (Mormoopidae). Measurements of the right upper canine crown height and six other measurements of skull size were taken on (N=1039) museum specimens. A composite size variable was generated for each skull by calculating the geometric mean of the six cranial measurements. Canine size was adjusted for each individual by dividing canine height by the composite size variable. Four distinct patterns of dimorphism emerged: Seven species (16%) had

males that were significantly larger than females in both skull and canine size (after size-adjustment); 13 species (30%) had males that were significantly larger than females in canine size alone; 18 species (42%) had sexes that were equal in skull and canine size; and 5 species (12%) had females that were significantly larger than males in skull size, but not adjusted-canine size. Therefore, males with enlarged canines occurred in roughly half of the phyllostomids examined. Comparison with published accounts of mating habits suggests that there may be some association between canine dimorphism and the maintenance of year-round harems. However, our knowledge of mating habits of most phyllostomid species is currently not extensive enough to establish definite associations between canine dimorphism and mating strategy. Patterns of sexual dimorphism show few distinct evolutionary trends from a phylogenetic perspective. Glossophaginae appear to have the highest proportion of species exhibiting dimorphism, and large females seem to characterize 'short-faced' stenodermatines. Often, the kind and degree of dimorphism differs between sister taxa, indicating that dimorphism of the skull and canine may be highly malleable from an evolutionary perspective. The fact that marked canine dimorphism does exist in many species of phyllostomids highlights opportunities and need for research into mating habits, intra-specific encounters, and dietary differences between male and female bats.

Where is Waldo? Searching for Hibernacula in the Pacific Northwest

Ormsbee, Patricia C., 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 above snowline and are inaccessible during winter. To locate additional hibernacula, we have begun collecting temperature/humidity data and activity data at caves and mines in 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 Using Genetics

Ormsbee, Patricia C., Jan Zinck, and Rebekah Hull

U. S. Forest Service, Eugene, OR; U. S. Forest Service, Arcata, CA; Portland State Univ., Portland, OR

Selecting locations for data collection on bats is often an arbitrary effort — we go where we know or suspect bats will be found. To reduce the bias of arbitrary site selection, we have begun to develop a systematic design for collecting data on bats that is based on a cell-grid covering the state of Oregon. We have begun genetic sampling, using wing biopsies, of bat species in each cell. This data will serve as a baseline for describing genetic variability within and between species. At a finer scale, we have tested a method for conducting bat surveys under bridges that requires little or no intrusion on bats. Guano is collected at regular intervals and dry weights are recorded as an indication of relative abundance over time. DNA is extracted from the bulk guano to query if species of concern are present using species-specific DNA markers. Applying this survey method as well as others towards an inventory and monitoring protocol conducted across the cell grid is our ultimate goal.

The Fort Collins Bats and Rabies Study: Overview and Progress Report

O'Shea, Thomas J., 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 (ranging up to 34 per cent of adults). PIT tag records document survival and reproduction of seropositive bats through the first full year of study. This suggests that bats may acquire immunity to rabies, a hypothesis we are currently testing.

Localization Performance and Behavioral Flexibility in the Frog-eating Bat, *Trachops cirrhosus*

Page, Rachel, University of Texas at Austin, Austin, TX

The fringe-lipped bat, *Trachops cirrhosus*, feeds on túngara frogs, *Physalaemus pustulosus*, which it locates using the advertisement calls male frogs produce to attract their mates. Male túngara frogs produce two types of advertisement calls, simple and complex, and studies show that *T. cirrhosus* prefer complex túngara frog calls to simple ones. Complex túngara frog calls have components that are short in duration, have fast rise and fall times, and a rich harmonic structure—factors that should maximize binaural comparisons and increase localizability. In a pilot study on Barro Colorado Island, Panama, I investigated the hypothesis that *T. cirrhosus* prefer complex calls to simple ones because complex calls are easier for them to localize. I tested the localization performance of *T. cirrhosus* for simple and complex túngara frog calls by presenting *T. cirrhosus* with a speaker concealed beneath a leaf litter covered screen. The speaker position was determined randomly and changed between trials. From the speaker, I broadcast simple and complex túngara frog calls with and without masking noise, and with and without food rewards. For each trial, I measured the latency of flight (time from the onset of the frog calls to the bat's flight from its perch), and the distance of closest approach to the speaker. I also investigated the flexibility in *T. cirrhosus*' association between acoustic cues and potential

prey by examining the bats' response to novel acoustic stimuli. Despite the small sample sizes often associated with a pilot study, my results suggest that: (1) In the absence of rewards, bats localize complex túngara frog calls faster and with higher accuracy than simple calls, both with and without masking noise. (2) In the presence of rewards, the bats' localization performance is similarly high for complex and simple calls. (3) Bats can be conditioned to respond to novel stimuli. These results offer preliminary support for the hypothesis that bats prefer complex túngara frog calls to simple ones because they are easier to localize. The results suggest that localization performance and motivation are tightly linked, and they lead to new questions concerning behavioral flexibility and learning in prey acquisition.

Montserrat Redux-Recovery After a Seven-year Itch?

Pedersen, Scott C. and Gary G. Kwiecinski,
South Dakota State University, Brookings, SD; University of Scranton, Dalton, PA

Apart from the minor inconvenience of being blown apart by hurricanes and being incinerated by pyroclastic flows (1995-99), the bats of Montserrat have recently suffered through two very bad draught years (2000-01). Given this run of bad-luck, our database is rather unique in that it documents how this relatively isolated fruit bat population has responded to three diverse natural disasters over a 25-year period (1978-2002). Predictably, fruit bat populations have decreased after each successive disaster due to direct or indirect effects on foraging and roosting habitats. During the volcanic activity (1995-2000), the fruit bats were hard pressed to find adequate forage and housing, and they exhibited several non-lethal stress-related pathologies (hair-loss, dental attrition) associated with the incidental ingestion of volcanic ash. These problems became increasingly common as the volcanic crisis continued. The 2002 census followed on the heels of a cessation in volcanic activity and two years of draught. 2002 was the first 'normal' (i.e., wet) spring since 1995. Indeed, several varieties of fig trees that had not been observed to produce a significant fruit set since 1995, were heavy with fruit during July 2002. Fruit bat capture rates during 2002, at stations that have been repeatedly sampled since 1993, indicated that overall capture rates were 3.4 times greater than those during the peak of volcanic activity (1997-98) and 1.5 times greater than the previous census in 2001. This rather dramatic fluctuation in the fruit bat population is driven almost entirely by an increase in both the absolute and relative numbers of *Artibeus* and *Monophyllus* captured (e.g., 0.09 vs. 0.56 *Monophyllus* captures per net per night; 0.31 vs. 2.39 *Artibeus* per net per night). *Ardops* and *Brachyphylla* are monoestrous producing a single pup per year and very little is known of the reproductive cycle and reproductive potential in *Monophyllus*. However, *Artibeus* is polyestrous and usually produces two pregnancies per year, but is capable of producing three if there is no delay. Given this reproductive potential, populations of *Artibeus* are clearly capable of, and perhaps predisposed to, rapid recovery following disturbances such as those noted on Montserrat.

***Corynorhinus* Phylogeny and Conservation Implications: Do Molecules Match Morphology?**

Piaggio, Antoinette J., 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. The conservation implications of an alternative taxonomy based on a molecular phylogeny will be discussed.

Can the Abundance of Foraging Yuma Bats (*Myotis yumanensis*) Be Used to Predict the Abundance of Macro-invertebrates and, Therefore, Stream Quality?

Pyrch, Matthew and Dave Johnston, Santa Clara University, Santa Clara, CA

There is little known about the bat populations in the San Francisco Bay Area. To better understand bat populations along streams in the Bay Area, we started a long-term study to monitor populations of the Yuma bat (*Myotis yumanensis*) along the Guadalupe River watershed in the South San Francisco Bay drainage. One aspect of the project was to compare the time spent by foraging Yuma bats to the overall density of aquatic macro-invertebrates for specific sites in the watershed. To determine time spent foraging by the bats we set up acoustic surveys using an ANAbat5 program and Titley electronics hardware. To survey for macro-invertebrates we collected invertebrates in 5 one-meter samples within a 10 m range of stream length. Our hypothesis was that the time spent foraging by the Yuma bat (a riparian obligate species) will correlate to the presence of aquatic macro-invertebrates. Because the results of aquatic macro-invertebrate surveys have been used as indicators of healthy versus polluted and disturbed watercourses, a secondary goal was to determine if the presence of Yuma bats 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 the presence of Yuma bats is correlated with the abundance of macro-invertebrates. The middle of the watershed did not necessarily follow this trend, but this may be due to a paucity of available roosting sites in these reaches of Guadalupe River.

Habitat Use and Roost Selection by Pallid Bats in British Columbia: The Case of the Okanagan Gleaners

Rambaldini, Daniela, University of Regina, Regina, SK

The range of pallid bats extends along a north-south corridor that stretches from the Okanagan Valley in south-central British Columbia into arid habitats of western U.S. and Mexico. Little is known about the activities of pallid bats in Canada despite the fact that this species, considered rare and in low abundance throughout the Osoyoos Arid Biotic Zone, is included on British Columbia's Red List and is designated Threatened by the federal government (COSEWIC 2000). Habitat destruction and modification threaten the Canadian population due to loss of roosting sites and foraging areas. The main objective of this study is to increase the amount of available data about Canadian populations of pallid bats. This study was conducted from April 6th to September 9th, 2002 in the Okanagan Valley. I radio-tagged adult and juvenile bats to investigate roost selection and foraging habitat.

The Hormonal and Behavioral Response to Group Formation and Acute Stress in the Solitary Little Golden-mantled Flying Fox (*Pteropus pumilus*)

Reeder, DeeAnn M., Eric P. Widmaier, and Thomas H. Kunz, Boston University, Boston, MA

The behavioral and physiological response to breeding group formation and restraint stress was examined in captive little golden-mantled flying foxes (*Pteropus pumilus*). Because of the relatively asocial and solitary nature of this species, we predicted that bats in breeding groups would have elevated basal and stress-induced levels of the hormones cortisol and corticosterone (glucocorticoids) compared to bats in same-sex (control) groups. Glucocorticoid hormones are important for energy regulation, exhibit a strong circadian rhythm, and are highly responsive to stressors. Females, but not males, that were moved from same-sex groups to breeding groups showed significantly elevated total glucocorticoid levels one day after group formation, which persisted for three months. Control females, but not males, also responded to social manipulation (removal of same-sex animals from their group) with significantly elevated total glucocorticoid levels. Females, but not males, maintained close proximity to one another but lost body mass in the first two weeks following group formation. One day after group formation males spaced themselves farther apart from each other but closer to females. That females responded more to group formation than males was surprising, as injurious fighting occurred only among males. Contrary to our predictions, males did not respond to breeding group formation with elevated testosterone. Rather, testosterone was highly variable in breeding and control males for the first few weeks following group formation, but then significantly decreased and remained low for the next three months. In response to blood sampling and 30 minutes of restraint in autumn, all bats exhibited a highly significant cortisol response that did not vary among groups. Similar results were observed for corticosterone, except in breeding males, in whom corticosterone was not increased by restraint. Different results were obtained in spring, when males exhibited a greater acute stress response to restraint than did females. Males returned to baseline glucocorticoid levels by the following morning, whereas glucocorticoid levels in females were still elevated the next morning. In both groups of males, testosterone significantly decreased in response to blood sampling and restraint. These results suggest that females are overall more disturbed by social disruption and are generally more susceptible to stressors than males. Lack of overall differences in glucocorticoids and testosterone between breeding and control animals may stem from the relatively low levels of social interaction observed in all groups; thus, comparison with a more social species would be informative.

Comparing the Diet of *Myotis yumanensis*, the Yuma Bat, in Two Different Habitats along the Guadeloupe River

Reich, Katie H., Santa Clara University, CA

We compared the diets of Yuma bats (*Myotis yumanensis*) from two different habitat areas along the Guadeloupe River in central coastal California. The upper watershed habitat was composed of riparian habitat dominated by white alder (*Alnus rhombifolia*) and willow (*Salix* spp.), whereas the lowest part of the watershed was composed of fresh and saltwater marshes, salt ponds, and a slough. Although we observed a few Yuma bats foraging along cottonwood (*Populus fremontii*) - willow riparian along the central part of the watershed, no bats were caught in this area; and therefore, we have no dietary data on these scarcely observed bats. Captured bats were kept for about one hour in labeled bags to collect fecal samples. Forty fecal pellets were collected from eight bats, four from the alder-willow habitat and four from the marsh areas. We used an Olympus camcorder connected to a Snappy program and a PC monitor to record images of insect parts observed in the dissecting microscope. Our analysis suggested that the bats in the alder-willow habitat ate trichoptera, diptera, coleoptera, hemiptera, and ephemeroptera, whereas bats from the marsh complex ate primarily diptera and hemiptera. In the riparian habitat we observed bats foraging primarily over separate pools, whereas in the marsh complex, we observed bats for-

aging over the slough as well as the salt marsh habitat immediately adjacent to the slough. Because remains of the reticulated water boatman commonly occurred in the guano occurs and high densities of this species occur in nearby salt ponds, we hypothesized that Yuma bats also forage above these nearby anthropomorphic salt ponds. Although we only have a few samples, our preliminary data suggested that Yuma bats' diets on the watershed varied more by location and habitat type than temporally.

The Importance of Saladeros to Frugivorous Bats During Pregnancy and Lactation

Reid, Fiona A., Mark D. Engstrom, and Burton K. Lim, Royal Ontario Museum, Toronto, ON

The distribution and abundance of some frugivorous bats may be related to availability of minerals and other nutrients that are not easily obtained in the diet. Most fruits contain low levels of iron and calcium and other trace minerals that are especially important for proper development of the fetus and infant. One might expect that pregnant and lactating bats in particular would actively search for nutrients in sources other than fruit. We surveyed bats at two 'saladeros' (mineral-rich mud wallows) and at other forested sites in Napo Province, Ecuador, in 1995 and 1996. Based on mist-net captures, we found bats to be 5-20 times as common at saladeros than at other ground-level sites. Bats in the genera *Vampyressa*, *Sturnira*, *Platyrrhinus*, *Uroderma*, and *Vampyrodes* were abundant at the saladeros but were often rare in other forested habitats. We examined reproductive condition of bats caught in January-February, May-June and October. Although there were seasonal differences in extent of reproductive activity, in each season we recorded a greater proportion of pregnant or lactating females, and a skewed sex ratio favoring females, at the two saladeros compared to other sites. Several species were common at saladeros when breeding and absent at other seasons. Bats were observed drinking water from the shallow pools at saladeros. Analysis of water samples revealed significantly higher levels of calcium, sodium, iron, magnesium, and potassium in comparison to muddy, non-saladero sites. These data are consistent with the hypothesis that females concentrate at saladeros to obtain minerals and nutrients necessary for reproduction and lacking in their frugivorous diet. Mineral-rich wallows likely are key to successful reproduction in these bats and other frugivorous mammals and should be high priority areas for conservation.

The Value of Variation:

A Long-term Demographic Study of the Little Brown Bat *Myotis lucifugus*

Reynolds, D. Scott, St. Paul's School, Concord, NH

Since 1993, I have been studying the demographics of a little brown bat (*Myotis lucifugus*) maternity colony in Peterborough, NH using mark-recapture techniques. After capturing 3,244 bats over the nine year period, a pattern has begun to emerge about the role of intrinsic and extrinsic variables on the complete life history (growth, maintenance, and reproduction) of this population. The intrinsic factors investigated in this study included body composition, reproductive experience, and maternal age. Although the first two variables appeared to have no influence on life history traits, maternal age did influence reproductive timing and offspring sex ratio. The extrinsic factors investigated in this study were ambient temperature and precipitation. Precipitation appears to influence offspring sex ratio and reproductive timing. Ambient temperatures in the spring influenced reproductive rate, reproductive timing, and the degree of reproductive synchrony. There is also evidence to suggest that late summer temperatures have an influence on yearling recapture rates. This ongoing project suggests that inter-annual variation in key life history variables is part of the population biology of temperate bats, and questions the blind faith of static measures of life history values derived from short-term studies.

Bats, Insects, and Islands: Predator-prey Interactions and the Effect of Island Size on Abundance and Species Richness

Rice, Heidi K., Eastern Michigan University, Ypsilanti, MI

This study seeks to identify bat and insect fauna present in Sleeping Bear Dunes National Lakeshore, and determine effect of island distance and size on prey availability, predator diversity, and predator diet. The study site is a protected national park located on the eastern side of Lake Michigan, encompassing over 71,000 acres of woodland, lake, and dune areas on both the mainland and offshore islands. During two sampling periods over the summers of 2001 and 2002, I trapped insects, netted bats, and monitored bat activity with ultrasonic detectors on the two islands, North Manitou and South Manitou, as well as the park mainland. Diets of bats were determined by analyzing guano collected from captured bats. I also used SEM analysis of prey remains to identify insects further taxonomically. Four sites on each island and seven sites on the mainland were sampled each period, for a total of 30 net nights. Results show bat species richness and insect abundance was higher on the larger North Manitou Island and the mainland. The diversity of prey also decreased as island size decreased. Diets of captured bats showed a lower diversity of insects on islands than on the mainland, suggesting predator-prey interactions might be affected by island size.

Evidence of Territoriality in the Neotropical Tent-roosting Bat, *Rhinophylla pumilio* in Eastern Ecuador

Rinehart, J. Benjamin, Boston University, Boston, MA

Despite the apparent ubiquity and high abundance of the Neotropical tent-roosting bat, *Rhinophylla pumilio* throughout Amazonian South America, there is evidence that population densities may be limited by territoriality of males. While no aggressive behavior was witnessed between individuals, dispersion of *R. pumilio* suggests that individual males maintain exclusive access to roost areas of approximately 10 hectares. In this study, adult males were radiotracked daily to locate each of their multiple roost sites. All individuals roosted exclusively beneath leaves that had been modified to form tents. Putative 'territories' were mapped by creating minimum convex polygons that contain each of an individual's known roosts. Bats were subsequently radiotracked during the night to locate feeding roosts and to verify that patterns of nocturnal use corresponded to day-roost territories. Each territory was then intensively searched for other conspecifics roosting within a territorial boundary. All additional bats were captured and assessed for age, sex and reproductive condition. These data were used to calculate abundance and density estimates and to assess social structuring in *R. pumilio*.

Phylogeography of *Myotis californicus* and *Myotis ciliolabrum* in the Southwestern United States

Rodriguez, Rogelio M. and Loren K. Ammerman, Angelo State University, San Angelo, TX

The California myotis, *Myotis californicus*, and the western small-footed myotis, *Myotis ciliolabrum*, are two morphologically similar bats that have had a complex taxonomic history due to intraspecific geographic variation across their sympatric distribution of the western United States. Despite several published differences, field identification remains problematic in the southwest U.S. and has recently been questionable for bats captured in Texas. Skins and skulls of 32 specimens from Texas, Oklahoma, New Mexico, Utah, and California, either collected in the field or obtained from museum collections were examined for morphological characters. To illustrate previous methods of discrimination, cranial measurements were analyzed statistically using principal components analysis (PCA). Mitochondrial DNA sequences were extracted and isolated from 20 of the 32 specimens that had available tissues. *Cytochrome b* and control region sequences were sequenced and used for detection of genetic markers and to illustrate species

boundaries. Results of intraspecific and interspecific levels of sequence divergence and phylogenetic analysis indicate that there are no distinct lineages and possible species intergradation.

*** Bats and Panmixis: Investigating Population Genetic Structure in Large Populations of Migratory Bats**

Russell, Amy L., University of Tennessee, Knoxville, TN

Highly vagile or migratory species such as many birds, bats, insects, and marine organisms, are often characterized by population structures that are hard to predict. One such species is the Brazilian free-tailed bat, *Tadarida brasiliensis*, a highly vagile, migratory mammal that is characterized by extremely large population sizes. Using mitochondrial DNA (mtDNA) sequence data, I compare molecular genetic analyses of population structure between and within subspecies with structure that has been proposed from morphological, behavioral, and ecological data. The molecular genetic data reveal significant differences between populations in North America and those in South America. Cladistic analyses of gene flow suggest genetic structuring among females in North America that is not consistent with the current subspecific taxonomy. Both allozyme and mtDNA data do not support distinction between North American subspecies, and do not support the genetic uniqueness of previously hypothesized migratory groups within the subspecies *T. b. mexicana*. Genetic data indicate that this subspecies evolves as a single genetic unit, with an extremely large effective population size. The effective population size estimated for *T. b. mexicana* is of a magnitude typical for large insect populations, and is extraordinarily large for a mammalian species.

* Amy Russell received the Karl F. Koopman Award.

Bats, Road-Kill, and the FBI (Flat Bat Investigation)

Russell, Amy L., Calvin Butchkoski, Annie Tibbels, and Gary F. McCracken
University of Tennessee, Knoxville, TN; Pennsylvania Game Commission, Petersburg, PA

The protection of populations of an endangered species can be hindered in situations where the protected species is difficult to positively identify. Under such circumstances, molecular genetic analyses of DNA can provide species identification even when specimens are too degraded for morphological analysis. A mixed colony of little brown bats (*Myotis lucifugus*) and endangered Indiana bats (*M. sodalis*) occupy a roost in a church near Altoona, Pennsylvania. A two-lane highway near the church is about 7-8 meters wide and encumbers traffic at a rate of approximately 8200 vehicles/day with 12% being trucks. This highway has been scheduled for a construction project in 2003/2004 to widen the road. Road-killed bats found near the colony were suspected to include Indiana bats, but the specimens were too degraded to be differentiated from the morphologically-similar little brown bats. A road-kill carcass that had been struck by several vehicles was analyzed to determine the species to which it belonged. DNA was isolated from the carcass, and mitochondrial DNA (mtDNA) was sequenced for phylogenetic analyses. The sequence was compared with an existing database of homologous sequences from known Indiana and little brown bats. Both parsimony- and distance-based analyses show that the carcass was an Indiana bat. Such genetic analyses may prove useful in situations where morphological identification of a species is ambiguous or even impossible.

*** Echolocation Behavior of *Vespertilio murinus* Foraging in Open and Edge Space**

Schaub, Andrea and Hans Ulrich Schnitzler, Universität Tübingen, Tübingen, Germany

The proximity of insect prey to background clutter is the most relevant ecological constraint on foraging bats exerting selective pressure on the design of search signals. Clutter conditions can therefore be used for the definition of bat habitats. Bats forage in open space if they search for prey far from background targets and do not react to such targets in their echolocation behavior. Bats forage in edge space if they search for prey flying at vegetation edges and in gaps and react to background targets in their echolocation behavior. In our study we recorded search signals of *Vespertilio murinus* foraging in the open and at vegetation edges and determined signal parameters such as start frequency, peak frequency, terminal frequency, bandwidth and duration for bats flying at different horizontal distances to vegetation and vertical distances to the ground. The bats reacted to background targets only if they flew lower than about 4 m and/or were less than about 6 m away from vegetation. Beyond these borders, i.e. in open space, the signal parameters were not changed in relation to background targets. In open space, bats emitted FM-QCF signals mostly every second or third wing beat with a bandwidth of about 14.3 ± 4.9 kHz and a duration of about 11.7 ± 2.3 ms. Within the measured borders, i.e. in edge space, the bats emitted one search signal at every wing beat. They increased bandwidth and reduced duration with decreasing distance to background targets which resulted in broadband, steeply modulated FM signals.

* **Andrea Schaub received the Speleobooks Award for best student poster.**

Non-random Mating in Big Brown Bats?

Schmaeman, C. N., and M. T. Mendonça, Auburn University, Auburn, AL

Very little is known about the mating systems of temperate vespertilionid bats. Available data are usually anecdotal and only represent a snapshot of which males are successfully mating in the population. Furthermore, there has been no study monitoring male mating success over time. Over the last four years, we documented the reproductive behavior of big brown bats, *Eptesicus fuscus*, in captivity. From Dec.-Mar. (the breeding season) 1999-2002, male and female bats were housed in large environmental flight cages and given varying temperature regimens that we have documented to stimulate mating activity. In each of the seasons, individuals were observed nightly for eight-hour periods and scored for attempted and successful mounts by males. Males varied in the number of different females that allowed successful mounts (i.e., intromission) (ranges for the respective seasons: 0-4, 0-7, 0-10, and 0-18). This suggested some type of female preference. The females also varied in the number of different males over the season they would allow to successfully intromit (ranges for the respective seasons: 0-7, 0-8, 0-8, and 0-10). In the first three seasons, neither body weight (BWT), forearm length (FL), nor condition index (residuals of BWT/FL) correlated with male mating success. Only in the last season (2001-2002) was male mating success significantly correlated with condition index ($p=0.018$) and weight ($p=0.017$). Although a significant correlation was found in 2002, the R^2 value (.094) indicated that CI accounted for little of the variation. However, we did note that the 2002 season had a significantly higher percentage of males that mated with more than one female (69% vs. 45.5%, 38.5%, and 10.9%: 2001, 2000, and 1999, respectively; $p=0.002$). Additionally, 2002 was the year with the highest range in CI (26 vs. 17.5, 17.5, and 13: 2001, 2000, and 1999, respectively). In future studies, we will experimentally test the effect of male condition index on female choice. Other possible factors may account for variation in male mating success such as: age, cryptic selection (sperm competition), vocalization/echolocation, genetics, or other hormone levels.

Identification and Distribution of *Myotis yumanensis* in Oregon

Scott, Shonene A., Pat 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 U.S. 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 12S rRNA to 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. The use of genetic analysis to discriminate among species provides, in addition, an excellent opportunity to gather supplementary species-specific data, all supported by accurate species determination. To facilitate identification of in-flight *M. yumanensis*, a variety of different bat species' echolocation calls are being recorded in order to determine sets of call features that can be used to easily and accurately distinguish *M. yumanensis* from other species, and to create species reference call libraries for use in future inventory efforts. 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. Echolocation calls were recorded using a Pettersson bat detector upon hand release or by using a tethered zip-line. In the laboratory, standard protocols are followed for RFLP analysis to unequivocally identify each bat to species. The time-expanded recordings of echolocation calls will be analyzed to quantitatively identify species-specific call features and evaluate their usefulness for identification. 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. A revised species distribution map for *M. yumanensis* will be developed using location data and the results of the genetic analyses.

Ecology and Conservation of the Comoros Rousette, *Rousettus obliviosus*

Sewall, Brent J., Elise F. Granek, and Will J. Trehwella

University of Minnesota, St. Paul, MN; Projet Conservation de la Biodiversité et Développement Durable aux Comores, République Fédérale Islamique des Comores; Action Comores, Nottingham, UK

Rousettus obliviosus is a megachiropteran bat endemic to the Comoros Islands in the western Indian Ocean. This species is broadly distributed on three of these islands, but appears absent from the fourth, Mayotte. Roost sites are shallow and deep caves, in dark locations with infrequent human disturbance. Colony size ranges from one hundred to several thousand, and at two sites we observed seasonal variation. Total estimated population size is 7,100 – 17,100. *R. obliviosus* feeds on a variety of native and non-native tree fruits and flowers, and is found in agricultural areas, underplanted forest, and native forest habitats. *R. obliviosus* is a maneuverable flyer able to hover for brief periods, and may echolocate. A small range, sensitivity to disturbance, limited roost site availability, and deforestation combine to threaten this species. Protection of roost sites, further surveys to identify additional roosts, further ecological research and protection of remaining forest are conservation priorities for *R. obliviosus*.

Target Interception by Echolocating Bats Viewed through Simultaneous Video and Acoustic Reconstruction of Flight

Simmons, J. A., K. M. Eastman, M. Olsheski, M. J. O'Farrell, D. R. Griffin, G. Auger, A. D. Grinnell, R. R. Roverud, and J. Hammond, Brown University, Providence, RI; O'Farrell Biological Consulting, Las Vegas, NV; Harvard University, Bedford, MA; UCLA, Los Angeles, CA; Lafayette College, Easton, PA

Understanding the perceptual capabilities of echolocation in bats has long been impeded by the difficulty of observing their natural behavior at night, especially when they fly against dark backgrounds in complex surroundings. While bat detectors provide the means for acoustic monitoring, until recently actually watching individual bats flying in the dark has been nearly impossible. Present knowledge comes from observations of flight and interception staged in the laboratory for acoustic and motion-picture or video recording, or at selected field sites where pursuits of individual insects have been recorded when a bat enters the field-of-view of the cameras. From this work, pursuit maneuvers are conceived as stereotyped patterns of action and species-related vocalization regulated primarily by distance to targets. Using thermal-imaging longwave IR video cameras or third-generation night-vision devices on video cameras with shortwave IR illumination, and using microphone arrays and digital recorders with video and multiple ultrasonic channels, we have observed the flight action and acoustic behavior of FM bats (*Eptesicus*, *Myotis*, *Pipistrellus*) intercepting prey, sometimes near obstacles and sometimes with swarms of insects present as well as other bats. From ultrasonic recordings with three microphones, we reconstruct the source locations of sonar broadcasts to associate individual bats with their sounds in the video images, and 3D video reconstruction shows flight-paths and spatial relations among bats and targets. In our results, the dominant theme is variability in the flight and vocalization patterns of bats from one catch to another, whether the situation consists of one bat and one insect or multiple bats and multiple targets. Distance-related changes in vocalizations occur but not always in the same stereotyped manner as seen in laboratory captures. When bats fly in swarms, their broadcasts become very dense, converging on the same 1-2 ms duration for all sounds, without the obvious target-related changes seen in other circumstances. It is unclear how the distances to multiple insects or multiple bats as well as the potentially interfering effects of the sounds of other bats influence each bat's sounds. Sound density is so high that the bats may adopt an alternative imaging strategy by exploiting each other's sounds to ensonify the scene. Real-time stereo observation of bats quickly disabuses us of the notion that from previous studies we know the limits of echolocation performance or that we understand how it is achieved.

Chiroptera in "Mammal Species of the World – A Taxonomic and Geographic Reference"

Simmons, Nancy B., American Museum of Natural History, New York, NY

The Chiroptera chapter for the 3rd edition of "Mammal Species of the World" has finally been submitted for publication. Including 1105 bat species, this work provides an up-to-date taxonomic and geographic summary of bat diversity. Changes since the last edition include recognition of over 175 additional bat species and 25 additional genera, an updated classification from subspecies to family level, citation of author and date for every synonym, updated information on geographic range and conservation status of each species, corrected type locality descriptions, and expanded comments including systematic literature citations for most species. Many taxonomic changes in the 3rd edition are based on recent phylogenetic analyses, and paraphyletic and polyphyletic taxa have been split into monophyletic units as far as possible. Several problematic "wastebasket" taxa have been subdivided into multiple genera following results of recent systematic studies (e.g., *Eptesicus*, *Pipistrellus*, *Micronycteris*). Traditional subgeneric classifications have been abandoned in cases where the units are clearly polyphyletic (e.g., subgenera of *Myotis*) but have been retained where subgenera appear monophyletic (e.g.,

within *Artibeus*). Subspecies are recognized in cases where subspecific names are in current usage and appear justified (or at least not refuted) by the data at hand. A review of patterns of description of new species over the last 200 years reveals that new valid species have been described at a relatively constant rate of about 40 species per decade since the early 1900s. The large number of additional species recognized in the 3rd edition is a result of both new species descriptions and "resurrection" of previously-named taxa that have long been treated as subspecies or junior synonyms of other species. Not surprisingly, the largest increase in number of recognized species and genera was in Vespertilionidae, with addition of 93 species (a 29% increase over the 2nd edition) and recognition of 13 additional genera (37% increase). Although the Chiroptera chapter will not be published until 2003 or 2004, it is available as a pdf file from the author.

Differences in Torpor Use and Roosting Behaviour between Mountain and Prairie Populations of the Western Long-eared Bat (*Myotis evotis*) in Alberta

Solick, Donald I., University of Calgary, Calgary, AB

In the temperate zone, bats that inhabit mountainous regions have less time available to them for reproduction and growth than bats inhabiting lowland regions. Due to this constraint, females in mountainous areas should be under greater selective pressure to accelerate reproduction. One way females might accomplish this is by minimizing their time spent in torpor - a process that saves energy, but delays gestation and lactation. However, forgoing torpor use is energetically expensive, especially for small-bodied mammals living in cool, wet mountains. To compensate for the cost of reduced torpor, bats in the mountains may attempt to maintain high body temperatures by either selecting warm roost environments or clustering with other individuals. The goals of this study were to determine whether reproductive females in the mountains spend less time in torpor than females in a lowland area and, if so, whether mountain-dwelling females accomplish this by selecting warmer roost sites and/or clustering with larger groups of individuals than lowland-dwelling bats. To meet these objectives, I captured western long-eared bats (*Myotis evotis*) in the foothills of the Rocky Mountains and attached temperature-sensitive radio-transmitters to reproductive females. I continuously monitored body temperatures of tagged individuals using a LOTEK scanning receiver and radio-tracked bats to locate and characterize roosts (mainly in rocks) in terms of structure and temperature. In addition, I performed exit counts to determine the number of bats occupying a roost. I then compared these data to previously published data on torpor use and roost-site selection of a prairie population of *M. evotis* in eastern Alberta. Preliminary analyses indicate that mountain-dwelling females clustered together in larger groups, and more often, than prairie-dwelling females. Further results on group size, torpor use, roost structure, and roost temperature between the two environments will be presented and discussed.

Diet of Two Endemic Bats in the Antilles: The Importance of Protein

Soto-Centeno, J. Angel, Eastern Michigan University, Ypsilanti, MI

Two species of nectarivorous bats, the brown flower bat (*Erophylla sezekorni*) and the Greater-Antillean long-tongued bat (*Monophyllus redmani*), occur sympatrically in Puerto Rico. I examined the diet of these two endemic species of bats through fecal analysis and pollen sampling during their reproductive period, from May to August 2002. Bats were captured at the entrance of Culebrones Cave in Arecibo, Puerto Rico, and pollen and fecal samples were obtained. Both species were visiting the endemic tree maga (*Thespesia grandiflora*), and pollen grains from this flower were the most common among my samples. *E. sezekorni*, although usually classified as nectarivorous, also incorporates a large amount of fruit (*Muntingia calabura*, *Piper aduncum* and *Solanum torvum*) and insects (Coleoptera) in its diet. *M. redmani*, consumed the fruit of *M. calabura*, and a large number of insects (Lepidoptera, Diptera and Coleoptera).

The large amount of insects found in fecal samples of both species suggests that these bats are utilizing insects as an additional resource to meet their protein demands over the reproductive period.

**Food Habits of the Co-roosting Golden Crowned Flying Fox (*Acerodon jubatus*) and Philippine Giant Fruit Bat (*Pteropus vampyrus lanensis*):
Implications for Conservation and Forest Restoration**

Stier, Sam C. and Tammy L. Mildenstein, University of Montana, Missoula, MT

The species-area relationship and other ecological models developed over the last thirty years have resulted in the general understanding that an unprecedented extinction of species is underway due to anthropogenic disturbance of forests, particularly in the Tropics. Despite the comparatively long period of time this has been known, very little habitat restoration in the Tropics has been undertaken. Dietary studies can make an important contribution to the habitat restoration initiatives that are immediately called for, particularly given the new impetus for tree planting in the Tropics generated by interest in offsetting CO₂. In light of the need for generating dietary information to guide reforestation designs, we studied the dietary habits of two large Philippine megachiropterans (*Acerodon jubatus* and *Pteropus vampyrus*) using fecal analysis techniques and interviews with bat hunters. We found these methods proved effective at cheaply and rapidly discerning some of the major food items used by each species, and helped define some of the intraspecific similarities and differences which may govern these species' future co-existence. Results of this research indicate that the endemic and endangered *Acerodon jubatus* frequently feeds on hemiepiphytic figs from the subgenus *Urostigma*, while the less threatened *Pteropus vampyrus* frequently utilizes both *Ficus* spp. and certain agricultural tree crops. We provide a framework of research questions to guide future bat dietary investigations whose goals include contributing information to reforestation initiatives.

Angle-dependent Backward Masking by the Echolocating Bat, *Eptesicus fuscus*

Sümer, Susan, Annette Denzinger, and Hans-Ulrich Schnitzler, Universität Tübingen, Tübingen, Germany

Masking affects the ability of echolocating bats to detect a target in the presence of nearby clutter targets. To study backward masking, four big brown bats (*Eptesicus fuscus*) were trained in a two alternative forced choice procedure to detect a wire with a diameter of 1.2 mm offered at a distance of 1 m in the presence of an angular reflector (masker) positioned at different distances directly behind it. The masker reflected an echo that was about 20 dB above the wire echo. At a distance difference between wire and masker of 11 cm the bats reached threshold criterion (75% correct choices). In a second detection experiment spatial effects of backward masking were studied. The masker was kept at the threshold position and the wire was presented at angles between 0 - 15° relative to the masker. With increasing angles the bats were able to detect thinner wires with diameters decreasing from 1.2 mm (target strength -36.5 dB) at 0° to 0.4 mm (target strength -48.4 dB) at 15°. Without a masker, the bats detected wires with diameters of 0.2 or 0.15 mm (target strength -60.8 and -62.7 dB). This indicates substantial masking effects at 15°. Analysis of the sonar signals and their echoes allowed to evaluate possible adaptive strategies in the echolocation behavior during the given detection tasks. All bats enhanced the intensity of the 2nd harmonic of their signals, which may improve the spatial separation between wire and masker due to an increased directionality at higher frequencies.

Roost Characteristics of Bats in Eastern South Dakota

Swier, Vicki J., South Dakota State University, Brookings, SD

Census work during the summer of 2001 demonstrated six species of bats inhabiting eastern South Dakota: *Myotis septentrionalis*, *Myotis lucifugus*, *Eptesicus fuscus*, *Lasiurus borealis*, *Lasiurus cinereus* and *Lasionycteris noctivagans*. All six were mist-net captured along the Missouri River corridor that splits South Dakota into eastern and western halves. More species were collected along the Missouri River than at any other location in eastern South Dakota during 2001. To further investigate the importance of the Missouri River as important habitat for bats in South Dakota, a radio-tracking study was performed in the summer of 2002. Four species (*Myotis septentrionalis*, *Myotis lucifugus*, *Eptesicus fuscus* and *Lasionycteris noctivagans*) were radio-tracked and the presence and location of roost sites were documented. Roost tree characteristics such as species, circumference, height, and age were documented for each roost. Circumference and height measurements were also taken for all available trees in the area. These four species consistently used Eastern Cottonwoods (*Populus deltoides*) as day roosts, while *Eptesicus fuscus* also night-roosted in Bur Oaks (*Quercus macrocarpa*) and underneath a concrete bridge. All four species selected larger circumference roosts (compared to the available trees), but the age of trees and duration of occupancy differed among species. A single *Lasionycteris noctivagans* consistently roosted in younger trees and occupied more roost trees than other bat species. *Myotis* spp. roosted in many different age classes of trees, and reproductive females occupied more roost trees than non-reproductive females. Roost switching was observed during the summer of 2002. Two individual *Myotis lucifugus* of different reproductive classes were found night-roosting in a picnic shelter. The post-lactating female day-roosted in several Eastern Cottonwood trees and night-roosted in the picnic shelter, whereas the non-reproductive female switched exclusively to the shelter as a day/night roost after having spent several days consistently day/night roosting in Eastern Cottonwood trees. Data-loggers (temperature, humidity) were placed inside the picnic shelter and the tree roost used by this non-reproductive female. Comparisons of the tree and shelter revealed that the shelter was consistently warmer in the early morning and evenings and cooler in the afternoons. The warmer temperature may explain why the post-lactating female roosted in the shelter in the evenings while the cooler afternoon temperature of the shelter may explain why the non-reproductive bat switched the hot tree roost to the shelter. Several hypotheses will be explored to explain the roost switching behavior of these bats.

Multivariate Acoustic Transforms for Identifying Bat Species

Szewczak, Joseph M., University of California White Mountain Research Station, Bishop, CA

Despite the ready abundance of acoustic information that bats provide, confident acoustic species recognition has remained an elusive goal for many bats. Even calls from bats that we think we know can be rendered uncertain when subsequent studies reveal an acoustically similar sympatric species capable of exhibiting a presumed discriminating characteristic within the time-frequency domain. One approach to surmounting these challenges is to apply additional acoustic information beyond the basic time-frequency relationships on which many studies have concentrated. Furthermore, while many studies have analyzed call structure using static variables such as maximum and minimum frequency, call structure actually consists of a continuous multivariate effect of frequency, time, and power. With digital processing we can combine various acoustic parameters of bat echolocation calls to produce transforms of time-varying interrelationships and represent them in two-dimensional plots. These transforms are produced by shifting the original time-frequency sonograms based upon mathematical combinations of the acoustic information at each time point. For example, a power-slope transform will enhance the interaction of power and slope. With this transform, call portions with the steepest slopes and highest powers will be most affected and is thus sensitive to an overlap of high amplitude and

high slope. Calls with similar time-frequency domains, but different power allocation will be rendered distinct under such a treatment. This approach can render striking visual contrasts between some species with inexplicit distinctions in standard time-frequency plots and lead to more confident species discrimination.

Discovery of Extant *Natalus major* (Chiroptera: Natalidae) in Cuba, with Comments on Taxonomy, Natural History and Extinction of West Indian Bats

Tejedor, Adrian, Valeria Tavares, Gilberto Silva-Taboada, and Dialvys Rodriguez, American Museum of Natural History, New York, NY; Museo Nacional de Historia Natural, La Habana, Cuba; Centro de Investigaciones y Servicios Ambientales ECOVIDA, Pinar del Rio, Cuba

The sole Cuban representative of the bat genus *Natalus*, described as a fossil in 1919, was discovered in 1992 as an extant colony in Cueva La Barca, in the western tip of the island. Other extant Greater Antillean populations of this genus were known before from Jamaica and Hispaniola and, together with the fossil *Natalus* from Cuba, were considered synonyms of the continental species *Natalus stramineus*. Morphometric comparison of the Cuban *Natalus* with other West Indian and mainland populations of the subgenus supports the taxonomic separation of the Greater Antillean section of *Natalus* from *Natalus stramineus*. We further discuss the taxonomic status of *Natalus major* suggesting that it may actually represent a complex of three species (*N. primus*, *N. jamaicensis*, and *N. major*) distributed respectively to Cuba, Jamaica, and Hispaniola. Comparison of recent specimens with fossil material suggests that the Cuban *Natalus* has decreased in size since the end of the Pleistocene. The potential for extinction among West Indian bats is discussed in light of the natural history of the rediscovered living *Natalus*. We argue that stochastic factors may play a fundamental role in the extinction of cave-dwelling bats specialized in the use of hot caves.

Preliminary Results from a Long-term Study of the Biodiversity, Breeding Patterns, and Roosting Behavior of Cave-dwelling Bats in the Bocas del Toro Archipelago, Panama

Thomas, Maurice, Palm Beach Atlantic University, West Palm Beach, FL

Many aspects of the biology of bats in Panama have been investigated, especially on Barro Colorado Island (BCI), the site of a venerable biological station of the Smithsonian Tropical Research Institute. However, the natural history of bats in the Bocas del Toro Archipelago, a series of islands just off the northwestern coast of the country, has received much less attention. Unlike BCI, many of these islands have limestone caves that serve as roosts for large, diverse bat communities. A cave on Isla Colon, locally known as "La Gruta," presently contains large numbers of *Artibeus jamaicensis*, *Phyllostomus discolor*, and *Phyllostomus hastatus*. Historically, at least 18 other species have been recorded from this site. La Nitida cave, on Isla Bastimentos, two kilometers from Isla Colon, also has large numbers of the aforementioned species, but only six other species have been found roosting in this newly-discovered cavern. These two caves appear to be the most important diurnal roosts for many bats on these islands. A recent wave of tourism and development in the region could negatively impact the roosts through human intrusion. Baseline data on bat activity in these roosts are needed to help assess this impact. Observations on the biodiversity, breeding patterns, and roosting behavior of bats in La Gruta and La Nitida were made from June 17 to July 1, and September 9 - 20, 2002, with additional observations planned for December, 2002 and March, 2003. Preliminary results suggest that breeding patterns of most species examined correspond with those reported for their counterparts on BCI and elsewhere. *Artibeus jamaicensis* females, for example, appear to enter a postpartum estrus, as most adults (91%) were pregnant in June, yet appear to have recently weaned young. In September, adult females were nursing again. Preliminary reproductive data

for other species are presented. Details of a banding program using a beadchain necklace technique is discussed, as are certain aspects of roosting behavior.

**Roost Fidelity of Rafinesque's Big-eared Bat, *Corynorhinus rafinesquii*,
in Southern Mississippi**

Trousdale, Austin W. and David C. Beckett, University of Southern Mississippi, Hattiesburg, MS

We used banding and radiotelemetry to evaluate fidelity of Rafinesque's big-eared bat, *Corynorhinus rafinesquii*, to natural and manmade roosts. We captured bats that we had located during surveys of bridges and abandoned buildings in DeSoto National Forest in southeastern Mississippi. Of 103 bats banded between July 2000 and July 2002, 27 individuals have been recaptured, most of them at their original site of capture. Sixteen bats (6 males, 10 females) have thus far demonstrated long-term fidelity to specific roosts, that is, they were found at these sites \geq 3 months after their initial capture. Short-term fidelity (measured in days) was assessed for 14 radiotagged individuals. Males tended to use structures and exhibit high fidelity to these sites, whereas most females used trees and showed lower fidelity to their roosts. Maximum recorded distance between day-roosts used by the same individual was approximately 4.5 km. Although research continues, data suggest sexual differences in roosting habits.

Patterns of Facial Vibrissae and Interfamilial Relationships within Chiroptera

Turmelle, Amy S. and Nancy B. Simmons, American Museum of Natural History, New York, NY

Bats account for one quarter of all mammalian diversity, with over 1105 extant species within 18 recognized families. Historically, higher level relationships within Chiroptera remain poorly resolved. This study was part of a larger project aiming to resolve interfamilial relationships within the order Chiroptera through concatenation of morphological and molecular characters in a total evidence approach. External vibrissae are many times more sensitive than normal hairs and show conserved distribution on the face of mammals. The facial vibrissae have complex organization through development from the Hoxc13 cluster, musculature mechanization and sensory perception via the trigeminal nerve and associated rami. Variation was found in the patterned arrangement of genal, interramal, mystacial, submental, and superciliary regions of facial vibrissae across Chiroptera. A combination of binary and multistate characters, both ordered and unordered, were used to characterize the variation observed across taxa. Ten characters were scored for a total of 63 taxa, representing all families recognized within Chiroptera, in addition to several outgroup taxa. Analyses show that these characters, as a unit, do not add congruent signal to the most parsimonious reconstruction of interfamilial systematic relationships based on concatenation with over 350 previously scored morphological characters and comparisons with strongly supported recent molecular studies. The vibrissal characters, however, did consistently support familial monophyly and thus may be informative in characterizing lower level relationships within Chiroptera.

Jamming Avoidance in Echolocating Bats:

Taphozous perforatus*, *Tadarida teniotis*, *Otomops martiensseni

Ulanovsky, Nachum, Brock Fenton, Asaf Tsoar, and Carmi Korine, York University, North York, ON

When more than one bat of the same species is flying in the same air space there is evidence that individuals adjust their echolocation calls to emphasize differences. In this situation, bats may adjust the intensity, duration, interpulse interval, and/or frequency components of their calls. We recorded and analyzed the echolocation calls of three species of bats (*Taphozous perforatus* - Emballonuridae, *Tadarida teniotis* and *Otomops martiensseni* - Molossidae) either flying alone or with conspecifics. Recordings were made with a Petterssen D980 bat detector from which the high frequency output was taken directly to an Ines DAQ high speed card and the data recorded

directly into a laptop computer. The *Taphozous* and the *Tadarida teniotis* were recorded near Sede Boqer in southern Israel, the *Otomops* around Durban, South Africa. Recordings were analyzed using a combination of BatSoundPro and Matlab. We analyzed and compared series of 10 echolocation calls recorded from bats flying alone (10 series of 10 calls for *T. perforatus*, 10 *T. teniotis*, and 11 *O. martiensseni*) or with conspecifics (9 *T. perforatus*, 10 *T. teniotis*, 11 *O. martiensseni*). All three species changed the frequency components (lowest frequency, highest frequency, frequency with most energy) of their calls between the single and several bat situations. The degrees of differences varied, with *T. perforatus* showing the least changes and *O. martiensseni* the greatest changes. The significance of these changes in echolocation behaviour is discussed in the context of jamming avoidance, social interactions, and air traffic control.

Reproductive Stage Influences Summer Roost Use by Adult Female Eastern Pipistrelles (*Pipistrellus subflavus*)

Veilleux, Jacques Pierre, Sacred Heart University, Fairfield, CT

Female bats should select roost sites that confer advantages in terms of increasing fitness. In temperate regions, reproductive females may choose roost sites that offer optimal microclimate, particularly in terms of temperature. For example, warm temperatures are known to speed both gestation rate and developmental rate of young. Thus, selection of warm roosts by reproductive females may increase survival of young by providing the maximum time period for young to become experienced foragers and to add body fat prior to migration or hibernation. Non-reproductive females may choose roosts that provide maximum energy savings. Post-lactating females may prefer roosts that provide cool temperatures, and therefore allow for lower body temperature and associated energy savings. I tested the hypothesis that reproductive (pregnant and lactating) female eastern pipistrelles would differ from non-reproductive females in terms of characteristics of roosts and roost habitat. I predicted that reproductive female bats would roost high in the forest canopy, enhancing the degree to which solar insolation could warm the roost during the daytime, and that non-reproductive females would roost below the forest canopy and allowing shielding from insolation. Further, I predicted that reproductive females would roost nearer both to forest edge and to a water source. Roosting near the forest edge may increase insolation reaching a roost, and reduce commuting costs to foraging areas. Roosting near water may reduce commuting costs to foraging and drinking habitats. I located 59 roost trees used by adult female eastern pipistrelles; 37 used by 19 reproductive bats, and 22 trees by 11 non-reproductive bats. I compared five roost tree and site variables between reproductive and non-reproductive roosts. Univariate analyses identified three of five variables as discriminating between roosts. Reproductive females roosted in trees and in leaf clusters that were lower in the forest canopy, and further from the forest edge than non-reproductive females. Logistic regression identified four variables as discriminating between roosts. Reproductive females roosted further below the canopy, further from a forest edge, closer to water, and in areas with lower per cent canopy closure than non-reproductive females. Because pipistrelle colonies roost in foliage rather than in tree hollows or under bark, it may not be advantageous for reproductive bats to roost high in the canopy, particularly in terms of avoiding cooling effects of wind and rain. Roosting relatively far from a forest edge may also reduce exposure to the cooling effects of wind for reproductive females.

Preliminary Report of the Distribution and Abundance of Bats Occurring in Connecticut

Veilleux, Jacques Pierre, Sherry L. Veilleux, and Christopher P. Potanas
Sacred Heart University, Fairfield, CT; Indiana State University, Terre Haute, IN

A comprehensive survey of the summer distribution and abundance of bats occurring in Connecticut was initiated during the summer season of 2002. Few data are available in the lit-

erature describing the population structure of bats in Connecticut. Historically, nine species were known to occur in Connecticut during summer months. One is currently considered extirpated (*Myotis leibii*), one is federally endangered (*M. sodalis*), and three are listed as state special concern: the red bat (*Lasiurus borealis*), hoary bat (*L. cinereus*), and silver-haired bat (*Lasionycteris noctivagans*). The remaining species: little brown bats (*M. lucifugus*), northern long-eared myotis (*M. septentrionalis*), big brown bats (*Eptesicus fuscus*), and the eastern pipistrelle (*Pipistrellus subflavus*) are considered secure within the state. Twenty-five sites were sampled using both mistnets and AnabatII bat detectors. Data from mistnet captures are presented. Mistnets were typically set across small rivers and creeks, and more rarely over small ponds. Mistnets were set from dusk until 00:00 h. Following capture, bats were identified and assessed for sex, age, reproductive status, and mass. A numbered aluminum wing-band was attached to each individual. We captured 133 individuals representing five of the eight species known from Connecticut. In order of decreasing abundance the species were: *M. lucifugus* (n = 86), *E. fuscus* (n = 36), *P. subflavus* (n = 6), *M. septentrionalis* (n = 3), and *L. borealis* (n = 2). Overall capture success was 5.3 individuals per net night. These data represent the beginning of a long-term study aimed at determining the population status, in terms of distribution and abundance, of bats occurring in Connecticut.

A Tale of Two Siblings: Multiple Paternity in Big Brown Bats (*Eptesicus fuscus*) Demonstrated Using Microsatellite Markers

Vonhof, Maarten J., Diana Barber, M. Brock Fenton, and Curtis Strobeck, University of Tennessee, Knoxville, TN; Mesker Park Zoo, IN; York University, Toronto, ON; Univ. of Alberta, Edmonton, AB

In temperate bat species, the opportunity for sperm competition or other mechanisms of post-copulatory paternity biasing is thought to be great, due to the long delay between copulation and fertilization, demonstrated sperm storage capabilities, and observed promiscuity. In this paper we present the results of a study to assess whether litters of dizygotic twin big brown bats (*Eptesicus fuscus*) share the same father. We sampled 26 mother-twin triads from three colonies in Indiana and Illinois, as well as 304 additional adults (242 females and 62 males) from those and five other maternity colonies in the same area in 1997-98. All individuals were genotyped at nine highly variable autosomal microsatellite loci and one X-linked locus, and multiple paternity was assessed using four methods. First, we directly assessed paternity by sampled males using exclusion, and identified the father for 4 of 52 juveniles. In one case, both members of a litter shared the same father, whereas in two cases the father for only one pup in the litter was identified. Interestingly, 2 of 3 fathers were sampled in the same colony as the mother. Second, using an X-linked locus, we determined that the paternally contributed allele was different within 2 of 5 sets of female twins. Third, we used the maximum-likelihood methods in the program KINSHIP to distinguish between maternal half siblings and full siblings, and found that 12 of the 26 sets of twins were related only at the half-sibling level. Fourth, relatedness between twins was bimodally distributed, with peaks centered at the levels of relatedness expected for half-siblings and full siblings. Thus, four lines of evidence indicate that litter-mates regularly do not share the same father. Our results highlight the potential importance of female choice and post-copulatory mechanisms of paternity determination in the mating system of big brown bats, and have important implications for gene flow and population structuring in this species.

Colonial Roosting Requirements of Captive Microbats

Webber, Dharma, Bat World Sierra, Placerville, CA

As it is now common practice to keep colonial mammals with same or similar species, this is also true for colonial species of bats. While not all bats in the United States are colonial, most crevice dwelling species live within and often together in social groups. Case studies presented detail how these social animals thrive physically and emotionally when housed colonially. The

use of roosting pouches to integrate bats into a colonial environment is discussed. Construction diagrams and instructions are included to aid in making fabric pouches that simulate a natural environment and promote a colonial lifestyle by providing dark folds where the bats can hide. This poster presentation focuses on insuring humane habitat conditions by including companion animals as a vital part of colonial bat husbandry.

Seasonality of Bat Communities in Two Neotropical Lowland Forests

Weise, Christa D. and Elisabeth K. V. Kalko, University of New Mexico, Albuquerque, NM; University of Ulm, Germany; Smithsonian Tropical Research Institute, Panama

Neotropical bat communities are among the most complex and diverse. The exceptional diversity of Neotropical bats is mainly due to the diverse feeding ecology of Phyllostomids, the most speciose family of bats in the Neotropics. Bats are of critical importance for pollination and seed dispersal, and are predators of insects and small vertebrates in tropical forests. Though temperatures in the tropics do not vary strongly, rainfall is seasonal and influences community dynamics strongly by regulating food and roost availability. I am studying the seasonality of species composition and abundance of two Neotropical bat communities within the rainfall gradient between the Pacific and the Atlantic coast of Panama, a moist semideciduous forest, Barro Colorado Island, and a wet evergreen tropical lowland forest, Fort Sherman. These sites are geographically proximate but vary strongly in floral composition and annual rainfall (BCI: 2637mm, FS: 3200mm). The focus of this study is on frugivorous Phyllostomids, which can be well sampled with mistnet surveys. Due to differences in rainfall and the resulting differences in plant species composition at the study sites, bat assembly, abundance, and seasonality can be expected to differ. The species composition and seasonal occurrence of bats in the two forests is surprisingly similar, whereas differences in abundance are more substantial. Results of the ongoing study will be presented.

Designing Regional-scale Monitoring for Free-flying Bats: Incorporation of Detectability Estimates

Weller, Theodore J., 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.

www.batcalls.org: A Web Application for Sharing Bat Calls

Wenzel, Mary, Goleta, CA

A database-driven web application for sharing bat calls has been constructed with open source software (PHP, MySQL, HTML, Javascript). The website, www.batcalls.org, allows contributors to upload and download .wav files of bat calls. Contributors can enter extensive attributes for each call and attach images such as sonogram screenshots and bat photos. Though primarily intended for time-expanded echolocation calls, batcalls.org can also be used to share social calls. While observant birders around the world have been making significant contributions to determining the geographic ranges, migration patterns and population trends of bird species for over a century, opportunities for amateur participation in bat monitoring have been limited. Acoustic surveys offer the most promise for increasing the ranks of eyes and ears on the ground and substantially improving presence/absence range data for bats. Voucher calls, those that come from bats positively identified in the hand, are critical for acoustic monitoring. Though much work remains and some bat calls may never be assigned to species with 100% certainty, the existence of a framework for easily sharing voucher calls will serve as an important resource for professional and amateur bat researchers. Bat researchers worldwide are urged to contribute their voucher calls to www.batcalls.org.

Ecology, Life History and Longevity of Bats

Wilkinson, Gerald S. and Jason M. South, University of Maryland, College Park, MD

Traditional evolutionary theory predicts that life span should decrease in response to extrinsic sources of mortality. In contrast, a recent model for longevity extension predicts that resource predictability and communal care should be associated with variation in life span. To evaluate these predictions, life history and ecological factors were used to predict variation in longevity recorded for 64 species bats in captivity or in the wild. Relative to nonflying mammals of similar size, bats live 3.5 times as long with six species known to survive more than 30 years. A maximum longevity of 38 years has been reported for an 8 g male Brandt's bat from Siberia. Univariate and multivariate analyses of species data, as well as of phylogenetically independent contrasts obtained using a supertree of Chiroptera, reveal that bat longevity increases with body mass, hibernation and occasional cave use, but decreases with reproductive rate and is not influenced by diet or colony size. These patterns match predictions of the traditional evolutionary theory of senescence. The strong association observed between hibernation and longevity in bats is consistent with hibernation acting to reduce caloric intake and thereby mimic the effects of dietary restriction on longevity in other animals.

Roost Switching, Roost Sharing and Social Cohesion in Forest-dwelling Big Brown Bats

Willis, Craig K. R. and R. Mark Brigham, University of Regina, Regina, SK

Benefits of group living in cavity roosting bats, combined with bats' longevity and low reproductive output, could lead to evolution of large, temporally stable social groups. In spacious roost sites (e.g. caves, buildings) colonies may be large, but in forest ecosystems group sizes are limited by the physical space available inside roost trees. In theory patterns of roost selection in forests could reflect the maintenance of long-term social relationships between individuals in different trees. In this scenario roost switching could serve to increase numbers of individuals with which bats maintain associations. We used radiotelemetry to identify roosting patterns in forest-dwelling big brown bats (*Eptesicus fuscus*). Our objectives were to quantify roost switching behaviour, assess associations between bats resulting from roost switching, and determine if a stressful stimulus (captivity) affects roosting behaviour and body condition in female *E. fuscus*. Consistent with previous studies we found that bats switched trees often (every

2.4 days) and remained loyal to the same small patches of forest within years. Bats also exhibited loyalty to the roosting area between years. Roost switching significantly increased novel roosting interactions between bats. We devised a roost-sharing index to quantify associations between pairs of bats and found that most pairs associated more often than would be predicted with random roost and roost-mate selection but that all tagged bats spent at least some days roosting in different trees than preferred roost-mates. Captivity did not affect any of the roosting behaviours we measured, or body mass at recapture. Our results indicate that bats are adept at finding roost-mates in the forest, tend to roost with certain individuals but occasionally roost away from them, and that they likely depend on some form of information transfer (as opposed to spatial memory alone) to find occupied roosts on a given night. We contend that patches of forest to which bats remain loyal within and between years, may be analogous to spatially large roosts in caves, mines and buildings.

Long Term Re-use of Trembling Aspen Cavities as Roosts by Big Brown Bats (*Eptesicus fuscus*)

Willis, Craig K. R., Kristen A. Kolar, Amanda L. Karst, Matina C. Kalcounis-Rueppell, and R. Mark Brigham; University of Regina, Regina, SK; California State University, Sacramento, CA

Roost availability may limit some bat populations, implying that there is a selective advantage to being able to re-use sites on an annual basis. We monitored aspen tree use by *Eptesicus fuscus* during multi-year studies (spanning 10 years) at the same site in Saskatchewan. Our data suggest that aspen roosts are reused by groups of bats more often than by solitary individuals. We found that reuse of live trees over the medium term (three years) is more common than previously thought and that in some instances, long term (nine and 10 years) re-use can occur. This supports the hypothesis that cavity roosting bats exhibit between year loyalty, not just to patches of forest but to specific trees as well.

Insectivorous Bats as Predators during Forest Pest Outbreaks

Wilson, Joanna M., University of Calgary, Calgary, AB

Pest outbreaks in forests may provide important concentrations of prey for insectivorous bats, and bats may play a role in limiting such forest pest populations. During the summer of 2002, I investigated the predator-prey interactions between forest bats and western spruce budworm (*Choristoneura occidentalis*, Lepidoptera: Tortricidae), an economically important pest of Douglas-fir trees. According to optimal foraging theory, it should be advantageous for bats to spend more time foraging in dense patches of prey to maximize energy intake with minimal search effort. Therefore, I hypothesized that the bat community would show an aggregative numerical response (increased activity) and a functional response (increased moth consumption) to high concentrations of prey in western spruce budworm outbreak areas. I used bat detectors, fecal analysis and insect traps to measure bat activity, bat diet and insect abundance during a western spruce budworm outbreak in southern interior British Columbia, Canada. I compared bat diet, bat activity and insect abundance in both outbreak and non-outbreak sites, before and during the western spruce budworm moth flight period. I will present preliminary results from this work and discuss implications for bat foraging behaviour and forest pest management.

Seasonal Dietary Changes in Costa Rican *Carollia* (Chiroptera: Phyllostomidae)

York, Heather A., University of Kansas, Lawrence, KS

Frugivorous bats are well known to consume various non-fruit items, such as insects, pollen, nectar, and floral structures, in addition to fruits. However, it remains poorly understood whether the inclusion of such foods serves as a dietary substitute when fruits are scarce, as a dietary supplement to meet nutritional requirements, especially during times of reproductive activity, or a

combination of substitution and supplementation. To elucidate the role of non-fruit items in frugivorous bat diets, I analyzed the contents of fecal samples from mist-netted individuals of four species of *Carollia* (Chiroptera: Phyllostomidae) to compare diets between the wet and dry seasons in both an aseasonal wet forest (La Selva Biological Station, Caribbean lowlands) and a seasonal dry forest (Parque Nacional Palo Verde, Pacific lowlands) in Costa Rica. Preliminary results show that insects and floral structures are eaten only when fruits are scarce, namely, during the dry season in dry forest. In contrast, fruits are eaten almost exclusively when this resource is more abundant. The implications of this dietary trend for interspecific food competition and for relationships between diet and reproduction currently are being investigated.

*** Regulation of Leptin and Leptin Receptor Expression during Pregnancy
in *Myotis lucifugus***

Zhao, Jing, Thomas H. Kunz, and Eric P. Widmaier, Boston University, Boston, MA

Leptin is an anorexogenic protein secreted by adipose tissue, which acts on brain receptors as part of a feedback loop controlling food intake and energy balance. During pregnancy in mammals, there is a progressive increase in serum leptin levels coupled with an apparent state of leptin resistance; the latter may account for the hyperphagia of pregnancy despite elevated leptin levels. The origin of the increase in leptin levels may include either adipose or placental tissues, or both, depending on the species. Because leptin has also been suggested to assume important roles in maintenance of pregnancy and placental function, unrelated to its metabolic functions in the brain, we investigated regulation of leptin and leptin receptor expression during pregnancy in two animal models and in human choriocarcinoma cells. Circulating leptin levels in bats are higher than in any other known order of mammals. In *Myotis lucifugus*, leptin mRNA was detected in placentae, and leptin was secreted in large amounts from isolated placentae in vitro. Interestingly, leptin was also expressed in *Myotis* (and *Eptesicus fuscus*) liver, a phenomenon previously believed to be unique to birds with fatty livers. Histological examination of *M. lucifugus* liver, however, did not reveal the presence of fat-storing cells, suggesting that leptin might be expressed in hepatocytes. In contrast to bats, placental leptin expression and secretion was barely detectable in *Mus musculus*, and no leptin was expressed in liver. To investigate factors regulating leptin production during pregnancy, both bat placentae and a human trophoblast cell line (BeWo cells) were used. In bat placenta, leptin secretion was stimulated by cAMP, but not by glucocorticoids or progesterone. In BeWo cells, cAMP greatly augmented leptin synthesis and secretion. Corticotropin-releasing hormone and glucocorticoids stimulated leptin secretion but not expression in BeWo cells. As a first attempt to determine the mechanism of leptin resistance during pregnancy, expression of the active form of the leptin receptor (Ob-Rb) in the hypothalamus was examined. Because the sequence of bat leptin receptor was unknown, a portion of the 5' end of the coding region of *M. lucifugus* Ob-Rb was cloned and sequenced. Using probes derived from this sequence, receptor expression was detected in several tissues, notably the placenta. There was no significant change in hypothalamic Ob-Rb in either bats or mice, however, as gestation advanced. By contrast, at least three different isoforms of leptin receptor were expressed in placenta, and their synthesis increased from early to late gestation. These results suggest that hyperleptinemia in bats (but not mice) during pregnancy may partly result from placental leptin synthesis and secretion and that placental leptin is up-regulated by cAMP. Regulation of Ob-Rb production in the hypothalamus does not appear to be involved in mediating leptin resistance during pregnancy. Because of the presence and gestational increase of Ob-Rb in placenta, it is proposed that leptin might have an autocrine and/or paracrine role on the placenta in *M. lucifugus*.

* Jing Zhao received the Lube Foundation Award.

End of abstracts

Report on the 32nd Annual North American Symposium on Bat Research

Thomas A. Griffiths, Program Director, NASBR
Margaret A. Griffiths, Associate Program Director, NASBR

The 32nd annual North American Symposium on Bat Research met at the Radisson Hotel in Burlington, Vermont from November 6-9, 2002. G. Roy Horst of *Bat Research News* and William Kilpatrick of the University of Vermont were the conference hosts. There were 263 registered participants, not counting the educators who attended the special Bat Education Workshop on Saturday morning. Most of the participants (63.9%) were affiliated with academic institutions; 16.7% were from federal or state government agencies; 12% were from private business or private consulting groups; 4.5% were from zoos and parks; and 2.7% were individuals who attended simply because they were interested in bats. More than a third (36%) of the participants were students. The majority of the participants this year came from the United States (83.1%); 11.4% of the participants were from Canada, 1.8% were from Puerto Rico and Mexico, and 3.8% of the participants came from countries outside of North America (Germany, Sweden, Austria, the United Kingdom, South Africa, and American Samoa).

One hundred and thirty-one scientific papers were presented at the Burlington meeting, not counting the special presentations for teachers made during the Saturday morning workshop. Eighty-one were platform presentations and fifty of these were poster presentations. A single plenary session was held Thursday, and concurrent sessions were held on Friday and Saturday again this year.

Once again this year, graduate and undergraduate student participants were invited to enter their platform papers and poster presentations in a competition which judged the merits of their presentations. A new policy was implemented this year. The NASBR Board of Directors voted at the 2001 meeting to limit the number of times a student could enter the student competition for platform presentations. Under this new policy, each student may enter the student competition only once per degree program; the student chooses when his/her research is completed and ready for presentation in the plenary Student Competition Session. (The number of times a student can enter the poster competition has not been limited; students may submit posters to the student competition as many times as they wish.) Nineteen students presented platform papers in the plenary Student Competition Session, and eleven students entered their posters in the Student Poster Competition. In addition, twenty-four students presented papers in concurrent (non-judged) sessions on Friday.

A special committee headed by Betsy Dumont judged the nineteen student platform papers and eleven student posters. A new student award was established this year by Basically Bats Wildlife Conservation Society. Therefore, five cash prizes of \$250 USD each were awarded for outstanding student platform papers at the Saturday evening banquet. Hannah ter Hofstede of York University, Toronto, Ontario, Canada won the Basically Bats Wildlife Conservation Society Award; Nikolay Hristov of Wake Forest University, Winston-Salem, North Carolina won the Bat Conservation International Award; Paul Cryan of the USGS Arid Lands Field Station and the University of New Mexico, Albuquerque, New Mexico won the *Bat Research News* Award; Jing Zhao of Boston University, Boston, Massachusetts won the Lube Foundation Award; and Amy Russell of the University of Tennessee, Knoxville, Tennessee won the Karl F. Koopman Award. Andrea Schaub of the University of Tuebingen, Tuebingen, Germany won the Speleobooks Award for best poster; this year the prize comprised a gift certificate for \$100 in Speleobooks merchandise and a cash prize of \$150. Generous monetary donations from the Board of Directors of Basically Bats Wildlife Conservation Society, from Bat Conservation International, from Roy Horst at *Bat Research News*, from Roger and Sherry Haagenson of The Lube Foundation, 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.

In celebration of its 20th anniversary, Bat Conservation International hosted a reception on Friday evening following the poster session. The reception was a token of appreciation for twenty years of support from the membership of the NASBR. Thank you, Merlin Tuttle and BCI, for this very nice event, and congratulations on twenty years of successful work.

The Saturday evening banquet was another memorable event this year. Roy and Bill selected four outstanding entree choices for the banquet, including Vermont's Traditional Roast Turkey and Vermont's own Ben & Jerry's Ice Cream Puff for dessert. The hotel's Director of Catering, Dan O'Brien, and his staff were commended on providing such an excellent banquet. In addition to presentation of the student awards, several other events occurred at the banquet. On behalf of the NASBR membership, Robert Barclay presented Margaret Griffiths with an award in recognition of her service to the society. The highlight of the banquet was the presentation of the Gerrit S. Miller, Jr. Award to Robert Barclay of the University of Calgary, Calgary, Alberta, Canada. The award was presented by Brock Fenton, Robert's mentor and the 1982 recipient of the Miller award. The Gerrit Miller Award is presented to persons "In recognition of outstanding service and contribution to the field of chiropteran biology," and is the North American Symposium on Bat Research's highest honor. Robert joins a small group of distinguished individuals who have received this prestigious award.

Pat Morton of Texas Parks and Wildlife once again organized a special bat education workshop on Saturday morning of the conference. The workshop was well attended by Burlington-area teachers, conservation workers, and other local persons interested in the conservation of bats. This was the seventh year in a row that Pat has organized this workshop in conjunction with the NASBR. We thank Pat for her efforts in making the workshop possible, and also thank Bat Conservation International, the Lube Foundation, *Bat Research News*, Speleobooks, and Vermont Fish and Wildlife Department for their generous donations to help support the workshop.

We also thank Janice Valgoi, Dan O'Brien, and the entire staff of the Radisson Hotel Burlington who helped to make the 32nd NASBR a very memorable and successful meeting. We think everyone agreed that the Radisson-Burlington was a great venue for the meeting. Tom and Margaret extend a special thanks to the local hosts, Roy and Bill, to graduate student Ryan Norris of UVM, and to the members of the Board of Directors 2001-2002 (Hector Arita, Robert Barclay, Mark Brigham, Betsy Dumont, Trish Freeman, Roy Horst, Bill Kilpatrick, Gary McCracken, Dixie Pierson, and Nancy Simmons) for all the hard work they did to make this meeting a success. Also special thanks from all of us to Roy, the "founding father" of the society. And finally I, Margaret, want to thank Roy, Robert, and the entire NASBR membership for the special recognition award; you are a great group with whom to work. See you all in Lincoln, Nebraska in 2003!

RECENT LITERATURE

Authors are requested to send reprints of their papers to the Editor (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 tgriff@titan.iwu.edu 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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Announcement

US & Canada Bat Distribution Maps Available

GIS files and associated metadata documentation are now available for the 45 bat species found in the United States and Canada. The data are being served via the USGS National Atlas website at: <http://nationalatlas.gov/batm.html>

The bat maps are available in an interactive format on the National Atlas website at: <http://nationalatlas.gov/>, along with other layers including: cities, federal and Indian lands, precipitation, watersheds, aquifers, elevation, geology, forest types, forest fragmentation, county distribution records for over 500 moth species, wildlife mortality, organophosphate poisoning, cancer mortality, West Nile veterinary cases and mosquito surveys, nighttime lights, and human population density.

All of these files and their documentation are also available in GIS format for download, for use in your own mapping projects.

If you simply need jpeg images for reports, you may wish to access the BCI website: <http://www.batcon.org>. Choose Discovery from the left navigation bar, then click on Bat Species. The map for each species is available with a photo and abbreviated species account.

These maps were compiled by Bat Conservation International, using data from U.S. state natural heritage programs, Canadian conservation data centers, published literature, unpublished reports, museum collections, and personal communications from university, federal, state, and local biologists. Additional information about the BCI mapping project is available at: <http://www.batcon.org/nabcp/newsite/rangemaps.html>. Specific inquiries about data may be directed to:

Angela England, Bat Conservation International, PO Box 162603, Austin, TX 78716, telephone(512) 327-9721, or email: aengland@batcon.org

Notes

White-winged Vampire Captive Birth

Basically Bats Wildlife Conservation Society is proud to announce the captive birth of a white-winged vampire bat (*Diaemus youngi*). The female pup was born on November 12, 2002, at the Basically Bats New Mexico Bat Research Institute (NMBRI) located in Tijeras, New Mexico. We believe this is the first captive birth of this species in the United States. The pregnant bat, and nine other specimens, were collected this past summer in Trinidad by Dr. Bill Schutt (Southampton College and AMNH), Farouk Muradali, and members of Trinidad's Wildlife Ministry (Forestry Division). The bats were successfully transported to New Mexico where they will reside permanently. For more information, or a photo of this little cutie, contact Daniel Abram, Director of

NMBRI at diaemus@nmia.com or Sue Barnard, Executive Director of Basically Bats at batcons@mindspring.com. submitted by Susan Barnard <batcons@mindspring.com>

Winter Red Bat Record in Texas (*Lasiurus borealis*)

A healthy adult male red bat (*Lasiurus borealis*) was recovered in Austin, Texas (Travis County) on 21 December, 2002. Weight 10 grams; forearm length 27mm. The bat was found on

the ground. Temperatures varied on 21 December from 34 degrees F (1.1C) at 1:00am to 66 degrees F (18.9C) by 2:00pm (CST).

Submitted by Barbara French. e-mail: french@batcon.org

Fall and Winter Records of *Nycticeius humeralis* in Texas and Oklahoma

Twelve evening bats (*N. humeralis*) were recovered by the authors in Texas and Oklahoma between October and December of 2002 as follows:

Oklahoma City (Oklahoma County) OK, 1 female each on 14 October and 3 December; 1 male each on 26* October and 1 November; and 2 bats on 22 October that were not sexed.

Hinton (Caddo County) OK, 1 female on 30 October

Norman (Cleveland County) OK, 1 female each on 23 October, 6 and 25** November

Stillwater (Payne County) OK, 1 female on 31 October

Midwest City (Oklahoma County) OK, 1 female on 11** November

McAllen (Hidalgo County) TX, 1 female on 26 November

*found torpid in a woodpile

**found torpid in buildings

Submitted by Barbara French and Carol Bunyard. e-mail: french@batcon.org

New Records of Fruit BATS (*Rousettus aegyptiacus*) in Qeshm Island ,IRAN

While working on bat species diversity in Qeshm Island , six specimens of the fruit bat (*Rousettus aegyptiacus*) were collected on palm trees in (May, 2002). Although not quite rare, these fruit bats have been rarely captured in southern IRAN. DeBlase (1980) , Ettemad (1974) only mentioned the species name without any bat specimens in collections in Qeshm. Therefore this is the first collection for more than one century. None of the scientists working on this species were successful in capturing any specimen of the fruit bat in their studies in Qeshm Island .(Blanford (1876), Lay (1967) Ettemad (1974) , DeBlase (1980)) . Submitted by Hossein Zohoori, Dept of Environmental Sc., Sciences & Researches Unit of Islamic Azad University Tehran, Iran h_zohoori@yahoo.com

Ed.note: This note was accompanied by a small map which could not be satisfactorily reproduced. Apologies to the author.

News from Germany

What's Up in Ulm, Germany?

In 2000 Elisabeth Kalko became head of the Department of Experimental Ecology at the **University of Ulm** in Germany (<http://www.biologie.uni-ulm.de/bio3/index.html>). Meanwhile the University finds the department converted into a bat lab. Here is a short account of the different projects going on in Ulm at the moment:

Dina Dechmann spends about half of her time in Panama collecting data for her PhD-project on the socio-genetics of the round-eared bat *Tonatia silvicola*. The other half of her time is divided up between the Universities of Ulm and Zuerich (Switzerland), analyzing data and discussing it with her supervisors Elisabeth Kalko and Gerald Kerth.

Markus Dietz is working for his PhD-project on the feeding strategies and the changes in body temperature of Daubenton's bats (*Myotis daubentonii*). During summer sleep is rare as his schedule of catching and radiotracking or light-tagging bats keeps him busy.

Njikoha Ebigbo, after studying the echolocation behavior of the specialized group of constant frequency echolocating rhinolophids and hipposiderids in Ivory Coast, is now working on flying foxes for his PhD. In the Comoé National Park in Ivory Coast, these abundant and highly mobile animals disperse seeds of a variety of tree species. Njikoha wants to find out if and how these frugivores influence the regeneration of ecologically and economically important tree species in the region.

Jakob Fahr is currently writing up his PhD thesis on the community ecology of bats in Ivory Coast, West Africa. Recently, he has finished the manuscripts for several bat chapters in the forthcoming multi-volume handbook "Mammals of Africa". Together with Njikoha Ebigbo and Elisabeth Kalko, he is working in the multidisciplinary research programme BIOTA (www.biota-africa.de) with a main focus on questions relating to the impact of humans on diversity, funded by the German Research Ministry.

Stephanie Hartl is at the moment very happy and busy with her little daughter Paula (born on September 8). For the future she plans to share her time between her PhD thesis - where she compares insectivorous bat communities in temperate zones from Europe and North America based on their morphology, especially skull-morphology - and little Paula.

Elisabeth Kalko uses every chance she can get to "escape" from the manifold university duties into the field to continue working with her students on echolocation and foraging behavior of Neotropical bats and to expand her studies on community ecology. Her most favorite research site is the field station Barro Colorado Island (BCI) of the Smithsonian Tropical Research Institute (STRI) in Panama where she became scientific staff in 2000. Working together with the "bat group" from Ulm as well as with many other colleagues from other institutions and universities worldwide makes her life enjoyable and gives the necessary energy to continue with teaching, administration and committee work. To make research "go public" she collaborates with film teams and currently develops a curriculum for school children with the JASON foundation. All of these activities wouldn't be possible without the great support of the bat people!

Stefan Klose has joined the department after a research and study year in Australasia. During his stay at the University of Queensland (UQ), Brisbane, he conducted research on the social and vigilance behaviour of *Pteropus poliocephalus* together with Anne Goldizen (UQ) and Justin Welbergen (Nick Davies, Cambridge) and studied the behaviour and physiology of *Melonycteris melanops* in East New Britain, Papua New Guinea with Frank Bonaccorso of the

National Museum of Papua New Guinea. He is currently preparing to establish a hormone lab at the department.

Christoph Meyer conducted a telemetry study on Barro Colorado Island, Panama, where he had a great time trying to gain insight into the secret life of *Macrophyllum macrophyllum*, a phyllostomid bat foraging over water. He studied activity patterns and ranging behavior of these cute little animals for his diploma thesis and is currently doing the number crunching and looking for patterns in his data.

Katja Soer has spent 3 months at the newly established research station of the university of Würzburg (Germany) in the Comoé National Parc, Ivory Coast (West Africa). For her diploma thesis about the foraging strategy of the Old World Leafnosed bat *Hipposideros cyclops* she radiotracked individual bats. Simultaneously, she put up light traps to estimate the insect availability of the area.

Sabine Spehn is in Panama and about to finish her analysis of two years of fieldwork for her PhD, studying mechanisms of coexistence of two ecologically and morphologically similar gleaning insectivorous species (*Tonatia saurophila* and *Micronycteris hirsuta*, both Phyllostomidae). With radiotracking in the field and experiments in a flight cage with naïve, freshly caught bats she is sorting out if and how both species differ in their foraging strategy.

Marco Tschapka recently returned from Mexico where he has worked for seven weeks together with Ragde Sanchez, Yunuhen Rodriguez, Luis Antonio Caballero Martínez, and Rodrigo Medellín from the Instituto de Ecología at UNAM on the ecology of the murciélago trompudo *Musonycteris harrisoni*. Another project deals with the bat-pollinated palm *Calypstrogyne ghiesbreghtiana* that gets visited by hovering and non-hovering bats. Now awaits him a semester of teaching about starfish, fish and similar non-bat animals.

Fannie Wetterich is studying the vertical stratification of bats in Panama for her Diploma thesis. She has set high nets in the forest canopy on Barro Colorado Island, using a crossbow. In her analysis she addresses changes in species composition and capture frequency of bats along the vertical gradient of a tropical rain forest. She has already gotten two new records for the island, which brings the actual number of species on BCI up to 72.

Sandra Wilcken has spent three months on Barro Colorado Island (Panama), studying flexibility in echolocation call design of *Saccopteryx bilineata*. For her Diploma thesis she photographed free flying bats under stroboscopic illumination and simultaneously recorded their echolocation signals. In contrast to this field work in the rainforest she is now spending the next 180 days in front of a computer, analyzing 3400 pictures and 27 hours of sound recordings.

Moritz Weinbeer is currently studying the sensory ecology of *Lampronnycteris brachyotis* and *Macrophyllum macrophyllum* (Phyllostomidae) on Barro Colorado Island, Panamá, for his PhD thesis. In field and flight cage experiments he focuses on the question how ecological and evolutionary factors influence the use and the structure of echolocation in phyllostomids when searching for prey.

Christa Weise spent August 2001 to August 2002 in Panama collecting data for her dissertation project on comparing composition and seasonality of the bat communities in two tropical lowland forests that are geographically close but differ in rainfall regime and vegetation composition. She is now back at the University of New Mexico in Albuquerque for two semesters of teaching and taking classes.

Recent publications from the Department at the University of Ulm

- Brooke, A. P.; Tschapka, M. 2002. Threats from overhunting to the flying fox, *Pteropus tonganus*, (Chiroptera: Pteropodidae) on Niue Island, South Pacific Ocean. *Biological Conservation* 103: 343-348.
- Dressler, S.; Tschapka, M. 2002. Bird versus bat pollination in the genus *Marcgravia* and the description of a new species. *Curtis's Botanical Magazine* (ser. 6) 19 (2): 104-114.
- Fahr, J. et al., 2001. Priority areas for mammals, in: *From the Forest to the Sea: Biodiversity Connections from Guinea to Togo*, (eds. Bakarr, M., Bailey, B., Byler, D., Ham, R., Olivieri, S. & Omland, M.). Conservation International, Washington, DC. 78 pp.
- Fahr, J., 2001. A fresh look at afrotropical bat assemblages: Combining different sampling techniques and spatial scales. *Bat Research News* 42(3): 98.
- Fahr, J., Vierhaus, H., Hutterer, R. & Kock, D., 2002. A revision of the *Rhinolophus maclaudi*-species group with the description of a new species from West Africa (Chiroptera: Rhinolophidae). *Myotis* 40: 103-134.
- Kalko EKV, Handley CO (2001) Neotropical bats in the canopy: diversity, community structure and implications for conservation strategies. *Plant Ecology* 153:319-333
- Kock, D., Barnett, L., Fahr, J. & Emms, C., 2002. On a collection of bats (Mammalia: Chiroptera) from The Gambia. *Acta Chiropterologica* 4(1): 77-97.
- Korine C, Kalko EKV (2001) Toward a global bat-signal database. *IEEE Engineering in medicine and biology magazine* 20:81-85
- Korine C, Kalko EKV, Herre EA (2000) Fruit characteristics and factors affecting fruit removal in a Panamanian community of strangler figs. *Oecologia* 123:560-568
- Sampaio EM, Kalko EKV, Bernard E, Rodriguez-Herrera B, Handley CO (2003) A biodiversity assessment of bats (Chiroptera) in an upland rainforest in Central Amazonia including methodological and conservation considerations. *Studies in Neotropical Fauna and Environment*, in press
- Schnitzler HU, Kalko EKV (2001) Echolocation behavior of insect-eating bats. *BioScience* 51:557-569
- Siemers BM, Kalko EKV, Schnitzler HU (2001) Echolocation behavior and signal plasticity in foraging Neotropical *Myotis nigricans* (Schinz, 1821) (Vespertilionidae): a convergent case with *Pipistrelles*? *Behav Ecol Sociobiol* 50:317-328
- Tschapka, M.; Dressler, S. 2002. Chiropterophily: On bat-flowers and flower-bats. *Curtis's Botanical Magazine* (ser. 6) 19 (2): 114-125.
- Wendeln MC, Runkle JR, Kalko EKV (2000) Nutritional values of 14 species of figs (*Ficus*) and their role in the diet of frugivorous bats on Barro Colorado Island, Panamá. *Biotropica* 32:473-488

Book Review

Fleming, T.H. and A. Valiente-Banuet (editors). 2002.

Columnar Cacti and their Mutualists: Evolution, Ecology, and Conservation.

University of Arizona Press, Tucson.

This excellent book explores the interfaces between columnar cacti and animals. It belongs on the book shelf (among the books you actually have read) of anyone who is interested in bats, particularly bats that depend upon plants for food. The 17 chapters are arranged in 3 parts: part 1 consists of 6 chapters and deals with geology and evolution; part 2 includes 3 chapters and focuses on anatomy and physiology, while the 8 chapters of part 3 deal with population and community ecology and conservation. The book, which includes the work of 29 contributors, arises from a conference held in Tehuacan City, Puebla, Mexico from 28 June to 3 July 1998. Each chapter has an English and a Spanish summary.

Four chapters (5, 13, 14 and 17) deal specifically with bats, another (12) examines the role of bats and birds in the reproduction of columnar cactii in the northern Andes. Chapter 5 examines phylogeny and convergence in cactophilic bats. Here, N.B. Simmons and A.L. Wetterer conclude that cactophily evolved once in the Antrozoidae and at least 13 times in the Phyllostomidae. "Cactophilic" identifies bats that obtain a critical part of their diet from the nectar, pollen and fruit of columnar cacti. Many cactophilic bats are opportunistic in their use of cacti, but obligate cactophily characterizes some populations, for example of *Glossophaga longirostris*, *Leptonycteris curasoae*, *Leptonycteris yerbabuena*, and *Platalina genovensium*. Obligate cactophily may also occur in populations of *Cheronycteris mexicana* and *Leptonycteris nivalis*. The authors predict that the little-known *Musonycteris harrisoni* from southwestern Mexico, and *Monophyllus plethodon* and *Brachyphylla cavernarum* from the West Indies also will prove to be cactophilic.

Cactophilic glossophagine bats tend to be bigger than their non-cactophilic relatives, being heavier with longer forearms and skulls. These features probably are important in the arid and semi-arid habitats where columnar cacti are most common, and it is proposed that the longer rostra allow better access to nectar in large tubular cacti. Larger size may favourably affect water balance, temperature regulation and the costs of flight.

In chapter 12, M. Soriano and A. Ruiz report that columnar cacti from Andean enclaves in Colombia and Venezuela have flowers exhibiting syndromes of chiropterogamy and bats appear to play a major role in their pollination. The morphology of the fruits of these cacti appear to favour both chiropterochory and ornitochory. Chiropterogamic features include funnel-shaped corolla tubes, white to rose-colored petals, numerous stamens, and an odor reminiscent of decomposed vegetables. The flowers produce large quantities of nectar and pollen.

M. del C. Arizmendi et al. (chapter 13) note that the distribution of nectarivorous bats coincides with the geographic and seasonal distribution of columnar cacti and agaves. They summarize the available data on the diets of the cactophilic bats, and compare them to data on *Glossophaga soricina* which consumes food from many species of plantes but few cacti and agaves.

T.H. Fleming and J. Nassar (chapter 14) look in detail at the evolution and population biology of *Leptonycteris curasoae*, one of the most important pollinators of cacti in arid regions of the US, Mexico and northern South America. This species is highly gregarious and, among the subfamily Glossophaginae, relatively derived. Cave colonies of *L. curasoae* are often large (> 100,000 individuals), and widely scattered. Some caves serve as mating sites and each spring, thousands of pregnant females migrate over 1000 km from southcentral Mexico to the Sonoran desert. In the Sonoran desert these bats have large foraging areas (up to 2.5 km²), but although they often live in groups, they appear to forage independently, displaying no cohesive social behavior.

In the book's last chapter (17), M. Santos and H.T. Arita note that the traits of nectar-feeding bats make them more vulnerable to extinction than other bats. Specifically, the close mutualistic relationship between the bats and the cacti makes either more vulnerable to extinction that would be the case in the absence of the mutualism. Santos and Arita identify priority areas for the conservation of the bats and the cacti, noting that expanding human populations pose the main threat to both groups.

The book presents a wealth of information beyond the material about bats. I highly recommend the book to anyone interested in cacti, in bats, in evolution or in conservation.

M.B. Fenton, Department of Biology, York University, North York, ON M3J 1P3 Canada

Future Meetings

January 29 - February 1, 2003

2nd Four Corners Regional Bat Conference / 1st Annual Western Bat Working Group Conference for the Management and Conservation of Bats.

We would like to announce this meeting, scheduled to be held in Durango, Colorado, January 29-February 1, 2003. Conference registration information and call for papers will be available soon. Room reservations can be made now at the Doubletree Hotel, 970-259-6580. Ask for the rate for the Four Corners WBWG meetings. Rates will be \$59.00 + tax for 1 king bed, 1 or 2 people, \$69.00 + tax for 2 queen beds, 1/2/3 people. We encourage everyone to reserve a room early to get the reduced room rate. Be sure to mention that you are with the Four corners Regional Bat conference. Registration information is now available on the WBWG website.

(<http://batworkinggroups.org/>) Please contact Michael Herder at michael.herder@blm.gov or Laura E. Ellison at: laura_ellison@usgs.gov

October 8-11, 2003

The 33rd Annual North American Symposium on Bat Research will convene in Lincoln Nebraska hosted by Patricia Freeman of the University of Nebraska State Museum, October 8-11, 2003 Arrangements have been made for participants in the symposium to stay at the Cornhusker Hotel at very reasonable rates. All symposium sessions, displays, etc., will be in the Cornhusker Hotel. This hotel was our location for the 20th Symposium in 1990. Everyone who attended that meeting was very pleased with their hospitality. For more details see our web-site at: www.nasbr.com

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 www.miiz.waw.pl/IBRC

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

There are tentative plans for the following European Bat Research Symposium (2008) in Romania.

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.

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Front Cover

The front cover is a portrait of *Lasiurus cinereus* by Suzanne Lebeda of South Colton, NY. Suzanne has created many illustrations for wildlife publications as well as many beautiful posters for such agencies as the Adirondack Park Commission and The Saint Lawrence Seaway Natural History Center. This portrait was the master copy of the tee-shirt created for the recent 32nd North American Symposium. The original is in color and its attractiveness guaranteed that all the shirts were sold, the profits (nearly \$1,000) which were donated to the student awards program sponsored by Bat Research News and other participants of the symposium. Thank you, Suzanne