

# **3<sup>rd</sup> International Berlin Bat Meeting: Bats in the Anthropocene**

Berlin, Germany, 1<sup>st</sup> – 3<sup>rd</sup> of March 2013

Organised by

Leibniz Institute for Zoo and Wildlife Research (IZW)  
Alfred-Kowalke-Straße 17  
D-10315 Berlin  
Germany

[www.izw-berlin.de](http://www.izw-berlin.de)



Published by the Leibniz Institute for Zoo and Wildlife Research (IZW)  
Alfred-Kowalke-Str. 17, D-10315 Berlin (Friedrichsfelde)  
P.O. Box 601103, D-10252 Berlin, Germany

Printed on acid-free paper

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Setting and layout: Karin Schneeberger, Ana Popa-Lisseanu

Cover photo credits: Daniel Lewanzik, Christian Voigt, Ana Popa-Lisseanu

Printing: copy print  
Kopie & Druck GmbH, [www.copyprint.de](http://www.copyprint.de)

Order: Leibniz Institute for Zoo and Wildlife Research  
(IZW); Forschungsverbund Berlin e.V.  
P.O. Box 601103, 10252 Berlin, Germany  
[biblio@izw-berlin.de](mailto:biblio@izw-berlin.de)  
[www.izw-berlin.de](http://www.izw-berlin.de)

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## FOREWORD

Over the past centuries, humans have encroached into natural ecosystems worldwide, causing fragmentation, habitat degradation and severe biodiversity loss. This era of anthropogenic effects on natural ecosystems has been defined as the Anthropocene. How do bats, a charismatic group of mammals that is often in the centre of wildlife-human conflicts, perform in the Anthropocene? Many field biologists report that bats are quite sensitive to habitat disturbance and processes of urbanization. Yet some species are profiting from contact with humans by using buildings or other man-made structures as roosts. Recently, North American bat populations are dwindling in numbers due to the spread of the white-nose syndrome in hibernating bats. In other areas of the world, bats are an important reservoir for viruses that may prove lethal for humans. Bat rabies and its effect on livestock and humans are of major importance in many subtropical and tropical countries. Are bats especially susceptible to dangerous viruses? Even in the light of bat-related health issues, there is common scientific agreement, although not general public knowledge, that we strongly depend on the various ecosystem services provided by bats such as the control of pest insects, dispersal of seeds and pollination of flowers. Bats play an important ecological role in the Anthropocene, and so we need to discuss what their fate is, how we may mitigate bat-human conflicts and how we may preserve threatened populations and species in such a manner that they could coexist with mankind. We have invited you to attend our conference to discuss these various topics and we hope that you find your visit of the 3<sup>rd</sup> International Berlin Bat Meeting stimulating and thought-provoking.

This volume contains the contributions to the **3<sup>rd</sup> International Berlin Bat Meeting: Bats in the Anthropocene**. The conference brings together more than 300 scientists and students from 35 countries with diverse and complementary backgrounds, such as biology, veterinary sciences, politics, and legal administration. Oral and poster presentations cover a wide variety of topics related to bats in the Anthropocene. Ultimately, the conference aims to foster an exchange of ideas and methods between participants. Consequently, we have left ample space for discussion.

The first section of this volume contains the abstracts of invited plenary speakers, followed by the abstracts of the six sessions. Contributions were solicited for the following topics:

- Bats and urbanization
- Bats in disturbed habitats
- Emerging viral diseases/bat rabies
- Bats and wind energy
- Ecosystem services of bats
- Integrating research, education and outreach to promote bat conservation

The abstracts in this volume are organized according to sessions. Abstracts from talks were put in chronological order and those of posters were sorted according to

session and then in alphabetical order (first author's name). All abstracts were printed as submitted. To help you find an abstract of interest we have included an index of authors and an index of the scientific names of species.

We thank Karin Schneeberger and Sven Kühlmann for their significant contribution to the organization of this conference. We also thank Steffen Berthold, Dagmar Boras, Doris Fichte, Simon Ghanem, Olga Heim, Kseniia Kravchenko, David Lehmann, Daniel Lewanzik, Oliver Lindecke, Anja Luckner, Anke Schumann, Steven Seet, Tobias Teige, Sara Troxell, Wolfgang Tauche, Silke Voigt-Heucke and Melanie Wissing for all the assistance in the preparation of the conference and its scientific program. We are very grateful to the session organizers in putting together the program of their sessions. Finally we are very grateful to the German Research Council (Deutsche Forschungsgemeinschaft) for supporting the conference financially, to Eurobats for supporting selected participants from mostly Eastern Europe, to the Federal Institute for Risk Assessment (Bundesinstitut für Risikobewertung), to the Museum of Natural History in Berlin (Museum für Naturkunde Berlin) for kindly providing the facilities for our conference banquet, and to the Leibniz Institute for Zoo and Wildlife Research for general support.

We hope that you will enjoy the scientific and social program of this symposium.

Berlin, March 2013

*Christian Voigt and Ana Popa-Lisseanu*

# PLENARY TALKS

## Plenary

### Bats in the Anthropocene

*JONES, KATE E.*

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Biodiversity on this planet is being impacted as never before as the human population grows, uses up more of the planet's resources, and changes the earth's environmental conditions. In this "Anthropocene", I explore how bat species and populations are being effected and what this means for future bat biodiversity and conservation. I firstly review the spatial and phylogenetic patterns of past and historical extinctions and current patterns of extinction risk in bats compared to other taxa. Are bats more or less threatened than other mammals or more similar to birds? I then explore the most important processes currently threatening bat species (habitat loss, over-exploitation, urbanisation) and review the progress in building quantitative spatial and phylogenetic models of mammalian extinction. Models of extinction and extinction risk are likely to vary not only with threatening processes, but also across time, space and taxonomic group, and I investigate the power of existing models to explain the variation in and within bats. Extinction risk models can be used to predict the impact of future global change on species distributions and conservation status and I review the progress in understanding this for bat species. I explore the limitations in these models, such as a lack of a mechanistic understanding of the underlying processes and limited availability of suitable data on bat distributions and abundances. I discuss the future directions of these models including improvements on how we incorporate mechanistic processes and how we can rapidly accumulate better distributional and abundance data on bats using new technologies and empowering citizen scientists.

## Plenary

### Viral diseases in bats

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Studies in bats and other small mammals have recently yielded a whole range of new animal viruses. There is hope (and big promises) that virus discovery may give us a head start against the next pandemic emerging. Clearly it makes a lot of sense to make a census of all those viruses sleeping in animal reservoirs. These data can provide fundamental insights into the evolution of mammalian viruses, explaining how humans might have acquired some of their major infectious agents and providing new scenarios for the investigation of disease mechanisms. However, only in very selected cases findings of novel reservoir-borne viruses can have direct consequences for public health. The majority of discovered viruses have resided in their hosts for thousands or millions of years without affecting human health. We must not forget that the identification of reservoir-borne viruses can only be a very first step in viral risk assessment. Barriers that decide whether a virus can or cannot infect and spread in humans include complex processes such as viral entry, virus-host co-operation on cellular level, as well as the many components of epithelial and systemic host defense versus viral evasion. To achieve a real triage among reservoir-borne viruses in terms of their epidemic/epizootic risks, we need to invest much more work in comparative mechanistic virology. In this talk I will provide examples from our own work showing the use of virus discovery for the fundamental investigations of virus evolution, as well as challenges in mechanistic risk assessment of selected reservoir-borne viruses.

## Plenary

### Bats and wind farms

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Since the first reported large-scale fatality of bats at wind turbines in 2003, much has been learned regarding the causes of fatalities, and their variation in space and time, and among species. A consistent pattern in Europe and North America, is that the majority of fatalities involve open-air, migratory, tree-roosting species during autumn migration, especially during low wind speeds. Spatial variation in the distribution of critical habitat and thus the abundance of such species during migration, helps explain the patterns of fatalities across landscapes. Understanding the basic migration biology of these species will thus be important in placing wind facilities so as to minimize fatalities. Whether bats are attracted to turbines, or merely encounter them randomly, is still debated. Some data are available to test various hypotheses as to why bats might be attracted to turbines, but species differences are likely important and need to be understood. Turbines may be perceived as sites for feeding, roosting, or mating, although observations vary in their support for these hypotheses and actual attraction is difficult to assess simply using observations. Experimental tests are needed. In terms of reducing the impact of wind turbines on bats, several experiments show that changing turbine operation reduces fatalities significantly, with relatively low costs. However, to justify even these mitigation measures, we need to know whether there is a significant impact of fatalities on population viability, and this remains one of the key unanswered questions. Until a basic understanding of population size and structure is available, indices of change in population size (e.g. changes in fatality, capture, and detection rates over time) may be informative. In North America, fatality rates at most wind facilities have declined over time. While this may suggest population declines, there are other interpretations, and other indices of abundance are inconsistent. In addition, population declines may have occurred for various reasons, and we need to be able to separate the impact of fatalities at wind turbines from other potential causes. Until we have the information required for population viability analyses, this goal will remain elusive.

## Plenary

### Ecosystem services of paleotropical bats

BUMRUNGSRI, SARA<sup>1</sup>; HARBIT, ANDREW<sup>2</sup>; BENZIE, CHARLES<sup>2</sup>; CARMOUNCHE, KRISTINE<sup>2</sup>; SRIDTH, KITTICHATE<sup>1</sup>; RACEY, PAUL<sup>3</sup>.

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Although the floral traits of durian and *Parkia* conform to the bat-pollination syndrome, many visitors other than bats have been observed at their flowers and some chiropterophilous plants are also pollinated by other animals. The present study aimed to determine the breeding system of the economically important trees, durian and two species of *Parkia*, and to identify their pollinators. The floral biology and pollination ecology of durian, *Durio zibethinus*, were determined in eight semi-wild trees, while 28 trees of *P. speciosa* and four *P. timoriana* were examined. They are mostly or completely self incompatible. Flowers open fully during late afternoon or evening, and anthers dehisce around 2000 h when the stigmata are already receptive (*Durio*) or receptive at same time (*Parkia*). In a series of pollination experiments, the highest pollination success occurred either after hand-crossed (*Durio*) or open pollination (*Parkia*). Insect pollination resulted in fruit set in only 12% of *P. speciosa* inflorescences. Nectarivorous bat, namely *Eonycteris spelaea*, visit flowering plants continuously from dusk till after midnight. Several other fruit bats species also contribute to this pollination success. Nocturnal and diurnal insects (moths and giant honey bees, stingless bees) also frequently visit flowers. Bats visited durian and *Parkia* flowers at the rate of 26.1-112 visits per inflorescence per night. The pollination services of fruit bats to these plants were estimated to be 137 million US dollars annually in southern Thailand. Although these economically important plants depend on fruit bats as their pollinators, *E. spelaea* appear to be declining throughout its distribution, often as a result of persecution by farmers who believe the bats damage flowers. Therefore protection of fruit bat populations and their roosts is vital for the continued production of these fruit crops.

## Plenary

### Public outreach and the conservation of bats

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Bat researchers are well aware of the public relations problems faced by the blood-sucking, disease-laden, hair-tangling, blind, flying mice that they study. However, if bat populations are to survive the many pressures and conflicts of the Anthropocene, we must not only de-bunk myths, but instill stakeholder appreciation of the extraordinary taxonomic and ecological diversity of bats, the essential ecosystem services that they provide, and the perils they face. Public engagement and education is essential, and should be championed and implemented by those who know (and love) bats best, but few researchers truly commit to this critical aspect of bat conservation. The putative impediments are manifold: lack of time, lack of institutional credit, lack of expertise, lack of funds--all too often researchers lack luster and salve their conscience with an occasional school-visit or media interview, if anything at all. I posit that it is possible, effective, and immensely rewarding to integrate research with engagement, and share two personal efforts: an outreach campaign in Malaysia, and an education initiative targeting 10 and 11 yr-old science students in the US, both of which were embedded in and informed by my original research.

# ORAL PRESENTATIONS

## SESSION I: BATS AND URBANISATION

**Organizer: Gerald Kerth, Frieder Mayer**

### **Urbanization, two bat species and their winter range**

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Species being subject of the current research are *Vespertilio murinus* and *Nyctalus noctula*, both known to be long-distance migrants. The past absence of winter records (for *V. murinus*) or of records only in a few restricted regions (for *N. noctula*) in Ukraine, the known long distance movements of parti-coloured bats and common noctule bats ringed in North-Eastern Europe, as well as observations of migrating animals, have encouraged the consideration of these two species as hibernating solely or mainly outside of Ukraine and NE Europe as a whole.

Data gathered during recent years demonstrate that the winter range of the two considered species now includes the whole territory of Ukraine. *V. murinus* was recorded in winter in many provinces of Ukraine (including contact records and observations of advertising males). For *N. noctula* the appearance of winter colonies has been documented in most provinces. The great majority of winter records of these species come from rock-like localities (multi-storey buildings). All available data allow to ascertain that expansion of the winter ranges has occurred during the last few decades and is closely associated with urbanization, in particular with the appearance of continuous ‘massifs’ of quasi-rock structures (in plain regions), with roosts related to them and, probably, with urban heat islands.

## Factors shaping bat occurrence in urban green areas

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For a city and its inhabitants the presence of strong and diverse bat communities could mean an increase in the quality of life. Bats are responsible for a number of ecosystem services that are crucial for Man. For instance, the removal of large quantities of mosquitoes, moths and other insects in a city environment positively affects life quality, people's health and tourism. Ultimately this translates into positive economic value associated to the bat communities. That said, urbanization being one of the most long lasting activities of mankind is also associated to local extinctions. Bat species that are more sensitive to human activities have possibly suffered population declines due to the expansion of urban areas and habitat alteration. Nevertheless, the maintenance of urban green areas, with arboreal vegetation and water courses could promote the presence of bats and increase activity in general. In fact, these areas constitute a refuge for bats being the harbour for biodiversity in an urban environment. Given the amount of urbanization and its increasing growth rate, these green urban areas could even be relevant for conservation at the regional scale. Yet little is known regarding which characteristics an urban green area should have to promote the presence of bat species and improve the extent of foraging areas and roost availability. This study aims to identify which species are present in a set of urban parks and other urban green areas relating them to the landscape characteristics. The study was conducted at the council of Cascais, located in the central-western coast of Portugal. The area is known for the variety of its parks spanning from centuries old gardens to more modern green areas. During 70 nights, 365 acoustic listening points were made from September to October in 2011 and March to October in 2012, covering 19 green areas. These data were later analysed with a set of variables descriptive of the landscape characteristics (including several vegetation descriptives, age of the garden and water availability) and structure, and climatic conditions. Generalized Linear Models were employed and results have indicated which variables should be taken into account when projecting and designing green areas to increase bat species richness and general activity. The development of urban green areas adequate for the thriving of bat populations could hamper the decline in some

species while promoting an increase in the connectivity of populations in such a harsh environment for wildlife like the cities.

## **The abandonment of rural areas contributes to population growth of the lesser horseshoe bat (*Rhinolophus hipposideros*, Bechstein, 1800) in Galicia (NW Spain)**

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The lesser horseshoe bat, *Rhinolophus hipposideros*, is one of the most rapidly declining bats in Europe. The use of pesticides, roost' disturbances or their disappearance and landscape's transformation are pointed as the main threats for the species. Despite this general trend across Europa, *R. hipposideros* is well distributed and locally abundant in Galicia (NW of Spain), where this bat is tightly linked to humans, since there is only one shelter known located in a non-human structure. We hypothesize that both human migration and landscape transformations have had a positive effect on the evolution of *R. hipposideros* populations in Galicia. In order to investigate the genetic structure and dynamic of *R. hipposideros* populations we have studied the variability of the mtDNA marker HVII. Geographic patterns were inspected using SAMOVA and patterns of population dynamics through Raggedness and Mismatch Distribution analyses. We also have modelled the current colonies distribution of *R. hipposideros* in Galicia in order to understand the major factors determining the successful establishment of a colony. For the model we have used three major groups of environmental variables: climate, relief and land use measured at two scales. The probability of occurrence of horseshoe bats was described mathematically by the Maximum Entropy modeling approach (MAXENT). The average values of Area Under the receiver operating characteristics Curve of final climate, relief and habitat models ranged between 0.68 and 0.75, indicating overall good ability to predict the distribution of the species. Variance partitioning analysis showed that habitat had the greatest effect on the occupancy rate of lesser horseshoe bats, its pure effect accounting for 51% of the total training gain explained (ETG). In relation to habitat, 4 variables directly related with human activity had important and independent effects on horseshoe bats' occupancy, according to hierarchical partitioning analyses. These variables include the percentage of natural forest (ETG by its pure effect = 12%), percentage of urban areas (ETG by its pure effect = 10%), number of buildings (ETG by its pure effect = 5%) and percentage of timber crops (ETG by its pure effect = 1%). These results indicate that human population dynamic and land-use transformations are playing an important role in the growth

of *R. hipposideros* populations in Galicia. In fact, more than half of all shelters of *R. hipposideros* known in Galicia are at present abandoned buildings and the trend regarding the land use is an increase of forested areas in the region.

## **Acoustic mirrors as ecological traps for bats?**

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For echolocating bats smooth surfaces are like acoustic mirrors: their calls are reflected away for the most part, effectively returning no echo to the bat. Only when it gets close enough to the smooth surface it may receive an echo from those parts of the call that hit the surface perpendicularly. In field and lab experiments we showed that 1) horizontal smooth surfaces serve as a key feature for recognizing water surfaces. This behavioural pattern can be very stereotypical and persistent, is phylogenetically widespread and innate. Furthermore we found that 2) vertical smooth surfaces can mislead bats into taking them for holes in the wall, leading to collisions.

We compare these two situations and consider the circumstances that will lead to the described effects. Under natural conditions bats would only come across bodies of water as smooth surfaces. However, in our anthropogenic, modified world we find many of these smooth surfaces, both horizontal and vertical. We raise the question to what extent this might pose a problem for bats that live in such a modernised world.

## Living on the edge: studying bat colonization of bridges in northern Portugal

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It is widely acknowledged that bridges play a relevant role as roosting opportunities for several bat species in the U.S.A. However, in Europe that role has seldom been studied with only sporadic and scarce information available. In the scope of several environment impact assessments being carried out in Portugal, it was found that some bridges in the north harboured substantial numbers of individuals and bat species. In this context, we proposed to study which factors promote the colonisation of bridges by bats in northern Portugal (mainly at Sabor river watershed). In this area a large dam is being constructed and consequently new bridges are being built to compensate the loss of bridges that are going to be submerged by the reservoir. This provides a unique opportunity to analyse bridges with different ages. Therefore, main questions were 1) which characteristics promote the colonisation of bridges by bats? 2) are drivers of bridge colonisation similar between bat species? 3) which unsurveyed bridges in northern Portugal could be occupied by bats? 67 bridges of different ages and architectonic variables were sampled between June and August 2012. We searched for bats and signs of their presence (droppings, urine stains and corpses) using binoculars and a borescope. Whenever possible, individuals were identified to species level. The geographic coordinates of every bat/colony found were taken with a GPS. Variables as age and height of the bridge, altitude, distance to cliffs, trees and known colonies, bearing and insolation were also measured. 18 bridges were occupied by bat colonies from the genus *Pipistrellus* spp, *Eptesicus* spp but surprisingly the most common was *Tadarida teniotis*. The collected data will be modelled with correlative methods and results from this study are expected to highlight which characteristics should a bridge have to become “bat-friendly”. Consequently, these results will be used to developed a set of conservation guidelines for bats in bridges in collaboration with the national nature conservation authorities (Instituto da Conservação da Natureza e das Florestas), and several roads concessionaires (Estradas de Portugal, Ascendi).

## Does traffic noise matter for roosting bats?

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Negative effects of roads on wildlife population are prevalent and well documented. How to mitigate such negative effects becomes a shared concern. While there are several factors associated with roads being potentially responsible, traffic noise was repeatedly suggested to be a critical one. Bats are ecologically and economically important mammalian order living across the globe, but facing increasing threats from human activities. Nevertheless, little is known about whether traffic noise affects roosting bats. Taking a comparative approach, we played both mimicked traffic noise corresponding to three different distances (25 m, 50 m and 100 m) to a highway and three other natural environmental noise (bird song, colony noise and vegetation noise) to 14 roosting greater mouse eared bats (*Myotis myotis*) individually. Both skin temperature and behavioural data suggested that roosting bats were sensitive to noise and responded to them in a high proportion. Especially, all noise rarely failed to induce a behavioural response of roosting bats. In contrast, skin temperature data indicated that traffic noise had least effect on roosting bats, comparing to other three environmental noise; and bats showed dramatic capacity of habituating to continuous noise. Averagely, bats subjected to the continuous noise for the second time had a relative skin temperature of 3.3 °C lower than those for the first time. Like other acoustic predators hunting for preys by passive listening, *M. myotis* represents a bat species that is sensitive to relatively low frequency sounds such as traffic noise, while this is not true for many other bat species. We propose that traffic noise might not be an important factor in determining the roosting habitat selection of bats.

**Monitoring the effects of changed illumination on the roosts of lesser horseshoe bats *Rhinolophus hipposideros* (Bechstein, 1800) in churches in Slovenia**

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Many bat nursery colonies are established in buildings of cultural heritage such as churches. In Slovenia, numerous churches have been illuminated during the night for aesthetic reasons, yet mostly with exaggerated intensity and improper installation of luminaries. The impacts that such night lighting have on animals have not been considered, even though the negative consequences of light pollution on biodiversity are being increasingly documented. In cases, when the lighting of buildings cannot be removed, a question remains, whether the lighting can be set in a less disturbing way for the animals. Changing the illumination with the goal of improving the status for bats and moths is the central theme of the project “Life at Night”, co-financed via EU Life+ financial scheme ([www.lifeatnight.si](http://www.lifeatnight.si)). Project started in September 2010 and will last till February 2014, which includes three summer field seasons. Churches included in the project all had previously existing improper illumination. They were selected in triplets, which are groups of three churches situated in the same geographical region. Within each triplet the lighting among the churches differs, and each church will be lit differently in each of the three monitoring years. In each set, one church keeps the original exaggerated illumination, while the other two have illumination changed with specifically designed luminaires: one church having yellow-orange light and the other bluish-white light. The new luminaires have a decreased light intensity, a UV filter and tend to diminish the lighting of flight openings. In some cases their number per church was reduced. The focus species of the study are the lesser horseshoe bats (*Rhinolophus hipposideros*), a species that in Slovenia forms nursery colonies almost exclusively in buildings. The effects of different types of illumination on the evening emergence time, emergence behaviour and juvenile growth (monitored at one church triplet only) are being monitored during each season. Results of the observations in the first two years of the study are presented.

## **Bat activity and light pollution**

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Global ecosystems are currently subjected to climate change and habitat deterioration at unprecedented scales. Urban areas are expanding proportionally faster in a global context than any other land cover type, causing dramatic changes in the structure and functioning of ecosystems. Although research is now addressing the negative impacts of anthropogenic noise on biota, less attention has been paid to the effects of light pollution. Light pollution is a rising global problem affecting every inhabited continent, covering 100% of the land area in many countries. As human populations rise and become increasingly urbanised, global levels of light pollution are set to increase. Light pollution ranks as a key emerging issue in biodiversity conservation, and has important implications for policy development and strategic planning. As novel lighting technologies emerge, there is considerable scope for reducing negative impacts of artificial lighting on bats. We have used observational and experimental studies in the field to monitor potential impacts of artificial lighting on bats. Bats respond to artificial lighting in species-specific ways that correspond with flight morphology and likely predation risk. For a long time it has been known that many bat species that forage in open-spaces may exploit insects attracted in large numbers to street lights. However light-averse, slow-flying species such as lesser horseshoe bats show large-scale reductions in activity along commuting routes that are experimentally lit by high-pressure sodium (HPS) lights (Stone et al. 2009). Emerging technologies such as LED lights show a similar effect size to HPS lights in reducing activity levels of lesser horseshoe bats, and dimming may be ineffective for mitigation (Stone et al. 2012). Impacts of lighting may be especially severe for bat communities that are rich in numbers and diversity of light-averse species, such as bat communities in Southeast Asia that include large numbers of horseshoe bats.

Stone, E.L., Jones, G., Harris, S. (2009) Street lighting disturbs commuting bats. *Current Biology* 19: 1123-1127.

Stone, E.L., Jones G., Harris, S. (2012) Conserving energy at a cost to biodiversity? Impacts of LED lighting on bats. *Global Change Biology* 18: 2458-2465.

## SESSION II: BATS IN DISTURBED HABITATS

**Organizers: Ariovaldo Cruz-Neto, Matt Struebig**

### **Habitat preferences of bats in anthropogenically altered, mosaic landscapes of northern Poland**

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Only few studies refer to large-scale habitat preferences of multi-species bat assemblages of temperate mainland Europe. The aim of the following study was to describe habitat and landscape associations of foraging and commuting bats in postglacial lakelands and coastal plains of northern Poland. In total, 100 UTM squares (10×10 km) were selected at random and bat calls were recorded on linear walking transects, using broadband ultrasound detectors. Basic 33 habitat classes and 29 sub-classes were distinguished. Bats, if all species were lumped together, selected lakes and ponds, rivers and canals, but avoided arable land, meadows and pastures, mixed forests and its edges, roads in coniferous forests and suburb residential areas. *Nyctalus noctula* appeared to be an eurytopic species with the broadest habitat niche (measured with Levin's index), using most habitats, including arable land and rivers, in proportion to their availability. It preferred only lakes and ponds, while avoided tree lines and villages. *Eptesicus serotinus*, a synanthropic species, strongly selected villages, high-building urban zone and roads in mixed forests. Furthermore it remained eurytopic, with relatively broad habitat niche – it was the only species that did not select water bodies. Much narrower habitat niches were occupied by pipistrelles. *Pipistrellus pipistrellus*, being the most eurytopic member of its genus, strongly preferred tree lines, but also various water bodies. It avoided meadows and pastures, roads in coniferous stands and suburbs, but villages were used in proportion to their availability. *P. nathusii*, the second commonest bat recorded, selected water bodies, while avoided all open areas, tree lines and villages. *P. pygmaeus*, the rarest among pipistrelles in the area, strongly preferred lakes, ponds and roads in deciduous forests. Thus, although considered a sibling species of *P. pipistrellus*, it resembled *P. nathusii* much more in terms of habitat preferences. *Myotis* species, represented mostly by *M. daubentonii*, revealed the narrowest niche among the studied taxa, selection most bodies of water but avoiding all open habitats, roads in coniferous forests, tree lines and built-up areas. Some differences in bat use were found also among habitat subclasses – eutrophic and dystrophic lakes and ponds, surrounded by trees and free of floating vegetation were preferred, while meso- and oligotrophic ones were avoided. The results not only reveal a pattern of resource partitioning between co-occurring species (including all, three, Central European *Pipistrellus*, for the first time) but also provide base for region-specific landscape planning guidelines that may be applied for bat conservation.

## **How disturbance-gradients affect aerial insectivorous bats: two stories about the New and Old World tropics**

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One of the major global problems nowadays is the steadily expanding land alteration and its consequences for biodiversity. Bats as the second largest mammal order contribute a high functional diversity and deliver crucial ecosystem services, e.g., pollination, seed dispersal and arthropod predation in tropical ecosystems. While effects of habitat loss and alteration on diversity of nectar-feeding and frugivorous bats are more easily studied, information about aerial insectivorous bats in the Neo- and Palaeotropics is extremely scarce, due to the costs of acoustic monitoring and a lack in acoustic bat call libraries around the world. We studied aerial insectivorous bats with acoustic methods along land use gradients in the Atlantic rainforest in Bahia, Brazil and on the slopes of the Mt. Kilimanjaro, Tanzania. We focused our research on natural forest, intermediate habitats and intensively used areas. Using standardized sampling protocols we recorded 10468 bat passes in 51 nights. We classified bat passes into sonotypes, as a proxy for species identity, and counted to occurrence as a measure of relative bat abundance. Surprisingly, sonotype richness of aerial insectivorous bats was not negatively affected by land use intensification in both gradients, as found high sonotype richness in intensively used plantations and forest sites. In contrast occurrence of bats differed significantly between habitat types, albeit we found highest values in intensively used plantations in Tanzania and Brazil. Even so, bat assemblages differed significantly between habitat types and some species reacted strongly negative to land use intensification. In both regions we found species highly associated with forest sites, e.g., *Centronycteris* sp. in Brazil and *Kerivoula* sp. in Tanzania. Although we found high sonotype richness in intensively used habitats, forest sites represent an important refugium for many species. In order to preserve bio- and functional diversity in agricultural used areas, remaining forest fragments need to be protected and restored. Furthermore, both study regions showed high landscape heterogeneity, i.e., a mosaic of forest sites, intermediate habitat types and plantations, which maintains an overall high number of aerial insectivorous bat species in both countries.

## Impacts of rainforest modification on insectivorous bats

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Bats possess many of the features required of bioindicators for conservation assessment; namely high diversity, complexity of assemblage structure, and predictable responses to environmental change. We are investigating this assemblage response across a forest modification gradient from old growth forest to logged forest to fragmented forest to oil palm and *Acacia* plantation at the Stability of Altered Forest Ecosystems (SAFE) project in Sabah, Borneo. This is the first integrated research on bats of its kind in Southeast Asia and builds on work elsewhere on Borneo and West Malaysia. We aim to quantify the relative value of forest fragments and riparian strips to biodiversity in plantation-dominated landscapes and design a monitoring protocol applicable to environmental certification.

Here we report on the first phase of research focusing on the responses of bats to intensive logging. Bats were captured in 504 harp traps at 12 forested sites that varied in logging intensity, and assemblage data linked to habitat plots and roost surveys undertaken near capture points. Variation in canopy height, openness and tree roost availability defined the disturbance gradient, and was correlated with a decline in bat abundance and shift in assemblage structure in logged forests. Several species that roost in tree cavities were poorly represented at heavily disturbed sites, yet an IUCN-threatened species dependent on large fallen trees showed no such trend. Heavily logged forests, despite their low aesthetic value, still support representative levels of bat diversity, despite subtle changes in assemblage structure and species richness.

Ongoing work includes the analysis of 1440 night hours (3 months!) of ultrasonic bat recordings taken in tree-fall gaps at 15 sites in forest, *Acacia* and oil palm. In 2013 we will extend this sampling to riparian zones post forest-clearance, and also to birds and frogs, in order to establish a standardised acoustic monitoring protocol for biodiversity assessment.

## **On the magnitude and responses to the effects of fragmentation in bats: A phenotypic integration analysis**

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Loss of forest area and large-scale fragmentation are major threats to bat biodiversity on a global-scale. However, on a local scale, the magnitude and extent of this effect seems to be specie-specific. Some species of bats are not, or are even positively, affected by fragmentation, while others are more prone to local extinction. Thus, the magnitude of, and the mechanisms used by bats to counteract these effects are likely to differ between species. Usually, the magnitude of the effects of fragmentation is measured by comparing the relative abundance of target species between fragmented and non-fragmented areas. However, this metric can be misleading in some cases, and does not inform about the underlying mechanisms responsible for the differential response. Given the synergism and complexity of these effects, one approach to such problem is the phenotypic integration analysis. In this approach, one measures a series of phenotypic attributes related to organismal performance at different levels of organization that can be used to simultaneously determine the magnitude of the effects and to unravel the underlying mechanisms responsible for the differential responses to these effects. In this talk, we will present such analysis by integrating the results of genetic (inbreeding depression and level of homozygosis), morphological (fluctuating asymmetry, body condition and organ mass) ecological (dietary breadth) and physiological data (enzymatic activity, hematological and hormonal profiles, and energy expenditure) obtained from individuals of populations of 3 different species at fragmented and non-fragmented areas. We used as model organism 3 species of frugivores Phyllostomid bats, *Artibeus lituratus*, *Carollia perspicillata* and *Sturnira lilium*. Although these species are considered common in fragmented landscape, differences in their body mass and flight capabilities suggests that the effects of fragmentation would be experienced differently by these species, and that the mechanisms used by them to cope with such effects might also be different. By using the phenotypic integration analysis, we aimed to gauge more accurately the magnitude of the fragmentation effects in bats and to provide informations about the diversity of the mechanisms used by these mammals to counteract the negative effects of this impact.

Financial support: FAPESP grant # 2008/57687-0

## Temporal variation in responses of Neotropical bats to forest fragmentation

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Over the last decades a great deal of research has been devoted to studying the consequences of habitat fragmentation. For most taxa, however, fragmentation effects have essentially been studied as static phenomena, and we still know little about the dynamics of fragmented tropical ecosystems and how taxa respond to habitat fragmentation over longer timescales. In the Neotropics, bats represent important components of biodiversity from taxonomic and functional perspectives, and provide vital ecosystem services. Because of their local abundance, richness, and ecological diversity, bats are considered a promising indicator group for studying responses to landscape fragmentation in the Neotropics. Although a growing number of studies have addressed the effects of forest fragmentation on tropical bats, these were generally rather short-term, “snapshot” investigations, and consequently we are still lacking a clear understanding of temporal variation in response patterns of bats to fragmentation and how species responses are mediated by matrix dynamics over the longer term. We will present preliminary results from an ongoing project that is being conducted at the Biological Dynamics of Forest Fragments Project (BDFFP) in the Brazilian Amazon and which aims to contribute towards filling this knowledge gap. Using data from a previous bat inventory (1996-99) as baseline for our comparison, we have resampled the same sites (different-sized forest fragments and control plots in continuous forest) starting in 2011 using identical methods in order to assess temporal changes in the BDFFP bat fauna over the last ~15 years in response to vegetation development in the matrix. Preliminary results suggest greater within-site differences in species richness in fragments than in continuous forest in both study periods, indicating that fragment assemblages tend to be hyperdynamic compared to those in unfragmented habitat. The negative impacts of patch size on species richness, diversity, and abundance that were observed during the first study period seem to have faded or to be less marked, e.g. for certain groups such as gleaning animalivorous bats. These findings are most likely related to the mitigating impacts of the relatively mature secondary forest vegetation that now dominates the matrix. This change in matrix composition appears to be a main factor shaping the composition of the fragment

bat assemblages, linked to the turnover of certain shrub-frugivores and the relative increase of some gleaning animalivorous species. These findings underscore the important role of matrix management in conservation efforts.

## **Anthropogenic habitat fragmentation: Genetic consequences in two frugivorous bat species**

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Tropical ecosystems are strongly endangered by human impact. Once continuous habitats are converted into mosaic landscapes composed of forest remnants embedded into a matrix of cattle pastures and agricultural lands. A decrease in habitat connectivity may affect the functional connectivity among animal populations. Long-term effects on genetic population structure are becoming clearer for many taxa. However, studies on bat populations are still scarce, especially in the Neotropics. We studied genetic diversity and structure of populations of frugivorous bats on a small geographic scale of approximately 20 km. We focused on the species *Carollia castanea* and *Dermanura watsoni* inhabiting nine forest fragments in an agricultural landscape in Costa Rica. For our study we analyzed DNA sequences of the mitochondrial D-loop. We detected significant levels of population differentiation in *D. watsoni* ( $F_{ST} = 0.05$ ,  $p < 0.001$ ) but not in *C. castanea* ( $F_{ST} = 0.008$ ,  $p < 0.17$ ). Genetic diversity in forest fragments was reduced in both species. Habitat patch size and matrix configuration accounted for differences in genetic diversity among fragments in *Dermanura watsoni*. Our results demonstrate that neotropical bats inhabiting fragmented landscapes are not secure against loss of genetic diversity and population differentiation despite their ability to fly and the related high mobility. However, sensitivity towards habitat degradation seems to be species-specific. We assume that differential feeding strategies in our focus species might be an issue here. In detail, *Dermanura watsoni* feeds on a wide variety of fruits from mature forest whereas *Carollia castanea* is strongly specialized on *Piper* fruits from early and late succession. Hence we suppose that *C. castanea* is rather used to matrix habitats and less edge sensitive than *D. watsoni*. This in consequence might affect dispersal ability and hence gene flow among populations. As frugivorous bats play a keyrole as seed dispersers, especially in degraded ecosystems, we want to highlight the need for conservation plans in fragmented habitats.

## **The effect of a major road on bat activity and diversity, and the effectiveness of current mitigation practice**

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It is well known that roads have a significant impact, usually negative, on species and ecosystems. However, despite their protected status in many countries, research into the effects of roads on bats has begun relatively recently. We investigated the effects of a major road on bat activity and diversity using broadband acoustic surveys on 20 walked transects perpendicular to the M6 motorway in Cumbria, UK. Bat activity was recorded at different distances up to 1.6 km from the road. Climatic and habitat variables were also recorded, and the relationships between bat activity and these variables were investigated. Total bat activity, the activity of *Pipistrellus pipistrellus*, (the most abundant species) and the number of species were all positively correlated with distance from the road. Total activity increased more than three-fold between 0-1600 m from the road. These effects were found to be consistent over two years, with the scale of the impact indicating a barrier effect. We have recently carried out further work on the M5 motorway in Somerset, UK, with similar results.

To mitigate against these effects and comply with environmental law, many European countries install bridges, gantries or underpasses to make roads safe to cross. However, through lack of appropriate monitoring, there is little evidence to support their effectiveness. Three underpasses and four bat gantries were investigated in northern England. Echolocation call recordings and observations were used to determine the number of bats using underpasses in preference to crossing the road above, and the height at which bats crossed. At gantries, proximity to the gantry and height of crossing bats were measured. Data were compared to those from adjacent, severed commuting routes that had no crossing structure. At one underpass 96% of bats flew through it in preference to crossing the road. This underpass was located on a pre-construction commuting route that allowed bats to pass without changing flight height or direction. At two underpasses attempts to divert bats from their original commuting routes were unsuccessful and the majority of bats crossed the road at traffic height. Underpasses have the potential to allow bats to cross roads safely if built on pre-construction commuting routes. Bat gantries were ineffective and used by a very small proportion of bats, even up to nine years after construction.

Ongoing work will also be discussed, with reference to the species-specific effects of roads and the potential of habitat improvements as a mitigation measure.

## **Butyltin compounds in the food web: Impacts on chironomids and Daubenton's bats**

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Organic tin compounds (OTC's) in aquatic ecosystems originate from antifouling paints used on the hulls of ships. Although the use of OTC's in antifouling paints is now forbidden, high concentrations of these degradation-resistant compounds still exist in marine sediments especially around ports and repair shipyards. Organic tin compounds are lethal at high concentrations, but sub-lethal concentrations affect energy production, hormone balance and immune function with consequent effects of this biomagnifying substance on ecosystem function. The present work studies the distribution of a certain OTC, tributyltin (TBT), in the Archipelago Sea, S-W Finland, and the physiological and ecological effects it has in the foodweb from chironomids to Daubenton's bats. The results emphasize the point-source distribution of TBT where accumulation in chironomids and Daubenton's bats occurs only close to the source, a repair shipyard in the northern part of the study area. Tributyltin was found to affect many life-history traits in and community structure in chironomids. In Daubenton's bats, TBT was found to correlate negatively with immune function activity, but no correlation was found with redox-status or antioxidant enzyme activities. High heterozygosity in local Daubenton's bat populations also suggests TBT contamination does not pose a barrier to gene flow in the study area.

**SESSION III: VIRAL EMERGING DISEASES IN BATS**  
**Organizers: Christian Drosten**

**Nipah virus: A case study for using a one health approach to understand emerging zoonoses**

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The majority of emerging infectious diseases originate from wild animal populations. Human activities such as agricultural expansion, urbanization, deforestation, and global trade increase the opportunities for people and domestic animals to come into contact with wildlife. Encroachment on and utilization of wildlife habitat by humans and livestock create high-risk interfaces that facilitate the spillover of animal microbes that have the potential to cause disease in humans or other animals. In order to prevent emergence and re-emergence events, it is essential to identify interfaces and behaviors that increase the risk of spillover as well as the natural reservoirs for the agents of concern. In 1998, Nipah virus (NiV), a bat-borne paramyxovirus related to Hendra virus, emerged on a pig farm in Malaysia due to agricultural intensification which expanded the bat-pig interface and provided a suitably large susceptible pig population to support a sustained outbreak. Nipah virus has since been recognized as the cause of near-annual outbreaks of encephalitis in Bangladesh between 2001 and 2012 with greater than 75% mortality. Infections in Bangladesh are seasonal (Dec-Apr) and almost exclusively detected within a western region of the country termed the “Nipah Belt.” *Pteropus giganteus* appears to be the natural reservoir for Nipah virus in Bangladesh, and in-depth studies are underway to understand the ecology of Nipah virus using a comprehensive multidisciplinary approach to develop coordinated surveillance and outbreak response systems, that includes human and animal health experts, ecologists, anthropologists, and microbiologists. This initiative has significantly increased our knowledge of Nipah virus transmission among bats and from bats to people. The approach to surveillance has also enhanced Bangladesh’s ability to respond to Nipah virus outbreaks and other zoonotic diseases.

## **Determinants of the viral richness in 15 African bats: importance of the fragmentation of the distribution areas**

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The increasing incidence of emerging infectious diseases (EID) is mostly linked to biodiversity loss, changes in habitat use and increased habitat fragmentation. Bats are linked to a growing number of EID but few studies have explored the factors of viral richness in bats that may have implications for the potential reservoir roles of bats. We investigate the determinants of viral richness in 15 species of African bats (8 Pteropidae and 7 microchiroptera), present in Central and West Africa for which we provide new information on virus infection and bat phylogeny. We performed the first comparative analysis to test the hypothesis that fragmented distribution correlates with viral richness in bats. Because of their potential correlates and/or confounding variables, sampling effort, host body mass, and ecological and behavioral traits such as roosting behavior, migration, number of breeding seasons, and geographical range, were taken into account in the analysis.

Our results show that roosting behavior and fragmentation have significant effects on viral richness in bats: Viral richness is superior in bats roosting in caves than bats roosting in foliage and is positively correlated with the level of fragmentation of the bats' geographical distribution area. Bat species living in highly fragmented habitats harbor a high level of virus diversity.

So, accumulation of viruses should be related to the historical expansion and contraction of bat species distribution range, with potentially strong effects of distribution edges on virus transmission. For a given amount of habitat, more fragmented habitats contain more edges. Positive edge effects could be responsible for positive effects of fragmentation on abundance or distribution of some bat species that may have facilitated host switches of virus. An alternative explanation is the direct role of parasitism in shaping the distribution range limit of hosts through host local extinction by virulent parasites although this hypothesis was never tested using empirical data. As already emphasized, we should be aware on making difference between fragmentation and habitat loss, the consequences of habitat loss on bat viruses should not be similar according

to their range fragmentation patterns. Habitat loss following land use changes has been perceived as a major threat to biological diversity, whereas fragmentation may likely to be positive or negative. The consequences in terms of surveillance, spill-over and emergence in human populations are then bat species specific in relation to their historical biogeography, and actual range fragmentation, and ongoing losses of habitats.

## **Orthoreoviruses isolated from European bats**

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Bats are known to serve as reservoir hosts for an increasing number of emerging pathogens. Beside such high pathogenic viruses that can induce SARS, Ebola, Marburg, Hendra and Nipah infections, attention was devoted to another virus family: In 2007 an orthoreovirus was isolated from a patient with a respiratory disease in Malaysia. This virus was found to be genetically related to viruses that have previously been isolated from fruit bats. Consecutively, five additional, closely related orthoreoviruses have been isolated from fruit bats and humans in Malaysia, China and Australia.

Here we report the first isolation of three novel orthoreoviruses from European insectivorous bats (Microchiroptera). Unlike the fusogenic orthoreoviruses isolated from bats in Asia and Australia, these viruses are close related to the non-fusogenic species Mammalian orthoreovirus which are capable to infect a broad range of mammals including man. The novel isolate showed the closest sequence homology and phylogenetic relationship to strain T3/D04 isolated from a dog in Italy, suffering on hemorrhagic diarrhea. In addition to strain T3/D04 an increasing number of unusual high virulent mammalian reoviruses have been described in the last years.

It is noteworthy, that this is the second time we can report a virus, isolated from European bats, which's closest relative is a virus causing severe diseases in dogs. A study we recently published reported the close relationship of bat adenovirus 2 and canine adenoviruses. For the adenovirus we hypothesized an evolutionary inter-species transmission between bats and canids. These novel reoviruses might provide likewise a further rare possibility to get insights into the pathogenicity, possible inter-species transmission events and evolutionary origins of bat viruses.

## **Coronaviruses related to human betacoronavirus 2c EMC/2012 in African and European bats**

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Emerging infectious diseases have gained relevance in recent years, and major epidemics facilitated by an increasingly mobile global population have major consequences for both public health and global economies. There is a growing body of evidence linking the loss of biodiversity with transmission of infectious diseases in humans and wildlife. Bats, in particular, are increasingly identified as reservoir hosts for zoonoses. Minimising the risk of future epidemics requires knowledge about the reservoir hosts and how ecological factors may promote virus abundance and transmission, or provide conditions for host-switching events from disease reservoirs to other taxa. Coronaviridae comprises viruses pathogenic to both birds and mammals. The family includes human viruses responsible for mild respiratory diseases and the SARS coronavirus responsible for the global epidemic in 2002-2003, for which a likely reservoir has been identified in rhinolophid bats. In September 2012, health authorities were notified of two cases of severe respiratory disease caused by a novel human coronavirus (Betacoronavirus clade 2c, EMC/2012). We screened 4,758 bat fecal specimens (ten species) from Ghana for betacoronaviruses. Viruses related to the novel human virus were detected in 46 of 185 (24.9%) *Nycteris* bats in high virus concentrations. These formed a sister clade to the EMC/2012 virus and a European *Pipistrellus*-associated coronavirus. This confirms the relevance of bat hosts for the 2c coronavirus clade and highlights the possibility of a bat origin of the new human virus. Demographic factors predictive of the presence of the 2c-clade coronavirus in bats were assessed. Juvenile bats and lactating females were significantly more likely to be infected than adult bats and non-lactating females, respectively. This suggests that the virus is mainly transmitted between mothers and offspring. It remains unknown whether cross-order (e.g., chiropteran, carnivore, primate) host switches have occurred for 2c-clade bat coronaviruses. However, the massive amplification in lactating females and young *Nycteris* highlights the potential of *Nycteris* maternity colonies

as settings conducive to host-switches to alternate hosts, including humans. Additionally, hunting and consumption of bats and the use of bat caves as sources of water and guano throughout Africa may facilitate host-switching events. More broadly, demographic pressure leading to deforestation and land-use change throughout sub-Saharan Africa may increase the potential for human contact with such disease reservoirs.

**SESSION IV: BATS AND RABIES**

**Organizers: Charles Rupprecht, Thomas Müller**

**Inferences from lyssaviruses on prevention & control of emerging bat infectious diseases**

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Bats serve as the global reservoirs of lyssaviruses, the etiological agents of rabies in Africa, the Americas, and Asia. This zoonosis is an acute progressive encephalitis and is the most significant infectious disease associated with bats. Public health, agricultural, and conservation lessons focused upon rabies, and gleaned from the past century, have substantive applications to the management of disease issues affecting bats. Objectively, a basic understanding of the epizootiology, pathobiology, and infectious disease ecology has been fundamental to progress. Focused laboratory-based surveillance and utilization of licensed vaccines were two of the most important tools to understand and manage this disease. A balanced communication approach to risks of disease and benefits of the Chiroptera is critical. Accurate up to date information and professional/public outreach is necessary to demystify false impressions, correct myths, present basic facts, and examine available options. Clearly, lethal control in bats has been ineffective. Rather, methods to prevent overt exposure to bats, and medical/veterinary intervention after exposures, have been extremely effective in disease prevention among non-target species. Beyond indirect benefits resulting from renewed advocacy, education, and mitigation of viral exposures to humans and domestic animals, extrapolation of other measures may be possible to bats directly. For example, over the past several decades, the concept of wildlife vaccination has progressed from concept to reality in a broad range of vertebrates, which could be focused upon bats as well. Field surveys demonstrate that pre-existing immunity exists for a wide variety of bat taxa against diverse lyssavirus species. As such, exploitation of herd immunity should be possible given current technology. Preliminary research suggests bats can mount a productive immune response under captive conditions. Future development of safe and effective biologics may offer relevant solutions for the design of novel vaccines delivered by a number of selective routes. Such a multi-disciplinary approach for the practical prevention and control of rabies in bats could be extrapolated to other emerging infectious diseases via a similar strategy.

## Novel bat lyssaviruses in Europe and Africa – emergence or emerging efforts to discover?

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Lyssaviruses are the causative agents of rabies, the oldest known zoonotic disease. Notably, rabies transmitted by bats is also the first recorded bat associated zoonosis. In the past decades, beside European bat lyssaviruses 1 and 2 (EBLV-1 and 2) novel lyssaviruses that are all associated with insectivorous bats were discovered in Eurasia, including Irkut virus (IRKV), Aravan virus (ARAV), Khujand virus (KHUV) and West Caucasian bat virus (WCBV).

More recently, further four lyssaviruses were discovered in Africa and Europe. In 2009 a bat associated virus called Shimoni bat lyssavirus (SHIBV) was isolated from the insectivorous Commerson's leaf-nosed bat (*Hipposideros commersoni*) in Kenya. In May 2009 an African civet (*Civettictis civetta*) suspected of having rabies was killed in the Serengeti National Park, Kenya. The isolated virus named Ikoma Virus (IKOV) was genetically significantly different from all previously known lyssaviruses. Although the origin of IKOV is difficult to determine, a likely source is a spill-over from an infected possibly grounded bat. In 2010 another novel bat lyssavirus was detected in a Natterer's bat (*Myotis nattereri*) in Germany and was subsequently named Bokeloh bat lyssavirus (BBLV). Additional BBLV induced rabies cases in Natterer's bats in France and Germany in 2012 support the hypothesis that the Natterer's bat is the true reservoir species. A Schreiber's bent-winged bat common bent-winged bat (*Miniopterus schreibersii*) bat died soon after admission to a wildlife care center in the City of Lleida, Spain tested positive for rabies and the isolated Lleida bat lyssavirus (LLEBV) was most closely related with WCBV, also isolated from a Schreiber's bent-winged bat bent-winged bat.

The discovery of these novel lyssaviruses leave room to speculate on their "emergence". Details and similarities of the individual viruses will be presented and discussed in the frame of, e.g. bat rabies surveillance data.

## Is there a need for pan-lyssavirus vaccines?

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In recent years the detection of zoonotic pathogens within bat species has increased significantly. Bat species across the globe are now recognised as reservoirs for numerous important human pathogens with novel viruses being detected in bat species from almost all characterised virus families. Some important examples include coronaviruses, filoviruses, paramyxoviruses and rhabdoviruses. Of these viruses, human infection is most often fatal when the infecting virus is a lyssavirus. The lyssaviruses constitute a diverse group of important zoonotic pathogens of considerable risk to both public and animal health. The prototype lyssavirus, rabies virus (RABV) currently causes an estimated 50,000 deaths/year across the developing world, being principally transmitted through dog bite. Interestingly, the current understanding of bat derived lyssaviruses within different bat populations remains an enigma. Currently, across the New World only classical RABV is found within bat populations, being also present in populations of terrestrial carnivores. In contrast, in the Old World numerous divergent lyssaviruses have been detected, primarily within bat populations, but also within terrestrial carnivores following spill-over events. Importantly, despite the presence of RABV in terrestrial carnivore populations of the Old World, RABV has never been detected in Old World bats. However, despite the continued detection of lyssaviruses in the Old World, the impact of these viruses on human populations remains unclear although where human infection has been reported infection has resulted in death with clinical disease being indistinguishable from that caused by RABV. Immunologically, the maintenance of lyssaviruses within bat populations also remains unclear. What is clear is that for a number of these lyssaviruses, the current rabies vaccines are largely ineffective. Antigenically, lyssaviruses are characterised into three phylogroups based neutralisation and vaccination/challenge studies. All current rabies vaccines are based on inactivated preparations of passage attenuated rabies isolates belonging to phylogroup I. The serological response following vaccination with the current vaccines have been shown experimentally to provide no protection against viruses from phylogroups II and III.

The increased study of the ecology, immunology and disease status of bats both in the wild and within experimental settings means that there is increased interaction between human and bat populations. From this viewpoint we discuss here whether novel pan-lyssavirus vaccines are required to protect those at occupational risk from these divergent lyssaviruses where no vaccine protection is currently available. Here we discuss what is currently known regarding lyssavirus divergence and vaccine protection and discuss potential mechanisms to generate pan-lyssavirus vaccines.

## SESSION V: WHITE-NOSE-SYNDROME

**Organizers: Sebastien Puechmaille, Craig Willis, Gudrun Wibbelt**

### **White Nose Syndrome: Evolution our Understanding and Definition**

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White nose syndrome (WNS) seemed to come out of nowhere; devastating bat populations in North America and challenging wildlife biologists, veterinarians, and veterinary pathologist to apply their knowledge of bat behavior, physiology and diseases in new ways. Unfortunately, managing the spread of WNS has proved untenable and the outbreak has swept across North America at an alarming rate. Though understanding the epidemiology, risk factors and pathogenesis is a slow process we do know more about the condition now than we did the first year. Extensive post mortem evaluations were conducted by veterinary pathologists on bats from New York and surrounding states and that data yielded a great deal of information on bat health. This information included documentation of what diseases were normally present in hibernating bats and separating those from the lesions associated with WNS. Two of the most striking findings in the WNS affected bats were their profound lack of subcutaneous fat stores and the infection of their skin with a novel fungus, *Geomyces destructans*. Further analysis of the data revealed a difference in prevalence of *G. destructans* infection in different bat populations and at different times of hibernation. Since then, new cases of WNS occur in North American every hibernation cycle and they are marked by the appearance of distinctive *G. destructans* conidia. Thus, WNS and the presence of *G. destructans* have been assumed to be synonymous. However, though this may be a reasonable assumption for North American bats, recent findings in Europe and concerns expressed by European researchers bring this assumption into question. This presentation will discuss the initial pathologic findings in the original bats from the WNS outbreak, provide an update on breeding population data collected in New York over the last two years and present alternative definitions of WNS that take into account the pathology data from the initial cases in the United States and published data from Europe. It is likely that the host/pathogen relationship between *G. destructans* and bats may be different on different continents. It is essential that our definitions of WNS reflect these differences so we may better track the outbreak. Moreover, understanding why different bat populations respond to *G. destructans* differently could provide valuable clues regarding the pathogenesis of the disease.

## **WNS is a complex phenomenon: theoretical and practical issues**

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Three seasons of detailed monitoring of geomycosis on bats in the Czech Republic (undertaken by CESON - Czech Bat Conservation Trust) provided an extensive dataset promising to reveal roles of particular factors responsible for the respective phenomenon and help in explaining the essential differences between USA and Europe in effects of geomycosis upon hibernating bats. The smaller scale interregional differences and correlation with some contextual variables indicate certain relations, yet the essential variables composing the phenomenon were found to be nearly orthogonal. This suggests a multidimensional setting of the problem and a multifactorial background of the phenomenon. Some theoretical and practical consequences of it will be demonstrated.

## **Update on the phylogeny and epidemiology of *Geomyces destructans* from North America and Europe**

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*Geomyces destructans*, the etiologic agent of White-Nose Syndrome (WNS), is the most devastating disease ever recorded in bats. The fungus has been found on bats throughout eastern North America and Europe, but large-scale mortality events have only been documented among bats of North America since 2007. Initial phylogenetic work on *G. destructans* isolates using 24 microsatellite loci and paired-end Illumina whole-genome sequencing indicated that North American isolates of *G. destructans* lacked genetic diversity relative to European isolates, suggesting recent introduction of the fungus to North America followed by rapid clonal spread of the pathogen. It is not certain, however, that the pathogen in North America originated from a European source, and determining the origin of this pathogen could have international implications for cave access and use. We have recently expanded the number and geographic distribution of *G. destructans* samples from Europe in our phylogenetic analysis. Provided with this broader genetic sampling, we report upon the current state of *G. destructans* phylogeny, and its relationship to WNS epidemiology, specifically the possibility of introduction of the WNS pathogen to North America from Europe.

## **Does hibernation impair immunocompetence of greater mouse-eared bats (*Myotis myotis*)? Constitutive immune response before and after arousal from hibernation**

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Mammalian hibernation consists of prolonged periods of reduced basic metabolic rate and body temperature, which are interrupted by intermissions of arousal when most of the physiological functions are temporarily restored. Hibernation affects as well the immune function, and it has been hypothesized that arousals may activate the dormant immune response to combat accumulated pathogens. Despite a plethora of studies on hibernating rodents and insectivores, we know virtually nothing about the immunocompetence of hibernating bats. However, this field is of highest priority due to emergence of the White-Nose Syndrome in North America. We collected blood samples from greater mouse-eared bats (*Myotis myotis*) in order to compare the structure (total- and differential white blood cell counts) and the functionality (*in vitro* bacterial killing capacity of the whole blood) of the pre-hibernating, hibernating and aroused individuals' constitutive immune system. In accordance with previous studies on non-Chiropterans, hibernating bats showed reduced numbers of total leukocytes, both lymphocytes and monocytes being affected. After arousal, the numbers of these cells were restored, however at a lower rate compared with other hibernating species, while the number of circulating neutrophils was not affected as their values remain similar for all three physiological conditions. When compared with euthermic conspecifics, hibernating greater mouse-eared bats had the lowest bacterial killing capacity, although their immune system was able to function *in vitro* at both 37°C and 9°C. Our study is one of the first to demonstrate an effect of hibernation on immune responses in Chiroptera. The constitutive immune function is reduced during torpor, but contrary to all animal species studied so far, hibernation of greater mouse-eared bats has no influence on circulating neutrophils indicating a continuous preparedness of the immune system against pathogens. Further comparative studies are needed to test whether this is a general pattern among cave-dwelling, hibernating bat species and if dissimilarities occur in the structure and function of the immune system, to explain the apparent continental differences in susceptibility to skin colonization by *Geomyces destructans*.

## **Understanding species differences in immunological responses to the newly invading pathogen, *Geomyces destructans***

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White nose-syndrome is caused by the emerging fungal pathogen *Geomyces destructans* (Gd) and was likely introduced through anthropogenic activity. However, this disease does not affect all species or all populations equally; for example, big brown bats (*Eptesicus fuscus*) have significantly lower mortality than little brown myotis (*Myotis lucifugus*). Surviving infection with Gd is presumably influenced by a number of factors, including within- and between-species variation in thermoregulatory traits, life history and behavioral traits, and immunological responsiveness. Although a number of traits likely favor big brown bat survival in the face of Gd infection (including their larger body size and their preference for hibernating for shorter periods, at colder temperatures, and solitarily or in smaller clusters), their ability to withstand Gd infection is not truly known. We conducted captive experimental Gd infections of little brown myotis and big brown bats, measuring multiple aspects of immune function at 3, 7, and 13 weeks post-infection. Assessment of immune responses included total white blood cell counts, neutrophil to lymphocyte ratios, microbicidal assays, phagocytic assays, total and anti-Gd immunoglobulin assays and cytokine profiles. Housed in identical conditions, big brown bats developed much lower levels of infection than little brown myotis and showed larger immune responses to infection by Gd. Additionally, uninfected big brown bats exhibited greater immune responses in general and appeared to maintain immune system capabilities throughout hibernation better than uninfected little brown myotis. Differences may reflect less immunosuppression during hibernation in big brown bats or indicate general differences between the immune systems of these two species. Most notably, big brown bats appear to be equipped to respond immunologically to infection by Gd more quickly and effectively than little brown myotis, especially as hibernation progresses and the fungus proliferates.

**White-nose syndrome and microclimate: relative humidity affects hibernation physiology and behaviour of little brown bats inoculated with *Geomyces destructans***

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White-nose syndrome (WNS) is an emerging disease of hibernating bats caused by cutaneous infection by the fungal pathogen *Geomyces destructans* (*Gd*), and is responsible for devastating declines of bat populations in eastern North America. To date little is known about the effect of environmental conditions on host-pathogen interactions, or the consequences of behavioural changes exhibited by infected bats. We also have limited knowledge of how the disease progresses throughout the hibernation period, particularly the temporal aspects of conidial colonisation, growth and epidermal penetration, as well as subsequent changes to bat energetics. We conducted a *Gd*-inoculation experiment on little brown bats *Myotis lucifugus* to 1) test the effect of different relative humidity levels on bat hibernation patterns and fungal growth, 2) evaluate different stages of fungal infection over time and 3) measure behavioural changes and metabolism of bats during different stages of hibernation. Bats were either *Gd*- or sham-inoculated and held in artificial hibernacula at 7°C and one of four levels of relative humidity (85%, 90%, 95% and 99%). We recorded skin temperature using temperature-sensitive data loggers and monitored behaviour with motion-sensitive infrared cameras. Respirometry measurements were conducted at four-week intervals on a subset of bats held at 99% relative humidity. At the conclusion of the study all bats underwent necropsy, histopathology and blood haematology analyses. We found significant increases in arousal frequency with inoculation at high but not low humidity and analyses of other variables are nearly complete. Our results will help explain the variation in WNS-associated mortality among hibernacula in the wild and assist with the development of management strategies.

**Modelling *Geomyces destructans* distribution in North America and Eurasia using ecological niche modelling: what can we learn?**

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White-nose syndrome (WNS), an emerging infectious disease caused by the fungus *Geomyces destructans* (Gd), has been expanding year after year in North America, suggesting a recent introduction of the fungus (probably from Europe). Given the massive mortalities associated with WNS in North America, it is of prime importance to predict areas suitable for its causative agent, Gd. By modelling the occupied niche by Gd in Europe, we predicted its distribution in North America and Asia, and which ecological factors could be limiting its distribution. To achieve this, we used a species distribution modelling technique – maximum entropy modelling - that has been proven to accurately predict current species distributions. In the last years, the scope of this technique has widened greatly, nowadays being frequently used to predict suitable areas for species reintroductions, potential areas of invasive species or forecasting of range shifts under climate changes (past and future). We also calculated the similarities/differences in niche occupied by Gd between North America and Europe and highlight potential adaptations of Gd in North America. Finally, we determined potential dispersal routes that Gd could use to expand its current distribution. Results indicated that Gd distribution was limited by temperature variables, occurring in areas without a large temperature range and with minimum temperatures below freezing during winter. Therefore, models predictions comprised the currently known distribution of Gd in Europe but also predicted a high suitability area in southern Scandinavia although a comprehensive sampling has not detected the fungus in that region. Regarding the ability for models to accurately predict potential areas of occurrence outside Europe, in the U.S.A. WNS was firstly identified in cave in New York. Models extrapolated from Gd distribution in Europe failed to identify as suitable the region were Gd was first seen in New York State, though subsequent Gd expansion routes follow the more suitable areas as predicted by the models. This indicates that Gd is probably not occupying its entire potential ecological niche in Europe. Further studies should focus on identifying factors hampering a larger distribution of Gd in Europe and/or allowing Gd to explore a new niche in North America.

## Seasonal transmission dynamics and impacts of white-nose syndrome

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Understanding seasonal changes in *Geomyces destructans* transmission on multiple host species will allow for targeted disease management that may reduce the consequences of the recently emerged disease, white-nose syndrome. Impacts from white-nose syndrome differ among species such that the impacts of disease on solitary bat species have been found to be lower in smaller populations, but in highly gregarious species, declines were equally severe in populations spanning dozens to hundreds of thousands of individuals. Differences in transmission among species may drive differences in impacts, and ultimately determine which species will persist or be driven extinct from disease. In addition, faster spatial spread of the pathogen will be observed if transmission occurs vertically from mother to offspring during the summer, or during fall swarm when bats are highly mobile. In contrast, if transmission occurs only during the winter, it may be possible to seal uninfected sites once most bats have entered hibernation, thus preventing pathogen invasion to new hibernacula. We investigated seasonal transmission of the etiological agent of white-nose syndrome, *G. destructans*. Our results suggest that spread may be highest during late fall and early hibernation when bats may still be moving among hibernacula, but are more likely to be infected than during early fall. By late winter across two regions and 15 hibernacula nearly all bats are highly infected, but likely less mobile due to decreased fat reserves. Transmission differed among species with highly impacted species experiencing the highest transmission intensity. Infection intensity was higher in more recently affected sites than those with four or more years since WNS arrival. Depending on region, 10-100% of bats entered maternity colonies infected, but most infections were cleared by late summer, however some juveniles were detected with infections in late summer, suggesting vertical transmission is possible. Our results suggest there is a broad temporal window in which *G. destructans* may be transmitted, further complicating management efforts to reduce disease impacts. However, the substantial variation in transmission observed among sites may offer clues as to factors that may influence transmission that could be targeted for management of bat populations.

## SESSION VI: BATS AND WINDFARMS

Organizers: Jens Rydell, Robert Barclay

### Mitigating the potential negative effects of tall wind turbines on bats: vertical activity profiles and relationships to wind speed

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Wind turbines represent a novel source of hazard for bats, especially through collision with rotor blades. Tall turbines have their rotor at high elevation ( $\geq 50$  m above ground) but there is hardly any quantitative data about which bat species forage and commute at that altitude. We therefore investigated the vertical activity profiles of the bat community occurring at a site where a wind farm equipped with tall turbines is planned in the Upper Rhone valley in SW Switzerland (Valais). A specific focus was on mouse-eared bats (*Myotis myotis* and *M. blythii*) and European free-tailed bats (*Tadarida teniotis*), three rare species occurring locally that might be impacted by this new infrastructure. We also studied the relationships between bat activity and wind speed.

In July – October 2011 and May – June 2012 bat activity was monitored with automatic ultrasonic and upper sonic recorders (Batloggers®). In order to measure bat activity profiles, the devices were installed during several nights at different elevations up to 70 m above the ground, along cables spanning vertically from the top of a crane-truck to the ground. To identify potentially critical turbine locations within the planned wind farm, the devices also recorded bat community structure and activity at 6 different foreseen sites. Bat call sequences were analysed with Batscope®, in an attempt to attribute each sequence to a given bat species or species aggregation.

Vertical activity analysis showed that most bat species are little active at higher elevations ( $> 50$ m). The species more often recorded were *P. pipistrellus* and *H. savii*. Mouse-eared bats (*M. myotis* and *M. blythii*) were rarely recorded, being mostly active at low level: they seem to be out of risk of collision with the rotor blades. *Tadarida teniotis* shows a more evenly distributed vertical activity profile, being often active at rotor level, which puts it at risk. Bat activity generally declines with increasing wind speed: most bat activity occurred below a wind speed of 3.5 m/s, a threshold we suggest as a reference basis to fix the cut-in speed for operating turbines. These recommendations are likely to decrease the potential negative impacts of such tall wind farms on the local bat community.

## **Foraging as a possible cause of bat mortality at the Montezuma Hills Wind Resource Area, California**

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We used marine radar, enhanced night vision, full-spectrum acoustic monitoring and bat mortality based on daily carcass searches at Montezuma Hills in Central California to investigate relationships between bat fatality rates and activity indices, spatial variables, habitat variables and weather variables. The probability of finding a Mexican free-tailed bat (*Tadarida brasiliensis mexicanus*) fatality increased with higher wind speeds ( $F = 4.5$ ;  $p = 0.037$ ), higher altitude passage rate of migrants ( $F = 4.5$ ;  $p = 0.037$ ), and higher barometric pressure ( $SE = 0.066$ ;  $p = 0.052$ ). Hoary bat (*Lasiurus cinereus*) fatalities increased with lower wind speeds and lower migrant passage altitudes. Unlike bats and birds above the sweep area that showed strong directional movement, bats observed within and below the rotor sweep area ( $\leq 125\text{m}$ ) showed no directional trend suggesting bats were not migrating while at risk of collision. Using the GIS-based Hot Spot statistical analysis, we found hot spots for hoary bats at 2 turbines, each with a Z Score of 3.60 and  $p < 0.01$  and 1 hot spot for Mexican free-tailed bats, also with a Z score of 3.60 and  $p < 0.01$ . Both hot spots for hoary bat fatalities occurred southeast of a eucalyptus grove and for all fatalities, direction to a eucalyptus grove within 2 km is significant ( $p = 0.013$ ). All hoary bat fatalities during the fall months of 2009 and 2010 were males with relatively full stomachs suggesting fatalities at Montezuma Hills are not related to male – female interactions, but more likely foraging behavior.

## Using Species Distribution Modelling to Predict Bat Fatality Risk at Wind Farms

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In this study we aimed to predict which areas present higher risks to bat fatality when facing the presence of wind farms. In an innovative approach, species distribution modelling was employed with mortality data and the ecological conditions at wind farms located in Portugal. Predictive models were calculated to determine areas of probable mortality and which environmental factors are promoting it. Mortality data of four bat species, *Hypsugo savii*, *Nyctalus leisleri*, *Pipistrellus kuhlii* and *Pipistrellus pipistrellus*, was used. These are the species that have suffered the most fatalities at wind farms in Portugal, totalizing 445 of the 750 fatalities recorded from 2003 to 2011.

The mortality risk models calculated showed good performances, with all respective AUCs being ca. 0.99. Models determined that wind farms sited at humid areas with mild temperatures, closer than 5000 metres of forested areas and 600 metres of steep slopes, showed higher probability of mortality. It was also verified that the areas with high probability of mortality overlapped a considerable range of *N. leisleri*'s potential distribution, suggesting that populations of this species might be at high risk due to wind farm fatalities. Furthermore, we confirmed that the areas with high wind potential for wind farm construction are coincident with most of the areas with high probability of mortality. Due to the innovative approach of this work, it was considered necessary to ground-truth the models. These results will also be presented.

In a nutshell, by allowing the identification of mortality risk areas prior to wind farm instalment and the determination of which conditions promote such mortality, this study could be paradigmatic for the development of an important preemptive conservation measure for bat populations.

## **Bat-friendly operation algorithms: reducing bat fatalities at wind turbines in central Europe**

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We developed ‘bat-friendly’ operational algorithms to reduce the risk of bat collisions at wind turbines in central Europe. The method we propose includes standardised data acquisition and analysis, risk assessment, and calculation of cut-in wind speeds that differ with the turbine-specific level of bat activity, month and time of night. During times of high collision risk, rotors are stopped to avoid bat fatalities.

Our bat friendly operational algorithms were developed in cooperation with Enercon, the largest manufacturer of wind turbines in Germany facilitating their implementation at different sites all over Central Europe. Our method has recently been set as standard risk assessment and mitigation in Bavaria, a federal state in southern Germany and other federal states seem to follow this example.

We present data from an ongoing study that includes a field-test of ‘bat-friendly’ operational algorithms for wind turbines. Bat-friendly algorithms were run in an experimental set-up at 16 wind turbines at 8 sites (2 turbines each) in 4 different geographical regions in Germany and at 2 turbines at one site in France. The two turbines within each site were operated with and without algorithms in alternating one-week intervals from July to September of 2012.

All turbines in the experiment were equipped with at least 2 of 3 different acoustic detectors at the nacelle (Anabat SD1, Avisoft Ultra Soundgate, and Batcorder). Acoustic detectors sampled acoustic bat activity continuously during the night. Additionally, the area under the turbines was searched for animal fatalities each day during the entire time of the experiment.

Based on the fatality data we will draw conclusions on the effectiveness of the algorithms (loss in revenue per reduction in bat fatality) and on the total cost of their implementation. We will compare the number of bat fatalities predicted for the specific operational algorithm to the number of carcasses found after correcting for search biases. Finally, and most importantly we will develop guidelines and practical examples for the quantification and mitigation of bat fatalities using bat-friendly operation of wind turbines in central Europe.

## **Mitigating bat fatalities from wind-power plants through targeted curtailment: results from 4 years of testing of CHIROTECH<sup>®</sup>.**

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An increasing number of bat fatalities is reported on some European wind energy facilities, which raises concerns about their impact on the viability of bat populations. It has been repeatedly suggested that targeted curtailment, i.e. stopping the wind power plant during periods of high bats activity, could effectively limit bat mortality. It also generates lost energy production and it is essential to ensure that curtailment is cost-effective.

In order to check this hypothesis, we built a multi-factorial algorithm describing bats' theoretical activity under a wide range of environmental conditions and integrated it as a plug-in into wind turbine supervisory control and data acquisition software (SCADA). This has allowed us to remotely stop and start wind turbines according to modelled bat activity, whilst at the same time limiting losses of energy production.

The efficiency of this patented device, called CHIROTECH<sup>®</sup>, was tested for two consecutive years on the 8 wind turbines of Bouin (western France), and two consecutive years on the 9 wind turbines of Saint-Martin-de-Crau (Southern France) as well as during bats fatality period in Bisnett (southern Ontario), Frontline (southern Ontario), Cruscades (southern France) and Coume (North-eastern France).

Our results, based on an analysis of the number of bat carcasses found under regulated and controlled wind turbines, demonstrates a significant decrease of fatalities under regulated wind turbine, with a power output loss of less than 0.5% of annual production. These promising results offer renewed perspectives for reducing bat mortality induced by wind turbines facilities without compromising production targets or the economic viability of wind power plants.

## **Integrating applied ecology and planning policy: the case of micro-turbines and wildlife conservation**

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In spite of the rapid growth in numbers of micro-turbines (defined as units generating < 50kW), there has been little study of their impact on wildlife, and consequently the evidence-base upon which to establish planning guidance is very limited. In this study we provide an overview of the planning process for micro-turbines and how wildlife considerations are taken into account, using the current situation in the UK as an example. We show that: (1) the planning process for micro-turbines varies throughout the UK; (2) a lack of data on their effects on wildlife makes interpretation of ecological surveys problematic; and (3) recent changes to the planning process, designed to permit installation of micro-turbines in some contexts without requiring planning permission, are unlikely to change this *status quo*. The situation regarding micro-turbines in the UK appears to be a fair reflection of the state of play worldwide. Although the planning process varies between, and even within, countries, concerns about the lack of information (e.g. comprehensive data on the distribution of turbines and wildlife impacts) and the consequent absence of evidence-based guidance for siting are universal. Recent data suggest that micro-turbines may displace foraging bats at least on a local scale, but it remains unclear how the wider landscape context modulates any adverse effects. This is important from a planning and siting perspective, and guidance on siting micro-turbines to minimise adverse effects on wildlife is required as a matter of urgency. We suggest that further research and the development of siting guidance should occur in parallel and draw on expertise from all relevant parties and stakeholders. We therefore suggest that a working group including members of the scientific community, policy makers, statutory agencies and the turbine industry be convened to integrate this process. Only such an interdisciplinary approach to both the planning- and ecological issues surrounding micro-turbines will ensure effective future development of this renewable energy technology while minimising any adverse effects on wildlife.

## SESSION VII: ECOSYSTEM SERVICES OF BATS

**Organizers: Sara Bumrungsri, Gary McCracken**

### **Bats in South East Asian agroforestry contribute more to cacao pest control than birds**

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Bats provide numerous important ecosystem services, particularly in the tropics where they act as highly mobile links within and between different habitats. Their functional importance has often been underestimated partly due to lacking differentiation in former studies on the ecosystem services of flying vertebrates, attributing most observed effects to birds. Especially biological control of pest insects by bats has often been overlooked.

Agroforestry systems such as cacao agroforestry (*Theobroma cacao*) are considered to play an important role in increasingly modified and converted tropical landscapes not only for maintenance of biodiversity but also for farmers and the local communities. Further, local management factors such as shade tree availability and distance to primary habitats influence functional diversity and species composition.

We herewith present results from an extensive enclosure experiment from Sulawesi (Indonesia) in which not only birds, but also bats were excluded from cacao trees. We included a control treatment and a complete enclosure of both birds and bats. On the trees, we quantified leaf herbivory by plant eating insects, quantity and quality outcome of harvested cacao fruits, cacao diseases and the diurnal and nocturnal insect community over a period of 18 months continuously.

Our results show that the bat enclosure contributed stronger to changes in marketable yield, the pest insect community and the increase of leaf herbivory than the bird enclosure. Furthermore, most additive effects from the complete enclosure of birds and bats are dominated by the effect of bats. Effects of shade tree availability and distance to forest margin were only marginally significant. Nevertheless, the spatial distribution of different functional groups such as feeding guilds or habitat preferences is likely to be linked to increasing forest conversion and varying intensity of agroforestry management.

Although more knowledge on sustainable cacao farming and pest prevention is needed, the potential of smallholder cacao for more biodiversity friendly management is promising. An important step is to promote and disseminate knowledge about the possibilities of biological control by natural enemies, and how they contribute to the landscapes they inhabit. Bats are still underestimated and misinterpreted regarding their functional role in land use dominated landscapes.

Our study provides new results on the importance of ecosystem services by flying vertebrates in South-East Asian cacao plantations and highlights the contribution of tropical bats to pest insect limitation. These findings contribute to the

understanding of global ecosystem functioning and potentially improve further management concepts in the Old World tropics.

## Artificial light at night reduces seed dispersal by Neotropical bats

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Artificial light at night (LAN) has been shown to affect various organisms including plants as well as invertebrate and vertebrate animals. Obligate nocturnal animals such as bats can be expected to be particularly affected by LAN, since LAN is present in urban as well as in many rural habitats during their nocturnal activity period.

Among bats, a large diversity of feeding habits can be found. Temperate species feed exclusively on insects, whereas in the tropics – besides several generalists - many bat species are specialized on other food items such as nectar and fruits. Consequently, bats offer a multitude of ecosystem services, of which many are invaluable for humans (Ghanem & Voigt 2012). For example, it was calculated that by controlling pest insects the monetary value of bats to the U.S. agricultural industry amounts to about 23 billion US\$ per year (Boyles et al. 2011). Also, bats are important pollinators and dispersers of many tropical plant species. Short-tailed fruit bats (genus *Carollia*), for example, are specialized on fruits of the genus *Piper* and constitute the main disperser of many *Piper* species - important pioneer plants in the Neotropics that grow at forest edges or gaps and thus are key to forest regeneration. However, due to this habitat preference, *Piper* plants are predisposed to become affected by LAN, for example if street lights become installed along roads.

We asked whether LAN is reducing the visitation rate, and thus the dispersal of seeds by *Carollia* when frugivorous bats avoid illuminated areas due to an improved visibility to predators. We captured individuals of *Carollia sowelli* in a Costa Rican rainforest and transferred them singly to a flight cage. After a short acclimatization period, bats could choose to harvest fruits in a dark compartment or in a compartment dimly illuminated by a street light. On average, *C. sowelli* chose the dark compartment for its first entry into the choice area more often than would be expected by chance. Also, they conducted more flights and, importantly, harvested more fruits in the dark than in the illuminated compartment.

We conclude that LAN reduces the variety and quantity of ecosystem services that bats provide, i.e. specifically a reduction of seed dispersal and probably also of pollination. This might be particularly relevant in the tropics, where ecosystem services of bats are ecologically important for ecosystem functioning, and where at the same time the potential for light pollution to increase is very high.

Boyles J.G., Cryan P.M., McCracken G.F., Kunz T.H. (2011) Economic importance of bats in agriculture. *Science* 332:41-42.

Ghanem S.J., Voigt C.C. (2012) Increasing awareness of ecosystem services provided by bats. In: HJ Brockmann, TJ Roper, M Naguib, JC. Mitani LW

Simmons (eds.) *Advances in the study of behavior* 44, Burlington Academic Press, pp. 279-302.

## **Ecosystem services and migratory bats**

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In North America, noctuid moths, including serious agricultural pests such as the Corn Earworm (Lepidoptera; Noctuidae; *Helicoverpa zea*), move thousands of kilometers north in the spring with prevailing winds from tropical regions into the United States to take advantage of ripening crops, and then return south in the fall via wind shifts associated with cold fronts. Large colonies of Brazilian free-tailed bats (*Tadarida brasiliensis*) are known to provide a valuable ecosystem service to agriculture by tracking and feeding on these moths during their northward movements in the spring. As fall approaches, these bats are preparing for their own migration into Mexico but resources are scarce in the hot, arid region after the summer growing season. Returning migratory noctuid moths represent a very high quality but transitory food resource during this time. We investigated the behavior of bats before and during fall insect migration events. Preliminary results show that bat behavior as well as rapid increases in body mass of bats are significantly related to cold front passages and moth migration events during the fall migration season. Thus, bats are likely to provide previously undocumented ecosystem services that may contribute to limiting the size of returning pest populations in subsequent seasons.

**SESSION VIII: PUBLIC OUTREACH AND THE CONSERVATION OF BATS**  
**Organizers: Tigga Kingston**

**Why should I engage in public awareness of science activities? Benefits and challenges**

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Participating in scientific outreach can be time consuming, is often looked down upon by colleagues and administrators, and is not something most of us are trained for or comfortable doing. Some topics are more challenging in terms of making the science understandable and relevant to non-experts. However, more institutions, professional societies, and granting agencies recognize the importance of public outreach and include it as a component in evaluations for tenure, promotion, salary increases, and research funding. As scientific research is primarily funded by the public, many consider that part of every scientist's job should be communicating with and educating the public as to the value of research, especially fundamental or basic research. Being able to discuss science with non-experts is a valuable skill for faculty and students alike, especially as funding from government agencies becomes harder to obtain and other sources need to be convinced to fund research. For students, it teaches them to gauge the nature of their audience and pitch presentations accordingly. They also learn to think on their feet. Furthermore, if we expect the public to make informed choices regarding scientific issues and pressure governments to take scientific information seriously, who better to make these issues understandable than the scientists directly involved? Besides, discussing science with the public is fun! For example, school children, unlike university students, are not afraid to ask questions and often pose more challenging and stimulating questions. In addition, having informed children can help drive their parent's actions. Thus, although engaging in outreach activities can be challenging, it also has many rewards.

## **A citizen science project for swarming roosts of bats in cities**

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At present, 22 bat species are known from Vienna (Austria, Europe). Preceding studies showed that even the densely build areas of the city provide summer, maternity, and hibernating roosts. However, very little is known about swarming sites. As the swarming behavior of bats is rather striking, the monitoring of these sites seems very suitable for a citizen science study. Before starting such a study, we first had to develop and test a suitable protocol and evaluate its efficiency for discovering swarming sites.

Therefore we created a simple practical guide for finding swarming roosts and tested it with the help of 16 student groups from the University of Natural Resources and Life Sciences (34 students in total). To assure that the chosen method is adequate for a citizen science project, we focused on tree roosts, since most buildings in the city have courtyards which are not accessible to the public, thus reducing the chance to detect swarming sites in those. Each student group was assigned 5 study sites, all situated in densely build areas of the city. A site was included in the study if it had more than three potential roost trees (stem or branch cavities from wood rot, woodpeckers, storm damages, or bark sticking out).

To increase detection probability, we concentrated field work in the period of highest swarming activity (August 13<sup>th</sup> to October 15<sup>th</sup>, 2012). The observations of the selected sites started at 4:00 and ended at 7:00.

In 19 of the totally 79 examined study sites, swarming roosts could be found. This means that approximately every fourth to fifth examination night was successful (21,5%). To give an advice for future studies on swarming sites, detection probability depending on temperature and month will be considered. Due to these results, we recommend implementing lay monitorings for swarming sites in cities. The detection success is high enough to render such studies adequate for citizen science. They would bring good and quite reliable data and in the same time raise public awareness for this highly endangered group of mammals.

## **Colombian Bat Conservation Program (PCMCo): strategies and efforts adopted by Foundation Chimbilako**

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# POSTER PRESENTATIONS

## SESSION 1: BATS AND URBANISATION

### **Poster No. 1: Overheating of artificial roosts: a new, climate change-induced bat conservation challenge in Central Europe**

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Temperature during bats' parturition time has very important effects on the survival and development of young bats. Because the microclimate in buildings generally meets bats' requirements during summer more than the microclimate in underground sites, many species often roost in buildings to breed in Central Europe. In addition, suitable natural roosts such as caves are intensively decreasing in number, which is also promoting the change in roosting habits.

During the last 1-2 decades heat waves and extreme temperatures have occurred more and more frequently during the breeding season in Hungary. In order to assess the effect of these very hot temperatures on house-dwelling bat populations, we examined important colonies in buildings between 2010 and 2012 in North-eastern Hungary. We measured the temperature and humidity inside the roosts, evaluated the characteristics of microclimatic changes and investigated the reactions of bats. We also examined the effects of different solutions to reduce the temperature in the shelters.

The microclimate data collected in maternity roosts show that the air temperature may far exceed (max. 47.5 °C) the heat tolerance of bats (40-42 °C). High temperature clearly disturbed the bats, as they not only moved to the cooler parts of the roosts but mass mortality in pups and sudden removals were also detected.

These results show that periods with extreme high temperature – especially in the early postnatal period when suckling bats are poikilothermic and do not thermoregulate – may be very dangerous for bats in several roosts in Hungary. Consequently, metal roof covered buildings may work as ecological traps, whereby otherwise good conditions can suddenly become intolerable and even fatal to young bats.

According to our results, the predicted warming may have serious negative effects on house-dwelling bats in Hungary, as well as in Central Europe. Thus, the overheating effects in buildings could have serious implications for the conservation of bat colonies. Technical adaptations against overheating generally appear difficult to implement, hence the most suitable solution would be to provide alternative shelters for bats in the same roost or elsewhere.

**Poster No. 2: Effect of different light conditions on *M. myotis* foraging behavior**

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Several not necessarily mutually exclusive theories try to explain why bats are almost exclusively nocturnal. They all agree, however, that diurnal activity comes with a variety of risks for bats. As a consequence, many bat species strongly avoid light. To decrease disturbance effects by night illumination of cities and streets, Philips Lighting aims to develop a “bat-friendly” LED light. In a flight room experiment, we investigated the influence of light of different wavelengths and intensities on the foraging behavior of *Myotis myotis*, a species known to be highly light averse. We used two groups of bats: one group of freshly caught wild bats at our field research station in Bulgaria and a second group of animals living in captivity for 3 to 5 years in Seewiesen, Germany. We compared the effects of seven different light settings (i.e. combinations of wavelength and intensity, predefined by Philips Lightning) and darkness as a control.

Both groups of animals reduced their foraging activity significantly in the light as opposed to darkness. However, the seven different light conditions did not differ in their effect on the foraging behavior of our bats. We could not find a short-term (days/weeks) habituation effect to any of the light settings. A trend of the long-term captive bats to avoid light less strongly could indicate a slight long-term habituation effect to light exposure.

### Poster No. 3: Heavy metal contaminations in European bats

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European bat species play an important role as insect pest regulators. The decline of bat populations can result in wide-ranging consequences for ecosystems. Bioaccumulation of insecticides and other pollutants (e.g. lead) is thought to be contributing to this decline. So far, there are only few studies on heavy metal contaminations in bats and more knowledge of toxic concentrations is needed. This is essential for a better protection of bat populations. Therefore, the goal of the study is to determine the concentrations of heavy metals in European bats. Model species are *Myotis daubentonii*, *Pipistrellus pipistrellus* and *Nyctalus noctula*. The first two species both feed on Diptera, especially Chironomids. Chironomid larvae live in sediments and can accumulate heavy metals. The third species lives in the same feeding habitat but has a more wide-spread food spectrum. Heavy metal contaminations were determined for these three species.

All species were captured with mist nets in their feeding habitat in Giessen (Hesse, Germany) in 2011. As heavy metals ligate in hair, samples of dorsal fur were taken. The hair samples were cleaned three times in acetone, one time in Triton X (1:400) and three times in deionised water subsequent dried to constant weight at 60°C. Afterwards they were weighed and dissolved in salpetric acid in a micro microwave oven for 5 minutes at 200 W and for 5 minutes at 300 W. The solutions were diluted to 20 ml with deionised water. The heavy metal concentrations were analyzed using the inductively coupled plasma optical emission spectrometry (ICP-OES).

As, Ba, Cd, Cr, Cu, Mn, Mo, Ni, Pb and Zn were detected in hair samples of *P. pipistrellus* and *M. daubentonii*. No As and Ba could be detected in *N. noctula* samples. *N. noctula* had significantly higher concentrations of Mn and lower Pb and Cr values than *P. pipistrellus* and *M. daubentonii*. Comparing *P. pipistrellus* and *M. daubentonii*, there were differences in the heavy metal concentrations of As, Cu and Zn. *P. pipistrellus* had higher Cd values than *N. noctula*.

Heavy metal contaminations in hair of the model species differ between species. This could be explained by their different food spectrum, as *M. daubentonii* most feed on Chironomids. *P. pipistrellus* and *N. noctula* have a more wide-spread food spectrum.

**Poster No. 4: Lesser horseshoe bats *Rhinolophus hipposideros* (Bechstein 1800) prefer non-illuminated buildings with suitable flight openings, which are not surrounded by urbanised or arable land – results of the study from central Slovenia**

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In Slovenia, almost all nursery colonies of the lesser horseshoe bats are known from buildings, especially churches. Knowing what influences the presence of bats in the roost is of vital importance for protecting the local populations. We studied the churches and their surroundings in about 640 km<sup>2</sup> large region in the central Slovenia. We recorded the number of bats and juveniles at churches, as well as characteristics of churches and its surroundings. We analyzed land use at different distances from the church (up to 100m, 100-500m and 500-2500m). We checked 58 churches in the region, while we did not get granted access to the remaining 32 churches. Lesser horseshoe bats were found at 44 churches, of which six had three or less individuals and the rest had on average 38,4 adult bats (min 9; max 259). Two most important characteristics, which influenced the presence of lesser horseshoe bats, were presence of suitable flight openings as well as absence of night illumination of the building. The impact of land use on presence of bats was analyzed using logistic regression models. Considering immediate surroundings of the church, distance to the forest patch was the most important factor. The proportion of urbanized area at different distances from the church was the main negative factor influencing the presence of lesser horse shoe bats. At the distance 500-2500m from church, the proportion of open areas (including meadows with individual trees) also had positive impact. The proportion of forest was recognized as a differing factor between inhabited and uninhabited churches, while the univariate analysis revealed the positive impact of forests at distances 100-500m and 500-2500m. While the presence of lesser horseshoe bats can be predicted from characteristics of surroundings, the size of the colonies was not significantly correlated with any land use. Colony size was positively related only to the size of flight openings. Proportion of juveniles per colony was not correlated with any of observed roost and surroundings characteristics. Our results are important for developing management plans for conservation of lesser horseshoe bats in the region. Of great importance are also communication activities, as even during our field work we stimulated positive attitudes of managers toward bats in buildings.

**Poster No. 5: Radio telemetry of bat daytime roosts in the densely build areas of Vienna (Austria, Europe)**

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In the city of Vienna, 22 bat species have been detected so far. Preceding studies showed a high activity of bats within the densely build areas and this suggests a correspondingly high occurrence of roosts. In order to provide data for a new management concept for urban bat conservation, we captured and marked 30 bats (of seven different species, all preferring crevices as roosts) with radio transmitters and detected their daytime roosts. The field work started in July 2008 and ended in September of the same year. Bats were captured with mist nets in the Stadtpark located between the first and the third district and the botanical garden of the University of Vienna in the third district of the city. As none of the captured individuals was a reproducing or lactating, we assume all recorded roosts to be simple daytime roosts. Out of the 30 marked bats, 18 individuals (one *Pipistrellus kuhlii*, *P. nathusii* and *Plecotus auritus*, two *Eptesicus serotinus*, five *P. pygmaeus* and eight *Nyctalus noctula*) could be monitored whereas 12 (one *P. pygmaeus*, two *P. pipistrellus* and *E. serotinus* and seven *N. noctula*) could not be found again after release. With a total of 57 re-findings in trees as well as in buildings, both turned out to be equally important sources of bat roost in the densely build areas of the city. Roost trees showed stem or branch cavities from wood rot, woodpeckers or storm damages. Buildings with roosts were mostly in good condition. To test if the diameter at breast height of trees as well as the condition of a building and the surrounding urban green influences the choice for a roost, additionally collected pseudo-absence data of trees and buildings with no recorded bat roosts will be considered.

**Poster No. 6: Questions about impact of synanthropisation processes on biology of *Rhinolophus euryale***

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*Rhinolophus euryale* is originally cave dwelling bat species reaches the northern border of its area in central Europe (Slovakia and Hungary). However, there is a major change in roost preference in summer observed in this region; the species started to use lofts and roofs since the 70's of the 20th century in Slovakia and Hungary as the result of the synanthropisation process. We analysed database of faunistic records on *Rhinolophus euryale* (more than 1500 data items) from Slovakian, Hungarian and Romanian range of the species covering period 1878–2012. We evaluated changes at the sites (both, winter and summer roosts) where long term data were available. We analysed data on temperature from eight *R. euryale* roosts (6 attics and 2 caves) for one year period. The year-round average differences between two roost types are 4.6 °C. Daily temperature amplitude in cave roosts were only 1.5 °C, but in attics roost were 8.4 °C. Thus, caves roosts are relatively stable comparing to attic roosts. We hypothesised that these facts must have impact on species ecology and probably in biological adaptations. There should be differences in active social thermoregulation, immunological characteristics, or other anatomical attributes. Preliminary results showed that there is significant difference in forearm length within the females roosting in caves and females from attics. More research effort in this topic is necessary.

**Poster No. 7: Annual utilization of man-made structures by the Lesser horseshoe bat (*Rhinolophus hipposideros*) in the Western Carpathians, Poland**

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Lesser horseshoe bat (*Rhinolophus hipposideros*), which occurs in Poland at its southernmost edge of the range, use various anthropogenic structures for reproduction, hibernation and as a accidental shelters. Data on the annual utilization of man-made structures are still scarce, what often makes impossible to take adequate protection measures. We conducted studies on the utilization of anthropogenic structures by the Lesser horseshoe bat in Western Carpathians (Poland) in 2000-2012. Inventory of shelters was supplemented with a regular annual monitoring of (1) large attic, which serve as a nursery colony, and (2) bunker originated from the Second World War used by bats as a secondary shelter. We also applied rings to mark some individuals in order to assess site fidelity and distances between hibernacula and summer roosts. We discovered nursery colonies exclusively in large warm attics of churches and bigger buildings, while secondary shelters were observed in cellars, bunkers, wooden huts and attics of smaller buildings. Lesser horseshoe bats hibernated mostly in natural caves, from which they disperse up to 16 km to summer roosts. Annual monitoring of a large attic revealed that Lesser horseshoe bats use it throughout an entire year, with maximum number (236 individuals) observed in August. Some individuals use the attic even in winter. Bunker was irregularly visited by maximum of five Lesser horseshoe bats, from April to October, but they were the most abundant in April-May and September-October. Ringed individuals shown high site fidelity. Presence of Lesser horseshoe bats in nursery colonies located in attics during winters shows, that even in this period, eventual construction work must be preceded by an careful bat inventory. The high site fidelity indicates that the destruction of the given shelter may have implications for the conservation of the species.

**Poster No. 8: Bedbugs at home: the disadvantage of living in comfortable warm churches instead of cold and moist caves**

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Presence and numbers of ectoparasites can be one of the factor conditioning the choice and use of a determinate roost for bats. For the tree dwelling species is well known that the in-trees environment can be heavily colonized by species that spend the whole life cycle over the bat as well as who spend part of the his growing phase in the litter as the Siphonaptera. Also the humidity condition and availability of shelters close to the body of the host contribute to benefit parasite density. Frequent change of use of these roost by the bats can be also correlated to the necessity of reducing the heavy parasitic load. Caves are preferred by other parasite typologies and, in particular, from those that spend all their life on the host one as Acarina, and, partially, Nycteribiidae.

During studies on the bats parasites in Italy, observations were carried out on different colonies of the two sibling species *Myotis myotis* and *Myotis blythii* in different part of the country that cover different altitudinal and ecological belts. The two species often closely rest in the same roost and share largely the ectoparasites community. In Italy there are two main groups, verified also genetically by former studies, of *Myotis myotis* that inhabits in caves in Mediterranean bioclimate or in buildings in Alpine area. The second group, in southern Tirol, lives in the attic of churches that have entirely different microclimate conditions and substrate compared to wet and cold (about 12-15° C) caves of the Mediterranean area.

To collect parasites we checked directly more than 200 specimens of both *Myotis* from colonies in Sicily, Calabria, Molise and Emilia Romagna regions as well as 4 colonies in South Tirol region.

Only in two of the colonies in churches we detect an high presence of *Cimex pipistrelli* Jenyns, 1839. The bugs are dominantly found in the wood crevices of the roost and just few individuals were caught on host bodies. In one of this churches, in the village of Vezzano, it was possible in a part of the wooden roof to count up to 35 nymphs and adults per 10 cm<sup>2</sup>. This was one of the hottest and driest roost among those controlled during the summer in days reaching temperatures over 37°C. All the others colonies, even though they are rich of the presence of Nycteribiidae and Acarina, are without this presence due to the type of substrate and microclimate that do not allow their survival.

**Poster No. 9: Trick or treat: opportunity and dangers in an urban population of *Nyctalus noctula***

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*Nyctalus noctula* is widely distributed throughout Europe and the breeding sites are typically found in countries of central and northern parts of the subcontinent. Later, with the migration, the females move to Mediterranean regions for breeding and wintering. Reproduction in the southern part of distribution range appears to be proven, as well as in northern Italy and just for the north of Spain. In Friuli, Veneto and Tuscany are located perhaps the few other colonies known in Italy.

In the town of Cervia (44°15'45"N and 12°21'17"E) noctule population has been studied to determine the type of roost and their use and to promote sustainable management of these presences which gather in the most central streets of the town. During the study more than 2100 trees have been monitored and at least 22 were occupied by bats. Some trees are historically used by the major aggregations of females that will give birth to in the early stages of season. In whole summer there is a spread in smaller shelters and in various parts of the town. Recently, has been also found the use of a building, the first case in Italy.

The group of breeding females is of more than 500 individuals and the highest concentrations, with more than 200 females each, are in few large Plane trees decaying.

Recently, after the cutting of some hundreds trees related to their dangerous status, some groups of females change place and move into buildings and under the roof of a villa. This is a new opportunity for the breeding groups but generate also new possible problems. One of the roofs was protected with pigeon dissuaders that causes some death among the young trying to learn to fly.

In one case a group of a few dozen females moves to a 8 m high chimney and gave birth there. Weaning unfortunately happened in a very hot and dry period and many young had problems of survival. Thanks to the sensitivity of the citizens, we were able to open the bottom of the chimney and recover 14 live noctules on 88 dead. They were so weak and dehydrates for not being able to climb up.

Urban environment, generally speaking, is a well-protected area where to live but some new kind of problems can arise. Danger doesn't come from citizens, which are now conscious and proud of this presence, but from the management of trees and of the roofs and the new campaign with bat boxes should be a new opportunity of conservation.

**Poster No. 10: The influence of LED illumination on the behaviour of hibernating bats**

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The tunnels of the former *Nordbahntrasse* in the city of Wuppertal have not been used for human purposes for several years. Meanwhile they serve Daubenton's bats (*Myotis daubentonii*) as hibernacula. The city of Wuppertal plans to make these tunnels available again for pedestrians and bicyclists, but to do so the tunnels have to be adequately illuminated. To find a way to keep the disturbance for hibernating bats inside the tunnels as low as possible, we were asked to investigate the effect of LED illumination on hibernating bats. In a laboratory experiment, we tested the influence of LED light of two different wavelengths on the hibernation behaviour of six male greater mouse-eared bats (*Myotis myotis*) and three male Daubenton's bats (*M. daubentonii*). In a four-week control we kept the bats in climate chambers and used respirometry to record their undisturbed torpor-arousal patterns. During the experiment we switched on amber or white light between arousal bouts and monitored potential changes in the bats' torpor-arousal patterns.

We could not detect an effect of the light of either colour on the torpor-arousal pattern, nor on the torpor or arousal bout lengths as compared to the control recordings. However, the artificial circumstances of this experiment allow no predictions about the effect of illumination in semi-natural bat hibernacula as in the tunnels in Wuppertal.

**Poster No. 11: Bats of Minsk (Belarus): species composition, habitat ecology and features of hibernation**

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Minsk is the capital of Belarus and the largest city of the country. Buildings of Minsk, mainly, are over five floors, although there are the territories of private one-storied private homes. 44, 8% of the territory of Minsk is covered by parks and gardens. In addition, a large part of area is occupied by various aquatic systems. Thus, the territory of Minsk is quite fragmented and has a large number of potential habitats for bats.

Data were gathered between 2005 and 2012. From 2011 the bat-detector “Laar TR 30” was used. For Minsk was fixed following species of bats: *Plecotus auritus* (captured), *Eptesicus nilssonii* (captured, detector registration), *E. serotinus* (captured, detector registration), *V. murinus* (captured, detector registration), *Nyctalus noctula* (captured, detector registration), *Myotis daubentonii* (detector registration), *M. dasycneme* (detector registration). Foraging activity (researched in April-June for all species) of *E. nilssonii* was registered, mainly, over the water bodies in areas of high-rise buildings (more than five floors). The same activity of other species, excluding *Pl. auritus*, was registered in park areas, which include different aquatic systems. There are established the hibernation of following species of bats in Minsk: *E. nilssonii* (one male was captured 27.01.2011), *E. serotinus* (six males and one female was captured since 2005 in late autumn ) and *V. murinus* (seven males and one female were captured since 2005, usually in the period from October to December). It should to be noted, that we observed the intensive mating activity (social calls) of males of *V. murinus* in October 2012.

Maternity colonies were registered only for *N. noctula* and *V. murinus*. These colonies were not located in Minsk, but exclusively in the suburbs. Also we have not registered any hibernation colonies of *E. serotinus*, *E. nilssonii* and *V. murinus*. All captured individuals were single.

## **Poster No. 12: Modelling flight-paths to identify conflict areas between bats and human infrastructure**

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Several bat species are highly sensitive to habitat fragmentation caused by transportation infrastructure or light pollution, as train routes, motorways and lights may act as barriers. Human infrastructure may affect not only roosts and foraging habitats but also traditionally used flight paths between roosts and foraging habitats. In order to mitigate conflicts between bat conservation and human infrastructure potential conflict areas are to be identified prematurely.

As bats are highly mobile – e.g. Geoffroy’s Bats (*Myotis emarginatus*) commute up to 15 km between colony and foraging habitats – the identification of flight paths may require extensive field studies. To address this issue efficiently, we developed a model approach to identify flight paths of the Geoffroy’s Bat without the need for large scale field studies.

This flight path suitability model is built on presence-absence data for the Geoffroy’s Bat (*Myotis emarginatus*). Based on telemetry data of 20 known flight paths of 7 Geoffroy’s Bats, we identified habitats preferred by animals on commuting flights. Important parameters were distance to streams as well as height and coverage of trees and shrub. Based on these habitat parameters, a cost-distance matrix with a spatial resolution of 10 x 10 m was calculated. Cells with high values for vegetation cover, vegetation height and low values for distance from streams had a low space resistance and vice versa. In a third step least-cost pathways from starting points to destination points were calculated. Starting points were known roosts of Geoffroy’s Bats. Destination points were known or potential foraging habitats within the range of the colonies. The resulting flight paths were validated. First, we checked whether the known flight paths were “identified” by the model approach. Second, we controlled all modeled flight paths concerning existing guiding structures. Third, we checked if there were obvious potential flight paths that were not identified with the model approach.

The results showed that nearly all known flight paths of the colonies were matched by the model approach and that all modeled flight paths were plausible. Therefore, this approach enables the prediction of areas with high probability of commuting flights at the regional scale. Consequently, potential conflict areas as well as i.e. the effective distance between different habitats can be gathered as a basis for planning mitigation measures or for evaluating the coherence of habitat networks.

**Poster No. 13: The trans-boundary importance of man-made hibernacula for some European migratory bat species**

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Some long-distance migrants such as noctule bats (*Nyctalus noctula*) hibernate in man-made structures in Europe, yet it is unknown how large the catchment areas of artificial hibernacula are for noctule bats. We asked whether *N. noctula* of two artificial hibernacula in Berlin (Germany) were of local or distant origin. To this end, we analyzed the stable hydrogen isotope ratios in fur keratin of all individuals occupying the hibernacula. Based on the stable hydrogen isotope ratios, we developed an isoscape origin model to predict the breeding origin of these bats. We found that the majority of hibernating individuals came from Poland or Belarus, and were thus of distant and not of local origin. We conclude that man-made hibernacula are of trans-boundary relevance for some European migratory bats such as *N. noctula*. The large catchment areas of these hibernacula highlight the pivotal value of such structures for the protection of migratory bats on a large European scale. We plead for strong conservation measures to protect natural and artificial hibernation sites of European migratory species from disturbance or destruction.

**Poster No. 14: Habitat use of *Myotis emarginatus* in a small-scale cultural landscape**

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Between 9th of August and 4th of September 2012 preliminary research based on radio-tracking method was conducted in the area around Diest (Flanders, Belgium; 50°59'N 05°03' E). Two females and one male of *Myotis emarginatus* were tagged with Picopip-transmitters (Biotrack, 0,27-0,35g), according to the 5% body weight rule. Three-elemental Yagi antennas were used and the tagged bats were followed during 5 nights. Tracking took place by car and by foot. The project was divided in stages : (1) finding *Myotis emarginatus*, (2) mist-netting and tagging bats, (3) finding maternity colony/shelter, (4) locating foraging sites. Three Pettersson D500 bat recorders were placed in a barn and two stables in 2 different farms, around 7,1 km from each other. Analyses of the records showed that *M. emarginatus* was using all 3 sites. The highest activity of this bat species was found on the records from ecological farm 'Bolhuis' (51.01325, 5.044782). Mist-nets were placed in and nearby the Bolhuis-stable. During 7 nights, 3 bats were caught and tagged. Successful radio-tracking on a young male of *M. emarginatus* allowed to locate few foraging sites. A tracked female lead to a small colony composed of 2 animals on the attic from an abbey (51.033467, 4.980068). That female was followed for 3 full nights, from the moment when she left the roost (around 21h45') till the moment of returning (around 5h45'). The maximum foraging time was established on 8h15' during one night when a female visited few foraging sites. The most frequented foraging sites were located 5 km from the abbey, the most remote were at a distance of 6km. The route followed by the bat from the main foraging sites till the abbey was 6,8km long. This route leded mostly via forested areas, and avoided lighted parts like larger streets and village centers. The closest foraging areas where located directly around the abbey, and were used right after leaving the shelter and shortly before returning. The habitats favored by the species were mainly wet grasslands, surrounded by small landscape elements like tree rows or small mixed forests, which are quite numerous in this area. The bats frequented the stables for foraging, resting and warming up, especially during cold and moist nights and right before returning to the shelter. Preliminary results show that man-made structures and landscapes affect ecology and hunting strategy of *M. emarginatus*.

## Poster No. 15: Bats and the City: A survey of the bats of Vienna

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An extensive research project on the distribution of bats in the city of Vienna (Austria) was carried out from 2007 to 2011. The city of Vienna covers urban areas, but also a wide range of different habitat types, including broadleaved forests (“Vienna Wood”), the river Danube and its riparian forests, and several large parks. To cover the whole area of the city of Vienna (41.5 km<sup>2</sup>) a grid on the map was established, resulting in 101 elements (approx. 2.08 km x 2.50 km). Every element was checked for the presence of bats with the aid of ultrasound detectors for 3 hours in summer and 1 hour in autumn. Mist-netting and automatic sound recordings were carried out at selected sites. Additionally, data provided from other sources were included. Special attention was directed to the four Natura 2000-sites situated within the boundaries of the city. Overall, nearly 5000 data sets of 22 bat species were collected. The species most often detected were: Soprano pipistrelle (*Pipistrellus pygmaeus*), Common pipistrelle (*Pipistrellus pipistrellus*), Noctule (*Nyctalus noctula*), Savi’s pipistrelle (*Hypsugo savii*) and Serotine (*Eptesicus serotinus*). Due to the great variety of habitats, Vienna also gives shelter to species one would not expect living in a big city such as Bechstein’s bat (*Myotis bechsteinii*), Natterer’s bat (*Myotis nattereri*), Geoffroy’s bat (*Myotis emarginatus*), Brandt’s bat (*Myotis brandtii*) or the Lesser horseshoe bat (*Rhinolophus hipposideros*). Furthermore the Alcathoe whiskered bat (*Myotis alcathoe*) was confirmed for the first time in Vienna with a female caught in a mistnet. Distribution patterns of species groups, such as the genera *Pipistrellus* or *Plecotus*, indicated species-specific habitat selection within these groups. To sum up, Vienna shelters at least 22 bat species, representing 78% of all bat species known to live in Austria.

## SESSION 2: BATS IN DISTURBED HABITATS

### Poster No. 16: Bridges as important artificial bat roosts in Ukraine (summer and migration aspects)

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Inspections of 56 bridges discovered that 42,9 % of them are inhabited by 9 bat species in the western(W), north-western (NW) and central (C) parts of Ukraine (*Myotis mystacinus*, *M. brandtii*, *M. dasycneme*, *M. daubentonii*, *Eptesicus serotinus*, *Plecotus auritus*, *Nyctalus noctula*, *Pipistrellus nathusii*, *Pipistrellus pygmaeus*). Record of one individual of *M. dasycneme* was found in the bridge located in western Ukraine (Buchko et al., 2011).

*M.daubentonii* was the most frequent and abundant (44.4 % records) and dominated in bridges of all the investigated parts of the country. *P.auritus* was relatively frequent too in all investigated regions (33.3 %). *E.serotinus*, *N.noctula* and *P.nathusii* were recorded in C and NW regions with the frequency of 14.8, 11.1 and 7.4 % respectively. However, *P.nathusii* used the bridges only in migration (mating) period.

Some species, *M.brandtii* and *M.mystacinus* were recorded exclusively in NW region and *P.pygmaeus* in C region.

The mean numbers of inhabited bridges were highest in NW and C regions (40.7 and 60.8 respectively). 13.3

The total number of species was highest in NW and C regions (7 and 6 species, respectively). It was lowest in W region (3 species). Breeding colonies were found in 14.8 % bridges. Bridges seems to be the most important for bats in the area with small presence of nature or artificial undergrounds. This is a reason that maximal numbers of inhabited bridges have been found in the Polissya (NW) and Central Ukraine areas, which were characterised by insufficient number of undergrounds. However, bats have some requirements to roosts conditions, which may varied according to seasons.

Species richness and diversity were highest in NW and C region where this type of roost had greatest importance to bat breeding and migration periods. Despite the fact that only single individuals occurred in 14.8% of bridges, these roosts, common and numerous in Ukraine, could be in total inhabited by thousands of bats yearly.

**Poster No. 17: Population genetics of *Rhinolophus hipposideros*: impacts of human-mediated habitat fragmentation**

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*Rhinolophus hipposideros* is a widely distributed species in the western and central Palearctic, reaching its north-westernmost limits of this distribution in Ireland. Here, this species is found only in the west of the country and colonies are distributed unevenly, occurring in clusters with large areas of habitat containing few or no colonies between them.

*R. hipposideros* is considered, at least in the north-west of its range, to be a broadleaf woodland species. Following the end of the last ice-age, Ireland was naturally colonised by tree species and was almost entirely covered in oak woodlands at the time of arrival of the first humans c. 9,000 years ago (9 kya). Forest clearance by Neolithic farmers is documented in the pollen record from 6 kya onwards. As the human population expanded and demand for agricultural land and wood products increased there has been a corresponding decline in woodland cover to less than 1% by 1800. Today, Ireland is still one of the least forested countries in the EU with only 1.5% broadleaf woodland cover.

The genetics of any population is key knowledge to aid in its conservation management. In the current study, mitochondrial and microsatellite markers are utilized to assess the current levels of genetic diversity and structure present within this woodland-associated species in a deforested landscape. At the mitochondrial level, a population expansion by this species within Ireland was supported (c. 6,000 years ago) during the time of maximal broadleaf forest cover. The highest genetic diversity at this marker was found in the north of this species' range in Ireland and significant genetic differences were found between colonies in the north compared with colonies in the south ( $F_{ST}$ ;  $P < 0.001$ ). The more quickly evolving microsatellite loci also showed significant genetic differences between northern versus southern colonies. Bayesian clustering algorithms (in structure and tess) supported the presence of two distinct clusters within Ireland: one in the north and one in the south of the species range.

The areas where low gene flow is occurring in this species resulting in population sub-structure are areas containing habitat which is predicted to be only marginally favourable for this species. We argue that this species which was once likely widespread in Ireland is now restricted to the only remnants of suitable habitat remaining and is currently experiencing low levels of gene-flow between colonies in areas particularly affected by agricultural intensification and urbanisation.

**Poster No. 18: Seasonal variations in habitat use and roosting behaviour in a tree-dwelling temperate bat reveals mating at summer sites**

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Sexual segregation is a common phenomenon in temperate bats, but little is known about driving factors or spatiotemporal patterns. In this study the sexual segregation of the tree-dwelling Daubenton's bat (*Myotis daubentonii*) was analyzed. Day roosts and foraging areas of radio-tracked animals were recorded during late spring, early summer, and late summer. Home ranges were calculated for each sex based on identified locations. Distance analysis between sex-specific roosts and foraging areas was conducted for each period. Mixed colonies were confirmed by trapping at roosts. Home range of males was larger (47.3 km<sup>2</sup>) than of females (9.7 km<sup>2</sup>). During late spring, distances between male and female roosts were larger (median = 715 m) than during early (median = 474 m) and late summer (median = 489 m). Distances between sex-specific foraging areas were larger during early summer (median = 2,134 m) than during both late spring (median = 1,116 m) and late summer (median = 628 m). The proportion of males in mixed groups increased from late spring (0.2 ± 0.1) to late summer (0.5 ± 0.2). These results show that sexual segregation is not static, but might depend on energetic demand of individuals and mating willingness. A high energetic demand in females and low mating willingness in both sexes leads to distinct sexual segregation during late spring. When mating willingness increases, despite an increasing energy demand in males, sexes aggregate to mate. Associations of parents in the same roosts before September support the hypothesis of regular mating activities at summer sites. Based on the assumption that successful mating of many European bat species occurs at summer sites after the young are fledged, anthropogenic habitat changes should steer clear of the seasonal activity period to prevent a reduced reproduction rate of local bat populations.

## Poster No. 19: Differences in the bat activity of clearcuts and forested sites in the woodlands of North-East Hungary

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Nowadays forests are under an extraordinary anthropogenic pressure worldwide. Many bat species rely on forests as a shelter, they form nurseries, mate, hibernate in different tree cavities or use woodlands as foraging areas. Most of the 28 bat species existing in Hungary depends more or less on different forest habitats. In the forested areas of Hungary, including our study area, the Bükk Mountains, clearcutting method is used by forestry considerably, resulting the presence of clearcuts in a significant sized area. The creation of clearcuts leads not only to the loss of the roosts of the forest-dweller bats, but possibly it affects the foraging activity of these and other bats too.

In this study we tried to evaluate the difference in the overnight activity of bats between clearcuts and neighbouring forested sites. Acoustic monitoring was performed at 10 sampling sites (5 in clear-cuts, 5 in forests) with two sound recording units in three periods of time: June, July and August (totally 30 detector-nights). Four categories were established based on characters and frequency of the bat calls: FM (frequency modulated, *Myotis spp.*, *Plecotus spp.*, *Barbastella barbastellus*), FM-CF-FM (frequency modulated starting and ending part with a long constant frequency part between, *Rhinolophus spp.*), FM-QCF Lo (frequency modulated beginning and quasi constant frequency ending, with a low best frequency value /<30 kHz/, *Nyctalus spp.*, *Vespertilio murinus*, *Eptesicus serotinus*) and FM-QCF Hi (similar to the former, but with a higher />40 kHz/ best frequency value, *Pipistrellus spp.*, *Miniopterus schreibersii*).

The statistical comparison revealed that the FM group had a significantly higher activity in forests than in clearcuts. No significant difference was found in the case of the FM-QCF Lo and FM-QCF Hi groups. The activity of *Rhinolophus spp.* (FM-CF-FM group) was not evaluated because of the very few data of these species.

Our research proved that clearcutting negatively influenced the night activity of FM bats. Most of the endangered forest-dweller species, like *Myotis bechsteinii*, *Myotis nattereri*, *Plecotus auritus* and *Barbastella barbastellus* belong to this group. These bats are strongly associated with forests, they rely on tree stands in the relation of both roosting places and foraging areas. Forestry schemes that ensure continuous forest cover are more favourable for these species because not decreasing the size of their foraging area.

## Poster No. 20: Bats and oil palm plantations – first insights from Central America

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Forest conversion and habitat loss play a major role in biodiversity decline. Moreover, the increasing global demand for agricultural crops comes mainly on the expense of tropical forests. Conversion of forests into uniform oil palm plantations dramatically alters habitat structure and, consequently, availability and abundance of resources like roosting sites and food. Nevertheless, oil palm is one of the most important cash crops and therefore plantations are continuously increasing. Cultivation of oil palm is on the rise not only in South East Asia, but also in the Neotropics, and there is urgent need to evaluate impacts on biodiversity in these regions. Bats provide important ecosystem services like pollination, seed dispersal and arthropod predation, therefore effects of habitat conversion on bats in human-dominated landscapes are of broad interest. Using a combination of ground mist netting supplemented by acoustic monitoring, we studied bat assemblages in oil palm plantations, at forest margins and in mature old-growth forest at the border of the Piedras Blancas National Park, Costa Rica. Both techniques are used to provide a first insight into the structure of Neotropical bat assemblages occurring in these monocultures in comparison to those in the interior and at the margin of a Pacific lowland rainforest. Our results report the “best case scenario” of habitat conversion, as the proximity of primary forest and oil palm plantations in the study area still provides options to retreat to the forest, while temporarily using this land-use system. Nevertheless, preliminary data analysis based on mist net captures indicates a significant change in species composition from forest towards oil palm plantations situated at the forest margin. Species richness of bats sampled in mist nets declined towards oil palm plantations, where about 2/3 of the species supported by pristine forest occurred. While some species (*e.g. Artibeus* spp.) are rather abundant in oil palm plantations and seem to use them as flight corridors, several species previously reported as being sensitive to habitat disturbance, *e.g.* members of the Phyllostominae, were not recorded in oil palm plantations at all. For these species, oil palm plantations may act as effective barriers decreasing landscape permeability, thereby preventing the colonization of isolated forest fragments embedded in today’s human-dominated landscape.

**Poster No. 21: Body condition and fluctuating asymmetry as measures of fragmentation effects in three species of Phyllostomid bats**

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The effects of fragmentation on bat populations are usually quantified by the measurement and comparison of occurrence and relative abundance data. However, this approach constitutes time-lagged response that does not inform on the actual population status, and that can be problematic for long-lived species, such as bats. Thus, there is a need for metrics that reflects proximal ecological mechanisms underlying the population response to habitat degradation, and that can be effectively used to monitor the actual status of bat populations. The main objective of this study is to apply two morphological metrics, body condition (BC) and fluctuating asymmetry (FA), to monitor the status of 3 species of Phyllostomid bats, *Artibeus lituratus*, *Carollia perspicillata* and *Sturnira lillium*, in fragments of Atlantic Forest in South Brazil. BC indices (BCI) are widely used to monitor the energetic and nutritional status of populations. FA reflects departures from a character that should otherwise be bilaterally symmetrical, but that can be affected by genetic or environmental stress during development. During two seasons in 2011 and 2012, BCI were calculated by the Scaled Mass Index procedure, from measurements of the forearm length and body mass of bats from continuous and fragmented areas. FA was calculated by these same bats and the index used was the module of the difference between the length of the two forearms ( $|Right-Left|$ ). BCI of *A. lituratus* were higher in fragmented areas ( $p < 0.001$ ) and during the winter ( $p < 0.01$ ). For *C. perspicillata* and *S. lillium*, there was no difference in BCI between habitats ( $p = 0.16$  and  $p = 0.17$ , respectively) and between seasons ( $p = 0.72$  and  $p = 0.13$ ). All species showed slightly departure from a bilateral bauplan, but this departure was not significantly different for all species as a function of the habitat ( $p > 0.05$ ). Results of BCI suggest that fragmentation does not jeopardize the energetic status of the species, but the underlying mechanisms used by them to maintain their nutritional status are probably different. The fact that all species are asymmetric in both environments suggests that the magnitude, but not necessarily the nature, of stressors acting during development is the same. However, this magnitude is not intense to promote deleterious effects on these populations. Overall, these results suggests that the current level of fragmentation of the area is not too strong to cause marked changes in the current status of the populations of these 3 species of bats.

Financial support: FAPESP grant # 2008/57687-0

**Poster No. 22: Genetic population structure of Natterer's bats (*Myotis nattereri*) in Germany**

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The Natterer's bat is widespread in Europe and strictly protected by European law (listed in Annex IV of the Fauna-Flora-Habitat directive). Despite its large range and importance for conservation very little is known about the genetic population structure of this species in Central Europe. The objective of this study was to compare the genetic population structure within and among maternity colonies of *Myotis nattereri* in Germany. In collaboration with several other bat researchers interested in bat conservation, 480 wing-tissue samples of Natterer's bats were collected from the western part of Germany (Münster), southern Germany (Würzburg) and the eastern part of Germany (Wooster Teerofen). We report on our results that are based on eleven polymorphic microsatellite markers and discuss their implication for the conservation of Natterer's bats in Germany.

**Poster No. 23: Survey of the bat fauna of a mixed forest/agricultural landscape in Småland, southern Sweden**

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The bat fauna of Sweden has already been studied quite extensively, largely based on mist netting, roost surveys and ground inventories using conventional bat detectors. However, modern bioacoustical and highly sensitive microphones now allow the automatic real-time detection of bat calls that often go unnoticed using conventional equipment. We here present results from ongoing surveys of the bat fauna of southern Sweden at two locations in Småland (southern Sweden): Sjöarp/Kvillsfors and Store Mosse National Park using an EcoObs batcorder. The batcorder was mounted to trees at 5 sites during 9 nights between 13-23 July 2012. Our surveys cover interior pine forest habitats, mixed agricultural and forest edge landscapes, and the shoreline of a large freshwater lake.

We recorded a minimum of 7 species including *Eptesicus nilssonii*, *Pipistrellus pygmaeus*, *P. pipistrellus*, *P. nathusii*, *Nyctalus noctula*, *Myotis nattereri* and *M. brandtii/mystacinus*. This species spectrum is typical of the surveyed habitats but includes records of several species that were rare in recent surveys of the area, documenting the usefulness of additional surveys. Highest calling activity was exhibited by *Eptesicus nilssonii*, *M. brandtii/mystacinus*, *Pipistrellus pygmaeus* and *Nyctalus noctula*. We did not record calls from *Plecotus auritus*, a common species in those habitats, although we in a previous year had found a specimen of this species at one of the sites. This confirms that the relatively low-intensity calls of *P. auritus* can remain undetected, even using modern bioacoustic equipment, reinforcing that several methodological approaches are necessary for comprehensive bat inventories. In addition, we recorded calls from what may correspond to *Myotis bechsteinii*, which, if true, would be among the northernmost records for this species in Scandinavia - possibly an effect of recent northward range expansion due to climate warming.

**Poster No. 24: Bat activity in small riparian water bodies and dams' reservoirs**

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Water bodies, like freshwater streams and natural ponds are very attractive places for bats because they provide food, water and shelter resources. Most studies developed on these types of habitats mainly focused on evaluating the role of environmental factors and/or human mediated disturbance on bat activity. Freshwater systems have been profoundly changed by the construction of dams. However, the influence of these structures on bat activity is poorly understood. In this study we compare bat activity across natural streams and dams' reservoirs. This study was carried out in 5 small streams of the Sabor river basin, located in the NE of Portugal, all of which are characterized for having small water dams. On each stream were selected 4 sampling points: upstream the dam ( $C_M$ ), downstream the dam ( $C_J$ ), on the dam's wall ( $P_1$ ) and the other at the opposite extreme of the dam's wall ( $P_2$ ). A total of 20 different points were continuously sampled, using an ANABAT SD2, for bat occurrence and feeding activity, during a period of 3 hours after sunset, in the summer of 2011. Each point was sampled three times. In order to correctly compare bat activity between different species/complex of species, we developed a correction factor (TtCI) based on the average time between calls (TBC). This correction factor standardizes the number of pulses detected for all species, making it possible evaluate specific dominance. Results showed that total bat activity is significantly higher in  $P_1$  or  $P_2$  in comparison to  $C_M$  or  $C_J$ . However no statistically significant differences were found between homolog sites (e.g.  $P_1$  vs  $P_2$ ;  $C_M$  vs  $C_J$ ). Feeding activity was significantly higher in  $P_1$  or  $P_2$  in comparison to  $C_M$  or  $C_J$ . However, no statistically significant differences were recorded between homolog sites. Comparisons between bat activity using TtCI values show that *Pipistrellus pipistrellus* is the most dominant species, in a total of 15 different species/complex of species detected on the study area. Though, this species is more predominant in reservoir points than in stream points. Results also show that, for dominant species, reservoir points have higher percentage differences than stream points. This study offers contribution to a better understanding of the impact of small dams on bat activity and therefore relevant for management and conservation issues.

**Poster No. 25: Do single trees and alleys improve the functional structure of agricultural landscapes for bats?**

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Number of studies have reported high ecologic value of single old trees in agricultural landscape for many groups of animals, including bats. Therefore scattered trees in open landscapes may offer an opportunity to improve the landscape quality for bats without strong interference to land use by farmers. Quantified studies concerning bat activity around scattered trees in agricultural landscape are scarce in Europe, and the impact of the single trees on bat populations is particularly poorly known. The aim of our study was to estimate the threshold density of trees, at which the landmark element transforms into foraging habitat for bats. We studied landscape structural gradient from single trees, scattered trees to tree lines in agricultural landscapes in southern Estonia. Bats were detected by acoustic point survey using SM2 stereo bat-recorders. We compared bat flight activity, species composition and richness close to trees and in the neighboring open agricultural land. At each survey point, tree composition, height, foliage layering and presence of potential roosts were recorded. We also analyzed the landscape structure from GIS-maps, covering gradients of the distance to the nearest water body and the distance to the nearest woodland. We simultaneously surveyed bats in neighboring forest or park stands to scale our observations to regional species pool and seasonal activity. We identified 10 out of 12 bat species observed in Estonia. Several species were recoded near single trees or alleys and also in open areas, but preliminary results indicate higher activity of bats near trees than in open land. The tree effect was apparent even around single trees. Large-scale structure of landscape around trees also affected the flight activity and species richness. We found that bats use single trees and alleys in agricultural land as landmarks and for foraging. Therefore we suggest that even scattered single trees can improve habitat quality for bats in agricultural landscape.

**Poster No. 26: A New Data about Breeding *Plecotus strelkovi* Spitzenberger, 2006 in Tajikistan**

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In summer 2012 we visited in dry old mines placed in Guzlon mountain in northern slope of Turkestan mountain range near Isfara in North Tajikistan. During July we inspected 4 mines in Dahana ( 14 km from Isfara) and 4 mines near Kulkent ( 11 km from Isfara). The distance between mines in each place is 100 – 300 m. In July 13, 2012 in the mine near Dahana in the length of 670 m at 8.00 a.m. we observed a colony of female with young's numbered 16-20 at 160 m from entrance in a crevice on the ceiling. A bats in crevice was active but no sounds we hear from this microhabitat. 4 bats catch from this colony are: 1) breeding female with lactation, the length of forearm are 43mm; 2) pup (male), the length of the forearm are 39,8 mm; 3) pup (female), the length of the forearm – also 39,8 mm; 4) pup (female), the length of the forearm – 42,7 mm. The temperature near colony was 24,3 C but in the floor – 17,9 C.

In July 14, we visited in old mines near Kulkent and also found the breeding colony of *Plecotus strelkovi*. In mine №3, the small group from 3 females and 3 younger's observed placed open on ceiling in the end of mine at 95 m from entrance. The length of the forearm of one of female that lactating was 42mm while the same of 2 pups - 40mm (male), 40,4 mm (male). In the mine №4 we observe only one female that finished lactation. In mine №5 the breeding colony numbered approximately 50-60 females and big younger's placed at 103 m from entrance. 38 bats was catch, their sex and age composition was: 1) 18 lactating females; 2) one female finished lactation; 3) two non-breeding females; 4) 17 pups – 9 males:8 females. The length of forearm from small pup was 35 mm; from middle – 39,5 mm; biggest – 41,6 mm. Thus, in north of Tajikistan the most preferable habitats in summer for *Plecotus strelkovi* are old dry mines where females group numbered up 50-60 bats and born 1 younger in June. In autumn this species leaving the old dry mines and migrate to winter habitats out from this mountain.

**Poster No. 27: The vulnerability, ecology and conservation of Finnish forest bats**

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To this date, 13 species of bats have been found in Finland. Of these, all of the seven non-migrant species use forests predominantly or almost predominantly for feeding, breeding or roosting. However, the interactions between forests and bats are not well known, especially in the boreal zone, although the link is obvious. The bats receive food and shelter from the forests and in exchange, the vegetation in the forest profits from reduced numbers of pests. Bats play a large role in forest ecology filling the nocturnal ecological niche left vacant by day active insectivorous birds. Many factors affecting the condition of the forest are also responsible for the decline of bat populations. Intensive forestry has greatly affected the structure of forests. For example the destruction of hibernation- and reproduction sites in forests and the felling of pine snags and old trees with woodpecker cavities as well as careless use of insecticides in forests reduce the survival of forest bats. The aim of this research project is to gather knowledge on the bat species and their distribution in different forest habitats and to focus on their habitat requirements in Finland. Of special interest are the true forest bats, the whiskered bat, the Brandt's bat and the Natterer's bat of which the last is classified endangered in Finland. This study is part of research programme of deficiently known and threatened forest species funded by the Finnish Ministry of the Environment.

## Poster No. 28: Impacts of forest fires on bats: a case study in a Mediterranean island

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Wildfire may favour forest regeneration and create habitat mosaics that enhance biodiversity. However, frequent fires may lead to forest degradation and negatively impact wildlife. In Greece, the frequency of human induced forest fires has excessively increased because of pressure coming from urbanization, particularly where there is high demand for land for touristic exploitation and near heavily grazed lands.

Although bats are an important wildlife component in Mediterranean forests, impacts of fire on their ecology is poorly documented. We examined post-fire impacts on bat diversity and activity on Zakynthos, a highly touristic and frequently burnt island on the west of Greece. This is part of an on-going study on post-fire impacts on the island's biodiversity, aiming at evaluating its conservation status and producing guidelines for the restoration and management of burnt habitats.

We acoustically evaluated bat diversity and activity in different pine (*Pinus halepensis*) stands in July 2012 to explore the influence of fire frequency and time elapsed since the last fires. The following forest areas were sampled: (a) unburnt, (b) burnt between 1975-1985, (c) burnt twice (at least once between 2000-2010), (d) burnt three times (at least once between 2000-2010), (e) forest with mature or young trees burnt in 2011, (f) degraded forest burnt in 2011. Overall, 5 species and 2 genera were recorded: *Pipistrellus kuhlii* was the most frequently encountered bat (63.7%), followed by *Tadarida teniotis* (18.1%), *Hypsugo savii* (12.8%), *Plecotus* (2.4%) and *Myotis* (1.9%) species. *Rhinolophus ferrumequinum* and *Pipistrellus pipistrellus* were a minority (0.64% and 0.51%, respectively). Sampling area significantly affected bat activity: it was higher at stands in particular with mature trees burnt in 2011 and stands burnt in 1975-1985; bats were principally hunting at forest edge, openings or where trees had been thinned; it was intermediate at unburnt and at multiply burnt sites with no or few standing trees where activity was primarily recorded near ravines or remaining small tree stands; and lowest at degraded stands burnt in 2011. Bat diversity followed a similar pattern. Our results suggest that occasional fire and thinning reducing clutter may increase the suitability of pine stands for bats, while frequent fires negatively affect bat diversity and activity levels. Thinning should therefore be a priority in conservation efforts to avoid fire while offering a favourable habitat for bats. The mostly encountered species were habitat generalists; species-specific responses to fire should thus be further studied and taken into consideration in management plans.

**Poster No. 29: Impact of forest fragmentation on bat communities**

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In the last 5,000 years, the great majority of the original woodland has been destroyed. Newly woodlands exist as islands (e.g. narrow corridors or riparian habitats along the major rivers) or small forest fragments in the agricultural landscape). Such forest fragmentation can impact on bats due to the limitation of feeding resources and potential roosts in tree holes. The aim of the study was to assess the differences in utilization of 21 isolated forest fragments of three size categories, i. e. small (<100 ha), medium (100-1000 ha) and large (>1000 ha), by bats, and to determine the impact of forest fragmentation on bat populations in the S-Moravian (Czech Republic) agricultural landscape. To analyse the flying activity and species diversity of bat assemblage inside forest fragments, point counting and line-transect methods of bat-detecting were used.

In small fragments the relative activity of bats was 27 positive minutes when calls of bats were heard per an hour of recording (min+/h), in medium 19.8 min+/h and in large fragments 19.3 min+/h. The level of flight activity showed significant similarity between medium and large fragments. If the number of bat species in the two smaller-size categories of fragments (1 and 2) had been lumped, significantly higher number of bat species was recorded in large fragments. In our model region, the presence of three large forest complexes is sufficient with respect to bats, despite of their non-balanced distribution. They are mostly distributed in western upland part of the region under study. Finally, we consider appropriate to make a forest-grassland mosaic where large fragments cover 10% of the whole region area at least. Further, in the same area, we recommend 20 small fragments with original tree species composition at least. Such small fragments should cover 1% of the whole region area and 10% of total region woodiness at least.

**Poster No. 30: Roosting and foraging ecology of the soprano pipistrelle bat *Pipistrellus pygmaeus* in agricultural landscapes**

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The soprano pipistrelle bat *Pipistrellus pygmaeus* is strictly protected under the EU Habitats Directive, but the formation of large maternity roosts in buildings can cause problems for human occupants. Information on the roosting and foraging ecology of this species is needed to inform management actions at roosts and also in the wider landscape. We radio-tracked 22 female bats caught at two maternity roosts situated within agricultural landscapes in the UK. Day roosts, night-time foraging areas and home ranges were identified. 33 alternative day roosts were located in a range of built and natural structures, but only three of these sites supported maternity roosts. Bats commuted up to 14km to reach foraging areas, which were at wetlands, woodlands and tree-lines. Individuals were faithful to specific roosts and foraging areas. Bats had generalist roosting requirements, but the small number of maternity roosts identified in this study suggests that exclusion from favoured roosts could negatively impact breeding success. Bats had specialist foraging requirements. Wetlands, woodlands and tree-lines should be retained or created in the landscape surrounding maternity roosts.

### SESSION 3: VIRAL EMERGING DISEASES IN BATS

#### **Poster No. 31: A novel Rhabdovirus from the straw-coloured fruit bat (*Eidolon helvum*) in Ghana**

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In the recent years an increasing number of novel viruses were discovered in bats. The straw-coloured fruit bat *Eidolon helvum* (*E.helvum*) harbours a high diversity of viruses and combines all characteristics of a small mammalian virus reservoir. They live in large colonies of up to 1 Mill. individuals, have close social interactions and are highly migratory. *E.helvum* is abundant in Sub-Saharan Africa and colonies are often in close contact to the human population. In addition, they are the most hunted bush meat on the African continent. Many rhabdoviruses are known to be harboured by bats however only few were found to infect humans. Those known to infect humans are associated with severe diseases. In this study we isolated a novel rhabdovirus from the spleen of *E.helvum* from Ghana. The full genome of the rhabdovirus was analysed from cell culture supernatant by 454 sequencing. In order to test the prevalence of the virus, *E.helvum* spleens were screened by specific real-time PCR for the novel rhabdovirus. From 494 bat spleens 23 (4.6%) were positive. The presence of antibodies was tested by ELISA and immunofluorescence assay. Of 352 bat sera 44 (12,5%) reacted positive in both assays. Neutralising antibodies were confirmed in a plaque reduction assay. The potential for a zoonotic spillover of this novel rhabdovirus is yet to be investigated.

**Poster No. 32: Generation of epithelial cell lines from reservoir host species *Rhinolophus ferrumequinum*, *Rhinolophus euryale* and *Pipistrellus pipistrellus* as a model system for the study of zoonotic coronaviruses (CoV)**

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With the emergence of SARS Coronavirus (SARS-CoV) in 2002/2003, bats have received increased attention by virologists all over the world and in 2012, again, a novel CoV pathogenic to humans (hCoV-EMC) emerged in the Near East. While SARS related CoVs are associated with Rhinolophid bats, the novel hCoV-EMC shows close identity to a bat CoV from *Pipistrellus abramus*.

However, while a plethora of novel CoVs have been discovered in bats in recent years, all attempts to isolate them in cell culture have been unsuccessful so far, limiting *in vitro* studies of bat CoVs. Further, it is not possible to study replication in the natural reservoir host under experimental conditions due to conservational matters.

To study the virus-host interaction of SARS-CoV and hCoV-EMC in relevant bat species, we established epithelial cell lines from the airways and kidney of *Rhinolophus ferrumequinum*, *Rhinolophus euryale* and *Pipistrellus pipistrellus*. These cell lines can provide insight in the virus host interaction of CoV in their natural reservoir host and may provide a novel tool for virus isolation.

**Poster No. 33: The prevalence of bat adenoviruses in the case of different sampling methods**

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Bats are reservoirs of an astonishingly high number of viruses. A variety of dangerous RNA viruses (e.g. SARS coronavirus, Ebola, Nipah, Hendra, and rabies viruses) were discovered in these flying mammals, but in bats, the diversity of DNA viruses is high, too. Adenoviruses (AdVs) are medium-sized, non-enveloped, icosahedral viruses with double-stranded linear DNA. A great host-specificity can be observed among them; usually every AdV has its own host. AdVs occur in all classes of vertebrates therefore are ideal models to examine viral diversity, evolution and co-evolution with the host.

The ground of screening for new viruses is the selection of the right sampling method(s). In the case of bats, we used three methods to get viral samples. First, guano under large nursery colonies in caves and buildings was collected. Other samples were gathered from moribund or dead-found specimens' organs. The third method was the individual faecal sampling of mist-netted or harp-trapped bats.

High prevalence was observed in the case of colony and organ samples. Individually sampled bats proved to be also infected with AdV in some cases, but the prevalence was not as high as in the case of the other two methods.

The observed difference can have more explanations. Bats urinate on the guano dumps under colonies, so either the urine may contain higher number of AdVs than faeces, or the AdV-infected specimens (present possibly in low percentage) can contaminate non-infected individuals' guano. The prevalence in moribund or dead-found animals can be high because of the possible pathogenicity of AdVs or they can emerge in them due to the impaired immune system. Although the prevalence in the case of individually sampled bats is lower, the method is not negligible because there are many bat species whose sampling with the other methods is very difficult or nearly impossible. Also, more attention has to be made on urine sampling in bat AdV studies.

**Poster No. 34: Reactivity of human and murine monoclonal antibodies to lymphocyte surface markers from different bat species**

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Bats (Chiroptera) are known reservoirs for many emerging pathogens, and act as natural hosts for diseases with importance for both public and animal health. With expansion of the human population and encroachment of bat habitats, the contact between humans, their livestock and different bat species are becoming more frequent, which facilitate the spill-over of different bat-associated pathogens and the emergence of novel diseases. Despite their epidemiologic role, little is known about immunity in bats and how their immune system control viral infections. Hindering investigation of bat immunity is the lack of bat-specific immunological and molecular tools. Such shortcomings prompted us to test the cross-reactivity of 21 anti-murine and human antibodies against different lymphocyte surface-markers (CD3, CD4, CD5, CD8, CD11, CD19, CD20, CD45 and CD79) with cells from four different bat species (*Desmodus rotundus*; *Myotis myotis*; *Phyllostomus discolor*; *Rousettus aegyptiacus*). We performed immunohistochemical staining analyses on formalin fixed, paraffin embedded- and cryo-preserved spleen samples and flow cytometry on leukocytes from blood. The results of our study identify bat-specific antibodies and constitute the first step in purifying bat B- and T-lymphocytes in order to obtain monoclonal antibodies specific to different bat species.

**Poster No. 35: Heterogenous distribution of viral prevalences in European bat colonies**

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Bats have been identified as subclinical carriers of several zoonotic diseases which may cause fatal diseases in other species. Recent studies from several work groups revealed a broad variety of viruses present in European bat species which also do not seem to have any health impact on the bats. In this study we analysed the prevalence of different viruses in native bat species as a tool of population dynamic studies by elucidating possible transmission pathways. We sampled bat colonies in Mecklenburg-Pommern, Saxony Anhalt, Bavaria and one colony in Romania by collecting oral swabs, faeces and urine. The samples were analysed using published PCR protocols followed by sequence analysis of the obtained PCR products. In total, 26 species were sampled for the detection of Astroviruses, Paramyxoviruses, Coronaviruses and Adenoviruses. These viruses were chosen due to their possibly different transmission behaviour and due to their diverging prevalences as described in the literature. Another reason was to investigate the absence or presence of viruses with zoonotic potential in European bats, especially within the families of *Paramyxoviridae* and *Coronaviridae*. First results revealed a broad variety within the different viral prevalences, ranging from 1% for Corona- and Adenoviruses and 5% for Paramyxoviruses to 40% for Astroviruses. These values also differ between bat colonies. The underlying reasons for different prevalences of one specific virus within different bat colonies still need to be elucidated. The understanding of these mechanisms may provide a new tool for the study of population dynamics of bats colonies.

**Poster No. 36: Diversity of Paramyxoviruses in Neotropical Bats**

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Paramyxoviruses comprise leading human pathogens, including measles and mumps virus. Recently, bats were proposed to host major mammalian paramyxoviruses. In previous studies it was shown that paramyxoviruses related to human viruses originated mostly from Old World fruit bats (Megachiroptera). In the New World, Megachiropterans do not occur and this ecological niche is occupied by echolocating bats (Microchiroptera), which are highly diversified in the Neotropics. Therefore, studies in the New World tropics are of great importance for the analysis of diversity, distribution and ecology of paramyxoviruses.

In this study, neotropical bats from Costa Rica were tested for paramyxovirus RNA. A high diversity and prevalence of Morbilli-related viruses was observed in Costa Rican insectivorous bats. Closely related viruses were detected in a single species (*Pteronotus parnellii*) through three consecutive years and at different locations.

**Poster No. 37: Seasonal, social, and species-specific differences in immune competence in fruit bats: field and captive observations**

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Bats represent critical species: in their physiology and ecology, in their ability to serve as reservoirs for zoonotic diseases, and in their susceptibility to white-nose syndrome (WNS). Yet, little is known about their immune responses and how they vary by sex, species, social processes, and environmental conditions. Differences in immune mechanisms between various species of bats may explain why some serve as carriers for zoonotic diseases such as those caused by rabies, Nipah, Hendra, and Ebola viruses or why some species are susceptible to WNS while others appear resistant. In captive Malayan Flying Foxes (*Pteropus vampyrus*) we have found significant seasonal, social, and sex differences in leucocyte counts that mirror glucocorticoid hormone levels (which reflect metabolic processes and the stress response) and that inversely relate to testosterone levels. Furthermore, in this species we have documented sex and seasonal differences in the ability to respond to antigen challenge (tetanus toxoid). Species differences in complement activity (an innate immune system component) have been documented in captive Pteropodids (*P. vampyrus*, *P. hypomelanus*, *P. pumilus*, and *Rousettus aegyptiacus*); and the complement response to immune challenge has been characterized in free-ranging African Pteropodids (*Epomophorus labiatus*). In this species, the response to a significant immune challenge that typically induces a fever response (injection of lipopolysaccharide (LPS), a component of the bacterial cell wall) was characterized by decreased, rather than increased complement activity, which may be related to the fact that some of the bats exhibited shallow torpor (in relation to ambient temperature) rather than a fever. Analyses of additional immune components, including cytokine and antibody levels are underway. Our findings contribute to the physiological and ecological knowledge base for this diverse taxonomic group and inform future studies of disease ecology in bats.

**Poster No. 38: The malaria parasites of bats from South Sudan**

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Malaria parasites that belong to six different genera have been described from bats. Compared to all other mammalian host groups, bats are parasitized by the most diverse suite of Haemosporidian species. That being said, bats still belong to the poorly studied host groups. We investigated bats (belonging to seven families) in South Sudan, a place of high chiropteran diversity and with some areas that feature an overlap of West and East African bat fauna. Microscopic, molecular and histological methods were combined to detect and characterize infections with malaria parasites and these results were then compared to previous findings in West African bats. The morphological and phylogenetic results of the South Sudan samples reveal two parasite genera, *Nycteria* (in different rhinolophid species) and *Hepatocystis*. We report a high prevalence of the latter genus in different pteropodid and hipposiderid hosts, with an unexpected high parasitemia. The overall findings suggest that *Hepatocystis* infections are common and widespread in the epauletted fruit bats of tropical Africa.

**Poster No. 39: Lyssavirus distribution in naturally infected bats**

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Rabies is the oldest known zoonotic disease and has been the first recognized bat-associated infection in humans. Today, 14 different lyssavirus species are known to occur worldwide, mainly isolated from the order Chiroptera. In Germany, three different lyssavirus species are identified as causative agents of rabies in indigenous bats: the European Bat Lyssavirus type 1 and 2 (EBLV-1, EBLV-2) and the Bokeloh Bat Lyssavirus (BBLV) for which the Serotine bat (*Eptesicus serotinus*) and Myotis species (*M. daubentonii*, *M. nattereri*), respectively, are primary hosts. Lyssavirus maintenance, evolution, and epidemiology in indigenous bat species are still insufficiently explored. Moreover, the small number of bats infected, the nocturnal habits of bats and the limited experimental data still hamper attempts to understand the distribution, prevalence, and in particular transmission of the virus. Next to the presence of viable EBLV-2 in the brain specific genomic RNA could be detected in a variety of organ tissues using highly sensitive molecular techniques of a few animals (Johnson *et al.*, 2006).

In an experimental study in Serotine bats a rather heterogeneous dissemination of EBLV-1 in organ tissues with high viral loads was found (Freuling *et al.*, 2009). However, it is not clear whether the EBLV-1 distribution is similar in naturally infected animals. So any further information on virus dissemination and viral load within the infected host could provide evidence for release of virus and methods of transmission (Johnson *et al.*, 2006). We therefore investigated organ tissues (tongue, salivary glands, heart, lung, liver, kidney, spleen, bladder, pectoral muscle) of EBLV-1 positive Serotine bats from Germany collected between 1998 and 2012 by qRT-PCR and compared the results with those obtained by Freuling *et al.* (2009). Additionally, tongue samples were fixed in 4% buffered formaldehyde for immunohistochemical detection of lyssavirus antigen in order to confirm the presence in taste buds.

A total of 38 Serotine bats from Mecklenburg-Western Pomerania, Hamburg, Bremen, Lower Saxony, Brandenburg, Berlin, North Rhine-Westphalia, Saxony-Anhalt and Saarland were investigated. In experimentally infected Serotine bats viral RNA was predominantly found in brain, tongue salivary gland, lung and spleen. Additionally, high amounts of viral antigen were detected in the taste buds

of the tongue. In contrast, results in naturally infected Serotine bats differed. Interestingly, while in individual EBLV-1 positive animals virus RNA was detected only in the brain, in the majority of Serotine bats viral RNA was found in various organ tissues. Virus dissemination and viral load was heterogeneous. As could be expected from the neurotropism of lyssavirus highest relative viral loads were detected in the brain.

## SESSION 5: WHITE-NOSE SYNDROME

### Poster No. 40: Investigation of *Geomyces destructans* colonizing bats in Germany

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The White-Nose Syndrome (WNS) is a dramatic disease affecting bats in Northern America with deadly outcome. Since 2006, more than six million bats have fallen victim to this disease. WNS has been identified to be caused by the white fungal pathogen named *Geomyces destructans* (*Gd*). This white fungus is mostly established at bat snouts and spreads over the wings.

In Europe, with *Gd* infested bats, mostly the species *Myotis myotis*, have also been observed. However, in contrast no mortality of European bats affected by this fungus has been noticed up to date.

In this study, the effects of ecological conditions concerning the growth of *Gd* on bats were investigated. For that issue, *Gd* affected bats were observed under different hibernacula climatic conditions in seven mines of Saxony-Anhalt. The hibernacula research revealed strong *Gd* affections on *Myotis myotis* for high humid air conditions (relative humidity about 100 %) and high temperatures (7 - 10 °C). In contrast, hibernacula with both lower temperatures und dryer conditions showed no growth of *Gd* on bats.

Laboratory experiments pointed out that the *Gd* grows optimally at 10 - 15 °C on different culture media. Experiments with different air humidity conditions showed no direct relation to *Gd* growth. Experiments with the addition of different rock from hibernacula location in culture media showed a strong increased production of *Gd* spore. Antagonistic tests indicated an inhibition of *Gd* growth by the bacteria *Pseudomonas veronii*-like PAZ1 (isolated by Mrs. Irmtraut Zaspel, vTI, Institute of Forest Genetics, Waldsiefersdorf, Germany). An antagonist test on mPDA agar culture medium clearly revealed that the bacterium *Pseudomonas veronii*-like PAZ1 totally inhibits the growth of *G. destructans*.

**Poster No. 41: *Geomyces destructans*: first records in Austria**

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Many studies have been conducted for a better understanding of the dramatic decline of millions of bats in North America for which the fungus, *Geomyces destructans* (Gd), is responsible. However, European bats seem to cope with it and individuals convalesce from this psychrophilic pathogen.

Our study represents the first extensive data of Gd occurrence in Austria. In 2011 and 2012 we visited 102 hibernacula and found five sites with 14 Gd-affected *Myotis myotis* / *oxygnathus*. At least one bat per site was analysed by molecular methods while bats too difficult to reach were registered visually. Positive records of Gd were located between 300 and 750 m above sea level in the northern, eastern and southern part of Austria. One may assume that the Alps, in the western part of Austria, represent a natural border for the fungus. To prove this hypothesis further research has to be concluded.

Transmission pathways and reasons for differences in Gd occurrence between bats and bat populations still remain unclear. The origin and distribution of Gd in Europe is still subject of interest and our study contributes to this necessary research across national borders.

**Poster No. 42: Statistical indices and software for analyzing beam-break data**

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Beam-break counters are infrared photo-beam-break detection systems that monitor the directional movement of bats entering and exiting a roost site. This new technology is useful for monitoring biological processes, including bat activity at roost entrances, and bat abundance within a roost. In 2010, Bat Conservation International (BCI) partnered with wildlife resource managers in Indiana, Arkansas and Kentucky, and installed Gatekeeper beam-break systems at six important hibernacula. These installations were to act as an early-detection system for the advent of White-nose Syndrome (WNS). WNS is an emergent wildlife disease which has killed an estimated 5.7 million bats in North America. Clinical signs of WNS include “abnormal winter behavior”, such as bats emerging in large numbers from hibernacula in the winter months. These systems were installed to estimate winter bat activity levels at these sites. Datasets from two sites, Mammoth Cave Rafinesque Chapel and Saltpetre Cave, both in Kentucky, were complete enough to develop the statistical indices and software tools necessary for data analysis. In 2012, BCI partnered with Dr. Thomas Ingersoll to develop the indices and models. We identified two biometric indices, maximum emergence and maximum immergence, that are crucial in data analysis. Then, we developed a software program written in the mathematical computing language R to calculate a suite of beam-break statistics, including nightly emergence activity, seasonal immergence and maximum nightly emergence from the roost. These statistics were used to demonstrate 1) how roost emergence is affected by season, 2) how roost emergence is affected by ambient temperature and 3) how maximum emergence can be used with hierarchical models to estimate abundance. Many challenges remain, but these initial results are hopeful. Future research will focus on the maximum emergence metric, improved methods for estimating bat abundance and a simulation study to validate this method.

**Poster No. 43: An entrained circadian cycle of peak activity in a population of hibernating bats**

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Biological rhythms exist in many diverse forms of life. Individuals must remain entrained to environmental changes to survive. Some hibernating mammals maintain biological rhythms even during deep torpor, but which cues are used for entrainment are poorly understood. We studied activity in an assemblage of hibernating *Myotis* bats (mainly *M. nattereri*) inhabiting a temperate maritime climate over 3 consecutive winters using ultrasound detectors and a series of active infrared motion detectors. Here we demonstrate that the timing of peak activity changes as day length changes over winter, but nevertheless remains entrained to a time close to dusk that is most advantageous for winter foraging. Diurnal activity is infrequent throughout winter. There is an increase in activity at higher hibernaculum temperatures, particularly as temperatures rise above the lower threshold for insect flight.

**Poster No. 44: Bat flight with bad wings: Is flight metabolism affected by damaged wings?**

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Infection of hibernating North American bats with the keratin-digesting fungus *Geomyces destructans* often result in holes and ruptures of the wing membrane, yet it is unknown if flight performance and metabolism of bats are altered by such injuries. I conducted flight experiments in a circular flight arena in *Myotis albescens* and *M. nigricans* where I observed individuals with intact and damaged wing membranes, i.e. a ruptured trailing edge of one of the plagiopatagial membranes. In both species, individuals with damaged wings were lighter, had a higher aspect ratio (squared wing span divided by wing area) and an increased wing loading (weight divided by wing area) than conspecifics with intact wings. *Myotis albescens* flew at a speed of  $1.7 \pm 0.8 \text{ m s}^{-1}$  and *M. nigricans* at  $1.9 \pm 0.3 \text{ m s}^{-1}$ . Bats with an asymmetric reduction of the wing area flew at a similar speed but performed less flight manoeuvres than conspecifics with intact wings. Despite of a 10 to 30% increase in aspect ratio and wing loading, individuals with damaged wings showed lower metabolic rates during flight than conspecifics with intact wings, yet costs of transport were similar in individuals with damaged and intact wings. Possibly, bats compensated an asymmetric reduction in wing area by avoiding flight maneuvers. In conclusion, bats may not suffer directly from wing damages by experiencing increased metabolic rates but most likely indirectly by a loss of weight associated with a reduced foraging success.

**Poster No. 45: New bat-victim of White Nose Syndrome? – *Barbastella barbastellus* infected with *Geomyces destructans* in Southern Poland**

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During routine inspection of the II World War military shelter located in Western Carpathians in Southern Poland, two dead bats were found with their muzzles, ears and forelimbs overgrown by white mycelium. An adult female of *Vespertilio murinus* was lying on the ground while an adult male of *Barbastella barbastellus* was still attached to the wall. Bats were transported to the laboratory and prep slides were taken directly from the white mycelium for identification trial. Samples of overgrown tissue were also taken, put onto Saboraud Agar and incubated in the fridge for isolation of the fungi. Direct observation of the samples detected only *Geomyces pannorum* and minor contamination with *Mucor* sp., *Penicillium* sp. and *Cladosporium* sp. in both specimens. However, isolation trials from *B. barbastellus* proved positive also for *Geomyces destructans*, proposed agent of WNS, and provided pure cultures with morphology typical for that pathogen. These results were subsequently confirmed by molecular analyses of the ITS region of fungal rDNA with 100% sequence similarity to the sequence of the type deposited in GenBank. Although the cause of death could not be determined and therefore this finding does not necessarily imply the occurrence of WNS, it is to date the first report of a bat outside the *Myotis* genus being infected by *G. destructans* and moreover, a bat with conservation status considered as ‘near threatened’ by IUCN and with overall population trend considered as decreasing.

## SESSION 6: BATS AND WINDFARMS

### **Poster No. 46: Which factors increase the risk for fatal collisions by bats at wind turbines?**

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The occurrence of bat fatalities at wind farms is receiving much attention in conservation planning, especially because wind energy is becoming increasingly common in many regions, and because numerous bat species are highly endangered. Knowledge about the factors which lead to collisions by bats with wind turbines is thus important to reduce the impact of wind energy devices on bats. We here present results from three different types of surveys to quantify the occurrence of bat fatalities at wind parks: (1) ground-level searching for carcasses (which is very labour-intensive and may miss some collision instances due to the presence of scavengers) and (2) surveys and landscape cover analyses to assess the biogeophysical characteristics of power plant sites (3) automatic bioacoustics monitoring at rotor height (i.e., where the actual collisions occur, a height often neglected in bat activity surveys that are conducted from the ground). Sites of wind energy parks which have an especially high number of bat collisions show a range of typical characteristics, including proximity to rivers or lakes, woodlands, mountain chains, but other factors including the seasonal occurrence of migrating bats at some sites can also influence the risk for bat fatalities. Currently, some wind farms are being shut down temporarily at times of high collision risk, a procedure that will hopefully reduce the number of bat fatalities in the future.

**Poster No. 47: Methods and approaches to study bat fatalities at wind energy farms**

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Fatalities by bats due to collisions with wind turbines and rotors are of high importance for conservation planning, but there is still little data on their occurrence, and about which factors govern them. Studying bat fatalities at wind farms is difficult because many collisions happen at night, and many carcasses may be removed by ground predators within hours or a few days. Further, knowledge about bat flight activities is so far largely based on assessments from the ground (and not at rotor height), so many crucial aspects of bat flight behaviour are not well understood. We here present an integrated monitoring approach that has been developed, tested and refined by our institute over the past years. The approach is based on (a) ground-level searching for carcasses, (b) surveys and landscape cover analyses to assess the biogeophysical characteristics of power plant sites, and (c) automatic bioacoustics monitoring at rotor height. Technical aspects of all three approaches are presented, and we discuss how to obtain results which can be used for environmental impact assessments.

**Poster No. 48: Bat activity at different wind facilities in Northwest Germany**

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We monitored the bat activity in five different wind facilities (Cappel, Cuxhaven, Timmeler Kampen, LK Aurich and Zetel) in Northwest Germany. Although these wind facilities are situated in the same geographical region, they differ in respect to the distance to the coast line. Cuxhaven and LK Aurich were investigated from April to October, Cappel, Timmeler Kampen and Zetel from mid of July to October.

In most of the projects we recorded the bat activity with Anabats SD1 and SD2 (Titley Electronics, Australia) with the exception of Zetel, where an Avisoft-System (Avisoft Bioacustics, Germany) was installed. We measured the activity at nacelles heights. At LK Aurich and Timmeler Kampen we additionally registered the bat activity at ground level.

Our aim is to set the bat activity, species composition and phenology in correlation to parameters such as weather conditions and distance to the coast line. Although all sites are situated in the same geographical region, we like to emphasize the differences and show that it is difficult to transfer the results from one wind facility site to another.

**Poster No. 49: Temporal patterns of autumnal bat migration at different latitude levels in northern Europe**

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In the past bat migration became the focus of attention since it was evident that especially migrating bat species are threatened by wind power facilities.

In this study we will focus on Nathusius' Pipistrelle Bat (*Pipistrellus nathusii*). This species is known to be a long distant migrant. We assume that *P. nathusii* is moving from northern latitudes towards the south and passing through our study sites where migrants mix with bats from local populations. According to this assumption, sites at different latitudes show different temporal patterns, such as seasonal peak duration and temporal extend. We will compare bat activity at different study sites: Måkläppen at the southwestern tip of Sweden at the Baltic Sea; Mellum and Wangerooge, two Frisian Islands at the German North Sea coast; Bagband and Wiesmoor, two wind farms in Eastfrisia, about 30 resp. 35 km away from the German North Sea coast line; Walsrode and Langwedel, two wind farms in the "Lüneburger Heide" far inland between Hamburg and Hannover (northern Germany). Måkläppen is our reference; Mellum and Wangerooge have no local bat population, whereas Bagband and Wiesmoor are in the north western distribution of this species in Germany.

To study the bat activity in 2012 we used long time monitoring detectors on all sites. We installed Anabat SD1 resp. SD2 (Titley Scientific, Australia) with the exception of Wangerooge and Walsrode, where we used the Avisoft System (Avisoft, Germany).

We will only briefly discuss the different activity levels at the sites, because the detectors are situated in different habitats and heights. Instead, we concentrate on the analyses of the migration phenology. We discuss the methodological possibilities of the used methods to identify important migration routes on a larger scale.

**Poster No. 50: Bat fatalities at different wind facilities in Northwest Germany**

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Northwest Germany is characterized as flat and a relatively open, highly agricultural used landscape. It is also known for strong winds which led to a high density of wind facilities. In this poster we show results out of five wind facilities both at the coast but also more inland (ca. 30 km from the coast line). The wind facilities Cuxhaven, Timmeler Kampen, LK Aurich and Zetel were investigated quite recently starting in 2011 or 2012 whereas the monitoring of Cappel took place in 2008/2009. In all cases we conduct a carcass search with carcass removal trail and search efficiency control. Bat carcasses were searched every third day. In addition the bat activity was also monitored (see poster 2).

We compare the species composition and occurrence of bat fatalities with the distance to the coast, structure richness, wind turbine heights and discuss whether the monitored activity of the species has a correlation to bat fatalities.

**Poster No. 51: Understanding Bat and Wind Turbine Interactions: Patterns, Challenges and Opportunities**

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As energy demands increase worldwide, many countries are seeking ways to reduce fossil fuel consumption and generate alternate forms of energy. Recently, wind power has gained prominence among renewable resources. This is driven, in part, by supportive government policies and growing economic competitiveness. However, wind-powered turbines are not environmentally neutral and have resulted in unexpectedly high numbers of bat fatalities. Although fatality estimates have been reported, primarily in the U.S., Canada and Europe, the full extent of the global impact of wind-powered generation on bat populations is unknown. Because bats provide numerous ecosystem services (e.g., insect suppression, pollination and seed dispersal), adverse impacts from wind energy development on bats could disrupt the ecological health and stability of a region. Despite nearly a decade of research, the cumulative impacts of wind energy development on bats remains inadequately investigated and poorly understood. Although data gaps exist, recent research points to several opportunities to minimize bat fatalities, to the greatest extent practicable. In 2003, Bat Conservation International (BCI) helped organize the Bats and Wind Energy Cooperative (BWEC), an alliance of private industry, state and federal agencies, academic institutions and non-government organizations to provide scientifically credible recommendations for standardizing protocols and research designed to reduce risk to bats and support long-term, responsible wind energy development. Here we present our current understanding of bat/turbine interactions, provide insight on persistent problems that researchers face, and offer potential solutions to resolve this issue.

**Poster No. 52: Using automatic measurements of bat activity to develop turbine-specific curtailment algorithms – a case study in two wind parks**

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On average, ten bats per wind turbine and year are killed in Germany, leading to an estimated total of 200000 bat fatalities annually. As all bat species in Germany are protected by European and German law, mitigation measures are necessary to prevent those frequent bat fatalities. For that, up to now curtailments of wind turbines are the only effective method. However, species composition, the total amount of bat activity and thereby the collision risk depend on the specific location of a wind turbine. To ensure the best compromise between bat protection and turbine efficiency it is vital to develop turbine-specific curtailment algorithms. Here, we present examples from our planning practice on how we use automatic activity measurements for the assessment of the collision risk and the development of turbine-specific curtailment algorithms.

To identify correlations of bat activity with wind speed, time of night and month, we installed automatic bat detectors with standardized calibration inside the nacelle of wind turbines in two wind parks in Northeastern and Southwestern Germany. Bat calls in the rotor-swept area were registered from July to October and May to October respectively. We used a statistical model based on a study at 70 wind farms in Germany to estimate the number of bat fatalities during sampling time. Furthermore, we adapted a second model from the same study for the estimation of bat activity from wind speed, time of night and month to the specific turbines. Both models were used to estimate the collision risk from these parameters. From this we calculated cut-off wind speed for combinations of time of night and month for certain tolerable numbers of bat fatalities per turbine.

In both wind parks the correlation of bat activity with wind speed, time of night and month was similar. However, there were big differences in species composition between the two wind parks. Furthermore, the total activity was much higher in the wind park in Northeastern Germany, leading to a higher estimation of bat fatalities. Due to this, much higher cut-off wind speeds were required in the park in Northeastern Germany to achieve the same tolerable number of bat fatalities. These results support the need for turbine-specific curtailment algorithms based on the specific activity pattern. A wide application of this method could ensure the ongoing fast growth of renewable energies while minimizing the impact on bat populations.

## Poster No. 53: Phenology of migrating bats crossing Central Europe

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The German Federal Agency for Nature Conservation (*Bundesamt für Naturschutz*) has funded a Research & Development Project on migratory pathways of long-

distance migrating bat species. While the entire R & D project consists of three parts, we here focus on the first part. For the four species *Nyctalus noctula* (Noctule Bat), *Nyctalus leisleri* (Lesser Noctule Bat), *Pipistrellus nathusii* (Nathusius' Bat) and *Vespertilio murinus* (Parti-coloured Bat) we gathered several thousand observational records from large areas of Germany (Baden-Württemberg, Bavaria, Thuringia, Saxony, Saxony-Anhalt, Mecklenburg-West Pomerania, Brandenburg and Berlin) and various parts of Switzerland and Austria. Data were taken from published literature and made available to us through databases of Coordination Centres for Bat Conservation, natural history museums, banding centres, governmental agencies for nature conservation / the environment of federal states, the Swiss Foundation for the Protection of Bats, and individual bat researchers. They include observations of several hundred bat workers across the three countries and span up to three, in parts even five or six decades.

We analysed the occurrence of the four migratory species over time and space and plotted the phenological presence in the above mentioned sector of Central Europe, which can be considered a “corridor”, as a function of time. This “corridor”, covering more than 1.000 km between the summer roosts in the Northeast and the hibernacula in the South of the project area, more or less reflects the general migration route.

Furthermore, we combined the occurrence data with land use data (CORINE land cover; ArcGIS10 analyses) in order to find potential correlations to the landscape / land use. We were especially interested in questions such as whether there are areas of higher concentration of animals at certain times and whether there is a link to particular landscape structures or geographical / topographical features (e.g., river valleys, mountain ridges).

A second module of the R & D project will comprise intensive field studies during the two migration periods in 2013. We will conduct radiotracking of noctule bats as a model species in order to determine their migratory pathways with as much spatial and temporal resolution as possible. Additionally, recordings of bat calls in a confined geographical mountainous area are planned to monitor bat movement throughout the migration periods.

## Poster No. 54: Bats and Wind Farms in Ireland

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Wind turbines are increasingly established worldwide with often fatal consequences for wildlife. Substantial research in North America and mainland Europe has shown wind farm siting and operation can have significant adverse effects on bats, with large numbers of dead bats recorded beneath wind turbines. To date little is known about the effect of wind turbines on Irish bats. European and US based research findings do not readily transpose to the Irish situation, given differences in bat species composition and behaviour, as well as differences in landscape characteristics. This research takes a fundamental approach to the issue in Ireland and investigates the presence of bats on wind farm sites compared to background assemblages. Factors that determine bat presence or absence at a wind farm site, including weather conditions, seasonal variation, wind farm and landscape characteristics are ascertained. Six wind farm sites in northwest Ireland were surveyed between June and October 2012. In the absence of any baseline data for the sites, methods were carried out simultaneously on the wind farm site and at a similar off-site location in the area for comparison. Using passive bat detectors, bat echolocation was continuously recorded at wind farm sites for one week periods, every three weeks. In addition active surveying, comprising twelve five-minute point surveys along a fixed route on and off each wind farm site, was carried out at least twice a month per wind farm. Bat activity and species composition on and off each wind farm site over five weeks of remote recording and eight active surveys are presented. The importance of different factors affecting wind farm suitability for bats are examined using a linear mixed model.

**Poster No. 55: Methods to study offshore bat activity**

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Bats are not surveyed as part of the standard investigation concept (StUK) in the authorization procedure for offshore wind turbines in Germany up to now. Studies in southern Scandinavia show that bats migrate and forage over the Baltic Sea and are attracted by offshore wind turbines and might thus be killed. In the German Baltic Sea about 1.000 wind turbines are projected. Beside data on bat occurrence and phenology standard methods are urgently needed to allow bats to be considered site-specifically during planning and authorization.

To test methods, different direct ultrasound recording systems (all time-expansion type) were installed at several coast locations and offshore. An Avisoft Ultrasound Gate System was mounted on a ferry crossing the Southern Baltic Sea between Rostock, Germany and Trelleborg, Sweden during the hole season. Four microphones were fixed about 20 m above the water. We tested an EcoObs Batcorder and a Batomania Horchbox on a research platform 2 km offshore. A Pettersson D 500x was installed for two seasons on a small island 12 km offshore.

Contrary to expectations microphones resisted the rough conditions and recorded several bat calls including *Nyctalus noctula*, *Myotis daubentonii* and *Pipistrellus nathusii*. Available systems are clearly appropriate to study bat activity offshore.

On land ultrasound recording systems are applied as standard method for acoustic monitoring to quantify pre-construction bat activity and post-construction collision risk at wind turbines. To our opinion, there is no factual reason why a comparable acoustic monitoring procedure is not implemented offshore yet.

## Poster No. 56: Bat fatality patterns at wind turbines in southern Europe

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Over the past decade, many bat fatalities at wind farms have been found over a wide geographical range. Our work focuses on southern Europe, where recent information show highly significant numbers of bat fatalities in some areas. These fatalities mostly belong to aerial-hawking species (e.g. *Nyctalus* and *Pipistrellus spp.*), a pattern which is consistent with that reported from other regions. To understand how the location and setting of wind farms affect bat mortality in southern Europe, we evaluated; a) which environmental variables affect bat mortality at wind farms in southern Europe? b) what range of values within each variable increases the probability of bat death's at wind farms? We analysed 100 wind farms in four countries: Portugal (38), Spain (47), France (6) and Greece (9). For each wind farm, information on climate, topography and land cover was obtained. To eliminate the effect of the wind farm size, fatality data were divided by the number of turbines present at the respective wind farm. General Linear Mixed Models were then calculated between fatality data and the response variables, while the sampling effort (number of monitoring years) was considered a random effect. Models and variables were selected using the Akaike Information Criterion. Results presented show which ecological factors contribute the most for the occurrence of mortality and how the probability of death at wind farms varies within each variable. Overall, preliminary analyses show that bat fatalities at wind farms are associated with areas with high temperatures and without vegetation, located near steep slopes. These results are of utmost importance to better understand this phenomenon and to allow the development of conservation guidelines adapted to the conditions in Europe.

**Poster No. 57: The catchment area of German wind power facilities: A plea for international regulations**

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Wind turbines are increasingly established throughout Europe and North America with often fatal consequences for wildlife, most importantly bats and birds. Yet, it is often unknown over what geographical distances wind farms are affecting animal populations. Based on stable hydrogen isotopes in fur and by developing an isoscape origin model, we assessed the geographic provenance of bats killed in summer and autumn at German wind power facilities. We found that killed *Pipistrellus nathusii* originated from Estonia or Russia, and *P. pipistrellus* from more local populations. Noctule bats (*Nyctalus noctula*) and Leisler's bats (*N. leisleri*) were of Scandinavian or Northeastern origin. Our isotopic geo-location reveals that wind power facilities kill bats not only of sedentary local populations but also of distant populations, thus having potentially a negative impact beyond political borders; an observation that calls for international regulations for implementing mitigation measures to prevent large-scale detrimental effects on endangered bat populations.

**Poster No. 58: Daytime observations of the noctule bat (*Nyctalus noctula*) in Austria**

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The noctule is a common wintering bat in the eastern parts of Austria, including Austria's capital Vienna. Males are known to stay during all seasons whereas females wander off to the maternity roosts in the Northeast, which are still unknown for this subpopulation. Especially during their autumn migration noctule bats can often be seen flying during daytime. The collected data set covers a period of twelve years with intensified observations from 2007 to 2012. A total of 1056 observations with 24728 individual bats were analysed. Sightings were mainly of single individuals and small groups up to 5 animals but could also reach thousands in some cases. The majority of sightings took place between 15:00 and 19:00 CET showing a strong association with low wind speeds less than four Beaufort. Most animals (ca. 75%) were seen in heights below 60 meters. Still there are also noctule bats flying up to more than 300 meters height and therefore also in critical heights for collisions with wind power plants. The most likely interpretation for the common diurnal activity is that the noctule bats find good feeding opportunities during daytime (for example swarming ants & bugs) to store fat for their hibernation. I would welcome additional data, especially from neighbouring countries in the East (Czech Republic, Slovakia and Hungary). Please contact me via office@t8b.at

## SESSION 7: ECOSYSTEM SERVICES OF BATS

### Poster No. 59: Numerical and functional responses of foraging forest bats to a key pine defoliator

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Global change is expected to modify the frequency and magnitude of defoliating insect outbreaks in forest ecosystems. Bats, as other generalist vertebrate predators, are increasingly acknowledged as effective biocontrol agents of pest insect populations. However, there is a need to better understand whether bat communities might contribute to the resilience of forests to climate-driven biotic disturbances. Here, we focused on the numerical and functional responses of forest insectivorous bats to a key pine defoliator increasing with climate warming, the pine processionary moth *Thaumetopoea pityocampa*. We used pheromone traps and ultrasound bat recorders to estimate the abundance and activity of moths and predatory bats along a gradient of increasingly infested pine stands. Total bat activity was quantified as the number of echolocation calls recorded, and foraging bat activity as the number of capture prey attempts. We also used pheromone lures to aggregate male moths at pine stand edges to test whether this increased foraging bat activity. We observed a narrow spatio-temporal matching between emerging moths and foraging bats, with bat activity significantly increasing with moth abundance. Moreover, the foraging activity of generalist forest bats, such as *Pipistrellus kuhlii* and *Eptesicus serotinus*, was significantly higher near pheromone lures, i.e., in the close vicinity of prey aggregates. These findings suggest that forest management practices should consider the maintenance of functionally-diverse bat communities to contribute to the biocontrol of insect pest populations.

**Poster No. 60: Ecosystem service of European bats in an anthropogenically shaped landscape – A project presentation**

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Bats are known to provide important ecosystem services like the distribution of seeds, the pollination of tropical plants and the consumption of insects (reviewed in Ghanem & Voigt 2012). In the temperate zone, bats are particularly relevant for humans by feeding on pest insects, thus reducing insect populations that are detrimental for agriculture (reviewed in Kunz et al. 2011).

In this study we aim to estimate the extent of ecosystem services provided by European bat species in an intensively used agricultural area in Germany. We investigate species richness and foraging activity of bats and the relative abundance of insects in relation to three crop types (corn, rapeseed and wheat). Additionally we assess if and how landscape structure mediates the interaction between bats, insects and agricultural areas. Using a genetic approach, we investigate the diet of two common aerial-hawking bat species. We are specifically interested in answering the question whether they feed on economically relevant pest insects, and whether this translates into a monetary benefit for the agricultural industry.

This study is embedded in a large-scale project (AgroScapeLabs: [www.scapelabs.org](http://www.scapelabs.org)) which aims at exploring land use effects on biodiversity and its links to ecosystem functioning in an agriculturally used landscape.

Ghanem, S.J., Voigt, C.C. (2012) Increasing awareness of ecosystem services provided by bats. *Advances in the Study of Behaviour* 44: 279-302.

Kunz, T.H., Braun de Torrez, E., Bauer, D., Lobo, T., Fleming, T.H. (2011) Ecosystem services provided by bats. *Annals of the New York Academy of Science* 1223: 1-38.

**Poster No. 61: A research on bat diet by the method of natural food offer in captivity**

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We studied food preferences of *Vespertilio murinus* and *Myotis daubentonii* by the method of natural food offer in captivity. This method on live bats allowed to study in detail to which species their victims belonged and their sizes. But the method was only an addition to other methods (analysis of stomachs and excrements). It consisted in the offer of live insects of various orders and sizes to hungry bats with the help of tweezers. We distinguished 16 groups of night insects: Lepidoptera, thin body <10mm; >10mm; thick body 10-15mm; 15-20mm; >20mm; >20mm, with wing span >70mm; Neuroptera; Trichoptera <14mm; >14mm; Diptera (Nematocera) <10mm; >10mm; Hymenoptera; Coleoptera <12mm; >12mm; Ephemeroptera <10mm; >10mm. Most frequently the groups included specimens of mass orders and species caught with light traps. From each group 6 moving insects (2 Lepidoptera and 2 Coleoptera insects) were given to bats with the help of tweezers. Each insect was offered maximum 5 times, after which the it was considered inedible. The bats for the experiment were caught in the Middle Urals (600 E.L., 570 N.Latd.) in mosaic biotopes (at the boundary between the forest and a human settlement) in summer 2004-2005. They were maintained in cells 100x90x50 cm. Each specimen was trained to take food from the tweezers during 1-2 days, then 2 experimental nights followed in succession. An important condition for the experiment was its short period (several days), because the animals got accustomed to choose “delicious” food frequently unavailable in the nature. It 21 days of the experiment to investigate 8 *M. daubentonii* specimens and 9 *V. murinus* specimens. The experiments showed that food preferences were connected with the size and hardness of the chitinous skin covering of the victims ( $0.61 < r < 0.67$ ). Both species had less appetite for Hymenoptera and large Lepidoptera (with wing span >70mm). *V. murinus* ate small Coleoptera ( $\chi^2=33.12$ ;  $df=13$ ;  $p=0.001$ ) and big Coleoptera much more frequently than *M. daubentonii*. Our results show that *V. murinus* ate insects with various hardness of chitinous skin covering (body size <20mm, wing span >70mm). Smaller *M. daubentonii* preferred small insects (<12 mm) with gentle skin covering, but they were also able to switch over to food objects of the middle size (<20mm) with gentle skin covering and to small objects (<10mm) with a hard skin covering. The work is supported with RFFI grant № 12-04-31257

**Poster No. 62: Habitat use of bats in a forest area of Pistoiese Apennine (Italy)**

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A detailed knowledge of how bat species partition space and time is fundamentally important for developing efficient strategies for land management and conservation efforts. Yet, data on habitat use of bats is scarce for most regions in Europe, particularly for Italy. In the summer of 2011, we investigated the assemblage structure of bats in different forest types in the State Reserves of the Pistoia Apennines. The survey was carried out by using a set of automated ultrasonic recorders (ecoObs GmbH, Germany). We focused on five major habitat types along an altitudinal gradient in the Sestaione Valley (Cutigliano, Pistoia): chestnut forest, beech forest, coniferous forest, mixed forest and mountain-top meadow. In particular beech forest is a silvicultural forest, managed by Italian State Forestry Service. In each habitat, we positioned 5 batcorders that automatically recorded all the ultrasonic pulses from 9 pm to 6 am for two consecutive days, between 24 and 28 June 2011. In total, we recorded almost 1700 bat sounds that we identified to the species level. Following the automatic identification algorithm of the batcorder that provided species names and probabilistic levels, all recordings were individually double-checked and compared with a library of local bat calls. This second analysis yielded the total number of recorded and identified bat species on which we performed statistical analysis. About 82% of them have been identified at the species level, while 18% of bat calls have not been identified with certainty. In order to assess the insect availability, we used light traps in each type of habitats too. Our results indicate that beech forests are of central importance as foraging habitat for various species, representing about 60% of all recordings. In particular, a small lake in the beech forest seems to be a key element for the local bat assemblage. Furthermore, there was a close link between beech forest and the overall abundance of *Nyctalus leisleri*, which was found almost exclusively in this type of forest. Differences were observed in the use of habitats during the night. Four important aspects for the conservation derived from this research: the central value of water bodies, such as small sized ponds, inside forests; the importance of small forest clearings (at least 50 m<sup>2</sup>) as activity hot spots; the value of several vegetation types, capable of sustaining different bat species and the significance of forest management.

**SESSION 8: PUBLIC OUTREACH AND THE CONSERVATION OF BATS**

**Poster No. 63: Earning money with high class edutainment on bats? – Experiences from Germany's information centre on bats**

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Since seven years NOCTALIS – world of bats Bad Segeberg shows on 560 square metres to more than four floors all about the exciting biology, the variety and beauty of bats. The visitors should diminish prejudices and get a feeling for the special ecological role of bats in nature. One gets to know these creatures as charming neighbours who earn sympathy and respect. Noctalis – world of bats is the modern supplement to the Bad Segeberg cave. More than 22.000 bats using this hibernacula in wintertime. The combination of a modern exhibition with an extraordinary natural bat habitat attracts more than 45.000 visitors per year. Accordingly Noctalis is one of the important places for public information about bats in Europe. The poster shows high lights from the exhibition, resume some results from questionnaires and gives insights in economical results.

**Poster No. 64: The importance of volunteers in bat conservation – example of activities related to problem of light pollution**

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Involving numerous volunteers in bat research work has been proved to be useful in different bat monitoring activities and in many public awareness and education activities. In Slovenia, individuals of different age and education interested in bats, are joined in the non-governmental organization Slovenian Association for Bat Research and Conservation (SDPVN) and get involved into various bat related protection activities. Volunteers that get interested in the bat research have also been found among the students of biology at University of Ljubljana that chose to fulfill their student obligations with work on the bats and also among young pupils in primary school that explore bats for their school projects. A strong kick off for the volunteers involvement in bat field work in Slovenia was a start of the three years project “Life at Night” (2010 – 2014, [www.lifeatnight.si](http://www.lifeatnight.si)) co-financed by the EU Life+ financial scheme. The main goal of the project is to improve the conservation status of nocturnal animals (moths and bats) by reducing the effect of artificial lighting at cultural heritage sites - churches. The volunteers got actively involved in performing field monitoring observations of bat emergence behavior at the chosen church sites. Even though the focus species are the lesser horseshoe bats (*Rhinolophus hipposideros*), the emergence behavior of all bat species and at all potential flight openings were monitored ten times each summer. Due to undemanding yet strict field protocol for bat emergence observations volunteers with little or no bat related field experiences can get actively involved. In addition to that, many students conducted own individual research studies on bats and light pollution, which included studies on bat emergence activities from lit or unlit churches, as well as observations of bat activity at different the street lights. Via SDPVN, many volunteers get involved in activities related to informing and educating the general public about the threats to bats, including the negative impacts of the light pollution. Many lectures and workshops for schools and general public are being conducted, and promoted through various media. The highest concentration of such actions is realized during the traditional International (former European) Bat Nights, that are organized for 14 years in Slovenia. The experiences of bat volunteers from their own field work with bats help immensely in transferring first hand information on bat ecology and conservation to wide public. Reports of the research as well as educating activities are published in SDPVN annual newspaper “Look, the bat!”, that is handed to the public and publicly available on the society’s web site ([www.sdpvn-drustvo.si](http://www.sdpvn-drustvo.si)). The role of the volunteers at achieving the goals of the project Life at Night as well other bat protection activities in Slovenia is of greatest importance – a sort of a “light shield” for the bats.

**Poster No. 65: 4 years of monitoring bats in Russia– iBats Russia**

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Bats are the second most species rich order of mammals, but our understanding of their distribution in Russia is extremely limited. Since 2009, PERESVET has been involved in the Indicator Bats Program (iBats). The project started in Transylvania in May 2006 and has been extended to many other countries. iBats aims to develop national bat monitoring programs globally in order to generate long-term data on biodiversity indicator species to assess the impact of national development and global change. During 4 years (2009-2012) we trained 253 volunteers from different regions in acoustic bat monitoring and survey techniques. Volunteers distributed over 11 regions (Bryansk, Smolensk, Orel, Voronezh, Kaluga, Kursk, Moscow, Tver, Leningrad, Adugeja and Krasnodar) of Western Russia, carried out 256 transects over four years. We used time expansion Tranquility Transect bat detectors attached to cars traveling at 25km/hr to record ultrasound sound along 40 km routes in accordance with iBats protocols ([www.ibats.org.uk](http://www.ibats.org.uk)). The evening surveys were carried out 30-45 minutes after sunset from the start of May to the end of September. Transects surveyed in July were repeated in August to provide baseline monitoring data. Each survey generated a 1-2 hour sound file in \*.wav file of time expanded sound. We used a GPS Garmin eTrex to gather accurate geo-referenced records. Calls were identified to species or species group using iBatsID after Sonobat software was used to extract the parameters from the calls. We generated more than 8600 geo-referenced occurrences for 12 species. We got new information about distribution of two species - *Nyctalus lasiopterus* and *Miniopterus schreibersii* (IUCN Status: Near Threatened) – included in Russian Red Data Book. Relative population trends of bat populations appear stable over this four year period but more data are required for a statistically significant trend. By generating long-term data on bats as biodiversity indicators, the iBats project supports Russia to meet Convention on Biological Diversity commitments and, as bats are migratory, meet Russia's obligations under the Convention of Migratory Species.

**Poster No. 66: Knowledge and perception of bats in scholars of different ages in Italy**

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A series of questionnaires were compiled in the attempt to investigate the knowledge and empathy related to bats of students of different age and gender in Italy, in the framework of "Year of the Bat" for 2011 and 2012 declared by the UNEP.

The project start with a first sample of schools in Forlì, covering first grade and high school.

47 nine years old of the primary school children have been tested and then 121 superior ones' boys of age included in the 14 and the 18 years.

At first we presented to the classes a quiz composed by 28 questions chosen to investigate the knowledge on the real animals, from systematic to the legends commonly charged on bats.

To have also a comparison with an animal that one presumes is much more well-known and with which one has bigger familiarity, the questions have been done also on the swallows.

The second part is dedicated to discover the feeling and empathy related to bats and different other animals. The mean level of knowledge on bats is generally poor and some typical legends as blindness, sticking to the hair, to bring bad luck and sucking blood are still widespread and considered a truth.

Also is quite remarkable how ignorance is deep for the more "common" animals, in the imagination, as the swallows are. Nevertheless some positive information are present as the protection by law, the control of mosquitos and the need for conservation

The differences between answer in the field of knowledge come from age classes but there are no significant differences between genders.

The most significant difference between the sexes appears in the answers concerning the value and the feeling towards bats, swallows and other animals.

Females in general show a more extreme charm with lower and higher scores while males are generally more attract to creepy animals.

The feeling about the bats still shows an image of "species" smart, a little dangerous, also a little evil and however from which keep away, especially in the comparison with the swallow.

Differences between age classes, type of school and gender are also reported and discussed.

## SESSION 9: OTHERS

### **Poster No. 67: Host specificity in spinturnicid mites: recent origin and frequent transmission between bat hosts suggests adaptive radiation of host-specific parasite species**

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Host specificity in parasites can be explained by spatial isolation from other potential hosts or adaptive radiation and specialization of parasite species. The first assertion is based on allopatric speciation, the latter on differential lifetime reproductive success on different available hosts. We investigated the host specificity and cophylogenetic histories of four sympatric European bat species and their ectoparasitic wing mites. We sampled >40 parasite specimens from each bat species and reconstructed their phylogenetic COI trees to assess host specificity. To test for cospeciation we compared host and parasite trees for congruencies in tree topologies. Corresponding divergence events in host and parasite trees were dated using the molecular clock approach. We found two species of wing mites to be host specific and one species to occur on two unrelated hosts. Host specificity cannot be explained by isolation of host species, since we found individual parasites on other species than their native hosts. Furthermore, we found no evidence for cospeciation, but for one host switch and one sorting event. Host-specific wing mites were several million years younger than their hosts. Speciation of hosts did not cause speciation in their respective parasites, but can be explained by a recent adaptive radiation of wing mites.

**Poster No. 68: Predicting species distributions for bat conservation across Western Russia**

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Knowledge of species' ecological and climatic requirements is critical for conservation planning and for understanding ecological and evolutionary determinants of the spatial structure of biodiversity. Bats represent about 20% of all mammalian species worldwide with forty one bat species thought to be found in Russia. However, the habitat and climatic requirements of Russian bats are poorly understood. This study develops spatial niche models for twenty nine species of bats found in Western Russia to understand their distributions. Research presents information about 11 genera in three families inhabit in Russia: *Myotis*, *Plecotus*, *Barbastella*, *Pipistrellus*, *Nyctalus*, *Eptesicus*, *Tadarida*, *Vespertilio*, *Miniopterus*, *Rhinolophus*, *Hypsugo*. Species locality data were assembled from natural history collections and the published literature (dating from 1811 – 2011) and 256 acoustic field surveys (from 2009 – 2012). 16,048 records for twenty nine species were used to build niche models using MAXENT, together with the following environmental data: bioclimatic variables averaged over 1950-2000 (WorldClim), land cover (Global Land Cover) and human density (Human Girded Population of the World). We used a grid size of 30 arc seconds and trimmed to the Western Russia boundary using ArcGIS. We describe the variables that are the most important determining bat distributions in Western Russia and present their the climatic and habitat suitability models. We also apply future global change models to understand how these species will be impacted by predicted change in this region.

**Poster No. 69: A method to obtain ejaculates from living Microchiroptera bats**

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Collecting sperm without killing the animal is anecdotal in bats (De Jong et al. 2005, Racey pers. communication). Here, for the first time, we present a method to collect ejaculates from living microchiroptera bats (Phyllostomidae, *Carollia perspicillata*). Ejaculates were obtained by electro-ejaculation using a rectal probe under narcosis. Trains of stimulations (maximum 0.4 mA) were produced using a free audio software and a sound amplifier. The method shows a high success rate of the males giving ejaculates of several microliters. No secondary effects or injuries could be detected. The effects of short-term abstinence and repeated collection were also tested. These results open avenues for the study of bat reproductive biology with promising perspectives in terms of conservation and basic research. Indeed bats are known to show a great diversity of mating systems with potential incidence on the biology of their sperm and ejaculate characteristics.

**Poster No. 70: Evaluation of river valleys as guidelines in bat migration**

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Many bat species conduct seasonal migrations to reach hibernation sites or habitats with an abundant food supply. However, the exact routes taken by the bats and the cues used for orientation and navigation during their migrations are largely unknown. For Central Europe it is assumed that rivers with their accompanying riparian forests are of great importance as guidelines for long-distance orientation and as feeding areas for migrating bats, but up to now data are sparse to prove this assumption.

We investigated the importance of two rivers for bats in the alpine range of southern Bavaria and northern Austria. We assumed, that bat species which move along the river valleys during migration, will be recorded more frequently in these linear habitats than in ecologically similar, insect rich habitats without proximity to rivers. To test this hypothesis we compared bat activity during migratory and nursery seasons at paired sampling sites: a) at the rivers, which represent linear landscape elements and b) at lakes in a distance of at least 4km from the rivers which represent insect rich but isolated habitats. To investigate the effects of large urban areas which are more often found at rivers than at lakes we performed extensive GIS analysis of the surrounding landscape.

Our results show only a slight seasonal shift in bat activity from lakes to the rivers. A concentration of migrating bats along the rivers was not observed. Good but not linear foraging areas as lakes are apparently also intensively used by bats during migration. However, urban areas seem to play an important role for hibernation in some bat species. Thus a high foraging activity at rivers close to urban areas in spring and fall may be caused by vicinal roosts and not by migratory movements.

**Poster No. 71: Evidence for elevational movements of bats along the slopes of Mount Kilimanjaro, Tanzania**

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Bats are important ecosystem service providers, and therefore most relevant for both lowland and highland habitats; particularly in the tropics. Yet, it is poorly understood to what extent they perform large-scale movements, in particular movements along mountain slopes. Here, we studied the elevational migration of African bats captured in mostly human dominated landscapes between 800 and 2,400 m above sea level at Mount Kilimanjaro in Tanzania. We analyzed stable isotope ratios of carbon, nitrogen and hydrogen in fur keratin to delineate the elevational origin of frugivorous and insectivorous bats. For sedentary bat species, we expected correlations between stable isotope ratios of the non-exchangeable portion of hydrogen in fur and the elevation of capture site, but not necessarily for stable carbon and nitrogen isotope ratios. In bats of both feeding ensembles, we found fur nitrogen isotope ratios to correlate positively with the elevation of capture sites, yet we could not document such an elevational gradient for stable hydrogen isotope ratios in fur keratin. In frugivorous bats, stable carbon isotope ratios increased with increasing capture elevation. Based on nitrogen isotope ratios, we used an isoscape origin model to predict the elevational origin of the prospective migrant *Miniopterus natalensis*, an insectivorous bat captured only between late August and early November at a median elevation of 1,800 m above sea level. Our model suggests that bats originated from around 1,400 m a.s.l. By looking at within-individual variation of stable carbon and nitrogen isotope ratios in fur and wing membrane tissues of *M. natalensis* and of a sedentary insectivorous species, we received supporting evidence that *M. natalensis* migrates seasonally between low and high elevations along the slopes of Mount Kilimanjaro.

**Poster No. 72: Non-invasive monitoring of stress hormones in *Eptesicus isabellinus***

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Environmental and social stress may directly correlate to decreased survival rates in wildlife. Hence, stress hormone analysis can be a useful tool to highlight environmental stress and deduce on the individual and population level fitness. Regarding stress hormone research, non-invasive sampling techniques, such as fecal sampling, may be advantageous, but have not been used in bats before. In bats, a principal factor inducing stress may be colony size. To test the applicability of fecal stress hormone analysis in bats we studied the influence of colony size on stress in five colonies of *Eptesicus isabellinus* with varying size and survival rates in Andalusia, Spain. First, we validated the hormonal analysis with an ACTH challenge, comparing blood stress hormone levels and fecal stress hormone metabolites in consecutively collected fecal samples. We identified corticosterone and cortisol and their derivatives in blood and feces and verified the increase of fecal stress hormones after inducing physiological stress with ACTH. The baseline and maximum blood cortisol levels, at 6.5 ng ml<sup>-1</sup> and 46.2 ng ml<sup>-1</sup> respectively, were low compared to other bat species studied before. Baseline fecal cortisol was at 224 ± 198 ng g<sup>-1</sup> and did not increase within 1.5 h after capture. We did not find a difference in fecal baseline cortisol levels between colonies (22 ± 5 individuals sampled per colony), despite significantly varying colony size and survival rates between colonies, nor a correlation between biometric variables, such as forearm length, and fecal cortisol. We argue that analysis of fecal stress hormones indeed allows non-invasive studies of stress in bats, however care needs to be taken when deducing on relations between hormonal stress and environmental factors.

**Poster No. 73: The stabilized distress calls in the least horseshoe bat  
*Rhinolophus pusillus***

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Behavioral studies at spatial scale help reveal characters' evolutionary process. Large volume of literature have demonstrated strong geographic variation in behavioral phenotype for local adaptation. However, less is known about whether evolutionary stasis prevails in some behavioural traits involved in individual and group fitness. We examined distress calls' structural and functional variations in *Rhinolophus pusillus* across a broad geographic regions. A total of 8 multiple distress calls from 4 populations were randomly selected as experimental sequences. Combined with the controls of silence and pink noise, we broadcasted experimental sequences to test bats' responses outside roosting caves at 3 geographic locations. Analysis revealed that each populations shared all distress syllable types. There was no significant population signature for the same distress syllables. Coefficients of syllables variation in spectro-temporal characteristics among populations were markedly lower than the values within and among individuals. Moreover, our playback experiments indicated that bats responded to distress calls greater than controls, but showed no responsive differences for distress calls from own and allopatric population. The results provide a new insight that antipredator calls may be subject to evolutionary stasis within species. Further studies can explore the mechanism of gene flow, social learning, and predation pressure acted on the stabilized antipredator signals.

**Poster No. 74: Health status of wild-living healthy bats from Africa**

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Bats have been identified as source for several infectious diseases that can affect both, humans and other wild or domesticated animals. Many of these diseases originate in the tropics, where the diversity of pathogens is still largely unknown. Whereas many studies focus on the detection of infectious agents in bats on a molecular biological level, information regarding the impact of microorganisms on chiropteran hosts and resulting histo-pathological changes in these species is rare. Within the context of a larger study on ecology and infectious diseases of African bats, we investigated 131 wild living and apparently healthy animals of 24 frugivorous and insectivorous species from rainforests in Sierra Leone and the Republic of Congo by routine histo-pathological methods. The most often findings were inflammatory and granulomatous lesions in about one quarter of all lungs and livers and an activation of the lymphoreticular tissue of the spleen in 75% of all animals, indicating that bats are permanently exposed to a high infectious pressure. Other morphological changes have rarely been found. Despite the multitude of potential infectious agents occurring within their habitats the prevalence of subclinical disease in healthy wild caught bats of this study is surprisingly low.

**Poster No. 75: Factors influencing habitat choice in temperate gleaning bats**

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Habitat choice is one of the most important niche-dimensions of sympatric-living bat species. Bats are long-lived, philopatric and usually have only one pup per year. Thus they are vulnerable to changes of their environment by anthropogenic alteration such as urbanization, agriculture or forestry. Consequently, habitat protection plays an important role in management and conservation of bat species. Understanding habitat requirements of the different species is vital for effective biodiversity conservation.

In our study, we investigated factors that might influence habitat choice in the gleaning bat species *Myotis bechsteinii*, *Plecotus auritus* and *Myotis nattereri*. We hypothesized that environmental parameters like 1) tree species composition, and 2) vegetation structure influence the distribution of the three bat species and that 3) the suitability of trees as possible roost sites depends on the quality and the accessibility of foraging habitat in the surrounding area. To characterize roosts and foraging areas we radio-tracked individuals of *M. bechsteinii* and *P. auritus* in different study areas. Furthermore, we characterized over 300 foraging areas and roost sites of *M. bechsteinii*, *P. auritus* and *M. nattereri* in Hesse with regard to vegetation and landscape-scale parameters. 1) All three species were predominantly found in mature beech stands or mixed stands of oak and beech at times interspersed with patches of conifers. 2) All three species seemed to mainly forage in mature stands with closed canopy. Furthermore, they relied heavily on an extent shrub and herbaceous layer while *M. bechsteinii* probably was least dependent on stratification. 3) All identified roosts were found within or close to the foraging areas which indicates that the suitability of trees as possible roost sites is amongst others determined by features of the surrounding foraging areas.

## Poster No. 76: Eco-immunology of Neotropical bats

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Ecological and social factors are central in the emergence and transmission of infectious diseases, thus bearing the potential for shaping a species' immune competence. Previous studies demonstrated a link between social factors such as promiscuity and the cellular immune system in captive mammals. However, it is yet poorly understood how ecological factors correlate with both cellular and humoral immune parameters. In addition, comprehensive studies on wild mammals are still lacking. Here, we tested if the cellular and soluble mediated constitutive immune system of free ranging bats is associated with two ecological factors: diet and shelter choice. We found that total and differential white blood cell counts (WBC) of 24 co-existing Neotropical bat species varied with the species-specific diet and body mass. Bats that included at least partially vertebrates in their diet exhibited the highest WBC, followed by phytophagous and insectivorous species, which is consistent with the prediction that the immune system is linked to the pathogen transmission risk of a trophic level. Roost choice was not correlated with the cellular immune system, nor was the soluble mediated constitutive immune response, assessed by an *in vitro* bacterial killing assay, associated with the ecological factors assessed. Our results suggest that the ecology of mammals is an important factor in the evolution of the immune system.

**Poster No. 77: Occurrence of *Litomosoides*-filariae in seven Neotropical bat species**

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*Litomosoides* spp. (Nematoda, Filarioidea, Onchocercidae) are of great interest for understanding zoonotic dynamics because of their similarity to human-infecting filariae. We investigated the *Litomosoides* species occurring in blood smears from 186 bats comprising seven species sampled in Panamá. Specifically, we (1) identified *Litomosoides* spp. by way of morphological analysis and assessed (2) ecological and individual host traits determining *Litomosoides* presence and (3) the immune response of the host individuals. Using this approach we identified eight species/morphotypes of *Litomosoides* microfilariae in five bat species. All of the *Litomosoides* (e.g., *L. solaris* and *L. yutajensis*) were host-specific. Five bats (2.7 %) were infected with multiple *Litomosoides* species. Our study includes the first record of *L. brasiliensis* in *Artibeus jamaicensis* and the first record of *Litomosoides*-like microfilaria and possibly *Litomosa* sp. in *Lophostoma silvicolum*. Multiple binary regression analysis showed that the presence of specific *Litomosoides* species was determined by host species identity, sex and reproductive status. Bats infected with *Litomosoides* showed a significantly higher count of eosinophilic granulocytes than uninfected bats, indicating an immune response of the bats.

**Poster No. 78: Vocal responses of noctule bats (*Nyctalus noctula*) to intra- and interspecific roost competition**

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Tree cavities as roosts are essential for forest dwelling bats, especially during the mating season when males become territorial. But these resources are limited and most likely difficult to find for bats. Several studies have shown that bats use social cues such as information transfer among colony members, eavesdropping on echolocation and social calls of conspecifics to reduce the energetic costs of roost search. Recently, it has been shown that bats use both con- and heterospecific social calls to gain information on potential roosts. Noctule bats (*Nyctalus noctula*) and Nathusius' pipistrelles (*Pipistrellus nathusii*) are forest dwelling bats in the western Palaearctic. Males of both species defend their mating roosts with song against male conspecifics. Since both species often occur in similar habitats, there is potential for interspecific competition for mating roosts.

To test whether interspecific competition between noctules and Nathusius' pipistrelles is mediated by communication, we conducted an acoustic playback experiment with three different stimuli. We played back territorial motifs of noctule song, courtship songs of potential heterospecific competitors - the Nathusius' pipistrelle - and as control courtship calls of common pipistrelles (*Pipistrellus pipistrellus*) to 18 territorial male noctules during the mating season. We found that noctules reacted to playbacks of conspecifics as well as to playbacks of the heterospecific competitors with song. Contrary to our expectation, they also reacted to the control stimulus. Focal noctules showed a significantly higher increase in the rate of territorial song motifs to conspecific playbacks than to both heterospecific playbacks. In contrast, the rate of a non-territorial motif did not differ in response to the different stimuli.

To our knowledge, our study is the first to demonstrate the ability of bats to discriminate between songs of con- and heterospecifics in a mating context. Due to anthropogenic influences, tree cavities as natural resources are becoming scarce, possibly leading to an increase in both intra- and interspecific competition for mating roosts. Our results emphasize the importance of conservation of trees with cavities or bat boxes as roost sites to buffer territorial intra- and interspecific conflicts in bats.

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## ACKNOWLEDGEMENTS

For financial support we are grateful to:

German Research Foundation (Deutsche Forschungsgemeinschaft)



Leibniz Institute for Zoo and Wildlife Research (IZW)



EUROBATS – The Agreement on the Conservation of Populations of European Bats



This symposium was hosted by the Federal Institute for Risk Assessment (Bundesinstitut für Risikobewertung, BfR) and the banquet by the Museum of Natural History, Berlin

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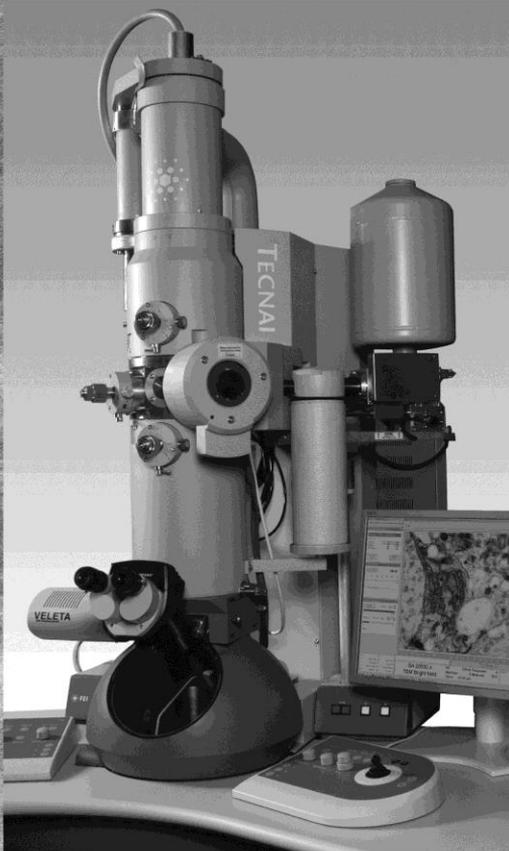
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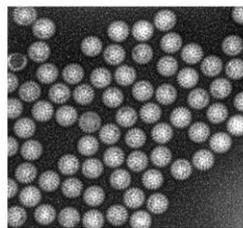
With the ease of a light microscope, The Tecnai™ Spirit TEM allows for the imaging of biological systems with the resolution needed to answer crucial biological questions. By automating 2D and 3D image acquisition, reconstruction, and visualization procedures, the Tecnai Spirit TEM ensures repeatable, high-quality results.

Visit [FEI.com/TecnaISpirit](http://FEI.com/TecnaISpirit) for more information and a list of specific publications empowered by the Tecnai Spirit TEM.

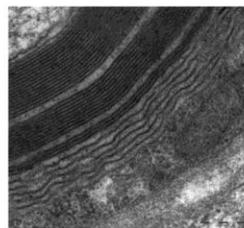
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## NOTES





















