Abstract Book

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Bild: Sönke von den Berg

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Fruit bat migration matches the green wave in Africa

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Many migrating animals respond to seasonal changes in the environment and often match peaks in resource abundance. However, it is unclear if and how frugivorous animals use phenological events to time migration, especially in the tropics. The straw-colored fruit bat (*Eidolon helvum*), Africa's most gregarious fruit bat, forms large seasonal colonies through much of sub-Saharan Africa. We hypothesized that aggregations of *E. helvum* match the timing of their migration with phenologies of plant growth or precipitation. Using monthly colony counts from across much of the species' range, we matched peak colony size to landscape phenologies and explored the variation among colonies matching the overall closest phenological event. Peak colony size was closest to the peak instantaneous rate of green-up, and sites with closer temporal matching were associated with higher maximum greenness, short growing season, and larger peak colony size. *Eidolon helvum* seem to time their migrations to move into highly seasonal landscapes to exploit short-lived explosions of food and may benefit from collective sensing to time migrations. The link between rapid changes in colony size and phenological match may also imply potential collective sensing of the environment. Overall decreasing bat numbers along with various threats might cause this property of large colonies to be lost. Remote sensing data, although, indirectly linked to fruiting events, can potentially be used to globally describe and predict the migration of frugivorous species in a changing world.

Session 1 – Friday 21.10.2022 – 20:00

Speaker: Vanuhi Hambardzumyan 

Biogeographic history and gene flow patterns within the 'Natterer's bats' in the Caucasus

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Pleistocene climatic fluctuations have greatly affected the distribution and population dynamics of most Eurasian taxa. Following climatic cycles, populations contracted into glacial refugia and expanded when environmental conditions became warmer. Such dynamics can have various evolutionary outcomes, ranging from genetic assimilation of allopatric populations upon secondary contact to the formation of new species. Therefore, studying the spatial and environmental context of past population dynamics is important for understanding how lineage diversity forms, persists or vanishes.
In our study, we investigated the past and the current distribution ranges of two bat species of the *Myotis nattereri* species complex, *Myotis araxenus* and *Myotis tschuliensis* in the Caucasus, by combining species distribution modelling (SDM) and whole genome sequencing approaches. Our main aim was to investigate the role and the extent of geographic separation in the evolution of hybridization barriers. We used MaxEnt for reconstructing potential distribution ranges of both species, which suggests distinct ecological differences. Genome-wide SNP data indicate that occasional hybridization can occur, although effective hybridization barriers prevent wide-scale gene flow between *M. araxenus* and *M. tschuliensis* even in areas of sympatry. In addition, we did not find evidence for *araxenus* obtaining larger body size (relative to *tschuliensis)* by hybridisation and introgression with the sympatrically occurring large bat species *Myotis blythii*.

Session 1 – Friday 21.10.2022 – 20:15

Speaker: Darija Josic

Gene flow in a secondary contact zone of two highly divergent lineages within the *Myotis nattereri* species complex

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Climatic change has a major impact on the spatial distribution and demographic history of taxa and is therefore a major driver of biological diversification. Populations may become isolated, for example in different glacial refugia, where they evolve independently during periods with unfavorable climatic conditions and may come into secondary contact following range expansion. Investigating contact zones of genetically diverse populations can provide insights for understanding the underlying mechanisms of population divergence, persistence and speciation. In this study, we describe the spatial extent of a hybrid zone and quantify population dynamics between two genetically distinct lineages within the *Myotis nattereri* species complex. We sampled bats throughout the contact zone and have collected 62 samples from 46 locations across Central and southeastern Europe. Using whole-genome resequencing and a suite of demographic methods, we demonstrate that the degree of admixture varied largely among individuals along a geographic gradient suggesting a lack of intrinsic reproductive barriers. However, notwithstanding the observation of admixed individuals and their dispersive nature, the two lineages still remain highly structured. Overall, we demonstrate how a whole-genome view on the spatial distribution of evolutionary lineages can inform our understanding how biogeography and demography contribute to macroevolutionary change in a well-known European mamma

Session 1 – Friday 21.10.2022 – 20:30

Speaker: Lara Keicher

Energy saving strategies in common noctule bats

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One of the most efficient energy saving strategies of heterothermic animals is torpor, characterized by an extreme reduction in metabolism. Torpor is often associated with cold temperatures, but in the last decades more diverse and flexible forms of torpor have been described. For example, some tropical bat species have a reduced metabolism and heart rate at high ambient and body temperatures. European temperate-zone bat species are assumed to use torpor only at cooler ambient temperatures, however, during summer ambient temperatures are often high. We therefore wanted to investigate whether noctule bats (*Nyctalus noctula*) from temperate European regions also show a form of torpor at high ambient and body temperatures, and how and when female and male noctule bats use torpor in different stages of their reproductive cycle. To do so, we used a combination of laboratory experiments and field observations. In the laboratory experiments we measured metabolic rate, heart rate, and skin temperature at a range of ambient temperatures. We found that, similar to tropical bat species and irrespective of reproductive status, noctule bats can have a reduced metabolism and heart rate, while body temperature and ambient temperatures are high. Using heart rate telemetry, we then monitored torpor use of free-ranging male noctule bats and found that laboratory studies reflected natural behavior in the wild only in certain reproductive stages. By implementing both approaches simultaneously and across life history stages, we thus were able to better understand the complex torpor use strategies of noctule bats and identify possible limitations of eco-physiological laboratory studies. We suggest that the capability to flexibly save energy across a range of ambient temperatures within and between reproductive states may be an important ability of noctule bats and propose that heart rate telemetry opens new possibilities to investigate more complex energy saving strategies also in other temperate-zone heterothermic species.

Bat rehabilitation in war, challenges for keepers and keeped

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On the one hand, the full-scale invasion of Russia caught the Bat Rehabilitation Center team in Kharkiv by surprise. However, on the other hand, we had an action plan in a case of a full-scale invasion.
First, we build the priority scale: i) safety of team members, ii) safety of bats that were on artificial hibernation in refrigerators, iii) an assessment of our ability to keep animals on life-long-rehabilitation, iv) save the biological collections and specimens.
From February 24, 2022 we act according to this priority scale. Each day we evaluate the level of danger for team members. The part of the team voluntarily decided to stay in town as long as utilities were running and the stores were open.
All the bats that were on winter rehabilitation (more than 3000 individuals) (until February 24) were released to nature. We manage to release them in two ways. The first was a cage that bats may leave by themself (constructed in the office building on February 24). The second way was a traditional handing release that we performed at the end of March and the beginning of April. The death rate in the last month of winter rehabilitation 2021-2022 was even less than in some previous years. The bats on all-life-long rehabilitation (around 40 individuals) continue to live with us and were not euthanized. Five females gave birth and 7 bat-babies successfully grew up and were released into nature.
Further, we saved, sorted and managed our biological collection. It is a well-known fact that bats are under strong protection all around Europe, and sacrificing them even for scientific purposes is strictly limited or even forbidden. However, bats play a key role in a plethora of research areas where fresh bodies, organs and cell-cultures are critically needed. From this point of view, UBRC team has collected all bats that were found already dead, bats that died during rehabilitation by unknown circumstances, and bats that had to be euthanized. All of these bat carcasses formed our working collection that we mostly kept in freezers. The beginning of the war became a threat to the preservation of this material (the shortages of electricity power, shellings and rocket hits). We achieved significant progress in saving these materials. We did the full inventory of these materials, sorted the carcasses by different stages (fresh, not fresh etc.). The material was divided for the purposes of different scientific projects and research areas such as morphometry, ecotoxicology, anatomy, craniometry etc. In addition, we temporarily removed the majority of the materials out of the city.
Finally, we did not regret our decision, and with minimal risk to the lives of team members, we finished the winter rehabilitation season, saved bats' lives and began to adapt to the new reality. Our lesson is to be realistic, do not panic and do not leave animals that you care. We were keeping and we still do the idea in our hearts: "You become responsible, forever, for what you have tamed" - Antoine de Saint-Exupéry.

Session 2 – Saturday – 22.10.2022 – 09:00
Speaker: Jannis Gottwald

Advances in open-source conservation technology for the study of bats and other small species

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To meet global conservation goals humanity needs to avoid and mitigate its negative impact on biodiversity and significantly improve its abilities to monitor ecosystems, wildlife populations and individuals. With 1,400 species bats account for nearly one-fifth of total mammal diversity, and they contribute to important ecosystem services such as pollination, seed dispersal, and pest control. Their small size and secretive and nocturnal habits in often cluttered habitats makes monitoring and research challenging. Methods and technologies that can help fill knowledge gaps about the ecology of these elusive animals and identify threats are therefore urgently needed.
Inexpensive but powerful single-board computers, such as the raspberry pi, are currently being regarded as one of the key technologies for the continuing revolutionization of conservation technology. Here, the development and assessment of two single-board computer based sensor tools (the tRackIT-System and the BatRack) that enable researchers to study the movement and behaviour as well as the presence and abundance of bats, birds and other small animals, is presented. Both tools are designed to operate autonomously in the field even under harsh environmental conditions.
While the tRackIT-System is exclusively designed for the real-time monitoring (live-data transmission and visualization) of vhf-tagged individuals, the BatRack also collects video and sound data from unmarked individuals whereby the combination of acoustic and image recordings facilitates the data analysis. The BatRack solves the problem of low detection rates and challenging individual recognition of small animals on camera traps and video recordings by using the ultrasonic calls of the bats or VHF-signals as a trigger for the camera unit.
Additionally two machine learning approaches are presented of which the first allows the classification of behavioural states of tagged individuals based on vhf-signal pattern recorded with the tRackIT-system. The models were trained based on 700h of behavioural observation of tagged individuals of two bat species (*Nyctalus leisleri* and *Myotis Bechsteinii*) using the BatRack. The performance was tested on independent data of bats, birds and humans. As a result, the activity state of VHF-tagged individuals can be monitored with a very high temporal resolution (~ 1 second interval) and accuracy (F-scores > 0.97 on independent test data).
The second machine learning approach is a novel bat-call detection and classification tool that not only facilitates the detection and quantification of species-specific calls in audio recordings but also helps to narrow down the amount of acoustically triggered video recordings to those most likely showing a) a bat and b) a bat of a certain species.
The potential of the presented developments to enable novel insights into the behaviour and ecology of small vertebrates and to facilitate practical nature conservation is demonstrated based on four case studies. We used a combination of the tools to investigate a) the daily activity pattern of *M.bechsteinii* and *N.leisleri*, b) their timing of swarming events at roost trees over the course of the breeding season, c) the mortality of wader chicks and d) the replacement of manual data collection methods in the impact assessment prior to windfarm constructions.

All tools are published under permissive open-source licences.

Automatisiertes Aktivitäts- und Bestandsmonitoring von Fledermausquartieren – lohnt der Aufwand?

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Im August 1992 wurden an der Kalkberghöhle in Bad Segeberg die ersten beiden am Arbeitskreis Wildbiologie an der Justus-Liebig-Universität Gießen e.V. speziell für die Fledermauserfassung entwickelten Lichtschrankensysteme in Betrieb genommen. Nicht der erste und auch nicht der letzte Versuch, Fledermäuse mittels Lichtschranken zu zählen. Die Skepsis unter den Fledermauskundlern war entsprechend groß. Und für die meisten klang es wenig glaubhaft, als im Frühjahr 1993 die ersten Zahlen bekannt wurden. Über 10.000 überwinternde Fledermäuse, wo zuvor gerade mal 350 Fledermäuse gezählt worden waren?
Initiiert durch dieses Highlight wurde 1995 ChiroTEC gegründet. Ein weiteres Startup mit großen Plänen. Die visionären Zukunftspläne wurden jedoch schnell auf den Boden der Tatsachen zurückgeholt. Trotzdem gelang es, basierend auf den ersten Erfahrungen, das System in den letzten knapp drei Jahrzehnten kontinuierlich weiterzuentwickeln und an die vielfältigen Anforderungen im Feld anzupassen. Treibende Kraft und damit Herzstück der Entwicklung sind bis heute eine Vielzahl von Eigenprojekten sowie die meist langjährige enge Zusammenarbeit mit den Kunden. Insbesondere die Einbeziehungen deren Erfahrungen und Wünsche haben zu einer signifikanten Optimierung der Technik geführt.
Inzwischen umfasst die Überwachungstechnik mehrere Lichtschrankenmodelle, einen vielfältig einsetzbaren Logger sowie eine Fotomonitoring-Einheit. Hinzu kommen weitere Module für spezielle Fragestellungen bzw. Anforderungen. Hierzu zählen insbesondere die täglichen Email-Benachrichtigungen incl. eines Fernzugriffs auf den Datenlogger.
Als größte Herausforderung im Zusammenhang mit dem Einsatz der Technik erweist sich das Energiemanagement. Im Gegensatz zur Kalkberghöhle, wo die Stromversorgung über einen Netzanschluss erfolgt, müssen die meisten Winterquartiere mit Batterien versorgt werden. Entsprechend groß ist der Wartungsaufwand. Während eine Lichtschrankenüberwachung vergleichsweise wenig Energie verbraucht und i.d.R. etwa eine 100Ah-Batterie/ pro Monat benötigt, liegt der Energiebedarf eines Fotomonitoring-System bei Verwendung zweier Kameras bei ca. 16 * 100 Ah-Batterien/ Monat! Und diese Batterien müssen turnusmäßig aufwendig von der Ladestation zum Einsatzort und zurück transportiert und sie müssen „gepflegt“ werden. Bei Langzeituntersuchungen eine echte Herausforderung!
Hinzu kommen die klassischen „Randbedingungen, angefangen von Diebstählen, überschwemmten Anlagen, Nager- und Verbissschäden an Kabeln, Spinnen, Schnecken und Blätter auf den Dioden, sowie sonstige Hard- und Softwareprobleme, die mancherorts geballt auftreten. Andererseits gibt es auch Anlagen, die beispielsweise in Wochenstubenquartieren über Netzstrom versorgt werden, und die jahrelang weitgehend störungs- und wartungsfrei ihren Dienst verrichten.
Und die jede Menge Daten produzieren. Erfreulicherweise ist der Auswerteaufwand bei einem reinen Lichtschrankenmonitoring relativ gering. Im Gegensatz zum Fotomonitoring, wo jedes einzelne Foto visuell bewertet werden muss. Aber auch hier könnte KI zukünftig den Auswerteaufwand deutlich reduzieren.

Auch wenn das System im Kurzzeiteinsatz betrieben werden kann, etwa im Rahmen von Umsiedlungsmaßen, liegt seine Bedeutung in der Langzeitüberwachung von Fledermausquartieren. Und den Möglichkeiten, die sich daraus ergeben. Dazu zählt insbesondere der Schutz der Quartiere, wie etwa Licht und Beutegreifer bzw. „überraschenden“ Sanierungsmaßen, wo bei entsprechender Benachrichtigung kurzfristig eingegriffen werden kann.
Darüber hinaus vermittelt die Technik aber eine Vielzahl weiterer interessanter Einblicke in den „Alltag“ der Fledermäuse. Dazu zählt die Quartierphänologie der verschiedenen Arten in Abhängigkeit ihrer Jagdstrategien, deren Überwinterungsstrategie wie auch Hinweise auf Traditionsmechanismen.
Insgesamt sicherlich eine zeit- und kostenintensive Überwachungstechnik, gleichwohl eine Methode, die das aktuelle Technikportfolie in der Feldforschung wirkungsvoll ergänzt.

Session 2 – Saturday – 22.10.2022 – 09:30

Speaker: Gabi Krivek

Automated bat species identification from camera trap images using deep learning

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Remote sensing technologies can increase the efficiency of ecological data collection and support data-driven biodiversity conservation. For example, infrared light barriers combined with camera traps installed at the entrance of bat hibernacula can be used to non-invasively and accurately monitor bat population dynamics. Moreover, camera trap images can be used to describe species level ecological metrics, such as diversity, relative abundance, and phenology of species with different activity patterns across seasons. However, when scaling to multiple large sites, the vast number of camera trap images exceeds the feasible limits of manual image processing. Therefore, we developed *BatNet*, an open-source, deep learning-based tool for automated bat species identification from camera trap images. The identification pipeline consists of three main steps: 1) a 'detector' that localizes the bat in the image, 2) a 'segmentation network' that removes the background and 3) a 'classifier' that identifies the species and provides a confidence level for the identification. We used 16,333 camera trap images from 32 hibernation sites to train a baseline classifier to identify 13 Central European bat species. In addition, the model can be retrained to improve the detector at new sites, and the classifier can be retrained to add new species. In initial evaluation on sites included in the training dataset, *BatNet* has a remarkably high 99.3% accuracy. At new sites, this high performance is maintained when the camera settings (i.e., angle and distance) are similar to those in the training data, and when images with low confidence are not considered (<10 % of the dataset). When the performance of the baseline model is lower than expected, retraining the detector with 500 local annotations is able to restore the accuracy to comparable levels as at trained backgrounds. In an ecological analysis context, we used full season camera trap datasets and found that species diversity, relative abundance, and phenology of different species are nearly identical when using *BatNet* predictions with appropriate confidence thresholds compared to human identifications. Finally, we highlight the ability of *BatNet* to learn new species that were not part of the original training dataset, while maintaining the classification accuracy for the other species. To facilitate the widespread use of this novel tool, we provide a user-friendly graphical interface that allows users without any programming knowledge to train site-specific detector models or to include new bat species from all over the world.

Session 2 – Saturday – 22.10.2022 – 09:45

Speaker: Anja Bergmann

Social calls of *Myotis* bats – variety and function during autumn swarming

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Besides echolocation calls, bats employ a broad variety of social calls, which are of lower frequency, longer duration and more variable structure making them better detectable over longer distances. However, for most species, social calls are far less studied than echolocation calls and their specific function often remains unclear. We investigated the function of in-flight social calls in front of a large hibernaculum in Northern Germany, whose main inhabitants are two species of *Myotis* bats, Natterer's bats (*Myotis nattereri*) and Daubenton's bats (*M. daubentonii*). Prior to hibernation, the bats swarm in front of the hibernaculum, a behaviour associated with a high number of social calls.

We recorded social calls in nights of high swarming activity over two consecutive swarming seasons. Based on the spectro-temporal structure we grouped the calls into ten types and verified the visual classification by a discriminant function analysis. Subsequently, we assigned social calls to either *M. daubentonii* or *M. nattereri* by analyzing the echolocation calls surrounding them whenever possible. As many individuals echolocate at the same time during swarming, we did not analyze single echolocation calls but the 'soundscape' surrounding each social call instead, encompassing not only spectral parameters but also the timbre (vocal 'color') of echolocation calls. We found that both species employ comparatively similar social call types in a swarming context, even though there are subtle differences in call parameters between species.

Additionally, we performed playback experiments in the vicinity of the roost with three call types from both species respectively to gain information about the general function of the calls emitted during swarming. We found an increase in bat activity (approximated as echolocation call rate) during and after stimulus presentation in three out of six treatments, indicating that bats inspected or approached the playback site. Sometimes we were able to identify the species of approaching bats by using a camera trap. Based on the photos taken during playbacks, we assume one call type to support interspecific communication while another call type works for intraspecific group cohesion.

Session 2 – Saturday – 22.10.2022 – 10:00
Speaker: Thejasvi Beleyur

Studying echolocating groups with the *Ushichka* dataset: methods and insights

Thejasvi Beleyur[1,2]

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Groups of echolocators regularly face intense jamming. Modelling shows that jamming affects detection of neighbours already above group sizes of 10 onwards for FM bats. Despite the reduction in echo detection with group size, many echolocators are famously gregarious – aggregating in hundreds to millions. Experimental studies to date have focused on qualitative descriptions of call parameter alterations with group size, or studied small (<= 5 bats) groups to describe the strategies bats use in groups. I argue that individuals in small groups below 10 bats do not suffer noticeable jamming, and that qualitative descriptions of echolocation parameters in the field do not allow strong inferences. The barriers to study individual-level echolocation decisions are technical and technological. Contextualising behaviour is hard with only audio or video, fusing multiple sensors is nontrivial and handling overlapping calls to perform localization is challenging. Finally there is a dearth of tools to perform such tasks.

I will present *Ushichka*, a multi-sensor, multi-channel dataset consisting of three thermal cameras, 8-22 microphones and a LiDAR scan of the cave where groups of upto 30 *Myotis myotis/blasii* fly together. Acoustic and camera localization allow precise trajectory and call emission reconstructions. Aligning flight and echolocation behaviour with the LiDAR scans of the cave allow for a contextual understanding with reference to cave structure. I posit that *Ushichka* is unique as it falls in a 'Goldilocks' zone for scientific and methodological advancement. The group sizes observed are appropriate to study the effects of jamming, while also remaining tractable to develop new methods to handle such data.

In the talk I will discuss the results of the multi-disciplinary team working on *Ushichka* over the past years. The depth-map correspondence algorithm places thermal cameras in the LiDAR scene despite low thermal contrast, poor image resolution and the absence of a calibration object. Multi-channel recordings with overlapping bat calls are often been left unanalysed due to the absence of tools to perform acoustic tracking. I will discuss the PyDATEMM package, an open-source tool to perform acoustic localization with overlapping audio. Thermal camera-LiDAR alignment along with acoustic localization of dense advance the plethora of conditions under which bats can be studied.

Having developed the methods to study groups of echolocating bats with multiple sensors, I will then discuss preliminary biological insights arising from *Ushichka* including characterising individual echolocation (call duration, repetition rate, spectral range) and flight decisions (speed, curvature, area of cave occupied) – along with broad descriptors of their collective behaviour (inter-neighbour distance and polarization) across group size.

Session 3 – Saturday – 22.10.2022 – 10:45

Speaker: Ava Kiai

The reverse cocktail party problem: Dynamic time-domain jamming avoidance in freely socializing bats

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Bats live and navigate in noisy environments, where acoustic signals are commonly masked or degraded by ambient noise. While short-term vocal adaptations (such as the Lombard effect) aimed at reducing interference with external sounds have been documented in several bat species, less attention has been paid to how bats exploit the temporal domain to optimize the signal quality of their vocalizations. In this study, we presented groups of freely socializing *Carollia perspicillata* bats with amplitude modulated white noise that masked significant portions of the frequency band used for both echolocation and social communication. We found that adult bats spontaneously adjusted the timing of their vocalizations by clustering call onsets preferentially in the amplitude troughs. This behavior was observed for different amplitude modulation rates and found to be dependent on the degree of frequency masking. We conclude that bats can dynamically adapt their calling behavior to maintain signal quality in the presence of rhythmic, predictable ambient noise. Our findings highlight the impressive vocal plasticity of Phyllostomid bats and illuminate avenues for further research on the bat's auditory-vocal-motor circuit.

Session 3 – Saturday – 22.10.2022 – 11:00

Speaker: Antoniya Hubancheva

A mating call that interferes with bats' sensory systems

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Mating signals are notoriously hazardous as they not only attract the attention of potential mates but also serve as a guiding cue for predators. Therefore, to avoid being eaten, courting animals employ diverse antipredator strategies. Most of those strategies, however, reduce the time for attracting mating partners or the quality of the mating signal. Here, we test the novel hypothesis that exceptionally conspicuous mating signals can overwhelm the sensory systems of predators and therefore offer protection to their senders. We explored the interactions between the conehead bush-crickets (*Ruspolia nitidula*) and the greater mouse-eared bats (*Myotis myotis*). We measured the natural soundscape of the foraging grounds of the mouse-eared bats, performed fine-scale diet analysis of wild bats and performed behavioural experiments in controlled lab conditions. Our results suggest that choruses of singing conehead bush-crickets create an intense broadband sound field that interferes with the sensory systems of foraging bats. The importance of our results is twofold. First, they open a new alley of research questions about potential new antipredator mechanisms. Second, they provide a better understanding of the acoustic dominance potential that this bushcricket species has. Its potential spread might alter the soundscapes of entire habitats, changing the sensory environment of the acoustic predators with unknown effects.

Session 3 – Saturday – 22.10.2022 – 11:15

Speaker: Sophie Holtz

Talking Echoes: The communicative potential of functional echolocation calls in the common big-eared bat, *Micronycteris microtis*

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Bats are acoustic and vocal specialists and highly social animals which heavily rely on acoustic communication. Their vocalizations can be categorized by their function: While social calls are used exclusively for communication, echolocation calls primarily evolved for orientation, navigation, and foraging, not to convey personal information. Nevertheless, over recent years an increasing body of evidence has surfaced demonstrating that echolocation calls can contain personal information about the calling bat and even facilitate social communication, thus serving a dual function. Here, we investigated whether echolocation calls of the neotropical bat *Micronycteris microtis* also have this communicative component. *Micronycteris microtis* is an active gleaning insectivore exhibiting extended maternal care by post-weaning food provision. It regularly brings prey items back to its night roost to consume and give to its pups. Observations suggest that *M. microtis* pups may recognize their mothers from a distance based solely on acoustic cues contained in the echolocation calls of their mothers. Therefore, we asked whether echolocation calls of this species encode individual identity and information about an individual's hunting success. We combined an established camera-trapping system at a night roost of wild, individually marked *M. microtis* with an acoustic monitoring set-up. This way echolocation call sequences of naturally behaving and free-flying *M. microtis*, for which not only individual identity but also information about hunting success was known, could be repeatedly recorded over several months. We analyzed more traditional acoustic parameters of the calls as well as acoustic features derived from a feature extraction analysis by a discriminant function analysis and subsequent computation of a generalized linear mixed model. Our analysis showed that echolocation calls of wild *M. microtis* carry enough inter-individual variance to allow for discrimination between individuals. Additionally, it revealed systematic differences in the echolocation calls depending on the presence or absence of prey items in the bats' mouths. Therefore, we argue that eavesdropping pups may not only recognize their mothers based on echolocation calls, but may also extract information on hunting success, thereby facilitating the prey transfer. Furthermore, the observed difference between echolocation calls emitted with and without prey items in the mouth could either be a consequence of changes in spatial characteristics of the oral cavity or hint at a possible switch between oral and nasal call emission in this species.

Session 3 – Saturday – 22.10.2022 – 11:30

Speaker: Eva Mardus

The Micro- and Macrodialects of the Parti-coloured Bat

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Bats are highly social animals which use acoustic signals for prey detection, orientation, and social communication. Some bat species not only use simple calls in a social context but produce a complex song for mate attraction and/or territorial defence. This makes bats one of the few mammalian taxa that are known to sing. Unlike the well-studied song of songbirds, comparably little is known about bat song. Studies on regional differences (i.e. dialects) of bat song are sparse and often limited in scale. The parti-coloured bat, *Vespertilio murinus*, is a palearctic bat species that migrates long distances and also sings. Its song is mainly emitted during flight and highly characteristic for this species: each song motif is composed of two different syllable types and motifs are repeated in long sequences. Here we present the first European-wide study on the song of the parti-coloured bat, conducted in 18 different countries. By comparing acoustic differences of song motifs from different locations in the same country and in different countries, we were able to study both small-scale differences (microdialects) and large-scale differences (macrodialects). In total, we analysed the acoustic parameters of more than 5000 song motifs. We found evidence for pronounced micro- and macrodialects in the song of parti-coloured bats. This study is an important foundation for future work on the functional significance of song dialects in a long distance migrator.

Session 3 – Saturday – 22.10.2022 – 11:45

Speaker: Theresa Schabacker

Intraspecific individual differences in vocal behavior

Theresa Schabacker[1,2], Lysanne Snijders[3] & Mirjam Knörnschild[1,2]

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Animals use vocalizations for communication, orientation or expression of emotional valence, and links to personality-related differences have been demonstrated. For example, certain songbirds exhibit consistent individual differences in vocalization during exploration. However, our current understanding of consistent individual differences in vocalization is primarily based on avian studies. This limits our understanding of how individual differences in vocalization may affect certain life history traits, as, for example, most songbirds do not use vocalizations for orientation. Moreover, most bird studies are carried out during the day, while vocalizing can be an especially functional behavior in the dark. Thus, we here investigated individual vocal behavior in bats, a nocturnal mammal that uses vocalizations in a wide variety of contexts. We repeatedly assessed exploratory behavior of two wild-caught bat species, *Pipistrellus nathusii* and *Glossophaga soricina*, through standardized personality tests involving the exploration of a maze-type arena (*P. nathusii*) and a flight cage (*G. soricina*). In the first species, we tested repeatability of vocalization as a cue sampling response, while in the second species we focused on vocalization as a cue sharing response. When introduced to the maze *P. nathusii* exhibited consistent intra-specific differences in spatial activity as well as echolocation call activity, given their spatial activity, a behavioral response we term 'acoustic exploration'. Acoustic exploration, a direct reflection of the level of environmental cue sampling, may provide a new measure when assessing intra-specific variation in exploration behavior in actively sensing species. *G. soricina* exhibited consistent intra-specific differences in social call production when exposed to novel environments or objects. This type of social call, termed 'alert call', has been previously observed when bats behaved warily or vigilantly. Thus, these preliminary results suggest that vocal production rate reflects individual levels of nervousness or alertness. Our results provide evidence for consistent intra-specific variation in the degree at which wild bats 1) collect information from a novel environment and 2) potentially express experienced levels of nervousness. Furthermore, we highlight the importance of vocalization as an additional relevant factor when assessing animal personality.

Session 4 – Saturday – 22.10.2022 – 15:00

Speaker: Camila Calderon

Multiyear and cave level variation in foraging behaviour of the Greater spear-nosed bat

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Greater spear-nosed bats (*Phyllostomus hastatus*) are facultative social foragers that live in stable groups of genetically unrelated, but highly cooperative females. Female *Phyllostomus* often forage together, actively recruiting group-mates to temporally unpredictable food sources like flowering trees and, it has been reported, jointly defending these valuable resources. For males the story is different, they are described to live in less stable groups and forage alone, but cooperating in foraging is still an open question. Because they are a widely distributed species that experiences significant fluctuation in resource distribution and availability throughout the annual cycle and across their range, *P. hastatus* has great potential as a highly tractable model system for testing foraging ecology. Leveraging advanced biologging techniques, we combined GPS-tracking and accelerometry data from 77 individuals, to understand how females and males of *P. hastatus* use their landscape during different years, within and between three different caves in Isla Colon, Bocas del Toro, Panama. Our preliminary results show that across years, most females and males use previously known foraging areas. Between caves, females and males from two caves forage in similar foraging locations that are located around 25 km west of Isla Colon, whereas females and males from the third cave forage south to a completely new area not known before. Within caves, females and males from the same group fly independently to known foraging patches, having individual foraging areas and routes on consecutive days, but using on many occasions adjacent foraging locations with other individuals in the same cave. Contrary to what has been described for the species, our results suggest that *P. hastatus* rather than cooperating with their group mates to find concentrated resources might exchange information at some point in time about those food sources that once localized, individuals can exploit individually. The fact that individuals from only one cave use completely different foraging areas suggest that *P. hastatus* is actively sensing the landscape to find resources possibly to avoid high intraspecific food competition. Long-term tracking and further research are needed to understand flexibility in foraging and target possible unevidenced cooperation during foraging.

Session 4 – Saturday – 22.10.2022 – 15:15

Speaker: Jenna Kohles 

Social Foraging Behavior and Information Use Linked to Prey Distribution in an Ephemeral Insect-eating Bat

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In highly variable environments, where food patches are unpredictable yet shareable, animals can use social information to locate patches more efficiently or more reliably. However, how resource availability fluctuates in space and time can vary in complex ways, and the behavioral strategies animals employ to exploit such resources can also vary, particularly if, when, and where they use available social information. We developed a framework for predicting and characterizing strategies of social information use across taxa, and used it to investigate the foraging behavior of *Noctilio albiventris*. We integrated GPS tracks of simultaneously foraging individuals with the distribution of their aquatic insect prey in two climatic seasons to determine: 1) food availability relative to foraging bout duration, 2) location of social information use, and 3) whether social information use is opportunistic or coordinated. Preliminary results suggest that the insect prey of *N. albiventris* is available in one location for less than the duration of their foraging bouts, they use social information near food patches, and they are flexible in their use of social information, switching between opportunistic and coordinated strategies even within a single foraging bout. Linking foraging behavior, food distribution, and social information is important to understand how ecology shapes social behavior.

Session 4 – Saturday – 22.10.2022 – 15:30
Speaker: Patrick Cvecko

Ulm's citadel between hibernating bats and increasing human use

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The citadel of Ulm (Wilhelmsburg) recently became one of the largest known hibernacula in Baden-Württemberg, with over 1000 hibernating pipistrelle bats. This was partly because of roost-enrichment measures. We gathered information on the parameters influencing the bat`s use of the citadel throughout the year and the choice of flight routes to and inside the building. I will present data from a cooperation between the University of Ulm and environmental consulting efforts supported by the city, and present results of several bachelor and master theses over more than three years. Future plans of the city to intensify the use of the citadel in the coming years will be a challenge to the establishment and maintenance of a safe environment for the swarming and hibernating bats.

Session 4 – Saturday – 22.10.2022 – 15:45
Speaker: Sebastian Brackhane

Of cattle, bats and insects - Can low intensity grazing and traditional land use promote biodiversity in Central Europe?

Sebastian Brackhane[1,2], Anna-Lena Hendel[3], Bernd Ihle[4], Hartmuth Mohr[4], Bettina Saier[5], Jochen Paleit[6], Albert Reif[3], Markus Dietz[7] & Mona Strack[7]

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Traditional land use systems formed the cultural landscape of Central Europe. This has led to landscapes with a high structural diversity and high biodiversity patterns. However, in the past decades, the intensification of agriculture and forestry has led to a decline in habitat and populations of wildlife in Central Europe, e.g. of insect populations. It is assumed that this has also affected the populations of many European bat species, with many of them nowadays being red-listed as vulnerable, threatened or (critically) endangered. In this study, we investigated how traditional land use systems, including low intensity grazing, influence the diversity and activity of bat species in the nature conservation site Taubergießen, located in the Upper Rhine Valley of Baden-Württemberg, Germany. In 2021, we conducted acoustic bat and nocturnal insects surveys on 54 plots using Batcorder 3.1 and light traps. We compared three different land use types: a) traditional land use systems including low intensity grazing, b) conventionally used forests and meadows, and c) strictly protected forests. The results can provide valuable insights for conservationists that aim to implement land use systems that protect and promote threatened bat species and insect diversity in Central Europe.

Session 4 – Saturday – 22.10.2022 – 16:00
Speaker: Christian Giese

Winteraktivität von Zwerg- und Mückenfledermäusen - Erfassungsmethoden zum Schutz von Fledermäusen bei Abbruch und Sanierung von Gebäuden im Winter.

Christian Giese

Oft werden Gebäude in den Wintermonaten abgerissen oder saniert, ohne dass eine mögliche Nutzung als Winterquartier berücksichtigt wird. Ohne diese Kenntnisse jedoch besteht die Gefahr, dass Massenwinterquartiere ersatzlos zerstört und lokale oder sogar überregionale Populationen von Zwerg- und Mückenfledermäusen ausgelöscht werden.
Es ist daher wichtig, dass Gutachterinnen und Gutachter die richtigen Methoden anwenden, um überwinternde Zwerg- und Mückenfledermäuse nachzuweisen. Besser wäre es, flächendeckende Kartierungen durchzuführen, um diese sehr wichtigen, aber auch sehr anfälligen Quartiere nicht nur den Behörden bekannt zu machen.
Aus diesem Anlass versuche ich, zum Schutz von Fledermäusen bei Abbruch und Sanierung von Gebäuden im Winter, das vorhandene Wissen zu sichten und eigene Daten zu erheben, um Methoden zu erarbeiten, die Gutachterinnen und Gutachtern, Behörden oder ehrenamtlich tätigen Personen das Erkennen von Winterquartieren zu ermöglichen.

Winter activity of common and soprano pipistrelle - Methods for the protection of bats during demolition and renovation of buildings in winter.

Christian Giese

Buildings are often demolished or refurbished during the winter months without considering their possible use as winter roosts. Without this knowledge, however, there is a risk that mass hibernation roosts will be destroyed without replacement and local or even supra-regional populations of common and soprano pipistrelle will be wiped out.
It is therefore important that surveyors use the right methods to detect hibernating pygmy and mosquito bats. It would be better to carry out area-wide mapping to make these very important but also very vulnerable roosts known not only to the authorities.
For this reason, I am trying to sift through the existing knowledge and collect my own data for the protection of bats during the demolition and renovation of buildings in winter, in order to develop methods that enable experts, authorities or volunteers to recognize winter roosts.

Session 5 – Saturday – 22.10.2022 – 16:45

Speaker: Anna-Lena Hendel

Evaluating the effects of retention forestry on bat habitat selection

Anna-Lena Hendel[1], Nathalie Winiger[1], Marlotte Jonker[1], Katarzyna Zielewska-Büttner[2], Selina Ganz[3], Petra Adler[3] & Veronika Braunisch[2,4]

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Retention forestry, which retains small set-asides within forests managed for timber production and other services, is an important conservation instrument for enhancing structural complexity and biodiversity in multifunctional forests. However, in contrast to local scale effects, its large-scale effectiveness is largely unknown, as this requires area-wide and sufficiently precise information on key structural elements and associated species' habitats. Bats are particularly sensitive to forest structural characteristics and are target organisms of most retention programs. To assess their response to existing retention efforts, we here compared key habitat structures and overall habitat suitability for bats across forest areas with and without retention, using forest structure variables derived from remote sensing along with topographic, climatic and land-cover variables and a multi-scale modelling approach. Based on acoustic data from 135 1-hectare plots across the Black Forest, Germany, we calibrated region-wide species distribution models for 8 bat species or bat species groups thereby identifying the best-performing scale (50-1000m radius) for each predictor and species(-group). Among predictors and species(-groups) forest structural variables explained 39.4% of bat habitat selection, with forest height heterogeneity (18.4%) and the percentage area with standing dead trees (12.4%) performing best, mostly at small scales (50-100m). Forests with retention showed higher values of these key structural variables, resulting in higher predicted habitat suitability for all dependent species(-groups), highlighting positive effects of retention on structural complexity in forests and on species that benefit thereof.

Session 5 – Saturday – 22.10.2022 – 17:00

Speaker: Simon Gaultier

Bats respond negatively to proximity of wind turbines in European boreal forests.

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Impacts of wind power on bats are usually evidenced by the recorded fatalities, while other impacts are not well understood or considered during project planning. However, wind turbines may affect use of the surrounding habitats by bats. Little is known about such impact, especially in the European boreal biogeographical region. We studied the consequences of operating wind turbines on the presence and activity of bats. Using passive recorders at 84 sampling sites placed at 200m intervals from 0 to 1000 metres (2 recorders per distance class), we monitored bat activity over four months at seven Finnish wind farms located in forested habitats. Our results show higher presence and activity at 600 m and further from turbines for Eptesicus nilssonii, and higher presence at 800 m and further for Myotis spp. We also saw an increase in bat activity during midsummer, which may be due to increased use of forest canopy cover during the short nights at this time. These results indicate a potential loss in habitat quality around wind turbines, e.g., a greater number of open areas in forests, which are unfavourable to Myotis species. This lower activity and presence could also be an indication for active avoidance of the wind turbines from the bats. Furthermore, these results are the first of their kind for the European boreal biogeographical region. They show undeniable impacts of wind power on bats in Finland, and enforce the requirement for better consideration of bats during the development of such projects in Finland. We also call for investigation on the causative mechanisms of the observed effect, to better facilitate mitigation.

Session 5 – Saturday – 22.10.2022 – 17:15

Speaker: Julia Ellerbrok

Activity of forest specialist bats decreases towards wind turbines at forest sites

Julia S. Ellerbrok[1], Anna Delius[2], Franziska Peter[3], Nina Farwig[4] & Christian C. Voigt[5]

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Worldwide, wind turbines are increasingly being built to reduce carbon dioxide emissions and meet the goals of national climate strategies. At the same time, land use pressure on open landscapes is constantly rising, leading to an expansion of wind energy facilities into forest habitats in recent years. Yet, the impact on forest biodiversity is barely understood. Bats may be heavily affected by the construction and operation of wind turbines in forests since most species depend on forest ecosystems for roosting and hunting and some of these experience high fatality rates at wind turbines. We performed acoustic surveys in 24 temperate forests in the low mountain ranges of Hesse, Central Germany, to monitor changes in the acoustic activity of bats in relation to wind turbine proximity, rotor size, vegetation structure and season. Therefore, call sequences were identified and assigned to one of three foraging guilds: open-space, edge-space and narrow-space foragers, the latter being mainly forest specialists. Based on the response behaviour of bats towards wind turbines in open landscapes, we predicted decreasing bat activity towards wind turbines at forest sites, especially for narrow-space foragers. We found that vertical vegetation heterogeneity had a strong positive effect on all bats, whereas responses to wind turbines in forests varied across foraging guilds. The activity of edge-space foragers did not change with distance to turbines or season, whereas the activity of open-space foragers increased close to turbines in late summer suggesting a seasonal attraction. In contrast, activity of narrow-space foragers decreased towards turbines over distances of several hundred meters, especially towards turbines with large rotors. In conclusion, habitat used by protected forest specialist bats is lost when wind turbines are built in forests. This habitat loss needs to be compensated by setting aside other forest areas

Session 5 – Saturday – 22.10.2022 – 17:30
Speaker: Christine Reusch

Wind energy production leads to habitat loss for common noctule bats in Europe

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In Germany, wind energy production is expanding largely along coastal areas and in forests. Coastal sites are used by migratory bats as migratory corridors and forests for roosting. Therefore, expansion of wind energy production along the coast and at forested sites may be in conflict with the conservation of bats. We used miniaturized global positioning system (GPS) tracking of more than 70 common noctule bats (*Nyctalus noctula*) to shed light on the spatial interactions of a high collision risk bat species in coastal landscape and at inland sites dominated by forests. At our coastal site in northern Germany, we analysed the movement tracks of 11 common noctules based on >6,000 locations and at our inland forest those of 60 common noctule bats based on >8,000 spatial positions. We used different spatial models to infer on the preferred and avoided landscape features in interaction with WT. At the coastal site, we found 3.4% of all locations close to WT, with bats preferring areas with high levels of impervious surface, identified as farmhouses. There, common noctule bats were also more present close to WT adjacent to paths and waterbodies. At the local scale, >70% of common noctule bats avoided WT, yet if bats approached WT we counted more positions at large WT, specifically close to known roosts. This was confirmed at our forest site, where bats were particularly active at WT near tree roosts, which increases the risk of bat casualties. Outside the vicinity of roosts, bats avoided wind turbines over distances of several kilometers, indicating that bats will also lose habitat when turbines are placed in forests.
Especially avoidance behaviour of bats toward wind turbines has not been considered largely during past impact assessments. Although avoidance behaviour of bats toward turbines may come at the benefit of reducing the individual vulnerability at wind turbines, avoidance may nonetheless lead to habitat loss by the operation of WT. Turbine-related habitat losses may become critical for affected bats when wind turbine densities are high.

Session 5 – Saturday – 22.10.2022 – 17:45

Speaker: Carolin Scholz

Fledermausschlag an alten Windkraftanlagen und der Verlust von trophischen Interaktionen

Bat fatalities at old wind turbines and the loss of trophic interactions

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Die Energiewende wird seit dem Regierungswechsel Ende 2021 stark vorangetrieben. Erneuerbare Energien und vor allem die Energieerzeugung aus Windkraft spielen hierbei eine entscheidende Rolle. Dabei liegt der Fokus vor allem auf dem Neubau von Windenergieanlagen (WEA) auf flächenmäßig erweiterten Vorrangflächen für die Windkraft. Allein in der ersten Jahreshälfte 2022 wurden fast 250 neue WEA an Land mit einer Leistung von rund 1.000 MW in Deutschland installiert. In den kommenden zehn Jahren wird es zu einem signifikanten Zuwachs an WEA kommen, wenn das 2% Flächenziel bis 2032 erreicht werden soll. Alten, vergleichsweise ineffizienten Anlagen wird absehbar keine große Aufmerksamkeit geschenkt. Dabei sind es vor allem alte WEA, die große Gefahren für Fledermausarten mit erhöhtem Kollisionsrisiko bergen. Mehr als 75% der bestehenden 30.000 WEA im onshore Bereich wurden vor der Etablierung von bundeslandspezifischen Handlungsempfehlungen gebaut. Dies führte dazu, dass viele alte WEA an ungeeigneten Standorten stehen und ohne Abschaltauflagen zum Schutz von Fledermäusen betrieben werden. Wir untersuchten (1) beispielhaft an einem Windpark mit drei WEA wie hoch die Schlagopferzahlen an derartigen alten Windparks potenziell sein können. Zum anderen untersuchten wir (2) beispielhaft am Großen Abendsegler (*Nyctalus noctula*), welche trophischen Interaktionen durch den Schlag von Fledermäusen an WEA potenziell verloren gehen. Bei unserer Schlagopfersuche am Fokus-Windpark in Brandenburg im August und September 2021 wurden insgesamt 18 Fledermauskadaver gefunden. Unter Berücksichtigung der Sucheffizienz und der Kadaverabtragsrate ergab sich ein Schätzwert von 209 getöteten Fledermäusen, die im zweimonatigen Untersuchungszeitraum im Windpark getötet wurden. Dies bedeutet eine Schlagopferzahl von 70 Tieren/WEA oder 39 Schlagopfer/MW in zwei Monaten. In unserer Studie zur Ernährungsweise der Schlagopfer untersuchten wir mittels DNA-Metabarcoding den Mageninhalt von Großen Abendseglern (*Nyctalus noctula*), die an WEA im Osten Deutschlands zu Tode kamen. Die Tiere verzehrten eine Vielzahl von Insektenarten sowohl aus aquatischen als auch terrestrischen Ökosystemen (z. B. Feuchtgebiete, Ackerland, Wälder und Grasland). Etwa 20% der gefundenen Arten waren landwirtschaftliche und forstwirtschaftliche Schadinsekten. Unsere Schlagopferschätzungen an einem alten Windpark zeigen deutlich, dass alte WEA hohe Schlagopferzahlen produzieren, da sie potenziell an ungeeigneten Stellen stehen und ohne Abschaltauflagen betrieben werden. Die 20-jährige Laufzeit des untersuchten Windparks unterstreicht, dass möglicherweise Tausende von Tieren alleine an diesen drei alten WEA zu Tode kamen. Wir fordern deshalb, dass der Betrieb der alten WEA dem aktuellen Kenntnisstand angepasst wird und diese mit Abschaltzeiten beauflagt werden. Zudem muss der Standort von alten WEA überprüft werden. Unsere Studie zur Ernährungsweise der Schlagopfer legt zudem nahe, dass der potenzielle Schaden der Windenergieerzeugung über den Verlust von Fledermausindividuen und den Rückgang von Populationen hinausgeht. Der Schlag von Fledermäusen an WEA fördert die Vereinfachung trophischer Nahrungsnetze in den betroffenen Habitaten. Der Verlust der ökosystemaren Dienstleistung von Fledermäusen könnte dazu führen, dass mehr Pestizide ausgebracht werden müssen, um Schadinsekten zu kontrollieren.

Vocalization and navigation behaviour in normal-hearing and hearing-impaired bats

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Bats not only orient and forage with their ears, but they also communicate with each other using a rich repertoire of complex calls and songs. Unlike most mammals, in which the vocal repertoire is innate, bats have been considered vocal learners. Vocal learning refers to an animal's ability to acquire new vocalizations through imitation using auditory feedback. Deafening experiments are therefore critical to verify vocal learning, but they can also illuminate other aspects of behavior. Here we compared echolocation and flight of two groups of Phyllostomus discolor: three normal-hearing bats and three bats that had been acoustically deafened at birth. Pups of both groups had thrived and grown into adults that are socially integrated in the colony and keen flyers in dim-light conditions. However, we hypothesized that (i) in darkness and unknown surroundings, hearing-impaired bats would not fly and (ii) in darkness and known surroundings, hearing-impaired bats could not navigate unknown obstacles. We recorded behavior via 3D thermal imaging and a 23-channel microphone array. We found that (i) all deafened bats voluntarily took flight off a starting platform in the center of an unknown dark flight room, and that (ii) deafened bats could fly without colliding with unknown obstacles in a dark, but familiar flight room. However, the duration of their flights was shortened compared to the normal-hearing control bats. During obstacle flight, deafened bats vocalized at higher amplitudes and with broader frequency spectra than the controls. Our results provide fascinating insights into innate vs. learned behavior and how the lack of hearing affects acoustic specialists like bats.

Session 6 – Sunday – 23.10.2022 – 09:15

Speaker: Marisa Tietge

Sexually selected behaviors and vocalizations in *Phyllostomus discolor*

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Sexually selected behaviors play a decisive role in the animal kingdom. While some taxa are already well studied, bats have received comparatively little attention so far, thus limiting our knowledge of their sexually selected behaviors. Our study focused on sexually selected behaviors and vocalizations of Neotropical pale spear-nosed bats (*Phyllostomus discolor*). By simultaneously recording video footage and vocalizations of a captive colony consisting of 15 individually marked adults and 3 pups, we documented the existence of a post-partum oestrus that is linked to complex male-male and male-female interactions. We observed mate-guarding behavior, copulations, and male-male threat behaviors in detail and documented them with video footage. We also analyzed the bats' social vocalizations and described 17 different syllable types, 10 of which could be assigned to a distinct behavioral context such as mate-guarding, distress, and threat. Our visual syllable type classification was confirmed by a discriminant function analysis which classified 84.9% of syllables to the correct syllable type. Furthermore, we used a Markov chain analysis to identify a consistent order of syllable types in multisyllabic phrases produced by males that were threatening a competitor. In conclusion, our study expands our knowledge of bats' sexually selected behaviors in general and about the vocal repertoire and social behavior of *P. discolor* in particular. Since the vocal communication of this species has been increasingly investigated in neurophysiological and neuroethological studies in recent years, our behavioral results are important to neurobiologists as well.

Session 6 – Sunday – 23.10.2022 – 09:30

Speaker: Ravi Umadi

Phyllostomus discolor Retain a Consistent Beam Size in Seeking Targets

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Control and coordination of the geometric shape and the acoustic features of the sonar beam are a source of dynamic flexibility and adaptability for a foraging echolocator. In the wild, FM bats use a highly directional beam in the search phase to avoid clutter and enhance the range by adjusting the mouth gape. In the final approach, they broaden the beam by lowering the frequency for better trackability. Phyllostomids and Rhinolophids can achieve beam size variability via nostrils and nose leaf positioning. However, the beam dynamics during the active pursuit of an object of interest in the presence of competing objects are not well established. In this study, we did experiments in a virtual echo-acoustic environment under the *oddball* paradigm. The bats were required to search and find a rewarding *deviant* phantom echo among the non-rewarding *background* phantom echoes. The bats were trained to sit restrained on a platform, 1.9 m away, and probe via echolocation the space in front of them, where a 45-channel parabolic array of microphone and speaker assembly units provided us a means to generate and define the virtual echoes in real-time playback experiments. We collected and analyzed the audio data for two experimental conditions. The first condition simulated an open-ended search. The bats searched the array for a randomly assigned rewarding unit while the speakers were muted. We then employed the oddball paradigm where the deviant echo was either a temporally or spectrally modified playback of the calls. We reconstructed the sonar beam imprint for calls in search sequences and derived the dimensions of the beam at 3dB amplitude drop. A comparison of the variability in the beam sizes between the two experimental conditions showed clear differences in beam geometry. In the first condition, the beam width and height ranged from 10 to 80° angles, and the beam area expanded to 4000 degree^2. In the oddball condition, the width and height of the beam centered around 40 ± 10°, and the beam area was limited to around 1000 degree^2. The data also indicate a shift toward constancy of beam dimensions in oddball search sequences; an initial random search presumably results in the identification of the target and prompts a constraint on the beam geometry. The call-frequency content analyses generally mirror the trend in beam geometry and could partly account for the changes in the beam size. As seen in the results from no playback conditions, *P. discolor* can produce a broad range of beam dimensions, conceivably via a combination of call-frequency and nose-leaf morphology adjustments, aiding the myriad of navigational and foraging contexts. However, the results from the oddball condition demonstrate that beam size consistency might be a preferable strategy for active target pursuit in complex scenes to ease both the processing load and motor coordination of the emitter and receivers. Moreover, for a given beam size, spectral and intensity adjustments nonetheless grant flexibility.

You eat what you hear: Hearing sensitivity as an underlying mechanism for niche differentiation in gleaning bats

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Tropical ecosystems are known for their high species diversity. Different adaptations enable species to coexist and thus permit niche differentiation. Historically, research focused primarily on morphological and behavioral adaptations for foraging, roosting, and other basic ecological factors. Another important factor, however, is differences in sensory capabilities. So far, studies mainly have focused on the output of behavioral strategies of predators and their prey preference. Understanding the coexistence of different foraging strategies, however, requires understanding underlying cognitive and neural mechanisms. The neotropical leaf-nosed family Phyllostomidae is ecologically highly diverse, with several species co-existing in the same habitat. We investigated the hearing in bats and how it shapes their co-existence. We present the hearing thresholds and echolocation calls of 12 different gleaning bats. In our study we measured their auditory brainstem responses to assess their sensitivity thresholds and dynamic responses to different acoustic stimuli. The audiograms of the 12 gleaning bat species had similar overall shapes but differed in slopes and sensitivity peaks. The bats' hearing sensitivities differed mainly in the low frequency range for frequencies below 9 kHz and in the high frequency range for frequencies of their echolocation calls.
Our results suggest that differences in hearing abilities among bats contribute to the diversity we see in foraging strategies of gleaning bats. We argue that differences in auditory sensitivity and hearing can be a key mechanism explaining diversity in sensory niches and coexistence of species.

Session 6 – Sunday – 23.10.2022 – 10:00
Speaker: Hans-Ulrich Schnitzler

Echolocation strategies of bats for the detection of fluttering insects in clutter

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Flutter detecting bats are specialized to detect and evaluate amplitude and frequency modulations caused by the moving wings in insect echoes to find fluttering prey even in dense clutter. Numerous studies describe that rhinolophids, hipposiderids and the mormoopid bat *Pternotus parnellii* analyze the flutter information in insect echoes to find and even identify their prey. CF-FM signals emitted at high duty cycle, Doppler shift compensation, and an auditory fovea are specific adaptions for this "high duty cycle flutter detection echolocation strategy". Other bat species foraging for insects in the acoustic habitat type "narrow space" may have evolved another so far undescribed echolocation strategy to assess flutter information: the "burst echolocation flutter detection strategy". These bats search for insects with groups or bursts of many short and frequency-modulated signals of high frequency and large bandwidth. We hypothesize that they use these bursts to sense the wing movements of fluttering prey. Ensonification of natural scenes with simulated burst signals revealed that amplitude and frequency modulations in echo sequences allow the discrimination of echoes with flutter information from unmodulated echoes from background targets. We show that burst echolocation is used by species from different families, the hipposiderid *Coelops frithii,* the phyllostomid *Micronycteris microtis*, the natalid *Natalus tumidirostris.* Most likely it is also used by thyroperids like *Thyroptera tricolor* and by vespertilionids of the genera *Kerivoula* and *Phoniscus.*

Session 7 – Sunday – 23.10.2022 – 10:45
Speaker: Lasse Jakobsen

Stealth echolocation in hawking bats reflects ancestral gleaning traits not counter-measures to moth hearing

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Reciprocal evolutionary change between prey and predator can escalate into an 'evolutionary arms race'. Bats and moths are textbook examples of such a purported arms race. Examples of insect-countermeasure to bat echolocation are numerous, but to date, the only example of a presumptive direct counter strategy to insect hearing is the emission of very low intensity calls by barbastelle bats, *Barbastella barbastellus*. However, we here challenge even this example of co-evolution. We show that barbastelle echolocation during target approach is more easily reconciled with restrictions imposed by a gleaning ancestor as opposed to a counter measure to insect hearing: barbastelles greatly increase their duty cycle during target approach compared to other aerial hawking vespertilionid bats, they emit low intensity calls even when prompted to increase intensity through noise exposure, and in contrast to all other hawking vespertilionid bats they do not broaden their echolocation beam. Phylogenetic reconstructions support this scenario, as many traits of the bat ancestral to barbastelles and other plecotine bats are typical of gleaning species. Our study therefore strongly indicates that barbastelle echolocation did not evolve to counter eared prey, but rather, that low intensity echolocation of the ancestral plecotine bat allowed adequate capture of eared insects, enabling the evolution of obligate aerial hawking barbastelles, in spite of the short echolocation range poorly suited for aerial hawking. Our study highlights the importance of considering the impacts of phylogenetic and morphological constraint in evolutionary arms races, fundamental evolutionary properties not often considered in the context of predator-prey interaction.

Vocal tract and acoustic allometry in neotropical bats

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Microchiropteran bats are one of the most species-rich and acoustically specialized mammalian clades, yet very little is known about how vocal morphology relates to sound production within the group. An emerging anatomical imaging technique called diceCT (diffusible iodine-based contrast-enhanced computed tomography) has greatly advanced the field of functional morphology in recent years, but thus far it has seen little use in studies of bats. diceCT involves staining specimens with iodine or other contrast agents prior to CT scanning. This allows for precise rendering of soft tissues and is far less destructive than dissection, serial histological sectioning, and other alternatives. Here, we present initial results from an ongoing comparative study of microchiropteran bat vocal morphology. Our sample includes 67 neotropical bats from 11 species and 6 families (Emballonuridae: *Saccopteryx bilineata*, *Saccopteryx leptura*, *Rhynchonycteris naso*; Molossidae: *Molossus molossus*; Vespertilionidae: *Myotis nigricans*; Thyropteridae: *Thyroptera tricolor*; Mormoopidae: *Pteronotus parnellii*; Phyllostomidae: *Phyllostomus hastatus*, *Desmodus rotundus*, *Carollia perspicillata*, *Glossophaga soricina*). To date, we have conducted unstained skeletal micro-CT scans of the vocal tracts of 62 individuals and performed diceCT scans on 24 individuals (≥ 1 male and female from each species) to analyze vocal tract soft tissues. We are currently assessing acoustic allometry across taxa by comparing vocal tract measurements with species averages of body size, forearm length, and morphologically relevant acoustic features of social and echolocation calls.

The first transgenic bat as a model organism for research on mammalian vocal learning

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Vocal learning is a fundamental building block of human spoken language and is a trait we share with few other animals. It has only been identified in 4 non-human mammal groups, of which bats are the only tractable model system in which the molecular and neural mechanisms can be addressed thus providing a unique window onto the biological foundations of vocal learning and complex communication. To this end we are exploring the role of a key speech and language related gene – *FOXP2* - in the Phyllostomus discolor bat. We looked at the evolutionary conservation of this gene and found high conservation of the FOXP2 protein sequence with only 7 amino acid differences between human and *P. discolor*. The Forkhead-box (FOX) DNA binding domain that characterises this protein was 100% conserved, suggesting high overlap of target sequences and therefore function between species. To explore direct links between FoxP2 molecular function and consequences for neural circuitry and vocal learning behaviour, we generated transient transgenic bats. We created an AAV5 viral construct to overexpress the *P. discolor* version of FoxP2 alongside a GFP marker protein. This was introduced into the striatum of adult bats and after 10 days incubation we assessed the expression of FoxP2 via immunofluorescence. This demonstrated strong upregulation of FOXP2 in the striatum and represents the first successful transgenic manipulation of a vocal learning mammal. Ongoing work will extend these studies to understand the first insights into the role of FoxP2 in molecular pathways, brain development and behaviour in a vocal learning mammal.

Determination of Physiological Body Temperature and Hematological Parameters in Captive *Rousettus aegyptiacus* and *Eidolon helvum* Bats

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In recent years, there has been growing interest in infectiology research on bats, stimulated by the discovery of different bat species as putative reservoir hosts for a number of highly pathogenic zoonotic agents. Therefore, we established breeding colonies of *Rousettus aegyptiacus* and *Eidolon helvum* fruit bats, which both have been identified as reservoir hosts for relevant zoonotic disease agents, such as Marburg virus and Lagos bat virus. Since 2013, individuals of both species have been recruited to the Friedrich-Loeffler-Institut (FLI) from zoological gardens in Europe, to where these species had been introduced from the wild decades ago. The aviaries have been designed according to national recommendations published by the Federal Ministry of Agriculture (Säugetiergutachten). Under these conditions, both species have been reproducing for years. To better understand the physiology of these animals, and to generate baseline knowledge for future infection experiments, we monitored the body core temperatures of *R. aegyptiacus* bats in the aviary and in the cage, and found a circadian variation between 34°C and 41.5°C. We also determined the hematological parameters of both species, and detected specific differences between both bat species. No correlation to age or sex was observed for clinical chemistry values. However, we determined some species-specific differences in biochemical and hematological parameters which will be presented. This underlines the necessity to define species-specific baseline profiles for each bat species prior to their use in experimental challenge, which is so far not performed routinely.

Session 7 – Sunday – 23.10.2022 – 11:45
Speaker: Renate Rabenstein

Revealed with modern and classical approaches – Hidden diversity in an Eocene Bat Fauna (Messel, Germany)

Renate Rabenstein[1], Sandra Engels[1], Gregg F. Gunnell(†)[2], Nancy B. Simmons[3] & Jörg Habersetzer[1]

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Unambiguous bats are very rare in the fossil record, as often only isolated teeth and bones are found. Exceptional rare are complete and articulated skeletons such as *Onychonycteris finney* (Wyoming 52.5 Ma), *Icaronycteris index* (52.2 Ma) and *Tanzanycteris manardi* (46 Ma). In contrast, the Messel Pit Fossil Site in Germany (Middle Eocene, MP 11, 48 Ma) is a unique site for fossil bats: In this former opencast mine fossil bats are found with striking frequency (>700 individuals), often preserved as complete or as almost complete skeletons, additionally with gut contents (insects) and/or even soft-body outlines (fur, wing membranes, pinnae).

Fossil bats became known from Messel in 1917 when Pierre Revilliod described the three species *Palaeochiropteryx tupaiodon*, *P. spiegeli* and *Archaeonycteris trigonodon*. They are the first published and so far also the oldest bat fossils from Germany. In 1981 the very rare *Hassianycteris magna* and the more common *Hassianycteris messelensis* were described by Smith & Storch, seven years later followed by *Archaeonycteris pollex* (Storch & Habersetzer 1988). In 2002 the seventh Messel bat species *Tachypteron franzeni* (Sigé, Storch & Habersetzer 2002) was detected in a museum collection, while the paratype was housed in another museum.

By far the most common taxon in Messel is *Palaeochiropteryx* which comprises about 75% of the bat individuals. The members of this genus show the greatest variability in body size: According to data from literature the body length varies within a species up to 44%. Thus, in addition to the two already known species, the existence of at least one other cryptic species has long been suspected. This is confirmed by our investigations of a number of new and very small individuals. Hence the large collection of Senckenberg Messel bats was re-examined and also fossils from the collections of Darmstadt and Tübingen included in our study. From the prepared specimen measurements of the skull, body, and radius were taken with calipers as well as digital measurements of these bones from 2D X-ray radiographs (resolution 25µm and 20µm). These provided also information of an adult age of the bat. Molars were measured with a stereomicroscope and/or on high-resolution digital 2D X-ray radiographs (resolution 7µm). Whenever necessary, the fossil bats were examined with micro-CT scans, as the teeth of nearly all of them were typically in occlusion. In addition, a historical collection of extracted teeth from the 1980s were investigated for the first time in detail and compared with the digital 3D-surface data of the new individuals. By combination of classical and modern methods we finally found striking evidence of a new species of *Palaeochiropteryx* from Messel.

Poster 1 – Saturday – 22.10.2022 – 20:00
Presenter: Leonie Baier

Cross-modal cues and the cocktail party

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Who should I mate with? What should I eat? To make decisions, animals need information. This information is often communicated via multiple sensory modalities. Male túngara frogs call out to female frogs, using the auditory modality, but additional modalities also relay information on male characteristics and location: The male's vocal sac inflates and deflates, also creating detectable water ripples. Such an elaborate mating display attracts eavesdroppers: The frog-eating bat exploits the different display components to home in for a meal. In this model system we study the interactions between different sensory modalities and their influence on decision-making. Here we investigate cross-modal facilitation, a process where sensory performance in one modality is improved by stimulation in another modality. Either in ambient noise or with masking frog-chorus playback, frog-eating bats must choose between two robotic frogs presenting either a (differing) unimodal acoustic display or a multimodal display that additionally includes (identical) echoacoustic cues, the dynamically inflating vocal sac and water ripples. Our study illuminates the complexity associated with multimodal signaling.

Poster 2 – Saturday – 22.10.2022 – 19:00

Presenter: Felix Häfele

Active control of receiver morphology of freely flying bats during prey capture

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Echolocating bats actively control their acoustic scene by adjusting intensity, duration, frequency and directionality of their emitted calls. Using a highly directional and dynamic beam, bats can efficiently and precisely detect, characterize and localize objects of interest. When closing in on a target, vespertilionid bats broaden their beam to increase their acoustic field of view by lowering the frequency of their signals in the terminal phase of the approach, the so-called buzz. The wider beam allows the bat to better detect evasive prey at close range. However, emission is only one part of this active sensing system. Reception is highly important as it decodes the acoustic cues contained in returning echoes. Yet, little is known on the receptive field of hunting bats. This study provides a first look at the active sonar system as a whole in freely flying bats. We use a 21-microphone array and high-speed stereo video to record four *Myotis nattereri* bats hunting tethered prey in a wind tunnel. We map out the emitted beam pattern using the multi-microphone array and track the receiver morphology at 20 distinct facial landmarks with an artificial neural net (DeepPoseKit) allowing us to reconstruct the 3D morphology.

Preliminary results reveal a forward-downward-outwards ear motion that is highly correlated with the beam broadening during the buzz. Using ear-tip separation as a proxy for ear motion, we find that ear movement starts immediately prior to the beginning of buzz II and increases throughout the entire phase. Separation of the ear-tips peak at 20% increase relative to the approach phase.

We believe that the dynamic adjustment of receiver morphology supports the broadening of the echolocation beam. The receiving beam is dictated by the shape and direction of the outer ears. Hence, we propose that bats actively move the highest amplified hearing-direction down and outwards, broadening the receptive field as well to better track echoes of potentially escaping prey. Our study shows, for the first time, that bats dynamically control both, sound emission and echo reception. By actively broadening the emitted beam on approach and moving the best hearing, bats exploit all parts of their active sensing system to control their acoustic scene and we believe this is key to the speed and efficiency with which they navigate and hunt in the night sky.

Poster 3 – Saturday – 22.10.2022 – 20:00

Presenter: Kaloyana Koseva

The importance of consistency and positive reinforcement in bat training

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Many behavioural and physiological experiments rely on animals consistently performing stereotypical behaviour under controlled lab conditions. While some basic behaviours (such as locomotion, feeding, etc.) could be observed naturally in those artificial conditions, most behaviours require prior training. Despite the importance of animal training for scientific experiments, however, the information on detailed training procedures is still sparse. Here we present a study case where we train wild greater mouse-eared bats (*Myotis myotis*) to perform two different tasks under controlled lab conditions. In the first task, bats were trained to land on a mounted spherical hydrophone capable of producing omnidirectional noise at different pulse intervals. During the second task, the animals were trained to capture a tethered mealworm in a large flight room. Here we present a novel four-stage training protocol, where each training stage is divided by smaller steps that are introduced gradually to the bats. Our results suggest that bats perform best when the training is structured, individual animals are trained consistently by one trainer and using positive reinforcement. So if the trained bat fails with the next step, it's moved back to the previous one to avoid negative reinforcement and to minimise the risk of the animal losing motivation.

Poster 4 – Saturday – 22.10.2022 – 19:00
Presenter: Diana Schoeppler

Echolocation behavior in the hipposiderid, *Hipposideros armiger,* and the rhinolophid, *Rhinolophus paradoxolophus,* while landing

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Narrow space flutter-detecting foragers emit echolocation signals with a long constant-frequency component (CF) followed by a short frequency-modulated component (FM). In both species the CF is present up to the end of the approach sequence which is a common feature of all flutter-detecting foragers. Here we compare the echolocation behavior of a hipposiderid and a rhinolophid species while flying from a starting place to a landing site.
With a microphone positioned behind the landing platform and two synchronized video cameras we recorded the orientation and approach behavior of three *Rhinolophus paradoxolophus* and two *Hipposideros armiger* while flying form a starting place to the landing site. We reconstructed the flight paths and analyzed the relevant signal parameters. The relative root mean square sound pressure level (rms SPL) was determined separately for the CF and FM.
The echolocation pattern differed distinctively in the two species. After take-off *R. paradoxolophus* emitted long orientation calls in the rhythm of the wing beat at high duty cycle of about 50%. The approach started about 1 m from the landing grid. It was indicated by signal groups with an increasing number of signals combined with a decrease in call duration and within group pulse interval, and an increase of duty cycle up to 77%. The terminal group consisted of about 10 calls with a minimal duration of 12 ms. In contrast, the orientation calls of *H. armiger* were much shorter and were arranged groups containing a variable number of a few signals. The duty cycle reached values of about 25%. The transition to the approach signals was less clear-cut than in rhinolophids. During approach this species reduced call duration and pulse interval continuously. The approach ended with a very long terminal group of about 40 signals and minimal duration of 4 ms. The duty cycle increased to about 45%. In both species the CF of the orientation calls had a higher amplitude than the FM. During approach the amplitude ratio between CF and FM changed in both species but in a different way. In *R. paradoxolophus* the rms SPL of the FM increased distinctly above that of the CF, *H. armiger* kept the rms level of the FM below or at the CF.
Bats approaching a landing target have to precisely know their approach speed and to localize the target for a successful landing control. The differences in the approach behavior between rhinolophids and hipposiderids may indicate different mechanisms to control landing. The very high duty cycle and the long CF in rhinolophids probably deliver sufficient Doppler shift information which encodes approach speed but a rather low update rate for position measurements with the FM, whereas in hipposiderids the FM update rate is high, but the shorter CF and the lower duty cycle may indicate that decoding approach speed from Doppler shifts may play a minor role. Here the approach speed could be encoded in the acoustic flow from succeeding distance measurements.

Poster 5 – Saturday – 22.10.2022 – 20:00

Presenter: Eugenia González Palomares

Stimulus-specific adaptation in the bat's frontal and auditory cortex

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In humans, scream vocalizations have strong amplitude modulations (AM) at 30 to 150 Hz. These AM correspond to the acoustic correlate of perceptual roughness. In bats (species *Carollia perspicillata*), distress syllables also carry amplitude fluctuations at rates of approximately 1.7 kHz (> 10 times faster than in humans). The distress calls with these modulations are used more prominently by males and might signal a greater urgency, since they elicit larger heart rate increments than their demodulated versions. In order to study the neural processing of these two sounds (the distress calls with fast AM and the demodulated versions), we simultaneously recorded in two brain areas from the bat neocortex, the auditory cortex (AC) and the frontal auditory field (FAF), a frontal area responsive to sounds. We searched for stimulus-specific adaptation (SSA), which is described as the neuronal adaptation to a frequently presented stimulus (standard) yet responding strongly to an infrequent sound (deviant). The amplitude modulated natural calls and their demodulated forms were used as stimuli pairs. Our results show the existence of stimulus-specific adaptation in response to natural distress sounds produced by the bats. In addition, we describe that the dynamics of stimulus specific adaptation differ between frontal and auditory areas within the bat brain.

Poster 6 – Saturday – 22.10.2022 – 19:00

Presenter: Shivani Hariharan

The Bat Cerebellum and Its Roles in Vocalization and Hearing

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Echolocating bats have been used as a relevant example in neuroscience to understand auditory processing and adaptive behaviour mechanisms. Though studies dealing with bat auditory networks are abundant, research outside of the auditory system of these animals is scarce. Here we present our findings from neurophysiological investigations of the bat cerebellum. Previous studies had shown that the cerebellum of a bat is a brain region implicated in sensorimotor integration, orientation, and auditory processing. We tested this idea in our experiments by investigating cerebellar responses to auditory stimuli across the cerebellar hemispheres through single-unit and field potential recordings in anesthetized fruit-eating bats (species *Carollia perspicillata*). In addition, we measured neural activity in awake, head-fixed, vocalizing bats that emitted sounds at their own volition. Since characteristics of the mammalian brain are preserved across species, we believe our study could shed light onto the role of the mammalian cerebellum for vocalization and hearing. Moreover, the results of this study could bring us a step closer to understanding cerebellar function and the neurodegenerative diseases that affect it.

Poster 7 – Saturday – 22.10.2022 – 20:00

Presenter: Luciana Francisca Lopez-Jury

Acoustic Context Modulates Natural Sound Discrimination in Auditory Cortex through Frequency-Specific Adaptation

Luciana López-Jury[1], Francisco García-Rosales[1], Eugenia González-Palomares[1], Manfred Kössl[1] & Julio C. Hechavarria[1]

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Sound discrimination is essential in many species for communicating and foraging. Bats, for example, use sounds for echolocation and communication. In the bat auditory cortex there are neurons that process both sound categories, but how these neurons respond to acoustic transitions, that is, echolocation streams followed by a communication sound, remains unknown. Here, we show that the acoustic context, a leading sound sequence followed by a target sound, changes neuronal discriminability of echolocation versus communication calls in the cortex of awake bats of both sexes. Nonselective neurons that fire equally well to both echolocation and communication calls in the absence of context become category selective when leading context is present. On the contrary, neurons that prefer communication sounds in the absence of context turn into non-selective ones when context is added. The presence of context leads to an overall response suppression, but the strength of this suppression is stimulus specific. Suppression is strongest when context and target sounds belong to the same category, e.g., echolocation followed by echolocation. A neuron model of stimulus-specific adaptation replicated our results *in silico*. The model predicts selectivity to communication and echolocation sounds in the inputs arriving to the auditory cortex, as well as two forms of adaptation, presynaptic frequency-specific adaptation acting in cortical inputs and stimulus-unspecific postsynaptic adaptation. In addition, the model predicted that context effects can last up to 1.5 s after context offset and that synaptic inputs tuned to low-frequency sounds (communication signals) have the shortest decay constant of presynaptic adaptation.

Poster 8 – Saturday – 22.10.2022 – 19:00

Presenter: Johannes Wetekam

How the brain detects important sounds: Deviance detection in auditory brainstem responses of bats

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The capability to detect unexpected acoustic cues in an environment of repetitive sounds is of major importance for animals. The neural correlate of this ability is called deviance detection and describes a change in neural response strength that is solely caused by the stimulus' probability of occurrence. Former studies could demonstrate the presence of deviance detection in both animals and humans across different areas of the brain. However, most of these studies focussed on higher-order stations of the auditory system, like the cortex and thalamus, while less is known about the role lower stations play in the processing of acoustic probability-encoding. With the current study, we aimed to tackle this issue by measuring deviance detection in auditory brainstem responses (ABRs) of the bat species *Carollia perspicillata*, a hearing specialist. Our results demonstrate significantly increased responses to unexpected deviant compared to expected standard stimuli already at the level of the brainstem, an auditory station that was previously not known to exhibit deviance detection. Additionally, our data show that (1) ABRs provide a powerful tool to study low-hierarchy probability-encoding by minimally invasive means, (2) differently filtered responses can be utilised to assess different parts of the auditory pathway and (3) bats are an excellent model organism to study deviance detection, due to their evolutionary specialisation towards the auditory domain.

Poster 9 – Saturday – 22.10.2022 – 20:00
Presenter: Frank Adorf

Automatische Erfassung von Jagdgebieten und Quartiernutzung im Eingriffsbereich mit dem tRackIT-System

Frank Adorf[1], Jannis Gottwald[2] & Regina Straub[2]

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Um die Abhängigkeit von fossilen Energien auf ein Minimum zu reduzieren, wird Deutschland den Ausbau der Windenergie radikal beschleunigen. Dabei entstehen Konflikte mit europäischem und deutschem Artenschutzrecht. Essentielle Jagdgebiete und Quartiere waldbewohnender Fledermausarten dürfen weder gestört noch zerstört werden.
Die gängige Methode der manuellen Radiotelemetrie zur Ermittlung der Raumnutzung besenderter Fledermäuse und der daraus resultierenden Ableitung des Gefährdungspotentials ist extrem zeit-, personal- und kostenaufwändig und mit Abweichungen von bis zu 200 Metern bei 5° Winkelfehler in ihren Ergebnissen sehr ungenau. Die mangelnden personellen Kapazitäten in den ausführenden Gutachterbüros bergen zusätzlich die Gefahr zum Flaschenhals des Windkraftausbaus zu werden.
An der Philipps Universität Marburg wurde das tRackIT-System zur automatischen Erfassung und Echtzeit-Übertragung von Sendersignalen entwickelt. Mindestens 40 besenderte Individuen können gleichzeitig und über die gesamte Senderlaufzeit ohne Personalaufwand aufgezeichnet werden und die empfangenen Daten werden in Echtzeit an einen Server übertragen und visualisiert.
In enger Rückkopplung mit Gutachterbüros (Büro für Faunistik und Landschaftsökologie, Frank Adorf) und verschiedenen Projektierern wurde die Methode für die Erfassung in Eingriffsvorhaben angepasst.
Fledermausquartiere oder essentielle Jagdgebiete werden über Abstandsvorgaben geschützt. Sendersignalstärke und Distanz (bis zu 1.000 m zwischen Sendertier und Empfängerstation) werden bei dieser Methode durch statistische Verfahren in Beziehung gesetzt und so der Abstand von Jagdgebieten und Quartieren zum geplanten Eingriffsort ermittelt. Der Messfehler beträgt im Mittel 30m und ist damit deutlich geringer als bei der manuellen Telemetrie. Daraus ergeben sich verschiedene Vorteile für Projektierer, Gutachter und den Artenschutz:

1.) Deutliche Arbeitserleichterung, wodurch mehr Untersuchungsgebiete pro Saison systematisch und reproduzierbar untersucht werden können.
2.) Hohe Transparenz und Reduktion von Qualitätsschwankungen durch Standardisierung; umfangreicher und belastbarer Datensatz; Erhöhte Rechtssicherheit von Fachgutachten.
3.) Differenzierte, detailreiche und damit eine präzise eingriffsbezogene natur- und artenschutzrechtliche Risikobewertungen.
4.) Massive Reduktion des Personalaufwandes und der Kosten: 500 Personenstunden pro Fledermauskolonie gegenüber wenigen Stunden Installation und Wartung der Stationen.
5.) Frühzeitige Erkennung von Planungshindernissen; zeitnahe Anpassung der Strukturplanung durch zeitnahe Standortoptimierung aufgrund artenschutzrechtlicher Belange; Beschleunigung der Projektplanung.
6.) Deutliche Reduktion der Zeitspanne zwischen Datenerhebung und Berichterstellung.

In >15 Windkraftprojekten über die letzten 3 Jahre in Rheinland-Pfalz und Hessen ersetzt sie die manuelle Raumnutzungs-Telemetrie vollständig. In weiteren Windparks wurden parallel manuelle Untersuchungen für die Mopsfledermaus durchgeführt. Der Vergleich der Ergebnisse sowohl für die Erfassung von Quartieren als auch für die Raumnutzung wird in diesem Vortrag präsentiert.

Poster 10 – Saturday – 22.10.2022 – 19:00

Presenter: Melina Dietzer

Bats and Forest Structure

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Conservation forestry is an instrument for maintaining and restoring structural diversity in managed forest and is also used in the Black Forest. In this process, small areas are not used for timber production but are left in the forest to increase structural diversity. One species that is sensitive to changes in structural diversity is bats. To assess the large-scale effects of retention forestry, the ConFoBi project (Conservation of Forest Biodiversity in Multiple-Use Landscapes of Central Europe), compares the effects on biodiversity in areas with more and less retention.
To further evaluate the success of retention forestry, this project compares small retention areas with large, protected areas in the Black Forest. At what point do the desired structures develop a) in an active process of structure acquisition and b) during a "passive" restoration process (protected area). Although clear-cutting is rarely practiced, natural disturbance areas due to fire or storm damage, as well as clear-cutting to minimize the spread of bark beetles, still occur. It remains unclear what effects such disturbed areas have on biodiversity of bats and how these areas should be managed, i.e., whether dead wood needs to remain on the area or whether it should be cleared. Since some species depend on open, light structures, the question arises as to which species benefit from disturbed areas, at what point they do so, and what influence the management of the disturbed area has on this.

Poster 11 – Saturday – 22.10.2022 – 20:00

Presenter: Sophie Ewert

Structurally rich dry grasslands – potential stepping stones for bats in open farmland

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Agricultural intensification in the 20th century has led to major alterations in ecosystems and species communities worldwide through land use changes as well as fragmentation and loss of natural habitats. European semi-natural dry grasslands have drastically decreased, leaving their remnants fragmented within agriculturally dominated areas. They are known for their very high biodiversity value for plant species and selected insect taxa, with positive effects locally and on landscape level. However, their relevance for highly mobile species, such as bats, is unknown, even though European bat populations are affected by habitat and connectivity loss and many bat species face challenges when moving through open landscapes. Especially in intensive agricultural landscapes, natural areas are important to facilitate species occurrence and movement. Therefore, we aimed to identify the relevance of dry grassland patches for bats. We anticipated that the importance of dry grassland fragments for bats, given their varying sensory requirements, would depend on local structural richness as well as features of the surrounding landscapes. Specifically, we expected a combination of local and landscape features as well as their interactions to affect habitat use by different bat guilds, formed of bat species/sonotypes with similar habitat requirements. We also predicted that the relative dominances of bat guilds would change with local and landscape features. Therefore, we sampled 12 dry grassland sites in Brandenburg (Germany) repeatedly with acoustic monitoring and identified bat guild activity and foraging. We assessed vegetation structural richness in the field and landscape features with digital land use data. We found a frequent use of dry grassland patches by a relatively high number of bat species/ sonotypes. Edge space bats were more active on dry grasslands when structural richness increased. Additionally, they were more active with less forest in the surrounding and foraged more when further away from woody features and when closer to waterbodies. Narrow space bat activity decreased away from woody features. Bats from all guilds used dry grasslands more with higher structural richness, when the surrounding landscape contained more open farmland. This was similarly the case for edge space guild foraging when the landscape was more homogeneous. Lastly, higher structural richness increased the dominance of edge space foragers. We discuss that dry grasslands fragments are relevant especially for edge space bats when other main habitats and foraging sources are scarce/distant, while narrow space bats face challenges with connectivity. We also argue that specifically structurally rich dry grasslands in an open and homogeneous agricultural environment offer important resources for commuting and foraging. For the first time, we show the relevance of dry grassland patches and their potential as stepping stones for bats in open and homogeneous farmland. We therefore underline the high value of dry grasslands for biodiversity and add evidence for decision based conservation management.

Poster 12 – Saturday – 22.10.2022 – 19:00
Presenter: Marcus Fritze

BATLAS - A database with integrated automatic analysis of count data for estimating population trends

Marcus Fritze, Stefan Mayr, Jens Berg, Peter Busse, Jörg Harder, Uwe Hoffmeister, Jörn Horn, Martin Koch, Gerhard Maetz, Sarah Malaske, Frank Meisel, Angelika Meschede, Ruth Petermann, Wolfgang Rackow, Marco Roßner, Klaus Thiele, Siegfried Wielert, Gerald Kerth, Alexander Scheuerlein

Population trends are crucial to assess the conservation status of a species. Hereby, animal count data over time are a valuable data source to calculate such trends. Nevertheless, gathering such data, storing and analysing can be challenging since data availability is often limited and count methods as well as data formats are not standardized. To overcome at least some of these drawbacks the statistical method TRIM was developed 30 years ago by Statistics Netherlands. These models can both deal with missing values, as well as serial correlation, and the frequently encountered overdispersion of data. We developed an on-purpose database for collection and storing bat count data in a standardized way which consists of a built-in tool (using the 'rtrim' package in R) for the automatic calculation of population trends. On the frontend, we created a web platform where appropriate filters can be set, while bat species-specific population trends, species distribution layers and data sources are displayed on a dashboard. So far, we collected bat count data from large areas across Germany, providing trend estimates for many bat species. This platform is the first of its kind and provides important, freely available information on species distribution, data contributions and population trend indices. We are confident that this approach will help to improve the assessment of bat species conservation status in the Red Lists and to provide decision-makers with data-based information on population developments.

Poster 13 – Saturday – 22.10.2022 – 20:00

Presenter: Pratigya Gyawali 

Importance of water bodies for bat conservation in a human-transformed landscape

Pratigya Gyawali*, Alexander Scheuerlein, Erik Sperfeld & Marcus Fritze

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Water bodies in urban areas play an important role in counteracting negative consequences of urbanization by providing essential habitats to aquatic species as well as foraging and drinking resources to other urban wildlife. Bats are the most diverse mammalian order in urban areas. Although water availability is known to affect bat species richness and their activity on the landscape-scale level, little is known about the microhabitat characteristics that actually determine the local-scale distribution/activity of bats in urban environments. We hypothesized that the characteristics of water bodies, as well as the surrounding landscape, determine the suitability of these water bodies for bats. Here, we acoustically monitored bat activity and bat species richness at 11 water bodies of Greifswald, a mid-size town in Mecklenburg Western-Pomerania, NE Germany. We measured water quality parameters, estimated the abundance of aquatic emerging insects, and included habitat parameters such as impervious surface and light pollution in our analysis. We found that bat activity was significantly positively correlated with nitrate concentration in the water body, with nitrate also being a positive predictor for aquatic insect abundance. Bat activity and bat species richness was influenced by the availability of linear landscape elements such as trees/bushes at the shore. Most of the species also responded positively to linear landscape elements. Activity of *Myotis* spp decreased at water bodies closer to the city centre, while it increased for *P. nathusii* and species of the NEV (*Nyctalus, Eptesicus, Vespertilio*) group. Tolerance towards artificial light at night was a major determinant of whether bats were present in the inner city. Especially *Pipistrellus* spp showed a high tolerance towards artificial light at water bodies. Also, bats tended to avoid water surface covered with floating vegetation. Our results highlight key parameters that make water bodies in urban landscapes suitable for bats and provide guidelines on how appropriate management measures may increase the suitability of urban water bodies even further. Our findings are of high relevance for urban planners and conservationists, especially in the light of worldwide increasing urbanization.

Poster 14 – Saturday – 22.10.2022 – 19:00
Presenter: Simone Huth

Einfluss von Landnutzungsveränderungen und einer Autobahn auf die Jagdhabitatnutzung von zwei Wochenstubenkolonien der Bechsteinfledermaus (*Myotis bechsteinii*) in Ostwestfalen (2011-2020)

Simone Huth[1], Jörg Bettendorf[1], Michael Veith[2] & Jochen Lüttmann[1]

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Im Rahmen einer Abschlussarbeit haben wir den Einfluss eines Autobahnbaues und –betriebs (BAB) und die Wechselwirkungen sich verändernder Landnutzung auf zwei Kolonien der Bechsteinfledermaus untersucht. Die Aktionsräume beider Kolonien werden durch eine Autobahn geschnitten. Wir verglichen die Ursprungssituation vor dem Bau (Before), die Situation während des Baus (During) und die aktuelle Situation nach Verkehrsfreigabe (After), um die Auswirkungen der Landnutzung einerseits und der direkten Auswirkungen der BAB auf die Raumnutzung der Wochenstubenkolonien andererseits im zeitlichen Verlauf zu dokumentieren. Basierend auf Telemetriedaten von 35 Sendertieren über den Zeitraum 2011-2020 wurde das Meideverhalten gegenüber der Autobahn quantifiziert und die Größe von Kernjagdgebieten und Aktionsräumen verglichen. Mit Hilfe historischer Luftbilder wurde die Landnutzung im Telemetriezeitraum nachvollzogen und deren Einfluss auf die räumliche Verteilung und das Jagdverhalten der Koloniemitglieder mittels generalisierter linearer gemischter Modelle (GLMM´s) ermittelt. Unsere Ergebnisse zeigen, dass es keine Anhaltspunkte dafür gibt, dass die Autobahn das Jagdverhalten der Kolonien über die Bauphase hinaus langfristig beeinflusst. Eine entscheidende Rolle spielt dabei vermutlich die Umsetzung nachgewiesenermaßen funktionaler Querungshilfen. Die räumliche Verteilung und das Jagdverhalten der Koloniemitglieder wird stattdessen durch die Nahrungsverfügbarkeit über Flächen verschiedener Landnutzungskategorien und individuelle Präferenzen maßgeblich beeinflusst.

Poster 15 – Saturday – 22.10.2022 – 20:00
Presenter: Kseniia Kravchenko

Ecological application of acoustic bat monitoring at wind turbines

Ökologische Anwendung des akustischen Fledermaus Monitorings an Windenergieanlagen

Frank Adorf[1], Thomas Grunwald[1], Kathrin Jäckel[1], Carsten Braun[1], Liam Bailey[2] & Kseniia Kravchenko[1,3]

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Acoustic bat monitoring at wind turbines is the widespread practice of environmental risk assessment. It is applied to estimate bat collision risks and adjust the curtailment algorithm for wind turbines. Yet, acoustic bat monitoring can be a decent source of information on bat phenology. We analysed the long-term dataset collected at 190 wind turbines located in Southern-West Germany. All acoustic recordings were collected and analysed in a standardised way.
Based on these data we investigated multiyear patterns of seasonal activity of *Pipistrellus pipistrellus* and *Pipistrellus nathusii*. The peak of acoustic activity of *Pipistrellus pipistrellus* was in July, while *Pipitrellus nathusii* was most abundant in September. We associated these peaks with seasonal events such as breeding and migration. Further, we investigated the impact of environmental variables on the timing of seasonal events. For that, we used an open-source e-obs gridded dataset of temperature, precipitation, and wind speed. We used climate window analysis (R package 'climwin') to identify which climates (time- and spatially-wise) have an impact on bat phenology.
Rapid climate change significantly influences the phenology of many species. The ability to recognise and respond to environmental cues is essential for species survival as it implies fitness consequences. However, for many bat species, we have limited knowledge regarding species-specific responses to annual weather fluctuations. Our study couples environmental conditions with the timing of the seasonal event and open perspective for phenological mismatch studies in bats. Also, our study shed light on potential cues which might be used by bats to adjust the timing of seasonal events.
From the practical point of view, we demonstrate how standardised acoustic monitoring data can be used in climate change research. Although acoustic bat monitoring has limitations, the standardised way of data collection at a constantly increasing number of wind facilities provides a growing body of data. Periodical analysis of these long-term monitoring datasets is suitable for comparison and prognosis in ecological studies.

Poster 16 – Saturday – 22.10.2022 – 19:00
Presenter: Frauke Krüger

Roost variety in a population of *Myotis daubentonii* in a mid-mountain region in North Rhine-Westphalia, Germany

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Daubenton's bat (*Myotis daubentonii*) are typically referred to as tree-inhabiting species. While during the lactating season the species is mostly found in trees, indeed, they show a wide variety of other roost types with differing, often not clearly understood, functions.
In the vicinity of the dams Lister and Bigge in North Rhine-Westphalia different roosts inhabited by Daubenton's bats probably belonging to the same local population are studied and described.
Whereas a colony of Daubenton's bats used tree cavities throughout the peak of maternity over a distance of 4 km, last year young were found to use structures in a highway bridge. These structures were also used by adult females and this year young later in the season, after maternity colonies disperse. Other anthropogenic structures, like river superstructures, were also known to be inhabited by Daubenton's bats during the summer season in the region in the past. As this time of use also coincides with autumn swarming season at winter roosts, one could hypothesize that the roost functions as
Manmade semi-natural structures are also found to play an important role for Daubenton's bats during hibernation. Our study shows that an old quarry in the same region is used as hibernation site by Daubenton's bats among other bat species. Different types of historical open pits are widely distributed over North Rhin-Westphalia and haven recently been identified as important hibernation roosts. Although natural forests still play the most important role as maternity roost habitats of Daubenton's bats, one must consider other, especially anthropogenic roost types as ecologically significant reproduction and resting sites for this species.

Poster 17 – Saturday – 22.10.2022 – 20:00
Presenter: Daniel Lewanzik

Decreasing Light Pollution is Key in order to Increase the Value of Urban Areas for Bat Conservation

Daniel Lewanzik[1], Tanja M. Straka[1], Julia Lorenz[1], Lara Marggraf[1], Silke Voigt-Heucke[1], Anke Schumann[1], Miriam Brandt[1] & Christian C. Voigt[1]

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Global change, including urbanization, threatens many of the >1,400 bat species. Nevertheless, certain areas within highly urbanized cities may be suitable to harbor bat populations. Thus, managing urban habitats could contribute to bat conservation. Here, we established evidence-based recommendations on how to improve urban spaces for the protection of bats. In a team effort with >200 citizen scientists, we recorded bat vocalizations up to six times over the course of two years at each of 600 predefined sites in the Berlin metropolitan area. For each species we identified the preferred and non-preferred landscape features. Our results show that artificial light at night (ALAN) had a negative impact on all species; even on species previously considered 'light tolerant'. For some species, ALAN had the largest effect sizes among all environmental predictors. Canopy cover and open water were especially important for bat species that forage along vegetation edges and for trawling bats, respectively. Occurrence probability of species foraging in open space decreased with increasing distance to water bodies. Our study shows that despite the many negative impacts of urbanization on wildlife, urban environments can harbor bat populations if certain conditions are met, such as low levels of ALAN and access to vegetation and water bodies. Our findings allow inferences on how to manage urban spaces in a bat-friendly way. We recommend limiting ALAN to the minimum necessary and maintaining and creating uninterrupted vegetated corridors between areas with high levels of canopy cover and water bodies, in which ALAN should be entirely avoided.

Poster 18 – Saturday – 22.10.2022 – 19:00
Presenter: Thomas Lilley

Large-scale long-term passive-acoustic monitoring reveals spatio-temporal activity patterns of boreal bats

Miika Kotila[1], Kati Suominen[2], Aleksi Lehikoinen[2], Anna Blomberg[2], Ville Vasko[2], Eero J. Vesterinen[1] & Thomas M. Lilley[2]

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The distribution ranges and spatio-temporal patterns in the occurrence of boreal bats are yet largely unknown due to their cryptic lifestyle and lack of suitable and efficient study methods. We approached the issue by establishing a permanent passive-acoustic sampling setup spanning the eastern part of the Fennoscandian peninsula to gain an understanding on how latitude affects bat species composition and activity patterns in the boreal zone. The recorded bat calls were semi-automatically identified to *Myotis* spp., *Eptesicus nilssonii* or *Pipistrellus nathusii* and the seasonal activity patterns were modeled for each taxa across the seven sampling years (2015–2021). We found an increase in activity across years of all studied taxa suggesting a positive population trend since 2015. For *E. nilssonii* and *Myotis spp.* we found significant latitude -dependent seasonal activity patterns, where seasonal variation in patterns appeared stronger in the north. We found the passive-acoustic monitoring network to be an effective and cost-efficient method for gathering bat activity data to analyze spatio-temporal patterns. Long-term data on the composition and dynamics of bat communities facilitates better estimates of abundances and population trend directions for conservation purposes and predicting the effects of climate change.

Poster 19 – Saturday – 22.10.2022 – 20:00

Presenter: Robin Weeber

The use of Ulm`s citadel (Wilhelmsburg) as a hibernaculum for bats

Robin Weeber[1], Marco Tschapka[1,2] & Patrick Cvecko[1]

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Over the last years we discovered Ulm's citadel (Wilhelmsburg) to be an important regional hibernaculum that is used by more than 1000 pipistrelle bats. Besides mapping the hibernating bats and the distribution of their feces, we surveyed each of the 508 rooms and categorized them in terms of accessibility, structure and position.
Besides the physical parameters relevant for roosting, human disturbance might have been the main factor for the encountered distribution of bats inside the citadel.
Currently, we are working on identifying the flight routes used by bats to get to the citadel during the swarming period in late summer.

Poster 20 – Saturday – 22.10.2022 – 19:00
Presenter: Laura Stidsholt

The echoic world of wild bats

Laura Stidsholt[1], Stefan Greif[2], Holger Goerlitz[2], Kristian Beedholm, Jamie Macaulay[3], Mark Johnson[1] & Peter Teglberg Madsen

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Hunting bats must find, pursue and catch often fast-moving prey amongst myriad distracting sensory cues. Solving this sensory-motor challenge requires rapid changes in sensory attention and in motor outputs in response to both prey and environment. Laboratory experiments have revealed that echolocating bats can adjust both their echolocation signals and their flight trajectories to reduce acoustic background clutter when hunting or solving tasks. Much less is known about the way these adjustments are used in wild foraging where echoes return from multiple objects in different directions, creating complex acoustic scenes that require rapid auditory identification, grouping and tracking of individual echo streams to inform prey interception. Here, we use on-board echo and motion recording tags to quantify how bats adjust their sensory sampling and motor strategies when hunting aerial prey in clutter and in open space in the wild. When searching, bats maximize the chances of detecting small prey by using large sensory volumes. During prey pursuit, they trade spatial for temporal information by reducing sensory volumes while increasing update rate and redundancy of their sensory scenes. These adjustments lead to very weak prey echoes that bats protect from interference by segregating prey sensory streams from the background using a combination of fast-acting sensory and motor strategies. Counterintuitively, such weak echoes allow bats to be efficient hunters close to background clutter broadening the niches available to hunt for insects.

Poster 21 – Saturday – 22.10.2022 – 20:00
Presenter: Beatrix Wuntke

Ergebnisse aus 10 Jahren Fledermausprojekt des NABU-Regionalgruppe Brandenburg-Havel

Results from 10 years of the bat project of the NABU regional group Brandenburg-Havel

Beatrix B. Wuntke

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Im Regionalverband Brandenburg-Havel im Naturschutzbund (NABU) läuft seit 10 Jahren ein Fledermausprojekt. Dabei werden 2 Fledermaushorchboxen der Firma Batomania, die automatisch Fledermausrufe aufzeichnen, an Interessierte aus der Region verliehen. Die Boxen zeichnen jeweils 3 Nächte am Auslegungsort Daten auf, werden dann bei der Koordinatorin des Projekts (B. Wuntke) wieder abgegeben und möglichst zeitnah ausgewertet. Für die, die sich eine Box ausleihen, bringt das Projekt Informationen zu den in ihrer Umgebung vorkommenden Fledermausarten. Für den NABU-Regionalverband bringt es Daten aus der Region, die sonst nicht erhoben worden wären.
So wurden mehrere Wochenstuben von Mücken- und Zwergfledermaus entdeckt. Auch die in der Region seltene Mopsfledermaus konnte mehrfach nachgewiesen werden.
Da das Projekt auf der Homepage des NABU-Regionalverbandes beworben wird und auch bei den jährlichen Fledermausnächten in der Region im August/September stets mit vorgestellt wird, werden auch Leute erreicht, die bisher nicht im Naturschutz aktiv sind. Das bietet die Chance, eine breitere Öffentlichkeit für Fledermäuse, Fledermausforschung und Fledermausschutz zu begeistern.

Poster 22 – Saturday – 22.10.2022 – 19:00
Presenter: Annette Denzinger

Vertical stratification of edge and open space bats in a neotropical bat assemblage

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Tropical rain forests show a high spatial heterogeneity across vertical strata which is a main factor contributing to species richness in the tropics. The large differences in the physical and biological conditions along the vertical axis open up a multitude of ecological niches which are exploited by bats. To study how bats, foraging in the edge and open space, use the vertical strata we recorded their echolocation calls with a microphone chain array along the canopy tower on Barro Colorado Island. Microphones were 6 m apart, which allowed an estimation of flight height in increments of 3 m. Species were manually identified based on their species-specific echolocation calls. To assess the link between gap size and species abundance we estimated gap sizes at all microphone heights. We show that the local assemblage of edge and open space foragers were not homogeneously distributed but show a distinct vertical stratification with a high species richness in the subcanopy and above the canopy. While *Eumops* species were recorded exclusive above the canopy, many edge space foragers searched for prey in the subcanopy and above the canopy but avoided the small gaps in the crown regions of the subcanopy and below. *Myotis nigricans* and *Centronycteris centralis* were almost exclusively registered below 18 m in small gaps. Preferred foraging height was negatively correlated with species specific frequency and the time of peak activity was about 30 min earlier at heights below 30 m. Overall, our study supports previous findings on vertical stratification in bats in tropical forests but emphasizes the importance of gap size for the distribution of aerial insectivores. In bats flight morphology and echolocations systems are adapted to where bats forage for prey. The closer to background bats forage for prey, the higher is the call frequency. This is mirrored in the negative correlation of foraging height and call frequency, as gap size also decreased with foraging height.

Poster 23 – Saturday – 22.10.2022 – 20:00

Presenter: Supawan Srilopan

Vertical stratification of insectivorous bats in 100 meter altitude in agricultural areas of central Thailand

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Insectivorous bats have been suggested to be one of the most effective natural suppressors of pest insects in agricultural landscapes. However, most bat monitors have been restricted to activity occurring close to the ground. Here, this study investigated foraging behaviors of insectivorous bats in response to altitudes and habitats in central Thailand. Bat echolocation at approximately 2 m, 25 m, 50 m,75 m, and 100 m above ground level were recorded by using AudioMoth bat detectors, which were attached on a helium-filled balloon-kite, in three land-use types (i.e., forests, agricultural areas, and water bodies). The results show that 13 species of bats in seven genera and five families were found. The foraging activity of bats was dominated by open space and edge space bat species, respectively. Moreover, bat activity was significantly different among altitude levels and habitats. The total number of bat passes in agricultural areas and water bodies were higher than in forests while, the activity of bats was highest at 2 m above the ground. These findings suggest that insectivorous bats predominantly forage in different vertical strata and habitats because foraging behavior is closely linked to wing morphology and echolocation call structure. Our results indicate that many insectivorous bats forage at high altitudes in agricultural areas. However, these open space bats (high-altitude flying) are likely to become more threatened in the near future by wind turbines in agricultural areas. Therefore, understanding the habitat of high-altitude foraging bats is an urgent need for bat conservation.

Poster 24 – Saturday – 22.10.2022 – 19:00

Presenter: Marit Kelling

Seasonal and individual variation in diet and habitat use of common noctule bats (*Nyctalus noctula*) foraging above farmland

Marit Kelling[1,2], Aileen Grünwald[1,3], Carolin Scholz[1,2], Jan Pufelski[2], Manuel Roeleke[2,] Torsten Blohm, Ran Nathan[4], Sivan Toledo[5] & Christian C. Voigt[1,2]

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Intensive agriculture is considered one of the main drivers of insect decline. Predators of insects such as bats presumably have a particularly hard time finding sufficient food over agricultural land. Our current project follows up on a previous study, which showed that common noctule bats (*Nytalus noctula*), a typical open-space foraging bat from Europe, rely on mobile sensory networks when hunting over insect-depleted agricultural land. We used the Atlas tracking system, a reversed GPS approach that yield spatial positions at very high temporal and spatial resolution, to investigate the movement behaviour of common noctules when foraging above farmland. Additionally, we used metabarcoding based on faecal pellets collected from our study bats to investigate their feeding behaviour. We were specifically interested in the following questions: Where do common noctule bats hunt preferentially and which insects do they consume? To answer these questions, we conducted comparative studies during two seasons (spring and summer) in two different years (2020 and 2022) on several dozens of common noctule bats from two colony groups. The poster presents preliminary results on the movement behaviour and feeding habits of these bats.

Poster 25 – Saturday – 22.10.2022 – 20:00

Presenter: Michelle Korn

Habitat use and spatial movements of Leisler's bats (*Nyctalus leisleri*)

Einblicke in die Habitatnutzung und das Raumverhalten von Kleinabendseglern (*Nyctalus leisleri*)

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Wind energy is booming in Europe, and in Germany particularly. Open-space and edge-space foraging bats are particularly vulnerable at wind turbines. Thousands of bats collide with wind turbines each year. Currently our understanding of how bats interact with wind turbines is restricted by large to small-scale surveys at the nacelle using acoustic detectors or thermal videogrammetry. Here, we studied the movement behaviour of Leisler's bats (*Nyctalus leisleri*) on the landscape scale. Leisler's bats are a species with a relatively high risk of collision at wind turbines. It is a forest specialist which hunts predominantly in the open space for insects. The habitat use of this species is still very sparsely studied and mostly known from conventional radio telemetry which is difficult considering the high mobility of this species. As a consequence, no one has looked at how Leisler's bats move over larger spatial scales and how they interact with wind turbines. Between July and August 2021 and 2022 we conducted a GPS tracking study on Leisler's bats. Here, we report some preliminary results. We conducted our study in a forest nature reserve in southern Brandenburg surrounded by small villages and agricultural fields. Three wind parks with a total of 130 wind turbines operated adjacent to the forest. We tagged each bat with a 1-g Pathtrack GPS logger. In total, we retrieved 34 out of 43 GPS loggers, resulting in ~5.000 GPS-positions of 34 individuals. Each individual dataset covers one complete night with a 2-min time intervals between subsequent spatial positions. First results show that tagged bats of different colonies separate in their hunting areas despite short distances between colonies. Individuals from the same colonies often left the roost at about the same time, ranging between 19 and 51 minutes after sunset. Individuals of the same colony usually flew in the same direction for the first hundred meters, before splitting up for foraging. Five out of seven tagged individuals, all belonging to the same colony, flew through one of the wind parks at 1 km distance while two passed by in short distance. Our preliminary analysis shows that some Leisler's bats use the airspace in a way that could expose them to collision risk at wind turbines, which is supported by the fact that this species is regularly found below wind turbines during carcass searches. Based on the obtained movement data, we plan to study the habitat preference of this species to inform stakeholders about how to best protect Leisler's bats.

Poster 26 – Saturday – 22.10.2022 – 19:00
Presenter: Manuel Roeleke

Common noctule bats form mobile sensory networks to optimize prey localization

Manuel Roeleke[1,5*], Ulrike E. Schlägel[1], Cara Gallagher[1], Jan Pufelski[1], Torsten Blohm[2], Ran Nathan[3], Sivan Toledo[4], Florian Jeltsch[1,6+] & Christian C. Voigt[5+]

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Insectivorous aerial-hawking bats are known to use public information to locate resource patches. The use of public information can lead to the aggregation of foragers at prey patches, a mechanism known as local enhancement. However, when ephemeral resources are distributed over large areas, foragers may also need to increase search efficiency, and thus apply social strategies when sampling the landscape. Here we radio-tracked a total of 81 aerial-hawking common noctule bats at very high spatio-temporal resolution during five sessions in three years, recording up to 19 individuals simultaneously. Analyses of interactive flight behavior provide the first conclusive evidence that bats form temporary mobile sensory networks by adjusting their movements to neighboring conspecifics while probing the airspace for prey. Complementary agent-based simulations confirmed that the observed movement patterns can lead to the formation of mobile sensory networks, and that bats located prey faster when networking than when relying only on local enhancement or searching solitarily. However, the benefit of networking diminished with decreasing group size. Our results on the one hand highlight the ability of aerial-hawking bats to thrive also in landscapes where prey is difficult to find for single individuals. On the other hand, our study indicates that declining local populations of social foragers may suffer from Allee effects that increase the risk of collapses under global change scenarios like insect decline and habitat degradation.

Poster 27 – Saturday – 22.10.2022 – 20:00
Presenter: Simon Ripperger

How to get around? Cross-generational information transfer in maternity colonies of greater mouse-eared bats.

Simon P. Ripperger[1], Lutz Ittermann[2], Jörg Harder[3], Frieder Mayer[1] & Ahana A. Fernandez[1]

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Every fall, temperate bats aggregate in great numbers near natural caves or man-made underground structures. At these locations, they swarm and mate before they later on go into hibernation. Such sites, which are crucial for reproductive success and for survival during winter, are often located at distances of tens of kilometers or more from maternity colonies where the very same bats are born or give birth to their own young in following years. So far, it remains unclear, if and how information on the whereabouts of important locations like swarming sites (i.e. potential mating sites) and hibernacula is shared among colony members and passed on to the next generation. In this ongoing project, we combine long-term monitoring data from three maternity colonies of banded mouse-eared bats with high-resolution social network data from proximity sensors to evaluate the role of maternity colonies in passing on information that guides bats on their seasonal movements. We expect that young and naïve individuals follow adult females while commuting to important locations. Proximity sensors allow tracking contacts among young and adult colony members both inside the day roost and outside during foraging and commuting, thus revealing potential flow of information among individual bats. Audio- und video observations will help to describe social interactions among departing individuals in maternity roosts. In case social information is shared at maternity colonies, then social networks from banding data from hibernating bats should show similarities to social networks collected form tagged bats inside maternity colonies.

Poster 28 – Saturday – 22.10.2022 – 19:00

Presenter: Alona Shulenko

Testing the long-term memory in Common Noctule Bat (*Nyctalus noctula*)

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Learning and memory in bats are poorly studied subjects, however, the natural history of these volant mammals may predict considerable cognitive abilities. We examined the ability to remember how to eat in captivity by individually marked eight *Nyctalus noctula*. Our study was conducted on the basis of facilities of the Ukrainian Bat Rehabilitation Center during winter rehabilitation work 2021-2022. For the reason of this study, 29 individuals of *N. noctula* were selected from all the number of bats kept on winter rehabilitation. Among these 29 bats, 8 (4 adult females and 4 adult males) were recaptured individuals after the previous winter rehabilitation circle (winter 2020-2021), which were released to nature in April 2021. The other 21 *N. noctula* (adult females - 10, this-year-born females - 4; adult males - 2, this-year-born males - 5) were randomly selected from all the number of *N. noctula* from winter rehabilitation (2021-2022). *Nyctalus noctula* from both groups were fed in the same conditions with measurement of time. The experimental feeding included 5 stages, all bats were weighted, and warmed up until euthermy. First, (stage Zero ("0") a bat was watered *ad libitum*. Further, a decapitated larva of super mealworm *(Zophobas morio)* was brought to the lips of a bat, immediately after a stopwatch was turned on, stage One ("1"). The size of larvas used in the experiment was similar in body mass (0.7 g) and length (4 cm). The Second ("2") stage was the moment when a bat started to eat by themself, the first bit. Thereby, the Third ("3") stage was being consisted the period of time when a bat continue eating a larva by themself. The last stage ("4") was the moment of complete eating of a larva, and at that moment the stopwatch was turned off. The time from beginning of stage 1 till the end of stage 4 (time of fully eating of a larva) was estimated in seconds, and was considered as time of learning of self-eating in captivity (here and after: time of learning). We found a statistically significant difference in speed of eating (seconds) of the first larva between *N. noctula* that had already eaten in captivity (average 70 s) and individuals without such experience (average 189 s). There was no statistically significant difference in speed of first eating between adult and this-year-born bats, however, young *N. noctula* started eating faster (146 s) towards adults (221 s). Our study suggests that *N. noctula*, that had experienced how to eat in captivity during winter rehabilitation (unnatural environment), can remember this for a year at a minimum. To the best of our knowledge, this is the first study presenting long-term memory in *N. noctula*.

Poster 29 – Saturday – 22.10.2022 – 20:00
Presenter: Florian Gloza-Rausch

Bats and Concerts - How light immissions can influence the migration of bats to their hibernation site

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Bats use buildings, bridges, tunnels, water pipes, etc. as roosts and have adapted to some degree to the environmental conditions and human impacts there. In some cases, however, bats do not have a choice, such as when human activities encroach further and further into large bat roosts that have been used for many centuries. Bat roosts can be negatively impacted by tourism, economic, or military activities. In addition to noise and air pollution, light immission has a major impact on the behavior of bats in and around their roosts. Using the example of a large bat hibernation site in northern Germany - the Segeberger Kalkberghöhle - the influence of light immissions from concerts and shows on the migratory behavior of bats of the genus Myotis in early and late summer 2022 was investigated. It could be shown that during the events especially the darkest areas around the cave entrances are used by the animals.

Poster 30 – Saturday – 22.10.2022 – 19:00

Presenter: Marie Gurke

Genomic investigation of introgressive hybridization in two cryptic bat species

Marie Gurke[1 2], Mozes P.K. Blom[1], Emrah Çoraman[3] & Frieder Mayer[1]

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Understanding the evolutionary consequences of introgressive hybridization is a major objective in Evolutionary Biology. The two bat species *Myotis davidii* and *Myotis mystacinus* are morphologically very similar but represent two highly divergent genetic lineages. Both species have wide distribution zones, both spanning major parts of Europe and Asia including a large potential hybrid zone in Eastern Europe and the Caucasus. Earlier studies found signs of mitochondrial introgression between the two species and observed a recent range expansion of *M. davidii* towards the West. In this study, we are analyzing whole genome data of currently 27 individuals. Population genomic methods are used to investigate introgression and adaptation. We found strong signs of introgression in *M. davidii*, likely going back to hybridization between *M. mystacinus* populations of the hybrid zone and the ancestor of expanding *M. davidii* populations. These findings raise questions about the adaptive nature of the introgression event.

Poster 31 – Saturday – 22.10.2022 – 20:00

Presenter: Moritz Krämer

Population genetic structure of barbastelle bats (*Barbastella barbastellus*) in Germany

Moritz H. Krämer[1], Gerald Kerth[1] & Jaap van Schaik[1]

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The barbastelle bat (*Barbastella barbastellus*) is a forest-dwelling species whose distribution and population dynamics in Germany are poorly characterized. In recent years, records of the barbastelle bat have increased throughout Germany, including in regions where it had previously not been seen in decades. A consortium project (https://www.mopsfledermaus.de/), "Schutz und Förderung der Mopsfledermaus in Deutschland", aims to shed light on the situation of the barbastelle bat in Germany. Within this project, our objective is to use population genetic techniques to investigate the genetic structure, diversity and connectivity of barbastelle bat populations throughout Germany. We have developed a panel of 17 microsatellite loci, the first for this species. Here we present a preliminary analysis of population genetic structure based on approximately 600 samples from nine federal states in Germany as well as samples from Austria.

Poster 32 – Saturday – 22.10.2022 – 19:00
Presenter: Nicolas Fasel

Serotine's secrets - No sexual penetration involved in the mating of *Eptesicus serotinus*, a new copulatory pattern in mammals.

Nicolas J. Fasel[1], Jan Jeucken[2], Kseniia Kravchenko[1,3,4], Marcus Fritze[5,6], Ireneusz Ruczyński[7], Ewa Komar[7], Alona Shulenko[8], Marharyta Moiseienko[9], Anton Vlaschenko[3,4,8] & Susanne Holtze[10]

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For most bat species, knowledge about mating remains anecdotal. An extremely large penile erection with a heart-shape terminal swelling has been observed in *E. serotinus*. The engorgement of the erectile tissues could take place after penetration and generate a copulatory lock. Alternatively, the long mobile and hard penis could be used to pass by the protective uropatagium in order to reach the vulva. However, under such conditions, the penis cannot penetrate the vagina.
With this study, we primarily investigated the copulatory behaviour and mating phenology of *E. serotinus*. We recorded dates, time and duration and described the involved behaviours of all observed mating events. The observations were collected in a parturition colony (St Matthias Church, Castenray, Netherlands) via video monitoring. Furthermore, we analysed mating events of *E. serotinus* in the Ukrainian Bat Rehabilitation Center (Kharkiv, Ukraine). We further investigated the morphology of female and male genitalia. The length of the erected penis was measured in 10 wild individuals captured in Poland and Germany. The general anatomy of the female genital tract was described using fresh bat carcasses.
We detected the peak of mating events in October. Fewer mating events were also observed in spring. This result reveals that males and females can store sperm in the epididymides and in the genital tract respectively. Our study also indicates that males visit female roost. It remains however unknown whether males also attract sexual partners in other locations.
During the mating, the male grasps the female in a dorsoventral position. The male probes the female ventral part with its erected penis until the penis is strongly pushed against the vulva. No sexual penetration was observed. After, the pair remains immobile up to 12.7 hours. The female vagina is short, about 4 mm and the erected penis is about four times larger than the vagina. Our results support that, the erected penis of *E. serotinus* serves to pass by the tail membrane of the female and is used to reach the vulva without penetrating the vagina. So far, this copulatory pattern has remained unknown in mammals.
The knowledge about animal mating and further fertilization-involved processes is crucial to improve conservation management efforts of endangered species and to open doors for further research in physiology, ethology and ecology. With this study we documented the still unknown mating phenology and behaviour of the serotine bats. Furthermore, we described a new copulatory pattern in mammals. Additional studies of the copulatory behaviours of bats may reveal other species using copulation without sexual penetration.

Poster 33 – Saturday – 22.10.2022 – 20:00
Presenter: Jannis Gottwald

The spatialMaxent UI: Accounting for spatial autocorrelation during model parameterization leads to less complex Maxent models and a better predictive performance on spatially independent data

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Species Distribution Models (SDMs) and habitat suitability models (HSMs) have become an indispensable tool in conservation research and practice. They have the potential to futurecast the distribution of invasive or endangered species under climate change scenarios or to identify areas of high value for the protection of endangered species. Government authorities are increasingly relying on these techniques as a basis for conservation management decisions. For instance, the federal states of Hesse, Rhineland-Palatinate and Baden-Württemberg have commissioned institutes to develop habitat suitability models for species vulnerable to the construction of wind power plants, including several endangered bat species.
The common practice for evaluating the results of SDMs is to randomly exclude 10-20% of the target species' locations from model training in order to subsequently use them for evaluation. Even though this is standard procedure in machine-learning applications, for species records a high spatial autocorrelation between training and test data can be expected. Several recent studies have demonstrated that this procedure often leads to inflated performance metrics, overly complex models and a poor performance on spatially independent data. The same research has shown that accounting for spatial autocorrelation during model tuning and parametrization results in less complex models with higher agreement between internal and external model error and improved performance on spatially independent test data.
The SDM-software Maxent is probably the most popular modeling technique, not least because it is readily available as an easy to operate user interface (UI). It has been shown that parameter tuning leads to better Maxent models in terms of complexity and performance. However, in close to 100% of published applications Maxent is used with the default settings that have been identified by modeling > 200 species from six regions of the world contained in the NCEAS data set. Spatial autocorrelation is also broadly ignored.
The lack of parameterisation and the ignoring of spatial autocorrelation during model tuning may be related to the fact that the Maxent UI does not include such functionalities. Both the source-code of the Maxent software as well as the NCEAS data set as a benchmark for the comparison of modeling techniques have been recently made publicly available, which opens up the possibility for the research community to contribute to the improvement of the methods.
We implemented parameterization functionalities that account for spatial autocorrelation in the maxent UI (spatialMaxent) which will be made publicly available. We compared our results both to models based on maxent's default settings and to parameterised models where spatial autocorrelation was not taken into account using the NCEAS data set. SpatialMaxent outperformed the other approaches in terms of model complexity and performance on spatially independent test data by far.
Ignoring spatial autocorrelation during training and testing of SDMs and HSMs not only shows erroneous results but may actually prove harmful to species conservation if conservation planning decisions rely on them. Thus we strongly recommend accounting for spatial autocorrelation and parametrizations especially since the respective functionalities have been made easily accessible through the spatialMaxent UI.

Poster 34 – Saturday – 22.10.2022 – 19:00

Presenter: Nicola Eccel 

Identification of bat fossil petrosals from Zoolithenhöhle (Burggailenreuth, Franconia, Germany) via micro-CT 3D modelling

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Unambiguous morphological determination of fossil bat material is often based exclusively on mandibles, maxillae, isolated teeth, and distal epiphysis of the humerus. However, even the bony parts of the inner ear allow accurate species identification. Petrosals (i.e. bulla tympanica - temporal bone) are commonly preserved in deposits due to their density and shape. Yet, these valuable remains are poorly studied and rarely used for fossil fauna evaluation. Here we investigate the bony labyrinth of nine bat petrosals with the aid of micro-CT reconstructions.
We focused on samples from Zoolithenhöhle near Burggailenreuth (Franconia, Germany), where the bat findings cover a period from the late Pleistocene until recent. This study aimed at species identification via comparison of 3D models of petrosal bones, inner ear cavities, innervations, and main vasculature.
Our investigations allowed the identification of at least two certain groups. The faunal assemblage inferred from the samples differed from the expected composition reported in the literature. Furthermore, while the bony labyrinth and innervations endocasts were found to have species-specific morphology, the vascular system showed a more inconsistent pattern, with wide intraspecific variation.
Overall, petrosal species identification, otherwise limited by the preservational state (e.g., damaged semicircular canals), was aided by the 3D models from micro-CT scans. The greater detail compared to bare stereomicroscope observation allows precise measurements, more efficient and immediate manipulation, and detailed visualization of small parts. Thus, this work showed the potential of bat petrosals for future palaeoecological and palaeoclimatic studies while offering a basis for possible phylogenetic, functional, or systematic analyses.

Poster 35 – Saturday – 22.10.2022 – 19:00

Presenter: Michelle Müller

How social are roosting groups of *C. perspicillata*? A pilot study on allogrooming and related behaviours.

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Cooperative behaviours between individuals promote cohesion, which is essential for the stability of a social group and decisive for the sociality of a species. To establish effects of sex, and the interacting dyad, on cooperation, the present study addresses socio-positive interactions in *C. perspicillata*. Within a colony, bats perch in stable, non-randomly associated groups including harems, associated bachelors, and mixed-sex groups of adults, or juveniles. A pilot study focussing on two harem groups tested whether allogrooming, food begging and anogenital sniffing/licking were symmetrically exchanged within a dyad and reciprocated between members of roosting groups. Indications for symmetry and reciprocity were found for food begging, performed mainly in female-only dyads. Allogrooming and anogenital sniffing/licking between females varied from nearly symmetric to highly asymmetric, suggesting individualised relationships within a roosting group. The harem males addressed both behaviours considerably more often to their females than vice versa, resulting in a significant asymmetry. Interestingly, allogrooming and anogenital sniffing/licking to a given female by the harem male were highly and significantly correlated, thus meeting a necessary prerequisite for a trading of the two behaviours in the context of female recruitment and reproduction. These findings provide a promising first evidence of how individualised relationships determine sociality in roosting groups. However, the emerging patterns need to be corroborated by independent data from more groups.

Poster 36 – Saturday – 22.10.2022 – 19:00

Presenter: Sofia Rizzi

Do female Bechstein's bats give a shit? The role of conspecific faeces odour in roost selection in *Myotis bechsteinii*.

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Every organism experiences a multitude of different stimuli during its lifetime, which have to be processed in order to obtain information about the environment. For nocturnal or crepuscular organisms that have little or no access to visual cues, auditory and olfactory cues are fundamental in providing information about the physical and social environments.
Bats, the second largest mammalian order, exhibit a diversity of ecological adaptations, life histories, and social systems, making them intriguing study systems. As most bat species are both nocturnal and highly social, olfaction plays an essential role in bats' everyday social life. Unfortunately, the role of olfaction in the social organization of bats remains poorly understood.
Female Bechstein's bats (*Myotis bechsteinii*), a European tree-dwelling bat species, form stable maternity colonies with virtually no exchange of individuals between them, despite the spatial proximity between neighboring colonies and the typical fission-fusion behaviour within each one of them. Even though the causes and consequences of the peculiar social structure of female Bechstein's bats have been studied for 30 years, the proximate mechanisms that mediate the maintenance of this social organization remain largely unknown.
Here, we present the preliminary results of a pairwise-choice experiment aimed at understanding the role of the odour of conspecific faeces in roost selection and the maintenance of social segregation between different maternity colonies. We set up experimental pairs of bat boxes, each receiving alternatively either of two treatments, i.e. same- and different-colony faeces, and we monitored exploration and occupation behaviour of individually marked female Bechstein's bats employing automatic PIT tag readers.

Poster 37 – Saturday – 22.10.2022 – 20:00

Presenter: Nittava Ruadreo

The large colonial bat, *Chaerephon plicatus* can alter their own cave temperatures

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Some bat species form large colonies throughout most of a year including *Chaerephon plicatus*, which up to several millions individuals roost in caves. This bat restrict to large limestone caves surrounded by agricultural areas. Therefore, they can help regulating crop pests in surrounding area. Interestingly, as living in large colony they might change cave microclimate compared to unoccupied caves. Additionally, the bat activities occurring in caves possibly affect the within cave temperature. This study examine the ambient conditions in caves used and unused by *C. plicatus* to elucidate relationship between the presence of this bat species and cave microclimates. We compared temperature of cave occupied with *C. plicatus* caves with unoccupied ones as a pair. Moreover, we determined changes of within-cave temperatures during bat emergence events and bat activities in Khao Wongkot cave (KWK), the second largest colony of *C. plicatus* in Thailand. The results exhibit that the temperatures of all occupied caves were significantly higher than the unoccupied caves in mostly every pair. For the temperature changes within cave, we noticed that the temperatures were cyclically changed every day correspond to the emergence period. The large colonial bat, *C. plicatus* can maintain dynamic microclimate while living in the cave. They can alter roost microclimate themselves by raising cave ambient temperature from the heat dissipation from their bodies. The alteration of cave microclimates can be important for survival and growth of offspring, and thus vital to conservation management of nursery caves.

Poster 38 – Saturday – 22.10.2022 – 19:00

Presenter: Janis Wolf

Experimentally increased roost temperatures lead to larger body sizes in Bechstein's bats (*Myotis bechsteinii*)

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The relationship between body size and ambient temperature is a well-known principle in physiology. Hence, for many species changes in body size as a result of global warming have been demonstrated. While in most endotherms the body size decreases with increasing temperature, for some species an opposite effect has been observed. In most of these cases, however, the effect could primarily be attributed to a temperature-related increase in food availability. In contrast, evidence of a direct influence of temperature on body size remains scarce. Since body size is also related to individual fitness parameters such as reproduction and survival, global warming could have a decisive influence on the resilience of populations or even entire species.

Individuals of the European Bechstein's bat (*Myotis bechsteinii*) born in years with relatively warm ambient temperatures in summer attain on average a larger body size. So far, however, it has remained unclear whether this is a direct effect of temperature or mediated by an additional factor, such as an increase in food availability in warmer conditions. Therefore, we conducted a heating experiment over three summers that allowed us to specifically control the roost temperature of maternity colonies of the Bechstein's bat.

In combination with a long-term data set spanning 26 years and including three colonies, we found that constant high roost temperatures around the thermoneutral zone of this species resulted in larger body sizes on average. We conclude that optimised roost temperatures directly promote juvenile body growth, independent of possible effects of temperature on food availability. We hypothesize that optimally warm roost temperatures reduce the need for both mothers and juveniles to enter torpor frequently, which ensures uninterrupted milk production and a consistently high metabolic rates of juveniles, both of which benefit body growth. In addition, we found that higher temperatures particularly benefit juveniles that grow up in smaller roosting groups, in which individuals benefit less from social thermoregulation and therefore enter torpor more often to save energy. This again supports our hypothesis that lower torpor demand due to warmer roosts promotes body growth.

Larger individuals of the Bechstein's bat have been shown to reproduce at an earlier age, but at the expense of a shorter life expectancy. In some ways, this could be seen as adaptation to the changing conditions of climate change. However, if environmental conditions cannot support the higher energy requirements of larger body sizes, e.g., due to the effects of intensive agriculture and forestry on food availability, or if extreme weather events limit reproductive success in more and more years, the persistence of *M. bechsteinii* populations could be at risk in the long term.