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'Can you see what I see?' – The importance of night vision aids to conduct effective emergence surveys of tree roosting bats - *Dr Ian Davidson-Watts,* Davidson-Watts Ecology Ltd

Current standard survey methodologies for detecting the presence of bat roosts in trees include the use of emergence surveys. The surveys are normally undertaken by surveyors equipped with bat detectors and involve the visual observation of emerging bats from potential roost features. Although current guidance suggests such surveys can be assisted by night vision devices such as infra-red or thermal cameras/scopes, it is understood that their use is not common or considered standard practice in professional bat surveys.

To test the effectiveness of this method, emergence surveys on 89 known tree roosts (located through radio tracking), supporting eight bat species, were undertaken at various sites in England between 2014 and 2019. Surveyors were equipped with either Sony Nightshot or Cannon XA camcorders, supplemented with powerful infrared illuminators to observe any emerging bats from known or potential roost features (PRFs). Surveyors recorded the time they could no longer see the PRF without the aid of the night vision device and they also recorded the time of first, tagged and last bat emergence observed visually or through the night vision device and/or subsequent review of recordings made.

Following the removal from analysis of 21 trees where no bat emergence was visually observed (emergence only confirmed through radio tracking), a total of 68 tree roost emergences were subsequently examined. Statistical analysis of the results showed that the difference between the time the surveyor could no longer see the PRF and the time of the first bat emergence differed significantly. Overall, 77% of surveys recorded the first bat emergence approximately eight minutes after the PRF could no longer be seen without the aid of a night vision device. Significant differences

in bat emergence times after PRFs could no longer effectively observed without a night vision device were also found between species and roost type (e.g. maternity and day roosts).

Based on these results it is recommended that night vision aids (e.g. IR or thermal cameras/scopes) should be mandatory for emergence surveys on potential tree roosts where such surveys are undertaken. However, it is important to note that even where night vision devices were used, approximately 25% of bats emerged from PRFs unseen. Only the movement of the radio transmitter indicated the bat had emerged.

Given the significant visual limitations of emergence surveys associated with trees and the low encounter rates of tree roosting species generally, the viability of current emergence survey methods for trees in respect of data quality are questioned, particularly where large numbers of trees or woodland habitats are affected. Instead for projects affecting large numbers of trees, we promote the use of advanced licensed bat survey techniques to inform a woodland habitat-based approach which has been used to successfully on a number of major infrastructure projects over recent years.

The importance of landscape composition and connectivity in determining sexual segregation in threatened UK bat species within fragmented woodland patches – Penelope Fialas, University of Bristol

1. Agricultural intensification and the resultant fragmentation of habitats has led the global declines in a wide range of taxa. How species respond to landscape connectivity and fragmentation has been studied extensively, however relatively little work has been done on intraspecific differences in responses. Bats have great potential as bioindicators in fragmented agricultural landscapes. Studying sex differences in bats can therefore allow us to gain insights into important woodland habitat and landscape features for bats and other taxa that rely on them.
2. In this study we aimed to test the predictions that i) habitat quality and connectivity will influence the probability of recording female bats in woodlands and that ii) sex differences in response to habitat type and connectivity will be species-specific.
3. We used high-quality citizen science bat capture data collected in rural woodlands over three years by trained volunteers for the Bat Conservation Trust Bechstein's Bat Survey. Data for six species (*Plecotus auritus*, *Myotis mystacinus*, *M. nattereri*, *M. bechsteinii*, *Pipistrellus pipistrellus*, *P. pygmaeus*) were analysed using generalised linear mixed effect models and probability of female compared to male occurrence in a woodland was modelled in response to a range of woodland characteristics and landscape metrics.
4. As predicted, we recorded sex differences in responses to landscape connectivity and composition in three species. We found a higher probability of capturing female *M. nattereri* in woodlands that were surrounded by a higher proportion of improved grasslands, whereas female *M. mystacinus* were less likely to be recorded in woodlands surrounded by semi-natural vegetation. Female *P. auritus* were more likely to be recorded in isolated woodlands with less connectivity to other woodland patches and where agriculture dominated the surrounding landscape.

Sources of lesser horseshoe bat population decline in Germany - Paul Fischer,

This article will identify and address potential regulatory and litigate strategies to two key sources of lesser horseshoe bat population decline in Germany: pesticide deployment and habitat fragmentation. Following a biological and legal introduction, the impact of the popular pesticides glyphosate and neonicotinoids on lesser horseshoe bat ecological requirements will be analyzed and

followed by a thorough review of litigation in which ecological data on pesticides have been released, habitats restored by application for funding through Natura 2000, and in which deterioration was prevented through enforcement of the Environmental Impact Assessment Directive and Natura Impact Assessment requirement of the Natura 2000 Directive will also be provided. Implementation of the recommendations to eliminate German sovereign rights to countermand environmental litigation to the German court system will ensure future funding deficits are not experienced. Increased transparency in the registration of pesticides will enable realistic and accurate ecological mitigation efforts through regulatory measures and prohibition where necessary. Failure to implement these recommendations will likely result in recurrence of the current crisis.

Vigilance Architecture and Emergence-Return of Indian Flying Fox – Pratik Das, Wildlife Institute of India

Vigilance is a manifestation of predation risk and competition among gregariously roosting Indian Flying fox, and this behavior varies spatially and temporally. We investigated spatial vigilance architecture in colonies of Pteropus medius with respect to its function (environmental and social), at three colonies of southern Assam, India. We hypothesized that environmental vigilance will increase from core to periphery while social vigilance will decrease respectively. Daily exodus to forage (emergence) and return to diurnal roosting sites were also investigated in relation to Environmental cues. Independent focal behavior samples (300 s) of core and peripheral bats within a colony were randomly taken. Outermost bats making up the surface of a group were designated peripheral while ones positioned inner to it are designated core. Based on 'proportions of time spent in each vigilance type', we compared core and peripheral bats. We found that spatial position influenced extent of overall vigilance, but particularly environmental. A significant increase in environmental vigilance of peripheral bats was evident (core= 0.79% ±0.36 & periphery= 7.54% ±1.71)- Edge effect. The peripheral bats also showed clear distinction between intensity of vigilance types (environmental> social; $p=0.02$, $n=106$). Interestingly, vigilance and its types did not vary with sex or roosting height. However males did show higher environmental over social vigilance ($p=0.029$, $n=60$). Hence spatial vigilance architecture is prevalent in colonies of Pteropus medius. For emergence-return, bats' mass movement into and out of a colony were timed and environmental variables like temperature, sunrise sunset timings, etc. were recorded. Both emergence and return show seasonal variation probably because of its strong correlation with sunset ($r=0.96$) and sunrise ($r=0.98$) respectively. After sunset emergence initiates faster in summer than winter ($p<0.002$).

Intense hunting pressure drives roost use by the Egyptian fruit bat - Benneth Obitte, Texas Tech University,

Overexploitation is a leading cause of global species extinction, yet it's impact is difficult to quantify, especially in bats where direct measures were previously unavailable. The Egyptian fruit bat (Rousettus aegyptiacus), an obligate cave roosting species is threatened by habitat loss and intense hunting – in southern Nigeria, offtakes using hunting sticks can reach 4,000 bats per cave visit. Always abandoned and non-reusable, hunting sticks at cave entrances provide a direct measure of hunting pressure. However, the impact of such intense hunting on R. aegyptiacus roosting ecology remains unknown. We assessed bat abundance at cave roosts by conducting emergence counts across localities in southern Nigeria. Cave dimensions, microclimatic conditions, landscape effects, and human disturbance drive roost use in other cave dwelling bats. Therefore, we measured cave microclimate and dimensions, vegetation at cave entrances, quantified hunting pressure by recording number of hunting sticks at 43 caves. We measured distance between caves caves (all

occupied or previously occupied by R. aegyptiacus) and nearest farms. We modeled the relationship between R. aegyptiacus abundance, and cave microclimatic conditions, surrounding vegetation, landscape characteristics, hunting pressure using a regression-based model – Conditional Inference Tree (CIT). Hunting pressure was the only significant ($P<0.01$) predictor of R. aegyptiacus abundance. In addition, hunting sticks were higher in previously occupied caves than in currently occupied caves, suggesting that bats are avoiding more intensely hunted caves or were hunted to local extinction. We demonstrate the negative impact of high hunting pressure on roost use by R. aegyptiacus, using a direct measure – hunting sticks. These results will inform cave prioritization for bat conservation.

Movements and in-roost behavior of the wooly false vampire bat, Chrotopterus auratus - Rodrigo A. Medellin, Instituto de Ecología, UNAM,

Carnivorous bats represent an ultimate extreme in specialization of bats in the New World. The woolly false-vampire bat, Chrotopterus auritus, is the second largest bat in the Americas but little is known about its ecology. We tracked the movements of 10 individuals from 2 colonies on 32 occasions for a total of 72 foraging nights, the largest sample size for any study on Chrotopterus. One roost was surrounded completely by undisturbed forest whereas the other was surrounded by deforested habitats used for agriculture and cattle pasture. Using miniature GPS tags, we documented an average home range of 108 ha, a core foraging area of 3.78 ha, and average maximum flight distances of 2.06 km. The bats ranged farther and flew significantly longer distances in from the roost in a relatively more disturbed landscape than on the undisturbed landscape. Males flew longer and more variable distances. Bats used the well-preserved semi-deciduous forest more often than secondary forest and agricultural fields for traveling and foraging, but the bats occasionally moved and foraged along the borders of secondary forest and agricultural fields adjacent to semi-deciduous conserved forest areas. Although this carnivorous bat might cope with some fragmentation, large well-preserved forested areas are highly important for its conservation. We also present the first evidence showing food supplementation in a variety of combinations. Genetic studies are under way to understand the identity of the bat involved