Abstract

Bats combine flight and active sensing through echolocation to forage in the night sky, taking advantage of an otherwise little exploited niche of hunting night flying insects. Echolocation has its strength by being easily adaptable to suit specific scenarios, unrelated to external sensory input. However, relying on an active sensing system, where information must be extracted from one's own signals, also present some possible downsides, as those signals can be disturbed by many different factors during their two-way propagation through the environment. One of these is echolocation calls from conspecifics, which may potentially interfere with a bats ability to obtain unambiguous echo information by overlapping with and thus masking its own signals. Multiple studies have shown how bats can adapt their echolocation to specific tasks or environments, by changing their echolocation source parameters, but it is still arguable to which extent this flexibility is used in cases where bats might experience jamming. The main goal of this thesis is to investigate if, when and how bats adapt their source parameters and how such adaptations may impact potential jamming situations, in particular with a specific focus on call source level and sound beam directionality, which so far has received relatively little attention in this context.

Before we can fully understand how bats react to situations of jamming, we need to know both how they respond to other factors influencing the specific situations and how flexible/limited bats are in their echolocation behaviour. To better understand the capabilities and limits of adaptive bat echolocation behaviour, I have investigated if bats tweak the shape of their emitted sound beam in two behavioural contexts; as bats approach and attempt to capture prey and when they move from the confined space of a flight room to the open area of the field. When they catch prey, aerial hawking vespertilionid and rhinolophid bats broaden their echolocation beam, presumably to counteract evasive prey manoeuvres. To test the general applicability of this strategy I studied three species of emballonurid bats and found that only one of them broadened its echolocation beam during prey pursuit. The other two species, however, emitted substantially more energy in the final stage of pursuit, which ensonifies the periphery of the sound beam on par with vespertilionid beam-broadening. These findings illustrate how specific species, even within the same family, may use different strategies to adjust their acoustic field-of-view. The surrounding environment also plays a large role on the echolocation behaviour of bats, which often navigate in different degrees of clutter during the night. The nose-emitting neo-tropical phyllostomid bat, *Macrophyllum macrophyllum*

utilize a unique hunting niche within its family, trawling over open water, where the dominating strategy of phyllostomid bats are gleaning in densely vegetated areas. Thus, I decided to study *M. macrophyllum* to get an insight into the impact both genetic heritage and hunting niche adaptations has on its echolocation behaviour in different degrees of clutter. The study shows that *M. macrophyllum* utilize a much larger search field than other members of its family, but still not as extensive as found for the niche sharing vespertilionid specie *M. daubentonii.* It furthermore does change its sound beam slightly between environments, but again not at the same level as found for *M. daubentonii*. These studies support the fact that bats are highly adaptive in their echolocation behaviour and this therefore opens several potential opportunities for behavioural adaptations in relation to jamming. Some bat species reportedly do change their source parameters in situations where jamming is likely to occur, e.g. by switching signal energy towards frequencies away from those dominated by the calls of conspecifics. However, I recorded the trawling bat *Myotis daubentonii* in its natural habitat and found no indications that this specie changes its echolocation behaviour, even while flying in close proximity to several conspecifics. From the field study I conclude that *M. daubentonii* is not sufficiently disturbed by jamming in its natural habitat to make any behavioural changes to this. It is also reflected in their prey capture success from studying their ability to successfully capture prey in a flight room with several conspecifics present. In the flight room *Myotis daubentonii* did, however, respond with an increase in source level, which correlates well with adaptations to a noisy environment. These two studies show that the presence of conspecifics might create a noise filled environment, but the responses indicate no negative impact caused by masking/overlapping related jamming.