

## Introduction

Bats are unique and important organisms. They play a vital role in the correct function of ecosystems and that is why it is necessary to ensure the conservation of their species. Besides insectivorous bats being the primary consumers of nocturnal insects, as bioindicators, bats are particularly sensitive to various alterations in their habitats, such as a change in their food sources or changes in temperature, likely caused by global warming (Ancilotto et al. 2016). They are also sensitive to the spread and major change of their occupied area or rise of sea levels, submerging some cave roosts under water (McWilliam, 1982). Pollution caused by heavy metals as a result of urbanisation is evidenced by the presence of metals such as cadmium or lead in some bats (O'Shea & Johnson 2009) and a study (Vaughan et al. 1996) has shown that polluted waters can have a negative effect on bat activity, attesting that bats can be used as bioindicators of water quality. This sensitivity to a vast amount of changes serves as warning and proof to various parties studying ecological changes to the environment. Even though there are many different organisms that act as bioindicators, bats have a particularly high significance thanks to their wide geographic range, their slow reproductive rate (their population size may drop quickly), their taxonomy being relatively stable and their responses to environmental changes correlating with those of other indicators (Jones et al. 2009).

Insectivorous species of bats play a critical part in lowering the negative effect of agricultural insect pests on crops and fruit orchards (Bartonička et al. 2017). By hunting and consuming agricultural pests such as June bugs, cucumber beetles, cotton bollworm moths, corn earworm moths, tobacco budworm

moths and Jerusalem crickets (Whitaker 1995), they not only lower their numbers, but also help minimise the negative economic consequences that are brought on a country by crop disease. It is estimated that nowadays the economic value of bats, in regard to the aforementioned issue, may reach up to 3,7 billion American dollars annually (Boyles et al. 2011).

Some tropical species of bats, known as plant-visiting bats, are important pollinators and plant seed dispersers of many different plants, including primary cacti species in the Sonoran desert (Molina-Freaner et al. 2004) or large seed fruits on various oceanic islands, where they are the sole pollinators capable of performing this task (Fleming & Racey 2009).

The above reasons alone should ensure a high interest in bat conservation around the world. And yet, most bat species are considered to be endangered (eg. Racey & Entwistle, 2003), with their numbers decreasing into dangerous territory. With various laws in place to ensure their safety and the sustainability of their populations, one would expect the species to thrive and yet, that is not the case. The reasons that may contribute to this issue seem never-ending, but one that particularly stands out, and that is the topic of this thesis, is the problem of motorways, frequently used by vehicles of various sizes and the negative effects these roads have on bats. The permeability of road constructions for bats is a topic that lacks research data, which may then complicate the efforts to optimise safety measures placed to minimise the negative effects of roads on our studied species.

Motorways are an unmistakable feature of every developed country and their expansions are not a rarity. Road construction brings forth several negative effects that may influence the behaviour of bats. The issues include noise pollution, which may result in a lower effectiveness during hunting (Schaub et

al. 2008), light pollution from the large lighting equipment used during evening construction, which may cause bats to abandon their regular flight corridors or hunting grounds (eg. Rydell 1992; Blake et al. 1994), and disturbance of existing roosts and their possible relocation (Altringham & Kerth, 2016) caused by the removal of vegetation and old buildings near a construction site of a road. Once the new road is built, the mentioned effects continue, and new ones appear. Roads may serve as barriers between roosting sites and foraging ground (Altringham, 2008) due to the reluctance of certain species of bats to cross these structures. They also cause fragmentation of a habitat and may cause habitat loss. Roads may pose as a threat to certain bat populations due to direct collisions of vehicles with individual foraging or migrating bats (Geisler et al. 2009).

Bat hunting strategies vary from one species to another. That results in different flight heights between clutter-adapted, edge-adapted, and open-adapted species (Abbott et al. 2011), which in turn may result in various and unequal risks of collision with vehicles when commuting across roads and road structures. Due to the risk of collisions, various mitigation measures and constructions have been implemented to reduce the possible dangers.

It is possible to determine the probability of a bat flying either above or under a road construction such as a bridge using information on flight heights. However, we must take into consideration the fact that behaviour in regard to flight height and hunting strategies may change due to the natural unpredictability of animal behaviour (CEDR, 2016a). That is why scientific observation of the permeability of road structures is needed.

The aim of this thesis is to describe in more detail the possible effects of motorways on bats, using information from various existing studies; to

summarise the mitigation measures that are put into place, in the hopes of reducing bat mortality caused by direct collisions with vehicles; to review the effectiveness of these measures by the means of existing studies; to sum up different bat hunting strategies used among species most commonly found in the area of our study, South Moravia; and to scientifically determine which species of bats are more likely to fly above a bridge standing in their flight path and which prefer to fly below it, using monitoring equipment in the field and then processing the results, in the hopes of contributing with useful data to the efforts of improving safety measures in position to protect bats.