# EFFECTIVENESS OF ECODUCTS AND HUMAN ACTIVITY

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https://doi.org/10.11118/978-80-7509-963-1-0064

**Abstract**
Ecoducts address the threat of biodiversity decline due to anthropogenic activities by preserving landscape connectivity. In this study, human and wildlife interactions on ecoducts in the Czech Republic are evaluated. Results from Rozkoš and Václavice ecoducts in the Liberec region monitored by camera trapping as part of a wider project involving a total of 23 migration sites across the country were analysed. Wildlife activity peaks at night, contrasting with daytime human usage. Proximity to settlements influences human activity, with Rozkoš attracting more cyclists due to its location. Discussion emphasizes ecoducts' dual role in facilitating wildlife migration and enhancing landscape recreation. Despite human presence, wildlife migration remains resilient, especially at night. Understanding usage patterns informs future ecoduct design and management for biodiversity conservation and human recreation.

**Keywords:** green bridge; anthropogenic disturbance; wildlife monitoring; camera trap

## Introduction

Transport infrastructure and other anthropogenic activities are one of the main drivers of the global decline in biodiversity (IPBES, 2019). Increasing traffic volumes and further construction of highway infrastructure have been a serious threat to landscape connectivity for wildlife in recent decades (Papp et al., 2022). One way to preserve the connectivity of the landscape is to build special migratory passages across infrastructure (Soanes et al. 2024). These were first built in America and Europe but gradually began to appear in all countries with heavy traffic (Brennan, Chow, Lamb, 2022). The ecoducts can occur both in forest environments (connecting forest complexes) and in intensively used cultural landscapes (connecting mainly agricultural landscapes with fields, meadows or orchards). Migratory objects are often operated as multi-purpose structures, i.e. they are not only a solution for wildlife but also provide local accessibility such as field and forest routes, cycleways or walking paths (Warnock-Juteau et al., 2022).
The first ecoduct in the Czech Republic was put into operation 25 years ago, in 1999, near the village of Dolní Újezd on the D35 motorway. By the end of 2023, a total of 34 objects that can be considered as an ecoduct or similar construction (type design N1 to N4 according to Hlaváč et al., 2020) have been built in the whole country, of which one object is located on the railway, all others on motorways or national roads.
The paper aims to evaluate two ecoducts in the Czech Republic concerning their use by humans including local recreation and leisure activities and the possible negative impact on their effectiveness in terms of wildlife migration.

## Material and methods

The camera-trapping method was the main approach for recording activity on migratory objects as it is an effective non-invasive method for collecting data on wildlife species (Delisle et al., 2021; Oliver et al., 2023). Oxe Spider traps were used, which allow sending photos by email over the GSM network. To receive, process, and evaluate the images from the camera traps, a common database was set up, which automatically stores the photos from incoming emails as individual records, which are subsequently manually analyzed and cleaned of blank and repeated shots. Multiple traps were installed at larger ecoducts to cover the entire area adequately.
Of the 34 sites, 23 ecoducts were monitored for at least part of 2023, of which 11 sites were monitored year-round. At least one trap per ecoduct was in operation for 4,997 days. For some highly exposed ecoducts, monitoring was only started later in the growing season so that the

traps could be hidden to prevent theft. Despite this, monitoring had to be stopped at 7 sites due to traps being robbed. In total, about 150,000 photos were received by the database, from which about 65,000 records relevant to monitoring were processed.

**Results**

In the following section, the movement of people and their activities at two selected ecoducts in the Liberec region were evaluated to reveal their regular daily and weekly patterns.

The first selected ecoduct is Václavice (10 km north of Liberec) on the national road I/35. It is located in an agricultural landscape with plenty of landscape greenery in the close vicinity of the migration object. Two camera traps were in operation for 299 days (43 weeks) during the period March to December 2023 covering the entire area of the ecoduct. During this time there were 2,954 records (see Fig. 1) of which 2,388 (80.8%) belong to wildlife. Of the rest, 440 records involved a person alone or with a dog, 20 cases involved a horse rider and 16 times a cyclist occurred. There were also 35 motor vehicles recorded and 55 records were classified as unrecognized.

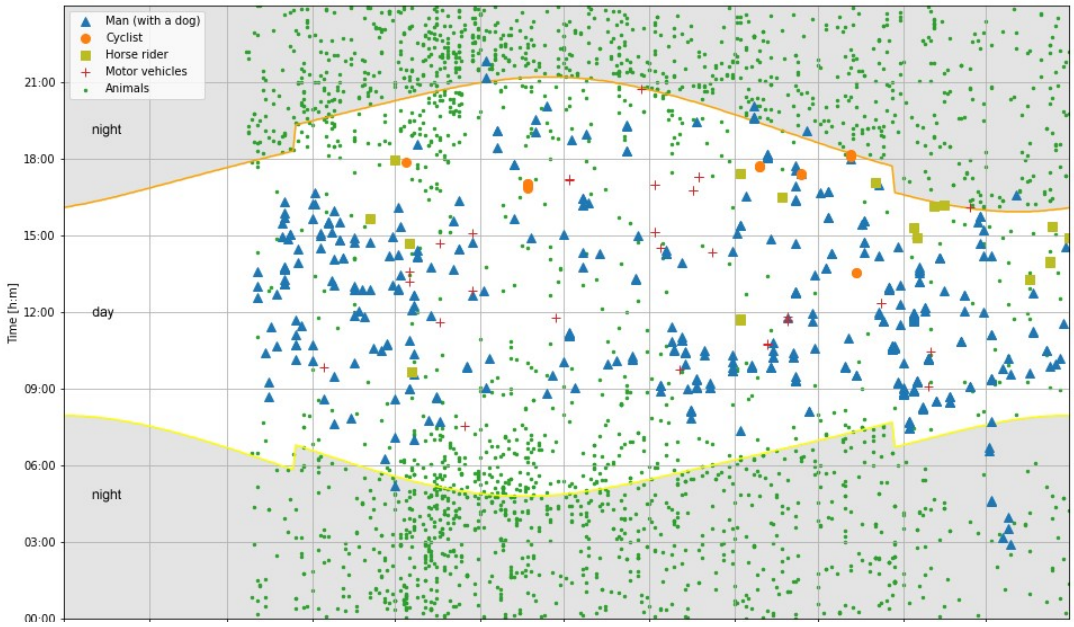


Fig. 1: All-year records of the movement at Václavice ecoduct

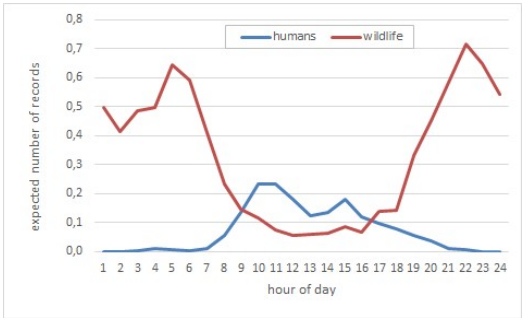


Fig. 2: Daily pattern - Václavice

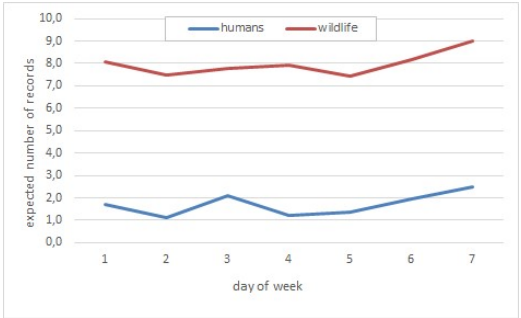


Fig. 3: Weekly pattern - Václavice

Fig. 2 shows a clear difference between human and wildlife activity within each day. For animals, activity is predominantly nocturnal with a peak in the early evening and early morning hours (0.72 and 0.65 expected records per hour, respectively), dropping to 0.05 expected records per hour during the day. In contrast, people use the ecoduct predominantly during the day with a peak of 0.23 expected records per hour in the morning. The weekly pattern in Fig. 3 revealed that the ecoduct is fairly evenly used on all days of the week by both wildlife and

people. Both series of values indicate slightly increased activity around weekend days, especially Sundays (2.47 and 9.00 expected records, respectively). For humans, there is then a secondary peak on Wednesday (2.12 expected record), while Tuesday, Thursday and Friday values are significantly lower (1.19 to 1.39 expected record). For wildlife, there is a non-significant peak on Thursday with a 7.93 expected record compared to a minimum of 7.42 on Friday.

The second selected ecoduct is Rozkoš on the I/13 road, which was completed in May 2023 and is thus the newest ecoduct in the Czech Republic. It is located on the border of a forest complex and pastures. Its construction was complemented by the fencing of the entire adjacent section of the national road, as the main motivation for the construction was the high morality of game on this stretch. The two camera traps were installed immediately after the completion of the vegetation works on the site at the end of May 2023 and were in operation for the rest of the year, i.e. 216 days (31 weeks). There were 4,577 records (see Fig. 4), of which 4,144 (90.5%) were wildlife. Of the 4577 records, 4,144 (90.5%) were wildlife. Human activity was recorded on 430 occasions (249 men with or without dogs; 129 cyclists; 28 horse riders and 24 motor vehicles) while 3 cases remained unidentified. The immediate response of the animals to the new ecoduct was interesting, with the first records coming as soon as it was completed.

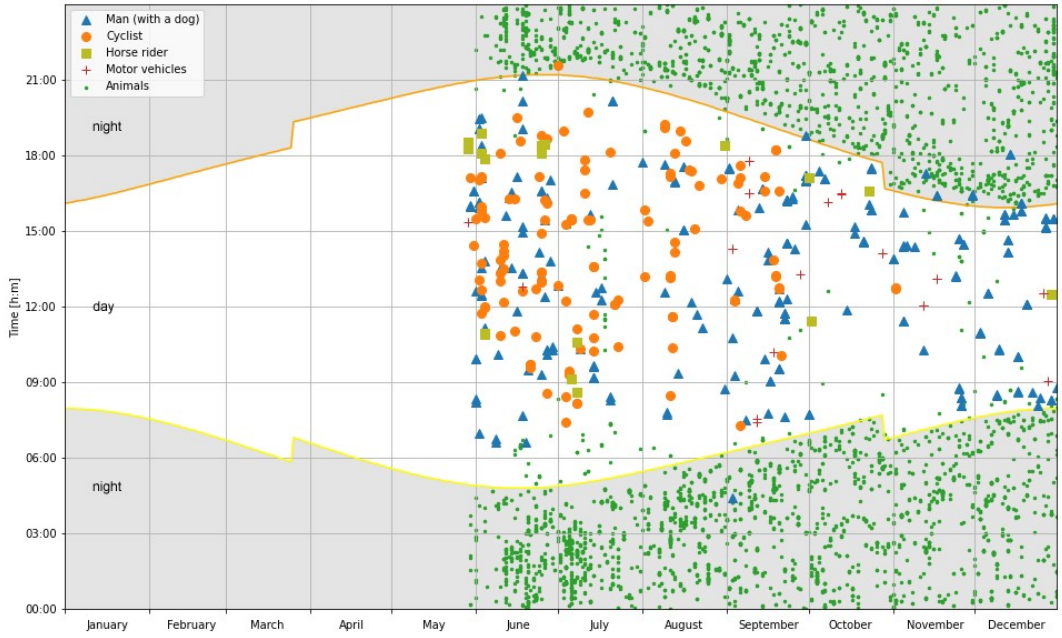


Fig. 4: All-year records of movement at Rozkoš ecoduct

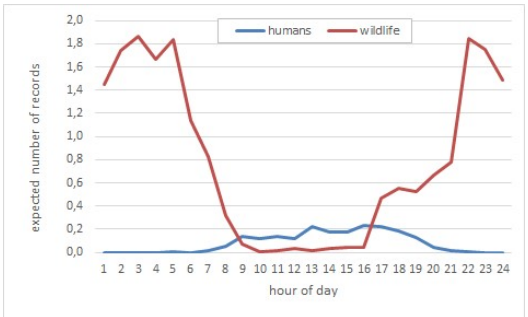


Fig. 5: Daily pattern – Rozkoš

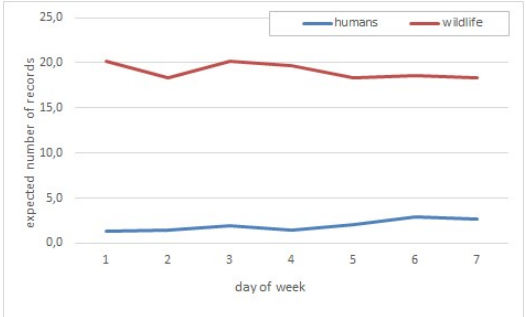


Fig. 6: Weekly pattern - Rozkoš

In terms of diurnal pattern, the trends are similar to Václavice, but in this case, there is an even more noticeable difference between the use of the object by wildlife at night and during the day.

Again, there are two nocturnal peaks (1.84 and 1.87 expected records per hour), but daytime use is virtually nil, with only single records during the entire monitoring period. Human activity overnight was also completely zero all the time, but daytime activity peaked in the afternoon (0.24 expected record per hour). The weekly pattern for humans is similar to Václavice, with a weekend peak of 2.93 expected daily records) including a minor peak on Wednesday (1.97 daily records), while for animals are nonsignicant peak days on Monday, Wednesday, and Thursday.

**Discussion**

In addition to their primary function of facilitating wildlife migration, ecoducts also serve as objects for improving the recreational function of the landscape - its permeability for people, especially in their leisure activities, e.g., walking in the vicinity, walking dogs, recreational running, cycling, horse riding (Warnock-Juteau et al., 2022). In particular, the distance from the nearest settlements, or the presence of hiking trails, bike paths, or local roads, is crucial for the intensity of people's daily movement on the ecoduct; the surrounding terrain and elevation also play a role. From this point of view, the Rozkoš ecoduct has a greater potential for human use (immediate proximity to the cycle path, closer distance to the settlement). The representation of cyclists here is significantly higher than at the Václavice ecoduct. As expected, the results confirmed that wildlife migration on ecoducts takes place mainly at night and that human movement on ecoducts during the day is only slightly restrictive for animals. Nevertheless, especially in the morning and evening hours, some species can take advantage of the absence of humans to pass through the ecoduct undisturbed.

**Conclusion**

The newly built ecoducts have multifunctional significance in the cultural landscape. Primarily they are designed for the migration of wildlife, but they are also used by people, especially for leisurely everyday activities - walking, dog walking, cycling, and horse riding. The proximity of settlements, the proximity of hiking and cycling trails, or the attractiveness of the surrounding area in terms of tourism and hiking are particularly important for the intensity of human movement. However, even with possible human disturbance, the monitored ecoducts are subject to intensive wildlife migration, especially at night or in the morning or evening.

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**Acknowledgment**
This paper is financed from the state budget by the Technology Agency of the Czech Republic and the Ministry of Transport of the Czech Republic under the DOPRAVA 2020+ Programme, project CK03000086 “Transport infrastructure permeability for fauna as a prerequisite for safe and sustainable transport”.

**Souhrn**
Ekodukty řeší hrozbu poklesu biologické rozmanitosti v důsledku antropogenních činností tím, že zachovávají propojení krajiny. V této studii jsou hodnoceny interakce člověka a volně žijících živočichů na ekoduktech v České republice. Byly analyzovány výsledky ze ekoduktů Rozkoš a Václavice v Libereckém kraji sledovaných fotopastmi v rámci širšího projektu zahrnujícího celkem 23 migračních míst po celé republice. Aktivita volně žijících živočichů vrcholí v noci, což kontrastuje s denním využíváním lidmi. Blízkost sídel ovlivňuje lidskou aktivitu, přičemž Rozkoš díky své poloze přitahuje více cyklistů. Diskuse zdůrazňuje dvojí roli ekoduktů při usnadňování migrace volně žijících živočichů a posilování rekreace v krajině. Navzdory lidské přítomnosti zůstává migrace volně žijících živočichů odolná, zejména v noci. Pochopení vzorců využívání slouží jako informace pro budoucí navrhování a správu ekoduktů pro ochranu biodiverzity a rekreaci lidí.

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