Mountain biking and wildlife – disturbance experiments with roe deer (*Capreolus capreolus*) in Switzerland

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Introduction

In addition to being the main habitat of European roe deer (*Capreolus capreolus*), forests provide diverse and outstanding settings for recreational activities such as hiking, horse riding and mountain biking (Jacsman, 1990). The effects of new patterns of recreational use such as night rides with bright floodlights are hotly discussed topics associated with the management of recreational forests. Animal ecology so far has mainly focused on spatio-temporal behaviour of individuals in undisturbed remote areas, while research on human behaviour mainly focused on visitor conflicts in highly frequented recreational forests (Arnberger, 2006). Therefore, our knowledge about the effects of new recreational activities on wildlife is currently insufficient. We studied the effects of mountain biking events on the immediate spatio-temporal reaction and subsequent habitat use of roe deer. Furthermore, we compared the effect of on-trail mountain bike events with other disturbance events that occurred off-trail such as hunting, orienteering and on site observations.

Methodology

Study area and context

Our study was counducted at the the Wildnispark Zurich and its surrounding forests, about 7 km south of the city of Zurich, Switzerland. The study area contains the typical fauna and flora of a Swiss midland mixed forest. The Wildnispark Zurich consists of a protected core area and a surrounding area with high recreational use due to its proximity to the city of Zurich.

Our experiments were part of an interdisciplinary research project that investigates the impact of recreational activities on wildlife. Between 2013 and 2015, 15 roe deer were fitted with GPS collars (Model GPS Plus, VECTRONIC Aerospace GmbH, Berlin, Germany). GPS collars were programmed to a general fix rate of 3 h, optimizing for a long battery life. For disturbance experiments, the fix rate was temporally adapted to 5 min.

Methodological approach

The research design consisted of systematic bike rides through the habitats of collared roe deer, in each instance by pairs of bikers with concurrent tracking over two weeks in summer and winter. Deer adapt their behaviour according to the time of the day and are most active during twilight hours in the morning and in the evening (Reimoser, 2012). The experiments were therefore carried out at dawn (within 1 hour after sunset) and at night (between 12pm and 1am).

GPS data of both bikers and roe deer allowed us to identify the exact disturbance time and location, and observe the immediate reaction of the roe deer. The animals usually fled and moved to sites with good cover (Sigrist et al., 2015). Flight initiation distances and the quality of cover sought following the disturbance event were compared between on-trail and off-trail activities.

Results

A total of 51 disturbance events were carried out. The statistical comparison states that flight distances (distance covered during a flight event) due to off-trail disturbances are significantly (p=0.0365) higher than due to on-trail disturbances (see below). After the experiment, completed distances return to normal. At night, distances are generally longer than at dawn. Reactions to mountain biking events could be

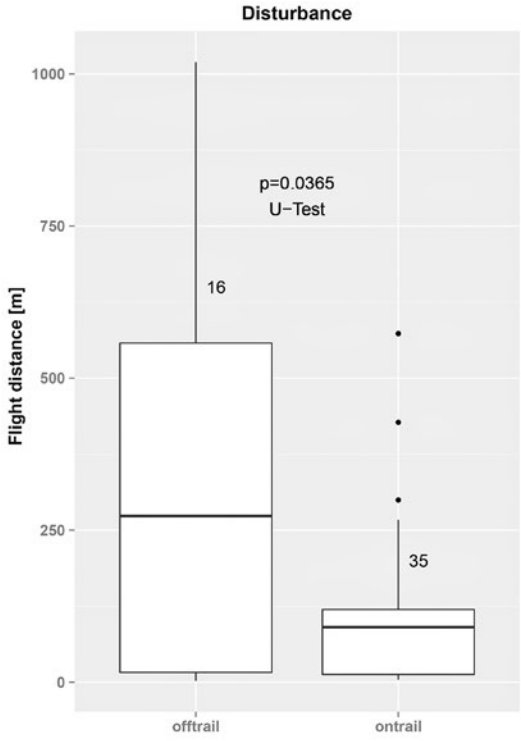

Figure 1. *Flight distance (distance covered during a flight event) of roe deer due to off-trail (hunting, orienteering, on-site observations) and on-trail (mountain biking) activities (n=46)*

observed with more than 50 % of the animals fleeing more than 50 m and one deer over 500 m. In comparison with mountain biking, off-trail activities (hunting, orienteering and on site observations) generally caused significantly longer flight distances ($p=0.0365$; Fig. 1). Due to off-trail events, 50 % of the animals fled over 250 m and maximum distances up to over 1 km were completed.

Discussion

New developments in outdoor recreation cause challenges for the management of recreational forests. Mountain biking at night is one example of this and its effects on the environment and wildlife are currently being discussed. The results of this study give a first insight into an important topic concerning the management of recreational forests and may provide some support for landscape management when questions of wildlife refuges or wildlife protection are discussed. This study used only position data of roe deer and mountainbikers. Statements on the animal welfare cannot be made. Nevertheless, significant reactions to the disturbance experiments can be measured, both in terms of an interruption of the previous behaviour and a flight over varying distances. Flight distance due to off-trail disturbance is generally longer than due to on-trail disturbances. The habituation of roe deer to existing pathways could be a reason for this, besides other factors that can be taken into account when looking at the disturbance response of animals (Beale, 2007). According to Reimoser (2012), the intensity of the disturbance effect depends on various factors and is increased at night, when the animals are active. This observation is partly confirmed by the outcomes of our experiments. However, research from the nearby Uetliberg has shown that mountain biking activities take place mostly in the evenings (Wyttenbach, 2012).

Conclusion

The experiments showed a significant reaction of roe deer to mountain biking at dusk and during the night. As mountain biking during the night seems to be an increasing human activity, it causes a further limitation of the habitat use by roe deer and other animals. How much disturbance can be sustained by a natural system? This research represents one of the first puzzle peaces to answer this question. For the management of recreational forests, it would be crucial to have more information on use patterns of mountain biking activities and the respective impact on wildlife. Looking ahead, the ongoing project will produce more data and hence more reliable sources and sample sizes.

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