# 28 Mapping the distribution of outdoor activities to assess their impacts on capercaillie (Tetrao urogallus) – Evidence from user-generated geographic information

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**Introduction**

The most severe effects of outdoor tourism/recreation (**OTR**) are habitat fragmentation, modification, and loss, which affect animal behaviour, survivorship, distribution, and reproduction (e.g.: Karlson & Mörtberg, 2015; Monz, Pickering, & Hadwen, 2017). A highly used path can create a barrier and lead animals to avoid a much wider area through trail-edge effects (Monz et al., 2017; Moss et al., 2014). Capercaillie (Tetrao urogallus) respond differently to different OTR activities, e.g., they avoid mountain-bike trails up to 1091.5m and winter infrastructure up to 327.1m (Coppes et al., 2017). Along multi-use tracks, capercaillie use trees closer to tracks in less visited woodland than in highly visited woodland, with tree use asymptotes of 197m and 291m, respectively (Summers et al., 2007). The present study assessed 1) patterns of recreational uses, 2) functional habitat loss of capercaillie due to trail-edge effects, 3) the impacts of OTR on lek site selection, and 4) the potential for capercaillie refuges.

**Methods**

This study was conducted in Badenoch and Strathspey, in the western part of Cairngorms National Park, Scotland. This area was selected because of its popularity for OTR (CNPA, 2015), and has 83% of the remaining capercaillie population in Great Britain (Wilkinson et al., 2018).

User-generated geographic information (**UGI**) was harnessed from four tracking applications: Strava, MapMyFitness, Wikiloc, and AllTrails. To analyse the most recent distribution of the most popular activities, individual GPX routes of mountain-biking, walking, and running from the year 2019 were downloaded and converted into shapefiles for subsequent spatial analyses in GIS in relation to capercaillie lek sites (Kortland & Doubleday, 2019). First, trail-edge effects were 'erased' from woodland layers (SNH, 2018) to calculate the number of lek sites within undisturbed woodland. Then, a Fishnet grid was used to assess the use intensity from 0 (=no activity) to 6 (=very high intensity) of on- and off-trail activities in the 2.25km² grids with lek sites. Finally, use intensity layers were overlaid with woodland layers ('erased' by infrastructure buffers) to identify capercaillie refuges.

**Results**

Mountain-biking was largely woodland-based, with much lower use levels on open, high ground. Off-trail analysis revealed that visitors were more likely to go off-trail in more crowded areas. 96% of the mountain-biking routes were on-trail, compared to 89% of walking and 90% of running routes. However, the highest density of off-trail activities near lek sites occurred in a mountain-biking area.

After 'erasing' trail-edge effects, only 39% (41% in spring) of established woodland, and 45% (44% in spring) of young woodland remained undisturbed by mountain-biking; these woodland areas were less disturbed by walking and running. More than half of the capercaillie lek sites (52.6%) were inside, and 96.5% within 200m of, undisturbed areas, demonstrating the species' avoidance of disturbance.

Assessment of use intensity levels near lek sites showed that 38.6% and 50.9% of the sites were in areas of no walking or running activity, respectively. Due to the wider distribution of mountain-biking, fewer lek sites were within areas of no mountain-biking activity (8.8%). However, 57.9% were within areas with a very low to low intensity of mountain-biking. There was a relatively high number of lek sites in medium-low to medium-high intensity areas for all three activities. This was attributed to the high quality of preferred capercaillie habitat in these areas. By combining woodland cover and use intensity levels, important capercaillie refuges were identified in six woodlands (Figure 1).

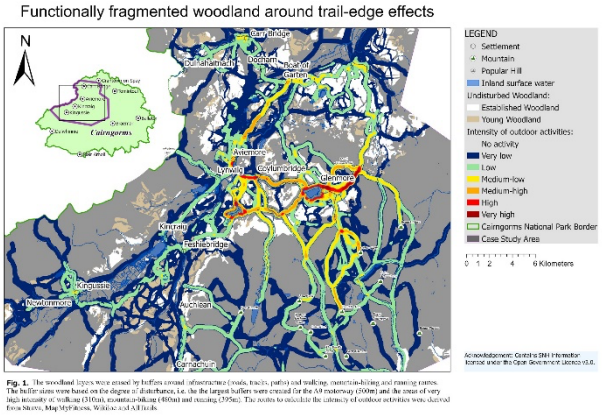


*Figure 1.*

## Discussion and conclusions

This research used UGI to investigate different levels of intensity of mountain-biking, running, and walking, to quantify spatial overlaps between OTR and capercaillie leks. While mountain-biking caused the highest functional habitat loss, mountain-bikers mainly used official trails, rather than going off-trail, as found previously (Monz & Kulmatiski, 2016; Nogueira Mendes et al., 2012). The ability to assess and predict the locations of, and reasons for, off-trail use close to capercaillie lek sites can help to identify appropriate management strategies for minimising unwanted disturbance during the reproduction and chick-rearing season (Norman & Pickering, 2019; Thiel, 2007).

The study also shows that capercaillie select leks in relation to both disturbance from outdoor activities and the availability of a high cover of established woodland. This confirms the results of previous studies (Jäger et al., 2020; Rösner et al., 2014; Summers et al., 2007), and shows that it is important to establish wildlife refuges in areas where disturbance from outdoor activities can be minimised because their levels are already low (Beeco et al., 2014; Henkens et al., 2006; Job et al., 2014) and woodland cover is high (Coppes et al., 2018; Summers et al., 2004).

This study showed that wildlife refuges can be identified by analysing UGI. The strength of this approach is the high level of spatial resolution of visitor data. However, as UGI only represent a small number of users (Jäger et al., 2020), the distribution and popularity of areas are relative rather than absolute, and such approaches should be used in combination with conventional visitor monitoring methods.

## References

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