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Challenges and innovations for grasslands resilience

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Extensive grazing in bird protection areas—does virtual fencing minimize the trade-offs?

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Abstract

Extensive livestock grazing can preserve semi-natural grasslands, which are an essential habitat for many bird species. However, ground-nesting birds are threatened by trampling. Temporary fencing can safeguard bird breeding success, but installing fences is labour-intensive. Virtual fencing (VF) could facilitate bird protection efforts. Virtual fences are defined on a digital map and transmitted to a GPS-collar on the grazing animal. We tested whether VF reduces cattle trampling damage using artificial bird nests. Over 33 days, 19 heifers were grazed on a 19-ha pasture in a national park at the Baltic coast. The pasture comprised four vegetation types, where we placed one small (100 m²) and one large (300 m²) VF-exclosure and equally sized open plots, respectively. We deployed artificial nests and checked them 5 times during the trial (912 nest inspections). Overall, we found 14 and 62 trampled nests in VF and open plots, respectively. Trampling probability was independent of plot size, within-plot nest position and vegetation type. Trampling was nearly 6 times more likely in open than in VF plots. Consequently, VF can effectively reduce bird nest losses caused by cattle. VF could thus optimize the conservation outcomes of extensive grazing systems while minimizing the workload for biodiversity-friendly grazing management.

Keywords: bird protection, cattle, conservation management, smart farming, trampling

Introduction

Extensive grazing with cattle or other livestock species is an established approach to preserve open landscapes, such as semi-natural grasslands, which are an essential habitat for many bird species. However, livestock grazing comes along with a conservation conflict, as nests of ground-nesting birds are threatened by trampling, which can lead to nest failure (Pakanen *et al.*, 2011; Sharps *et al.*, 2017). Consequently, temporary fences are required to foster the breeding success of bird species nesting within pastures. Installing such fences is labour-intensive and challenging in the agricultural practice. The rising technology of virtual fencing (VF) could facilitate such bird protection efforts (Wätzold *et al.*, 2024). Virtual fences are drawn on a digital map via a mobile device and communicated to a GPS-collar on the grazing animal (Umstatter, 2011). When the animal approaches the fence line, the collar emits audio cues, and an electric cue if the animal does not draw back. We tested whether VF is effective in reducing nest trampling damage by grazing cattle in a national park at the Baltic coast.

Materials and methods

The animal experiment was approved by the State Office for Agriculture, Food Safety and Fisheries Mecklenburg-Western Pomerania, ref. number: 7221.3-1-023/24. Mid-September 2024, 19 pure- or crossbred Fleckvieh heifers belonging to a large organic farm operating on the Darß peninsula at the

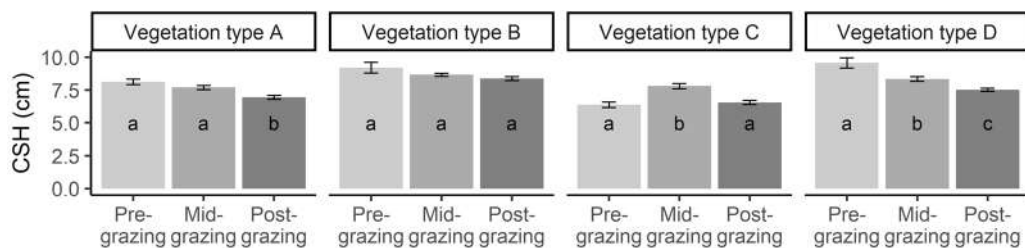


Figure 1. Mean \pm SE of the compressed sward height (CSH, raw data) in the four vegetation types with letters indicating significant ($P < 0.05$) differences between measurement time points within vegetation type after Tukey's HSD P -value adjustment.

German Baltic coast were fitted with virtual fencing collars (Nofence, Batnfjordsøra, Norway). Over 10 days, the animals were habituated to the collars and trained with the technology following Hamidi *et al.* (2022) on a ca. 1-ha section of a 19-ha pasture located in the Western Pomerania Lagoon Area National Park. The heifers were released onto the whole pasture on 27 September 2024 and grazed there until the end of the trial on 30 October 2024.

The pasture was classified based on its general appearance and species composition into four vegetation types: (A) short green grass (mostly *Holcus lanatus*, *Poa pratensis*, *Dactylis glomerata*), (B) *Juncus effusus*-dominated, (C) short dry grass (mostly *Bromus hordeaceus*) and herbs, (D) *Agrostis capillaris*-dominated. These types were distributed in several patches over the pasture. During pre-, mid-, and post-grazing, we measured the compressed sward height (CSH) 150 times per vegetation type with a rising-plate meter (excluding rushes). In each vegetation type, we placed one small (100 m²) and one large (300 m²) virtually fenced plot (exclosures) and equally sized open reference plots. We initially deployed five artificial nests composed of three commercially acquired snail shells (*Helix pomatia*) in the small plots and 10 nests in the large plots. After two weeks, we increased the numbers to nine nests in the small plots and 19 nests in the large plots. Nests were checked for trampling damage (1–3 shells broken) five times during the trial at 7-day intervals (except for the final check, which was done after 4 days) resulting in a total of 912 nest inspections.

We analysed the CSH in a generalised least squares model as a function of the measurement time point (pre-, mid-, and post-grazing) in interaction with the vegetation type, including a variance function structure to account for within-group heteroscedasticity. We analysed the probability of a nest being trampled in a generalised linear mixed effects model with binomial distribution. Plot type (VF or open), plot size, nest position (close to the border or in the plot centre), vegetation type, inspection date and their two-way interactions served as explanatory factors. The random effect accounted for the grouping of nests within plots. The global model was simplified based on likelihood ratio tests and AIC. All analyses were done in R (v. 4.4.1).

Results and discussion

The CSH varied significantly between vegetation types in interaction with measurement time points ($\chi^2 = 44.62$, $df = 6$, $P < 0.001$, Figure 1). In total, we found 14 and 62 destroyed nests in exclosures and reference plots, respectively. The probability of a nest being trampled was independent of plot size, nest position and vegetation type, while the effects of plot type ($\chi^2 = 28.17$, $df = 1$, $P < 0.001$) and inspection date ($\chi^2 = 15.57$, $df = 4$, $P = 0.004$) were highly significant (Figure 2).

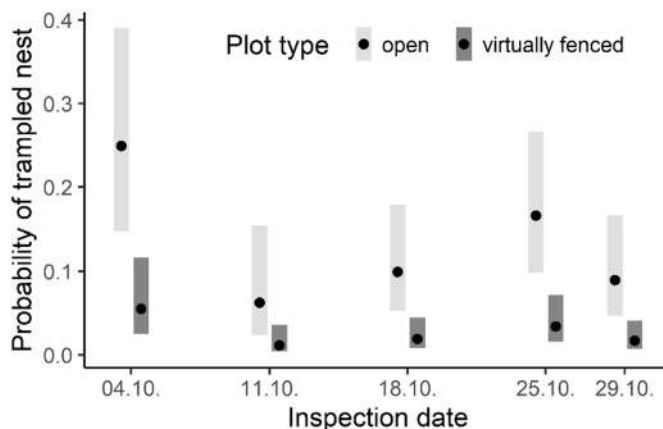


Figure 2. Estimated marginal means (\pm 95% confidence interval) of the probability of an artificial bird nest being trampled by heifers in open and virtually fenced plots during the grazing trial in 2024.

The probability that a nest was trampled in an open plot was 0.12 (SE = 0.03) compared to 0.024 (SE = 0.01) in VF plots (odds ratio 5.68, SE = 1.86, z -ratio = 5.31, $P < 0.001$).

Bird nests have been found to be trampled by cattle in both tall and short vegetation (Pakanen *et al.*, 2011) with the local intensity of cattle activity being an important driver of nest losses (Sharps *et al.*, 2017). Thus, it is not surprising that we did not find a difference in trampling probability between vegetation types despite moderate differences in sward height. The highest trampling probability was recorded at the first inspection date, which is in line with experimental results from Baltic coastal meadows in Finland (Pakanen *et al.*, 2011) and might be related to higher cattle activity and exploration behaviour at the beginning of the grazing period. This highlights the importance of protecting environmental assets or sensitive areas when cattle are released on a new pasture, for example via virtual fencing.

Conclusion

VF effectively reduced bird nest losses caused by cattle trampling under extensive grazing. Similarly, VF could protect occurrences of rare plant species or environmentally sensitive areas. Once economic and legal hurdles have been overcome, VF will be a promising opportunity to optimise the conservation outcomes of livestock systems, without burdening farmers with additional physical work for biodiversity-friendly grazing management.

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