The short-term impacts of cessation of grazing on plants and land snails in grasslands in the west of Ireland.

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Abstract

The Burren in western Ireland is famous for its biodiversity. It is well accepted that the high biodiversity of the region is linked strongly to its agricultural traditions. However, there are significant changes happening in the landscape including a major expansion of hazel scrub into grazing land. This is due, at least in part, to changes which have occurred in farming in recent decades. To provide some evidence-based insight into this issue, this study investigated the effects that the complete cessation of grazing in Burren grasslands would have on biodiversity – with the focus on vascular plant and land snail communities. Large changes were recorded from within fenced grassland exclosures (with more mixed pictures emerging for scrub and woodland). A significant decrease was seen in both species richness and diversity for the plants in the grasslands, along with a significant increase in the amount of litter present. In the case of the snails, however, abundance increased significantly inside the fenced plots, while there was only a very small change in the controls. Shifts in community structure were also evident. It is likely that the molluscs benefitted from the higher vegetation and denser litter, providing them with food, shelter and moisture.

Keywords: Mollusc, Burren, Land-use change, Exclosures, Diversity

Introduction

The Burren in the west of Ireland is famous for its flora and fauna and its impressive biodiversity and landscape (O'Connell and Korff, 2001; Viney, 2003). All of this is indebted in no small way to the agricultural traditions of the area (Dunford, 2002). Many of the best known habitats, including limestone pavements and species-rich grasslands, are now considered to be under threat from encroaching hazel scrub (The Heritage Council, 2006). The scrub also interferes with farming practices by blocking pathways used by stock and taking over grazing land. There is no single reason for the increased rate of scrub encroachment, but one of the main contributing factors is changes in farming practices. The use of less-hardy animal breeds, the decrease in the practice of out-wintering animals, farmers often working off-farm and the changeover from beef cattle to suckler cows has resulted in a general decrease in the grazing pressure on some of the most valuable Burren habitats (Dunford, 2002; Williams *et al.*, 2009). With these

changes in mind, the current study was devised in order to investigate the effects that might be wrought on biodiversity should grazing cease altogether. The focus was on vascular plant and land snail communities.

Materials and Methods

A network of twelve fenced exclosures (each 20x20m) was set up across the Burren region in 2006. The fences prevent access by large grazers (mainly cattle and goats) and were placed in three types of habitat: rough grassland, areas with low or scattered hazel scrub, and hazel woodland. Beside each fenced area is an unfenced control plot of similar size. Plants and snails have been monitored since the set-up in these paired fenced and control plots. Plant data were collected from five fixed 2x2m quadrats within each plot, and molluscs were sampled using 25x25cm quadrats placed adjacent to these (vegetation was removed, dried and the molluscs picked from the samples and identified to species level).

To investigate if the cessation of grazing had an effect on plant species richness or diversity, general linear ANOVA models were constructed. These tested for differences in changes in numbers of plant species and diversity between 2006 and 2008. Diversity was measured using 'Simpson's Diversity Index'. The factors used in the model were 'habitat' (fixed), 'site' (nested within habitat; random) and 'treatment' (i.e. fenced/unfenced; fixed). The effect of 'year' was accounted for in the analysis by using 'change in species number' as the response variable. Tukey Simultaneous Tests were used for post-hoc analysis. Before computations, data were tested for normality and homogeneity of variances, and transformed where necessary. Analyses were carried out in Minitab 13.3.

To elucidate the effect of cessation of grazing on mollusc community structure NMS (non-metric multidimensional scaling) was used. This is a form of indirect gradient analysis, and is a robust ordination technique, well suited to extracting patterns from community data which are often non-normal and 'zero-heavy' (McCune and Grace, 2002; Perrin *et al.*, 2006). All data were screened using outlier analysis, and the distance measure used was Quantitative Sørensen (Bray-Curtis). All analyses were carried out using PC-ORD 5. Only a subset of the analyses is presented here – i.e. the fenced grassland plot data only.

Results and Discussion

A significant interaction ($p<0.001$) between 'habitat' and 'treatment' was found in the test for differences in species number between 2006 and 2008, meaning that the effect of the treatment between years changed

depending on the habitat (Figure 1). Post-hoc analysis revealed that the changes in species numbers inside the fenced plot in grasslands were significantly different to the changes in the grassland controls (p=0.0001), but that this was not the case for either woodlands or scrub. For changes in diversity, results again indicated a significant interaction between habitat and treatment, with post-hoc analysis showing that there was a highly significant difference (p<0.0001) between the change in diversity seen in the woodland fenced and control plots (diversity increased more within the fenced plots) (Figure 2). There was a more moderate, but still statistically significant (p=0.0291), difference between the changes seen in the fenced and control plots in the grassland sites (diversity decreased inside the fences but remained almost unchanged in the controls). No significant differences were found for the scrub plots. These findings, though perhaps surprising clear-cut for a short-term study, are not without precedent. Other studies based in grasslands, such as those of Gibson (1997), Hansson and Fogelfors (2000), Moles et al. (2005), Enyedi et al. (2008) and Deenihan et al. (2009), have all found lower species richness and/or diversity in ungrazed grasslands, when compared to grazed sites.

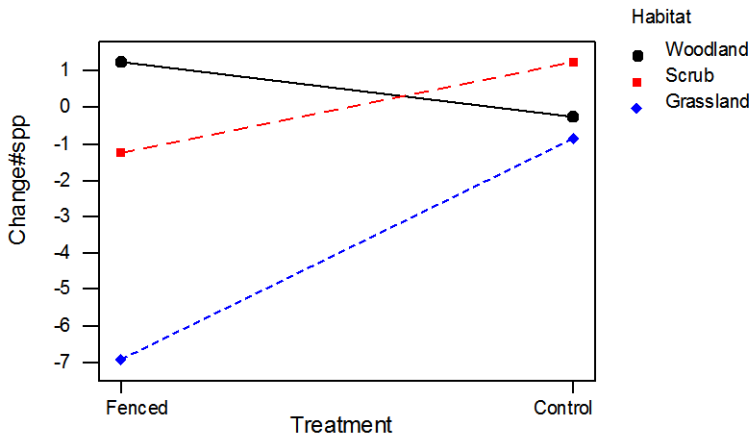

Figure 1. Interaction plot showing effects of treatment on the mean change in number of species between 2006 and 2008 in each of the three habitat types.

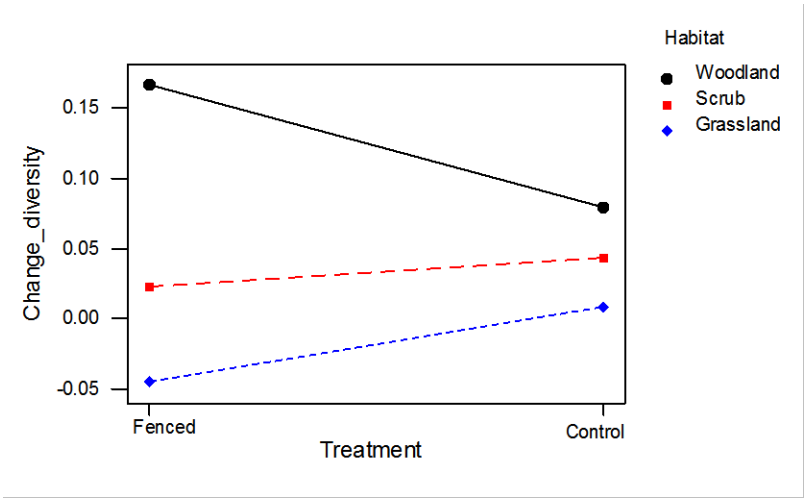

Figure 2. Interaction plot showing effects of treatment on the mean change in Simpson's Diversity Index between 2006 and 2008 in each of the three habitat types.

With respect to the land snails, while there was no change in the total number of species recorded (25 each year), the mean number of individuals collected per quadrat inside the fenced plots (across all species and all habitats) increased by almost 50% between the first and second sampling periods – from an average of 14.1 ±2.3 snails to an average of 20.9 ±5.4. There was only a very small change in the corresponding control plot numbers (a decrease of 3%, from 12.1 ±2.6 to 11.8 ±2.5). The largest and most consistent changes were seen in the grassland sites (more detailed data available on request).

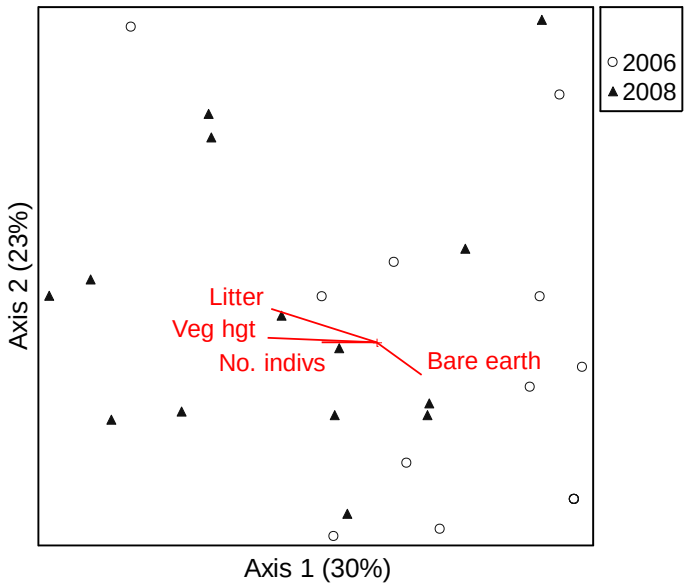

Figure 3. NMS ordination of mollusc data from fenced grassland plots. Each point corresponds to a quadrat. Figures in brackets on axis labels are the percentage of the variation in the distance matrix which is explained by this axis. The most influential variables are overlaid.

Multivariate analysis of the fenced grassland plot data showed a definite shift in the species composition of the mollusc communities over the two-year period, with quadrats sampled in 2006 tending to separate from those sampled in 2008 (Figure 3). (Analyses not presented here confirm that no such trend is evident from the control plots.) The main factors associated with this shift were found to be cover of litter and vegetation height, both of which increased substantially in the absence of grazing.

The findings presented here suggest that the snail populations overall benefitted from the longer vegetation and denser litter which resulted from the exclusion of grazers from grassland plots, and these findings concur with those of Boyd (1960) and Labaune and Magnin (2002). Ausden et al. (2005), in a study of fens, also found that the exclusion of cattle caused an increase in the number of molluscs. Further, on the re-introduction of cattle grazing, they recorded a reduction in litter, and a reduction in mollusc densities. It is likely that the build-up of litter provides extra food, shelter and moisture for snails, and thus conditions improve (at least for certain

species). It should be noted that no such trends were seen in this study in scrub or woodland habitats.

Conclusions

The significant decrease in both species richness and diversity in vascular plants recorded from within the grassland fenced plots points to the crucial role that grazers play in maintaining grassland plant communities. However, the numbers of individual snails recorded increased dramatically within fenced grassland exclosures over the study period. These contrasting findings highlight the importance of assessing a suite of taxa when investigating the effects of changes in management practices on biodiversity.

The exclosures set up during this study provide a valuable tool for monitoring long-term vegetation and landscape change in the Burren into future decades. It is hoped that this work will be continued into the longer term. In particular, it will be of interest to investigate the longer-term effects on rarer snail species and on those requiring open habitats.

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