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VEGETATION CHANGES IN SOWN GRASSLAND IN THE UK AFTER NINE YEARS OF EXTENSIVE GRAZING MANAGEMENT

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Abstract

The effect of extensive grazing management with sheep on vegetation change in sown pastures (initially containing *Lolium perenne* and *Trifolium repens*) in the uplands of Scotland was investigated from 1990-1999. One treatment was representative of current more intensive management systems; it was fertilized, and maintained at a sward surface height of 4 cm. Two treatments were unfertilized and were maintained at sward surface heights of 4 cm or 8 cm; the ewe numbers carried on these treatments averaged 74% and 44%, respectively, of those on the fertilized treatment. In all treatments the sheep were Scottish Blackface ewes. Their single lambs also grazed from May until weaning in mid-August. Over 9 years there were only small changes in species composition in the unfertilized treatments. The changes were primarily shifts in abundance of the species present initially, with only a few additions or losses of species. *L. perenne* made a similar contribution to cover in both the 8 cm and fertilized swards. The highest content of *T. repens* was in unfertilized swards and the least was in the 4 cm fertilized swards. This study demonstrates that the contribution of the sown species to sward composition remains high in grazed upland swards that are more extensively managed for nearly ten years. Since there was little overall change in species composition, it could be difficult to achieve increased plant biodiversity in these systems simply by removing fertiliser and reducing grazing intensity.

Keywords: extensive grazing management, perennial ryegrass, species diversity, upland grassland, vegetation change, white clover

Introduction

Many upland and marginal areas of the UK are unsuitable for arable cropping due to a combination of altitude, aspect, soil and climatic factors. The dominant agricultural enterprise in these areas is sheep grazing on permanent pastures. The sown pastures, based on *Lolium perenne* and *Trifolium repens,* were sown between 20 and 50 years ago, and they have been relatively intensively managed for several decades. However, policy changes and economic pressures are likely to lead to lower inputs of fertilizer and lower stocking densities than in the past in an attempt to reduce costs and output and increase biodiversity. Lower stocking densities provide increased opportunities for diet selection and associated changes in species composition. This can promote the development of a heterogeneous habitat, which can result in increased biodiversity (Crawley 1983). There is a need to quantify the impact of reductions in stock densities on species composition of the vegetation and the output of animal product to assist in the development of government policies. The experiment reported here describes the effect of more extensive management for 9 years on vegetation change.

Material and Methods

An experiment was set up in spring 1990 on sown *Lolium perenne-Trifolium repens* swards at three upland sites across Scotland to compare vegetation changes under five different extensive managements with a more intensive management. Details of all sites and treatments are in Marriott and Gordon (1997). In this paper, vegetation changes at one site from 1990-1999 for two of these extensive treatments and the more intensive treatment are presented. The site was in central Scotland at Macaulay Land Use Research Institute's Hartwood Research Station (3º 51' W 55º48' N, 245 m a.s.l.), on a poorly draining, non-calcareous, gley soil. Experimental plots were approximately 0.45 ha, and each treatment was replicated twice in a randomised block design. The extensively managed treatments were maintained by grazing at two sward surface heights, 4 cm (4u) or 8 cm (8u), from April until mid-November and received no fertilizer. The more intensive treatment (4f) was maintained at a sward height of 4 cm and was fertilized (an annual total of 150 kg ha^{-1} N and 20 kg ha^{-1} each of P_2O_5 and K_2O,). Height treatments were maintained by adjusting animal numbers in response to weekly measurements of sward surface height. All swards were grazed by Scottish Blackface ewes; their single lambs were also present from May until weaning in mid-August. The numbers of ewes grazing on the unfertilized grazed treatments relative to the fertilized treatment (4f) averaged 74% on the 4u treatment and 44% on the 8u treatment over 9 years.

Species composition of swards was measured using an inclined point quadrat. Measurements were made biennially in June from 1990-1996 and annually thereafter. The trends in similarity/divergence of overall species composition in the different treatments over time were summarised by ordination methods using CANOCO 4 (ter Braak & Smilauer 1998). Temporal variation in the sown species during the nine-year period is also presented.

Results and Discussion

Detrended correspondence analysis (DCA) of the vegetation data examined the overall changes in species composition over time. Axis 1 was short and the only significant one. The treatments showed little movement over time; the greatest movement was in the 8u treatment. Redundancy analysis (RDA) produced a model with the species-environment relationship explaining 94% of the variance with two ordination axes. The Monte Carlo permutation test showed the model to be significantly better than a randomly generated one (F=6.296, P=0.01 for the first canonical axis). The 4f treatment was negatively correlated with Axis 1 and positively correlated with Axis 2, the 4u treatment was negatively correlated with Axis 2 and the 8u treatment was positively correlated with Axis 1(Figure 1). The first axis separated the species common in short swards (negative) from those dominant under lower levels of utilization (positive). *L perenne* was most highly correlated with the 4f treatment, moss with the unfertilized treatments and *T.repens* with the 4u treatment. The differences between treatments and over time did not involve any major shifts in species dominance or the loss or colonization of many species. Studies over a similar time-scale in different grassland communities with different intensities and/or seasonal pattern of grazing, have also found small changes in species composition (e.g. Hulme *et al*. 1998). This contrasts markedly with the large and rapid changes in vegetation to cessation of grazing (Marriott *et al*., 1996).

L. perenne made a higher contribution to species composition of 4f and 8u swards than 4u swards (57.4%, 44.7% and 55.6% in 4f, 4u and 8u swards, respectively, s.e.d.=2.04, d.f.=14, P<0.001). There was some variation over time and the highest contribution, averaged over all treatments, was in 1997 (61.9%) and the lowest in 1994 (42%, s.e.d=3.17, d.f.=6, P<0.01). There was more *T. repens* in the unfertilized than fertilized swards, and the greatest amount was in 4u swards (8.1%, 20.3% and 10.5% for 4f, 4u and 8u swards, respectively, s.e.d.=0.87, d.f.=14, P<0.001). There were differences between years (P<0.01) and the highest content of *T. repens*, averaged over all treatments, was in 1990 (Figure 2). Although fertilizer applications had ceased in the unfertilized swards, nitrogen inputs from N_2 fixation by white clover partly made up for this. Nutrient redistribution via excretal return also continued. Thus sown species appear not to have experienced nutrient limitations in the unfertilized swards which would affect their competitive ability in the sward. This may explain why the proportion of sown species remained high.

This study demonstrates that sown species remained in grazed sown upland pastures that were more extensively managed. However the small changes in species composition over nearly ten years, suggest that it could be difficult achieve increases in biodiversity in such upland sheep systems simply by removing fertilizer and reducing grazing intensity. The presence of a diverse range of vegetation types within the local area should assist the colonization of new species. Otherwise, reseeding with the desired species may be necessary.

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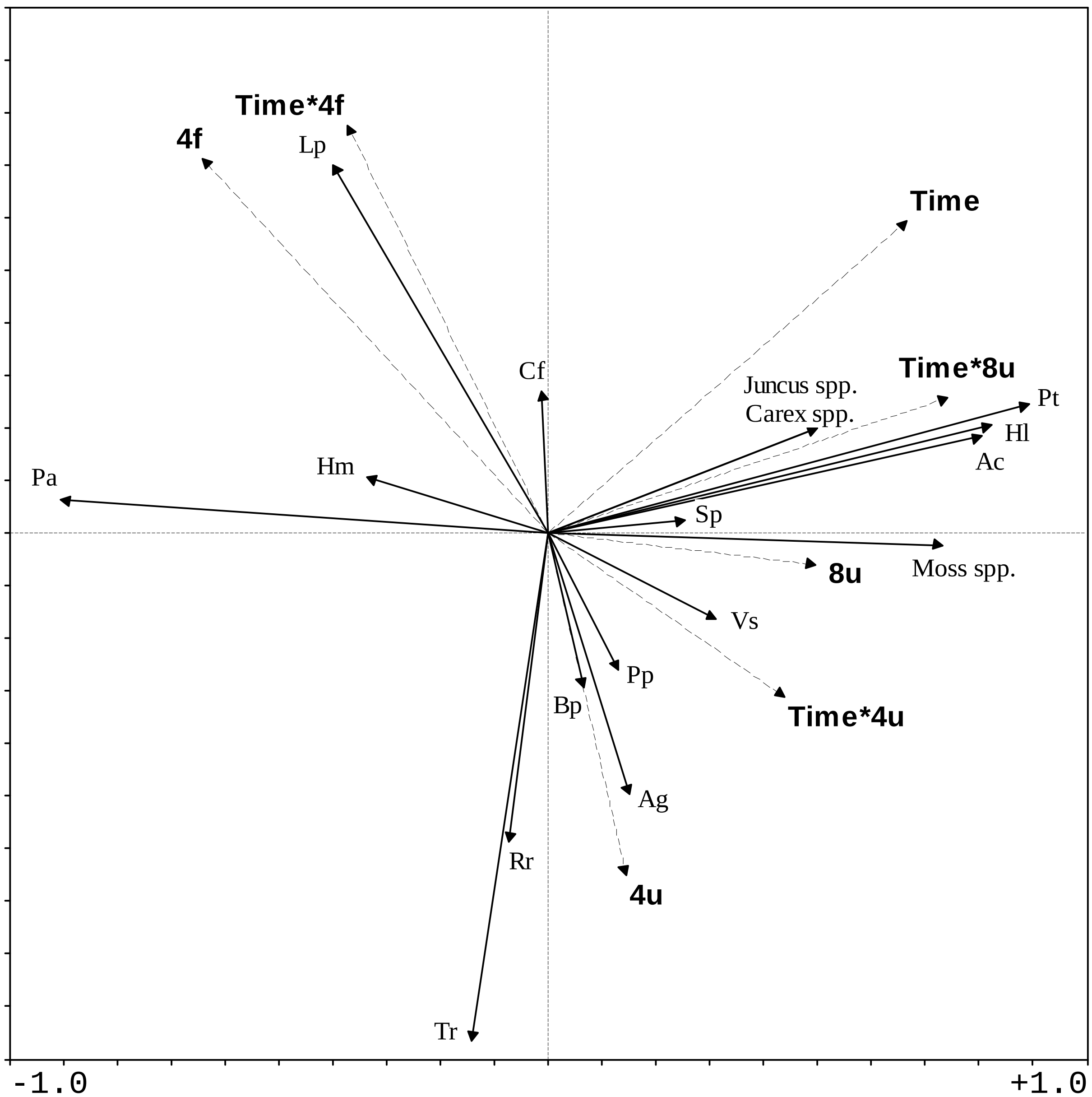

Figure 1 - Species-treatment biplot from Redundancy analysis (RDA), showing the effect of time, treatment (4f, 4, 8) and the interaction of treatments with time (Time*4f, Time*4, Time*8). Species codes: Ac- *Agrostis capillaris*, Ag- *Alopecurus geniculatus*, Bp- *Bellis perennis*, Cf- *Cerastium fontanum*, Hl- *Holcus lanatus*, Hm- *H. mollis*, Lp- *Lolium perenne*, Pa- *Poa annua*, Pp- *P.pratensis*, Pt- *P. trivialis*, Rr- *Ranunculus repens*, Sp- *Sagina procumbens*, Tr- *Trifolium repens*, Vs- *Veronica serpyllifolia*.

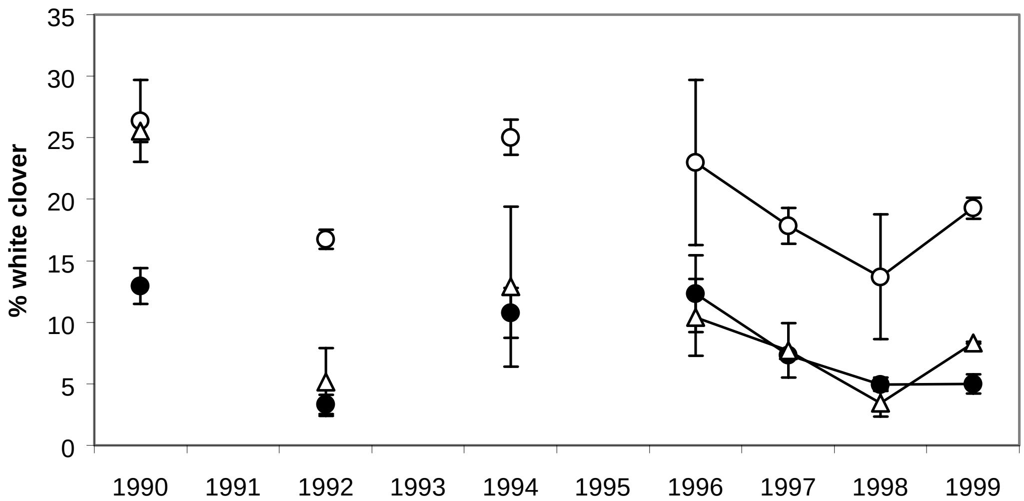

Figure 2 - Contribution of white clover to swards under different intensities of management (●, 4f; ❍, 4u; Δ, 8u) over 9 years.