Grazing and mowing as management tools on dunes*

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Abstract

A brief review of mowing and grazing of sand dune vegetation introduces the first results of the use of these management techniques at Newborough Warren National Nature Reserve, Anglesey, north Wales. In the mowing experiments, plots are mown one (May), twice (May and July), three times (May, July and September) and five times (May, June, July, August and September).

The grazing experiment has the equivalent of one or two animals to three-quarter acre paddocks (0.3 ha) which are grazed for one third, two thirds or for the whole year.

Mean numbers of species per plot, and *Lotus corniculatus* have increased in both sets of experiments whereas *Arrhenatherum elatius* has declined. Other species do not show clear-cut changes. Both methods provide practical means of maintaining a short turf, but the long-term effects of mowing may not be beneficial to the vascular plant flora. Grazing can however provide a crop as well as a desirable flora although manpower and capital costs may limit its use by conservationists.

Introduction

This paper describes work which has been done on the grazing and mowing of duneland vegetation as a management tool in Anglesey, Wales, Great Britain. The vegetation on the study area covers a wider range than just dunes, and includes stable *Ammophila* dunes through to dune slack where the water table is at or near the surface in winter. Only stable areas are considered, as grazing or mowing mobile habitats is unlikely to be contemplated as a routine management regime. Consideration of these management regimes on the fauna (both vertebrate or invertebrate) of the area is not reported although there are some obvious effects.

Background

The fact that grazing animals affected coastal plants was recorded at least 70 year ago in the first

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issue of the Journal of Ecology, (Rowan, 1913), where damage to plants by rabbits at Blakeney Point was described. Tansley (1939) was in no doubt about the effects of animals on plants and vegetation, while more recently the papers in Duffey & Watt (1971) bring the picture more up to date. However, the emphasis has been on other habitats than duneland e.g. chalk grassland. The upsurge of interest in semi-natural grassland management in the last 30 years is the result of the destruction of large populations of rabbits by myxomatosis and an increasing interest in the management of such grassland for amenity and nature conservation. The published work on chalk and upland grasslands is highly relevant to any studies of dune grassland as there are many species in common which can be expected to behave in a similar way.

For further information, the reader is referred to Duffey & Watt (1977), Duffey *et al.* (1974), Spedding (1971), the latter leading to the wider field of managing grassland for agricultural purposes. However, despite these reviews the activities of grazing animals (especially rabbits) in dune grasslands have not yet received the systematic study they deserve (Ranwell, 1972). Particularly since the structure of sand dune communities in Europe prior to myxomatosis was effectively the product of intensive rabbit grazing and Ranwell (1960) described changes in the flora at Newborough Warren resulting from the death of rabbits. White (1961) observed similar changes at Blakeney Point on the east coast of England. More recently Bhadresa (1977) studied the food preferences of the rabbit at Holkham, just west of Blakeney. In the same year, Zeevalking & Fresco described a quantitative approach to measuring intensity of rabbit grazing and its effects on species diversity in the Frisian Islands. Now the rabbits have greater immunity to myxomatosis, there is the possibility of a return to the heavily grazed dunes of 30 years ago. If this happens rabbits will require controlling to obtain the desired plant communities. Appropriate rabbit grazing intensities may be defined from work such as that of Zeevalking & Fresco (1977).

Grazing by domestic animals offers much more control over the amount of grazing and hence the resultant communities. It has long been known that cows, horses and sheep have different ways of grazing and result in different vegetations. Boorman (1977) quotes Blom & Willems (1971) who describe the species-rich area on Westduinen, Goeree, which provides summer grazing for about 100 cows and 10 horses.

While it is possible to guess at suitable grazing regimes for a particular site and adjust the grazing intensity in the light of experience, results from specific experiments will provide a more reliable basis for management.

In some instances, it may not be feasible to graze the land, but it may be possible to mow it despite its non-selective effects on plants. Spedding (1971) and Wells (1969) explain the important differences between grazing and mowing. Boorman (1977) suggests one advantage of mowing over grazing which is that it can be applied to small areas. Control of coarse grasses such as *Arrhenatherum elatius* can be effected by mowing, but it is not certain if long-term effects will be beneficial (Wells, 1969). Where the cuttings are removed, the site may be impoverished, while the build-up of cuttings at the soil surface may lead to acidification which may not be desirable.

The experiments described below are an approach to the production of general management prescriptions for sand dunes in western Britain.

Experiments in Wales

It became quickly clear that an experimental approach was going to be more satisfactory for investigating the dynamics of the dune grasslands under various management regimes than observation alone or the use of exclosures. There were two major limitations to the use of exclosures: (a) one did not know what animals were grazing outside nor how often or when, and (b) the exclosures were damaged by animals and humans. Fortunately it was possible to set up experiments at Newborough Warren National Nature Reserve in Anglesey. First the mowing experiments were started as these required less land and relatively little by way of equipment or organization, contrasting with the large area of land, long lengths of fencing and a supply of animals (soay sheep) needed for the grazing experiment.

The aim of the work was to be able to make practical recommendations for managing tall grass communities on dunes whether by grazing or mowing.

Grazing experiment

The experiment is on an area of stable grassland at the north-eastern edge of the Eastern Warren of Newborough Warren NNR near to Llyn Rhos-ddu (the only body of permanent freshwater on the reserve). The aims and description of the experiment is given by Hewett (1982). It consists of 24 acres (9.7 ha) divided into two blocks, each of 16 0.75 acre (0.3 ha) paddocks. There are two intensities of grazing equivalent to either one or two sheep per paddock. This is achieved in practice, by using flocks of 4 and 8 sheep in each block which are moved each week. The effect of grazing at different times is examined by dividing the year into thirds, namely January to April, May to August and September to December. The complete combination of one third, two thirds and whole year grazing periods is included in the experiment. There are also two ungrazed controls in each block. In each paddock are 12 2 × 2 m quadrats, systematically spaced on a grid pattern. A record of all vascular plant species and a visual estimate of cover was made during 1982. These data are the basis of the results reported below, with mean cover values per paddock for each species being used for the calculations, except where number of species was considered.

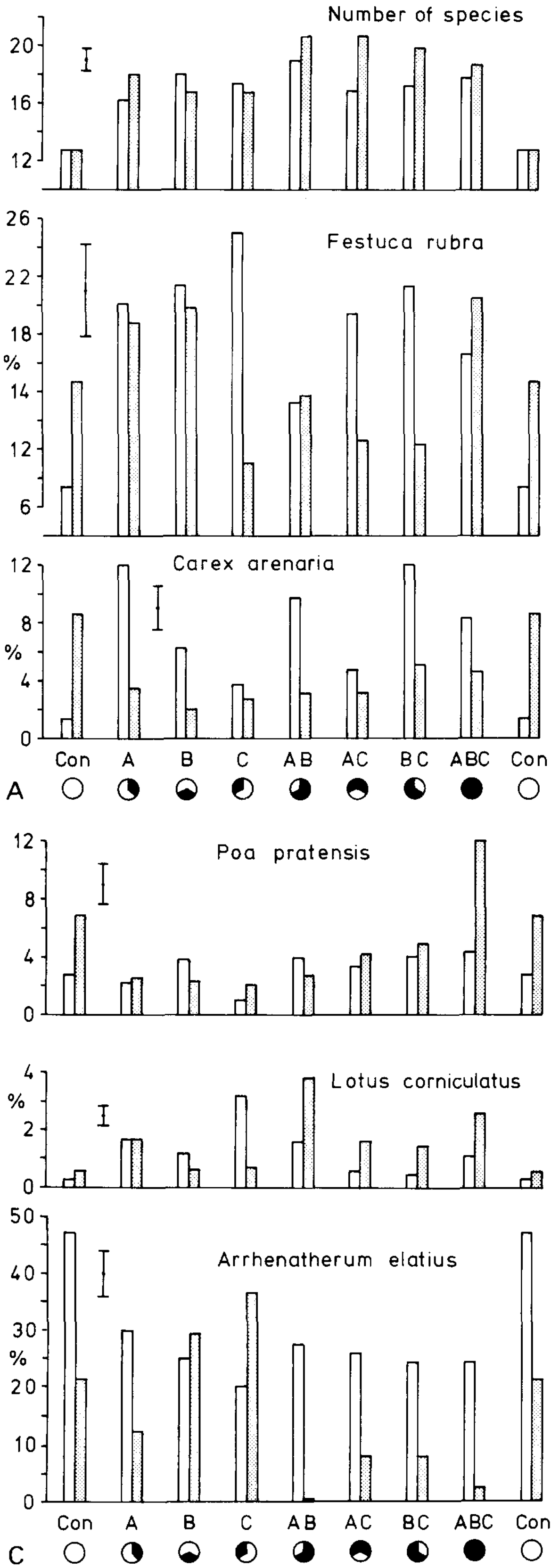
Number of species

This parameter refers to the mean number of species recorded in each paddock. The probabilities arising from the analysis of variance can be seen in Table 1. Only the blocks versus grazing level interaction was not significant. This analysis gives an indication of the variability of the habitat, e.g. the blocks are different and a warning that a cautious interpretation should be made of these data. Despite this high variability some interesting trends are apparent, summarized in Figure 1. All the grazed treatments have higher mean numbers of species than the ungrazed. There is very little difference between time of year treatments at the lower grazing levels except perhaps for AB, grazed Janu-

Table 1. Analysis of variance probabilities for selected species.

	Blocks	Time of year	Grazing levels	Blocks × grazing levels	Blocks × time of year	Time of year × grazing levels	Block × time of year × grazing levels	Residual
Degrees of freedom	1	7	1	1	7	7	7	352
Number of species	**	**	**	NS	**	**	*	
Festuca rubra	**	*	*	NS	NS	**	*	
Carex arenaria	*	**	**	NS	*	**	**	
Ammophila arenaria	**	**	NS	NS	**	*	**	
Salix repens	**	**	**	**	**	**	**	
Poa pratensis	**	**	*	**	**	*	**	
Lotus corniculatus	**	**	NS	NS	**	**	**	
Arrhenatherum elatius	**	**	**	**	**	**	**	

* = $p < 0.05$; ** = $p < 0.01$; NS = not significant.



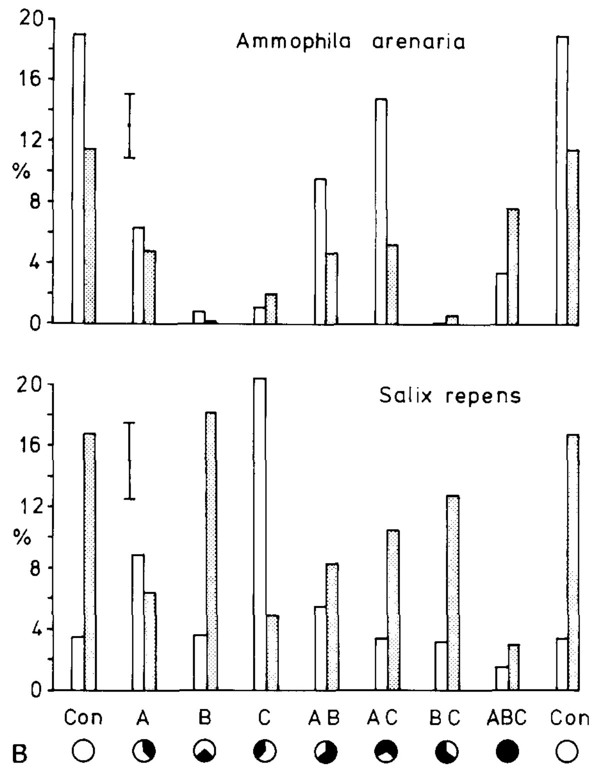


Fig. 1. Mean values of cover for selected species (except number of species) (y-axis) against time of grazing (thirds of a year) for low (plain) and high (stipple) grazing levels (x-axis). A = January to April, B = May to August, C = September to December. Bar symbol is twice approximate standard deviation.

ary to August. The largest mean number of species was for plots grazed for two thirds of the year at the higher grazing level, especially AB and AC, i.e. grazed January to August and August to April. Treatment ABC, grazed for the whole year, has values between the plots grazed for one third and two thirds of a year. It is clear that this highest grazing level is too heavy for optimum numbers of species.

Festuca rubra. *Festuca rubra* is a widespread duneland species and is certainly important in the grazing experiment. Yet there is considerable variation in the data presented (Fig. 1). In the analysis of variance, two of the comparisons were not significantly different, namely between blocks and time of year, and blocks and grazing levels, but all the others were (Table 1). There are increased cover values for most of the 'time of year' treatments at the low grazing level, except for treatment AB, grazed January to August. (Fig. 1). All the treatments for one third of the year have greatly increased values compared with the highest control. Treatments C, AC and BC, at the highest grazing intensity, have low values which are within the range of cover values of the controls. As reduced cover is a feature of all the paddocks concerned and not due to absent or exceptionally low values in one paddock, it is concluded that *Festuca rubra* is sensitive to heavy grazing in the later third of the year. This does not explain the high cover value for the all the year treatment at the high grazing intensity. There must be some compensating factor, possibly more palatable species being grazed, reducing the pressure on *Festuca rubra*

Carex arenaria. The differences in cover of *Carex arenaria* between the two blocks are not as great as for most of the other species (means 4.9% and 6.4% for blocks I and II, resp. This agrees with the analysis of variance where the difference between blocks is significant at $p < 0.05$ (Table 1). The interaction between blocks and grazing levels was not significant but all others were.

There is a suggestion in Figure 1 that the lower grazing levels have caused an increase in *Carex arenaria*, but the high levels have reduced its cover, particularly if considered against a mean of the two controls. However, only three of the low level treatments are greater than the highest control, whereas all the high level treatments are greater than the lowest control. Thus most of the results lie in the same range of cover values as the controls.

Ammophila arenaria. This species is important as a dune species but its distribution limited over the experimental area. The differences noted therefore reflects the distribution within the paddocks to some extent. It is more frequent in block II (Hewett, 1982). This could account for the significant difference ($p < 0.01$) between blocks in the analysis of variance (Table 1). There were significant differences between four other factors, but there was no significant difference between high and low grazing levels, nor in the interaction between blocks and grazing levels. The uneven distribution makes interpretation of Figure 1 difficult. For example it is absent from one of the ungrazed paddocks used in comparisons with the high grazing levels, so it is half its original value. In all, it is absent from 10 of the 32 paddocks, with 8 of them from block I. In the more heavily grazed paddocks, the young shoots are grazed and the dead material broken by the foraging animals. At low grazing intensities, it is relatively little affected, even by trampling, although the herbage is opened up to some extent.

Salix repens. This is another species whose distribution is determined by topography, occurring in areas with the water table near the surface. It has the opposite distribution to *Ammophila arenaria*, having the highest cover in block I. In the analysis of variance all factors and combinations of factors had significant differences at $p < 0.01$ (Table 1).

In Figure 1, the extreme values in treatments B, C and the controls are due to certain paddocks having very high cover values. Because of the extreme variability in the original distribution of the species, it is impossible from Figure 1 to be sure if any of the treatments have produced any real differences. The sheep certainly browse the upstanding twigs, but the plant is able to grow at ground level, producing a sward of closely grazed shoots, so the cover values may be relatively unchanged. *Prunus spinosa* is similar as it is browsed but not barked and contrasts with *Betula* spp. and *Crataegus monogyna* in which small specimens up to 2 m may be killed by browsing and damage to bark.

Poa pratensis. Again there are significant differences between all factors in the Analysis of variance, with all except two factors having $p < 0.01$ (Table 1). It is seen in Figure 1 that most of the cover values lie within the range of the controls except for the ABC treatment (all the year) for the higher grazing intensity. This would accord with the known behaviour of *Poa pratensis* which increases with high grazing levels. Kydd (1966) has suggested that *Poa* species, under conditions of severe defoliation, resist grazing by their prostrate growth and by producing small tillers. Edmond (1964) has shown that *Poa pratensis* is resistant to treading, suggesting it was due to its rhizomatous nature and the flattened shape of the leaves.

Lotus corniculatus. Although *Lotus corniculatus* is widespread throughout the grazing experiment, there is a significant difference between the two blocks ($p < 0.01$) Table 1. There are also significant differences revealed by the analysis of variance in other factors except between grazing levels and blocks and grazing levels. Like the other examples quoted there is a need to eliminate the effects of environment and distribution from the analysis to determine how real the differences shown in Figure 1 are. At low grazing levels, treatments A, B, C, have higher values than those at high grazing levels, but the reverse applies for the longer period of grazing. The highest cover values being in those treatments containing AB (the first two thirds of the year). At the lower grazing level, treatment C (grazed September to December) has a high cover value. However four of the means are little different from the controls.

Arrhenatherum elatius. There were significant differences at $p < 0.01$ in all comparisons made in the analysis of variance (Table 1). While some of the variation is due to the natural variability of such an area, there are real changes induced in the amounts of *Arrhenatherum elatius* by the grazing regime. Even so, the shorter periods of grazing at both levels (Fig. 1) have not been very effective, apart from opening the vegetation between the tussocks. In the longer periods of grazing, the vegetation has been opened by the smaller number of sheep, but with the higher numbers, tussocks have been killed, especially in the ABC (year round) treatment.

Mowing experiments

Two experiments based on 5 x 5 Latin Square designs are reported here. They were described in Boorman (1974) and Hewett (1974) and some results were given. The same species reported on in the grazing experiment are considered here, but *Ammophila arenaria* does not occur in the mowing experiments. *Arrhenatherum elatius* is present in one only. Most of experiment I is within 1 m of the water table and parts may flood in winter, while experiment II extends the range of habitats on to low dunes and is never flooded. The results refer to the early stages of the work and in that respect are comparable with the grazing experiment. Only results from plots mown five times per year, that is once in each month from May to September are displayed. There were no significant differences in those plots mown once, twice, or three times. Table 2 shows these results for the two experiments and it can be seen that there is little change among the species considered when compared with the unmown plots.

The decrease in frequency in *Arrhenatherum elatius* is in accordance with one of the aims of the experiments, namely to control the spread of this tussock-forming species and to reduce the height of the vegetation. In fact, although the tussocks are killed (mown to ground level), the plant survives in the sward. The increased frequency of *Lotus corniculatus* in both experiments suggests a trend towards the increased presence of small herbs, which would be considered desirable. Similarly there was an increase in number of species, which unfortunately did not appear in both experiments. There are apparently no changes in the presence of the other species.

Table 2. Response of selected species and numbers of species to mowing. Comparison of 5 times mown plots with unmown control in experiments I and II.

	I	II
Number of species	* increase	NS
Festuca rubra	NS	NS
Carex arenaria	NS	NS
Salix repens	NS	too few data
Poa pratensis	NS	NS
Lotus corniculatus	* increase	* increase
Arrhenatherum elatius	absent	* decrease

* = $p < 0.05$; NS = no significant difference.

Discussion and conclusions

The bar charts for this preliminary analysis show what appear to be changes resulting from the grazing treatments. These changes would normally be considered desirable in the amenity/conservation context, particularly in the increase in number of species, increase in *Lotus corniculatus*, and the decrease in *Arrhenatherum elatius*. For example, *Arrhenatherum* has certainly declined in abundance in the most heavily grazed paddocks and in the mowing experiment II. However, it remains ready to resume its invasive role should grazing or mowing cease. The inadequacies of these first analyses are that they do not take into account the original distribution of the species, nor any topographical effects. Both mowing and grazing alter the composition of the sward and amounts of species, but they do not remove them completely. This could presumably only come about by the complete destruction of the sward as used to occur with highly intensive rabbit grazing.

Both techniques provide practical means to manage dune plant communities to particular non-agricultural ends. Grazing provides more subtle changes, the possibility of animal production and a considerable degree of versatility.

There may be major advantages to a management agency. However there is the difficulty that the control of grazing animals requires considerable manpower and capital for fencing. The particular technique used will depend on the relative balance between the requirements and resources available.

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