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RECENT VEGETATIVE CHANGE AND THE MANAGEMENT OF ILKLEY MOOR, WEST YORKSHIRE

RICHARD T. SMITH *
AND
MARGARET A. ATHERDEN **

* School of Geography
University of Leeds
Leeds LS2 9JT

** College of Ripon and
York St. John
Ripon HG4 2QX

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INTRODUCTION

Ilkley Moor is an administrative segment of Rombalds Moor, a tongue of high ground between the Valleys of the Aire and Wharfe (City of Bradford n.d.). Formerly the responsibility of Ilkley Council, it has, since the last local government reorganisation been managed by the City of Bradford Metropolitan Council. Overlooking Wharfedale, the moor rises steeply behind Ilkley town through some 300 m of elevation within alternating gritstones and shales which form a stepped sequence (Edwards and Trotter, 1954; Lamming, 1969; Versey, 1967). The present vegetation is described in more detail elsewhere (Bartley, 1967; Fidler *et al.*, 1970; Smith and Atherden, 1985) and consists broadly of bracken and grasses with subordinate heath and rush species at lower elevations, while cotton sedge, crowberry and heather predominate at higher levels. Currently an area of public access, the moor has a major recreational and educational role while it is also an important grazing area for sheep and, like the majority of the adjacent moorlands, it sees a number of grouse shoots in the season.

While Ilkley Moor shares the general vegetational features of neighbouring sections of Rombalds Moor there are nevertheless distinctive characteristics of the present vegetation which have given rise to concern and which call for explanation. Although the moor has a long history of human exploitation (Smith and Atherden, 1985) the crucial period for a contemporary assessment of the vegetation would seem to be the last century. This paper will therefore concentrate on this period as well as discussing the results of some on-site experimentation carried out by the authors in conjunction with Bradford Metropolitan Council's Countryside Department over the last five years.

VEGETATIVE CHANGE OVER THE LAST 100 YEARS

Victorian writers on Ilkley Moor waxed poetic about the extent and beauty of the heather on these hills partly no doubt to attract the many visitors who were now able to travel by railway. An early survey of the vegetation by Smith and Rankin (1903) though not carried out in great detail does nevertheless confirm a former supremacy of heather particularly at higher levels where it had been stimulated by a policy of drainage and burning in swiddens. The lower slopes were, by contrast, described as "grass heath" (Figure 1). But by 1893 Ilkley Moor had passed from private ownership and became a public amenity and Urban Common, with commoner's rights persisting to the present day. Subsequently, two World Wars were to see Ilkley Moor as a location for army training, including tank exercises, while the move

towards the internal combustion engine between the wars saw the progressive withdrawal of the horse from a range of duties it had previously performed.

It would have been remarkable if these particular changes had not led to adjustments in the plant communities of the moor and by 1959 when the Wharfedale Naturalists' Society undertook a full survey, substantial changes had indeed been accomplished (Wharfedale Nat. Soc., 1960). The lower slopes were now dominated by bracken, while crowberry had become an equally widespread species at higher levels (Figure 1). In fact, observations along belt quadrats in the decade 1960-1970 showed an unrelenting increase in both the distribution and dominance of crowberry (Dalby *et al.*, 1971). It is also plain to see that the area allocated to cotton grass increased dramatically and, even allowing for 'interpretational error' between the two surveys, it would certainly seem that a deterioration of drainage did occur early in the century. It is equally clear from vegetation monitoring in the 1960's and from observation today that the area in 1960 allotted to cotton grass has now been greatly reduced by overgrowth of crowberry. In trying to explain precisely why changes of this type and magnitude should have occurred one must emphasise a basic principle, namely that plant communities do not naturally remain the same for great lengths of time and it is the purpose of positive management to so manipulate ecosystems that they are maintained in an artificial state in line with current economic objectives. Moorland drainage and cyclical burning is designed to promote heather for grousemoor while the earlier existence of cattle and horses on the hillsides helped control coarser herbage by both grazing and trampling. When Ilkley Moor became a Common these selective pressures, favouring heather and controlling a range of other species, were removed, and within the next 30 years or so sheep became, virtually the only animals to regularly graze the moor and, quite clearly, according to informed circles, in larger numbers than were stipulated in the Rights. A major factor in this appears to have been the pressures of wartime, and residents of Ilkley recall as commonplace former instances of sheep from the moor dropping into the town for a bite to eat!

As urban horses disappeared so also did the need for material for their bedding. Bracken was therefore no longer cut from the hillsides and with heavier animals virtually absent from the moor a most significant further ecological check on bracken was removed. It has to be said that in this respect the fate of Ilkley Moor was no different from many other upland areas during the same period and bracken thus became a weed on an unprecedented scale (Smith 1977; Taylor 1978 and herein). It does appear, however,

that Commons have been especially vulnerable to bracken encroachment, notably through legislation which has made it extremely difficult to implement more enlightened management policies capable, in particular, of regulating the grazing (Hughes and Aitchison, 1985; Stamp, 1964).

The fact that bracken and crowberry have both expanded within this period suggests that they represent a parallel and interrelated adjustment to ecological changes on the moor, precipitated by management. The most likely causes are summarised in Table 1, where it will be evident that the various factors have been operating over different time periods. Perhaps the most interesting possibility concerns the increasing pressure on heather as grazings at lower elevation are reduced by bracken encroachment. This would account for the major crowberry advance occurring later than that of bracken. Indeed, during the 1960's it was noted that crowberry was even extending into some previously bracken-dominated areas (Dalby, 1961; Dalby *et al.*, 1971) while, by general agreement, no significant bracken expansion has taken place within the last 30 years. Therefore, although Ilkley Moor has a unique history, the study of its vegetative changes over the last century seems likely to offer a framework of explanation for changes of a broadly similar nature in other upland areas.

FIELD EXPERIMENTATION

In 1979 three separate 10 x 20 m enclosures were established jointly by Leeds University School of Geography and Bradford Metropolitan Council Countryside Department. Their specific purpose was to provide data likely to contribute to the debate then taking place as to whether inadequate burning or unacceptably heavy grazing was the major explanation for crowberry opportunism on the moor, for the widespread dominance of this plant is not altogether typical of moorlands at the present time. Enclosures (E1-3) were sited in areas of progressively greater crowberry infestation. Before fencing, a strip was burned through the central portion of each designated area so that permanent quadrats could be monitored on burnt and unburnt surfaces both inside and outside the enclosures. In this way it was hoped to provide a measure of control. To date, five annual sets of data, concentrating on frequency and cover, have been collected from a total of 36 randomly-sited quadrats, 12 at each enclosure site. A specimen layout is illustrated in Figure 2 to give an idea of the disposition of quadrats associated with each enclosure.

Table 2 examines the relative impact of burning and grazing on overall species frequency and diversity. Burning has apparently increased species diversity to a small extent, an effect which is being reduced in time and which has been greatest where grazing was prevented. From these figures the species most obviously reduced by grazing are *Vaccinium myrtillus* and *Deschampsia flexuosa* while *Juncus squarrosus* may be encouraged by grazing. The effects of anticipated erratic change in the first two seasons following burning and enclosure have now stabilized and a pronounced recovery of heather has certainly taken place within all the enclosures. However, it is clear from the figures obtained from quadrats outside the enclosures that, here too, heather performance has improved since the start of these measurements and especially during the last 2-3 years. Table 3 is intended to emphasise the impact of grazing over the period indicated. The averages conceal some variation in performance between quadrats but the trends are consistent for the different enclosures with appreciable net gains in heather (exclusively *Calluna vulgaris*) and a somewhat less uniform decline in crowberry. The latter has, however, been maximal at E3 where crowberry had previously been most dominant.

These results are distinguished by their failure to demonstrate any convincing practical advantage of enclosure for the unburnt surfaces over the period in question. In this respect we had assumed at the outset that grazing intensity would remain level at least in the immediate future. However, data which has only become available to us in January 1985 from the Commons Commissioners indicate a substantial reduction of grazing pressure since the last full survey of sheep numbers in 1978. Allowing for uncertainties inherent in the figures (numbers of sheep permitted in grazing Rights do not necessarily accord with actual numbers grazing Ilkley Moor itself) this reduction can confidently be placed in the region 30-40%. We understand from the Bradford Countryside Department that this reduction is likely to have been progressive in nature throughout the last five years or so and taken together with the excellent growing seasons for heather of the last two or three years, the advance of heather on the moor at large seems amply explained.

As far as the effects of burning are concerned (Table 4), crowberry has virtually failed to return on 12 of the 18 burned quadrats. The exception is at E3 where unfortunately the original burn on one of the ungrazed quadrats in particular was insufficient, while the advance in the grazed area is entirely due to lateral overgrowth from crowberry in the unburned surrounds. This, we feel, has occurred where, in an area of crowberry dominance, slowness of

vegetative recovery of the burned surface outside the enclosure has invited crowberry overgrowth. On the burned areas heather and crowberry seedlings had germinated freely by the summer of 1981 (i.e. 18 months after burning) and especially large numbers of crowberry seedlings appeared at E3, an area of high crowberry seed source. However, the subsequent mortality of the crowberry seedlings particularly in the winter of 1981-82 contrasted with the survival of the fewer heather seedlings which, in general, had achieved a much greater size (see Dalby, 1961). As a result, there is a marked contrast in the subsequent performance of heather, an effect which is particularly pronounced inside the enclosures. The bulk of the difference in response between the grazed and ungrazed sites is attributable to trampling by both sheep and visitors, together with the grazing and wholesale uprooting of heather seedlings by sheep. These differences of disturbance are amply illustrated by the rate at which burnt areas are becoming vegetation-covered in grazed as opposed to ungrazed areas (Figure 3). One can say that, at a first approximation, it is taking grazed areas at least two years longer to achieve a given amount of vegetative ground cover.

The effect of trampling is a well-known limitation of enclosure-based research. With hindsight, some adjustment of experimental design, notably the provision of wider burns exterior to the enclosures, would have helped reduce this problem. On the other hand, experiments which aim to monitor a grazing effect cannot do so without an effective perimeter fence and do not provide a representative picture if the areas enclosed are of too limited a size. On the matter of open quadrats in areas of public access, our experience both here and elsewhere is that trampling still takes place in the course of relocating unobtrusive quadrat markers while occasionally one may lose a quadrat altogether unless the site has been accurately determined in relation to other fixed points on the moor.

CONCLUSIONS

The recording work described here will be continued for at least a further five years on an annual basis during which time more detailed numerical analysis of the data will be justified. In particular the situation on the open moor will prove especially interesting if data on sheep numbers become available for a longer run of years.

For the present it is possible to conclude that burning has been most

efficaceous for the return of heather which is outstanding as a genuine colonist of bare moorland peat compared with crowberry. The latter is much dependent on its ability to invade laterally which it will do if other species are either absent or severely suppressed. Surfaces predisposed to overgrowth by crowberry include those associated with peat erosion, burning - and especially over-burning - of peat and severe compaction or over-grazing suppressing adjacent vegetation growth. The crowberry mat is able to cover hostile surfaces which have a high runoff potential, and it subsequently becomes rooted. In turn, it is not uncommon to find that a path effectively prevents the spread of the plant in areas where it is expanding. In areas of high crowberry incidence it is therefore important that moor burning strips are of sufficient width so as to reduce the total effects of marginal repressive overgrowth by crowberry. These broader burned areas will also act to reduce the vulnerability of heather seedlings to grazing or removal and will also help dissipate the effects of trampling which any such area of bare surface tends to attract. One proviso, however, is that larger burns on steeper slopes will be prone to creating and gathering large amounts of runoff which, while being counter-productive to vegetation establishment, may in the meantime contribute to ponding and to the initiation of rill and gully erosion.

While in the short term the enclosures demonstrate a recovery of heather, in the future it can be predicted that the vigour of heather within the enclosures will eventually decline. At sites elsewhere at which burning has not been carried out for many years, and especially at exceptional sites where both grazing and burning have been prevented, the ageing heaths give way to a wetter community, including bilberry, sedges and mosses, together even, with crowberry. The present work was not conceived with a view to demonstrating that grazing is deleterious to heather growth, indeed it was taken as axiomatic that moderate and regulated grazing is likely to stimulate heather growth through promoting new sprouts. Providing an optimum grazing pressure can be maintained on the open moor a varied yet heather-dominated ecosystem may well be induced and perpetuated in this locality. Burning is necessary initially to reverse the decline of heather and to rejuvenate an ecosystem which comprises a derelict vegetation of little grazing or sporting value. However, while systematic burning maintains a patchwork of heather monocultures of value to grouse interests it must be reflected that the monoculture provides a less valuable grazing sward.

ACKNOWLEDGEMENTS

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TABLE 1. FACTORS OF BRACKEN AND CROWBERRY EXPANSION

Expansion of species	Primary and supplementary causative factors
Bracken (Pteridium aquilinum)	(i) Reduction and virtual elimination of grazing and trampling by heavier animals (ii) Reduction and subsequent cessation of bracken cutting (iii) Selective grazing by sheep tending to avoid bracken (iv) Ineffectual regulation of grazing pressure and lack of positive management policy (v) Acceptance of bracken as a natural and aesthetic element in the moorland landscape in an amenity context
Crowberry (Empetrum nigrum)	(i) Lack of cyclical burning to promote vigorous heather growth (ii) Heavy grazing of palatable species by sheep exacerbated by bracken expansion elsewhere (iii) Compaction and/or erosion of terrain favouring a laterally-spreading species (iv) Local desiccation following drainage

TABLE 2. SPECIES FREQUENCY AND SITE DIVERSITY

Figures are aggregates for period 1980-1984 inclusive. Values for 1984 alone are in parenthesis.

Species recorded (higher plants only)	Numbers of quadrats in which species recorded				% Frequency in 36 quadrats
	Ungrazed		Grazed		
	Burnt	Unburnt	Burnt	Unburnt	
Calluna vulgaris	9 (9)	8 (8)	9 (9)	9 (8)	97 (94)
Deschampsia flexuosa	8 (8)	8 (8)	7 (6)	7 (4)	83 (72)
Empetrum nigrum	9 (6)	9 (9)	7 (6)	9 (9)	94 (83)
Eriophorum angustifolium	3 (3)	3 (3)	5 (2)	3 (2)	38 (27)
E. vaginatum	9 (3)	4 (0)	6 (1)	2 (0)	58 (11)
Juncus squarrosus	5 (2)	4 (1)	6 (4)	4 (3)	52 (27)
Vaccinium myrtillus	8 (8)	8 (8)	6 (4)	7 (5)	80 (69)
Species score totals : Index of diversity	51(39)	44(37)	46(32)	41(31)	

TABLE 3. UNBURNT SURFACES

A. UNGRAZED

Changes in cover percentage 1980-1984 averaged for each enclosure (3 quadrats)

Enclosure	Crowberry	Heather
1	+ 3	+ 46
2	+ 2	+ 10
3	- 27	+ 24
Overall averages	- 8	+ 27

B. GRAZED

1	- 3	+ 13
2	- 30	+ 21
3	- 45	+ 26
Overall averages	- 26	+ 20

TABLE 4. BURNT SURFACES

A. UNGRAZED

Enclosure	Changes in cover percentage 1980-1984 averaged for each enclosure (3 quadrats) Crowberry	Heather
1	+ 1	+ 74
2	+ 4	+ 74
3	+ 30	+ 53
Overall averages	+ 11	+ 67

B. GRAZED

1	0	+ 18
2	0	+ 30
3	+ 52	+ 4
Overall averages	+ 17	+ 17

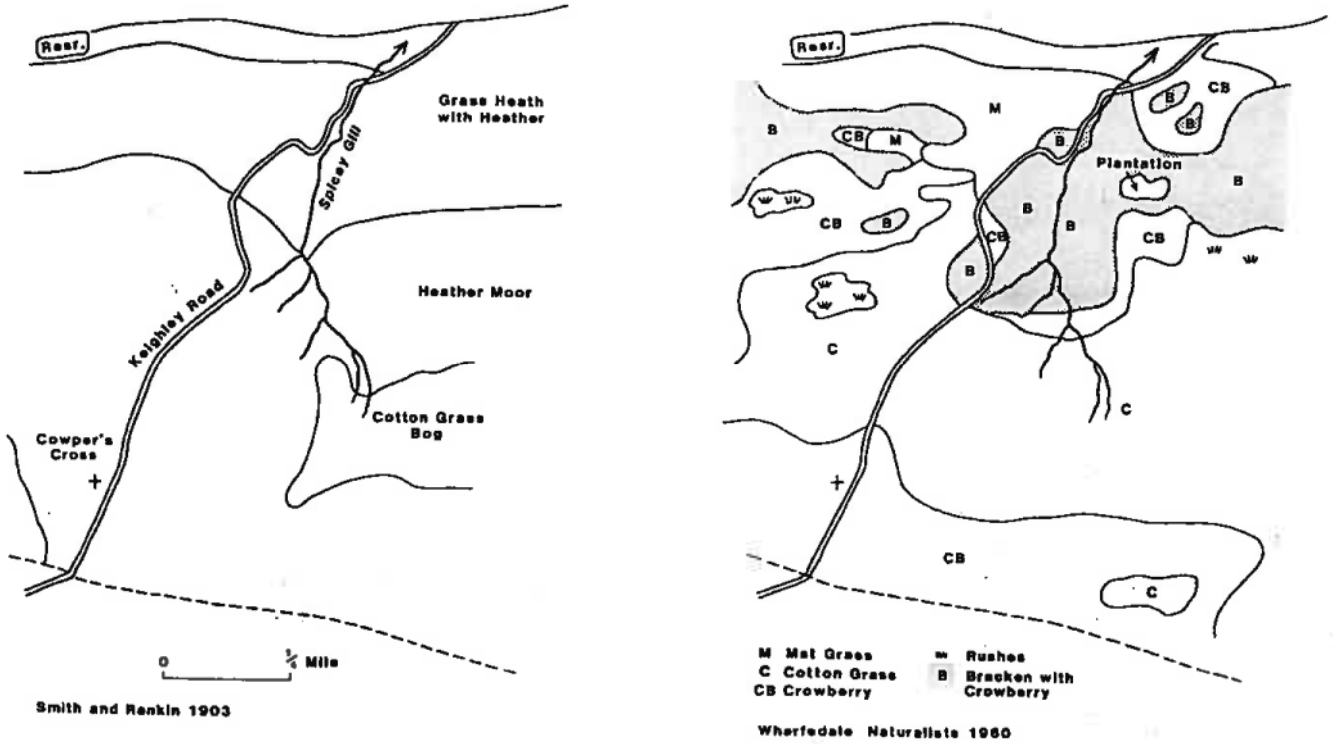


FIGURE 1. VEGETATION CHANGES ON ILKLEY MOOR AS REVEALED BY SUCCESSIVE VEGETATION SURVEYS

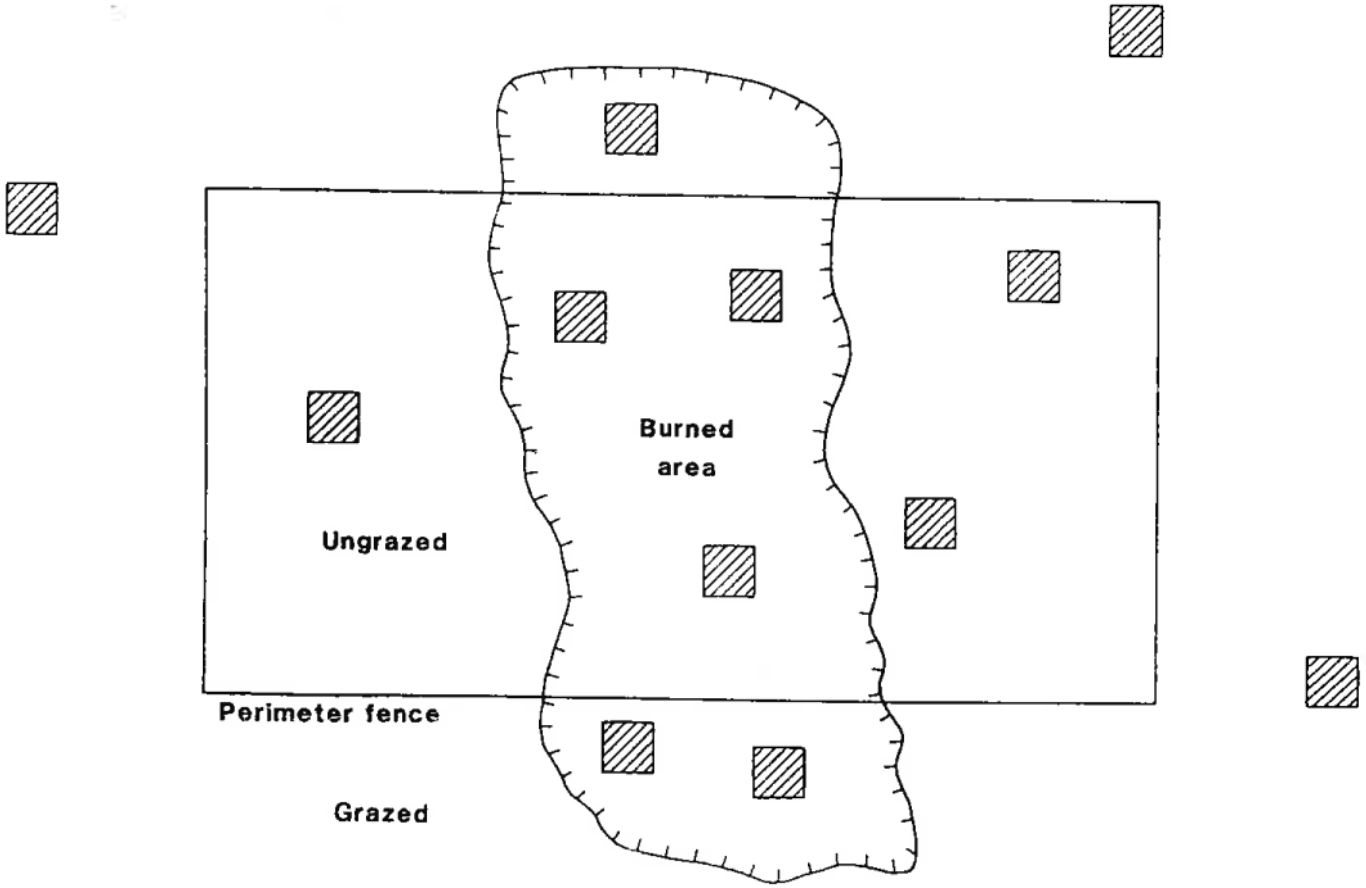


FIGURE 2. GENERAL DISPOSITION OF QUADRATS AT EACH ENCLOSURE SITE

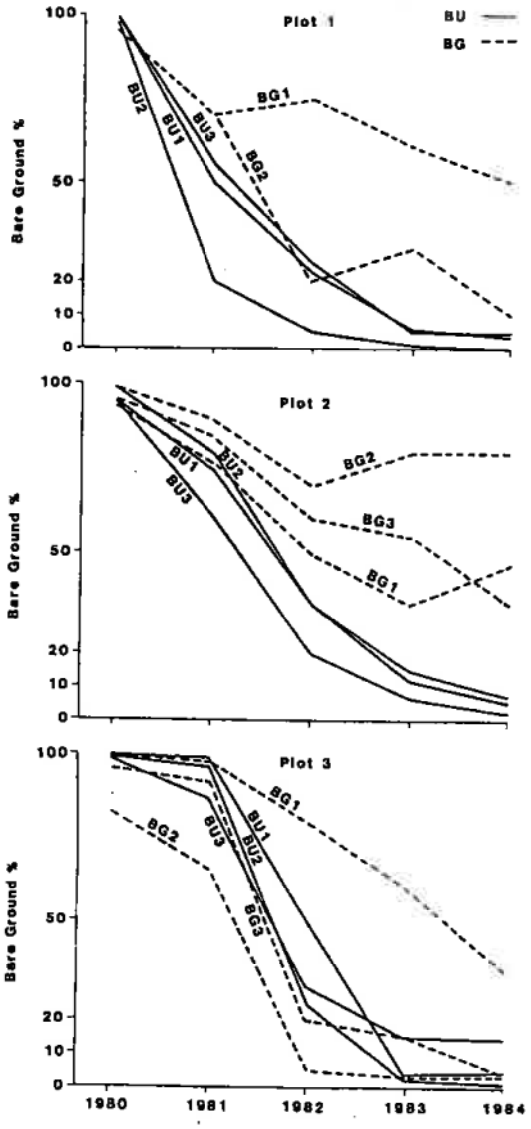
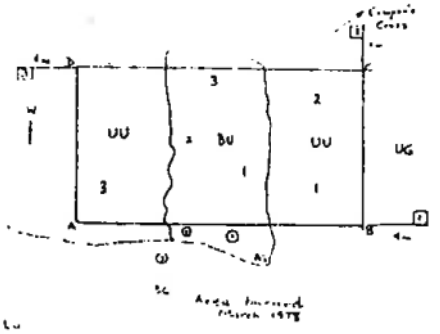


FIGURE 3. RECOVERY OF VEGETATIVE GROUND COVER FOLLOWING BURNING
(BU and BG are ungrazed and grazed quadrats respectively)

APPENDIX 1. SKETCH GUIDES TO QUADRAT LOCATION

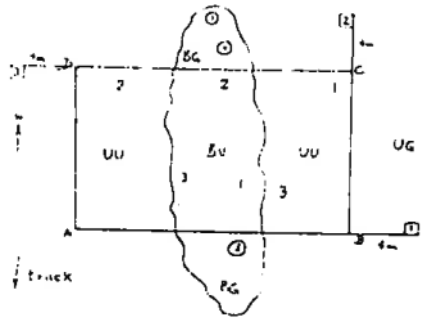
ENCLOSURE 1



Initial burns in plots November 1979

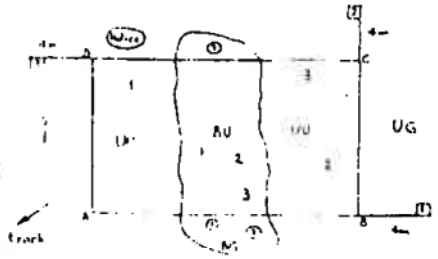
① 1 – 40 from fence : 6 – 20 from A
② 1 – 60 from fence : 9 – 70 from A
③ 4 – 60 from fence : 3 – 50 from A

ENCLOSURE 2



① 9 – 10 from B : 5 – 90 from fence
② 9 – 40 from C : 3 – 10 from fence
③ 9 – 50 from A : 3 – 40 from fence

ENCLOSURE 3



① 7 – 40 from A : 2 – 20 from fence
② 7 – 70 from B : 2 – 20 from fence
③ 10 – 30 from D : 2 – 20 from fence

Notes:
(1) Enclosure 1 is nearest the track while Enclosure 3 is furthest away.
(2) Quadrats within enclosures are marked by painted wooden posts.
(3) Quadrats outside enclosures are designated by the left corner of the quadrat nearest the observer when facing the enclosure.

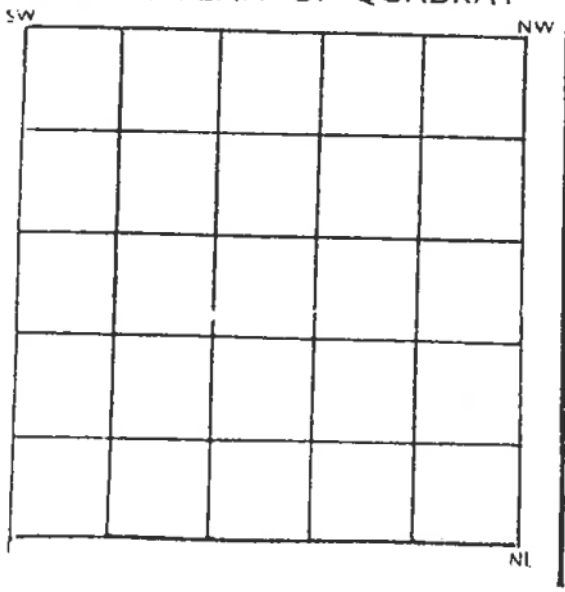
APPENDIX 2. FIELD RECORDING FORM USED IN THIS STUDY

ILKLEY MOOR PLOTS

PLOT NO.	QUADRAT NO.	DATE	NAME

PLANT SPECIES PRESENT	NUMBER OF SQUARES IN WHICH FOUND	ESTIMATED PERCENTAGE COVER	DOMIN SCALE RATING

SKETCH PLAN OF QUADRAT



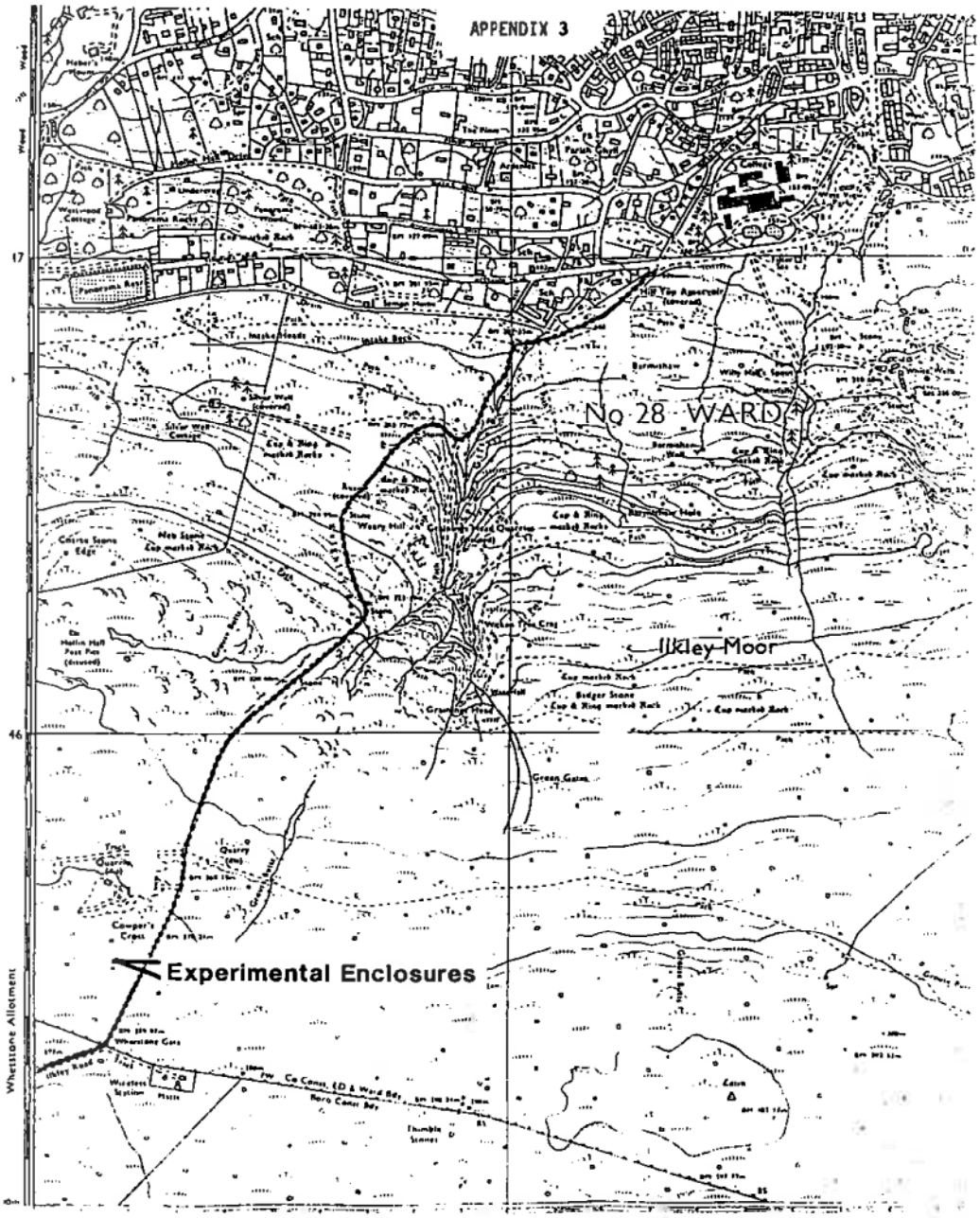
PERCENTAGE BARE GROUND

MAX. HEIGHT OF VEG.

AVE. HEIGHT OF VEG.

KEY TO PLAN AND REMARKS

APPENDIX 3



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