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REVEGETATION EXPERIMENTS ON
SEVERELY BURNT MOORLAND,
GLAISDALE, NORTH YORKSHIRE

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Introduction

The incidence of severe summer fires on moorland has increased throughout the 20th century, the worst occurring in the exceptionally dry years of 1947, 1959 (Radley 1965, Brown 1983) and 1976 (Doornkamp & Gregory 1980).

Such moorland fires result in substantial loss of income from grouse shooting and sheep grazing while the effects on the moorland ecosystem can be far-reaching involving the deterioration of soils through erosion and hydrological changes. Eyre (1966) described the effects of widespread wind erosion on Totley Moor following the 1959 fires in the Peak District and Arnett (1980) documented the severe erosion in the North York Moors after the 1976 fires. Vegetation recovery following severe fires is slow. Elgee (1912) recorded serious fires at Glaisdale Head which were identifiable 70 years later as patches of barren mineral soil lacking the peat cover of the surrounding moor and devoid of vegetation. Atherden (1972) observed that sites at Simon Howe and Botany Bay in the North York Moors which were burned in 1947 and 1959 still possessed an impoverished cover of Polytrichum mosses with large areas unvegetated. Much erosion damage takes place in the first few months following a fire (Arnett 1980; Moorland Restoration Project 1984) so measures taken early to encourage revegetation could reduce the time taken to recover fully. This paper describes experiments to accelerate revegetation on Glaisdale Moor which burned for 7 days in July 1976. A full account of this work is to be found in Bridges (1986).

The field site shown in Fig. 1 occupies part of the central watershed of the North York Moors National Park between 290m and 400m O.D., above Glaisdale (NGR. NZ 7400). It is underlain by Middle Jurassic sandstones and shales with large areas blanketed by peat. The mean annual rainfall is just over 1000mm. Vegetation before the fire consisted of large blocks of Calluna and Eriophorum, grazed by sheep and managed as grouse moor. In summer 1976 an area of 392ha was burned resulting in a wide variety of post-fire surface types (see Fig 2). Large areas lost their peat cover completely. In others the fire had smouldered in pockets for 1-3 months after the main fire was extinguished leaving a mosaic of charred peat hummocks and pockets of ashed peat which eroded rapidly down to the

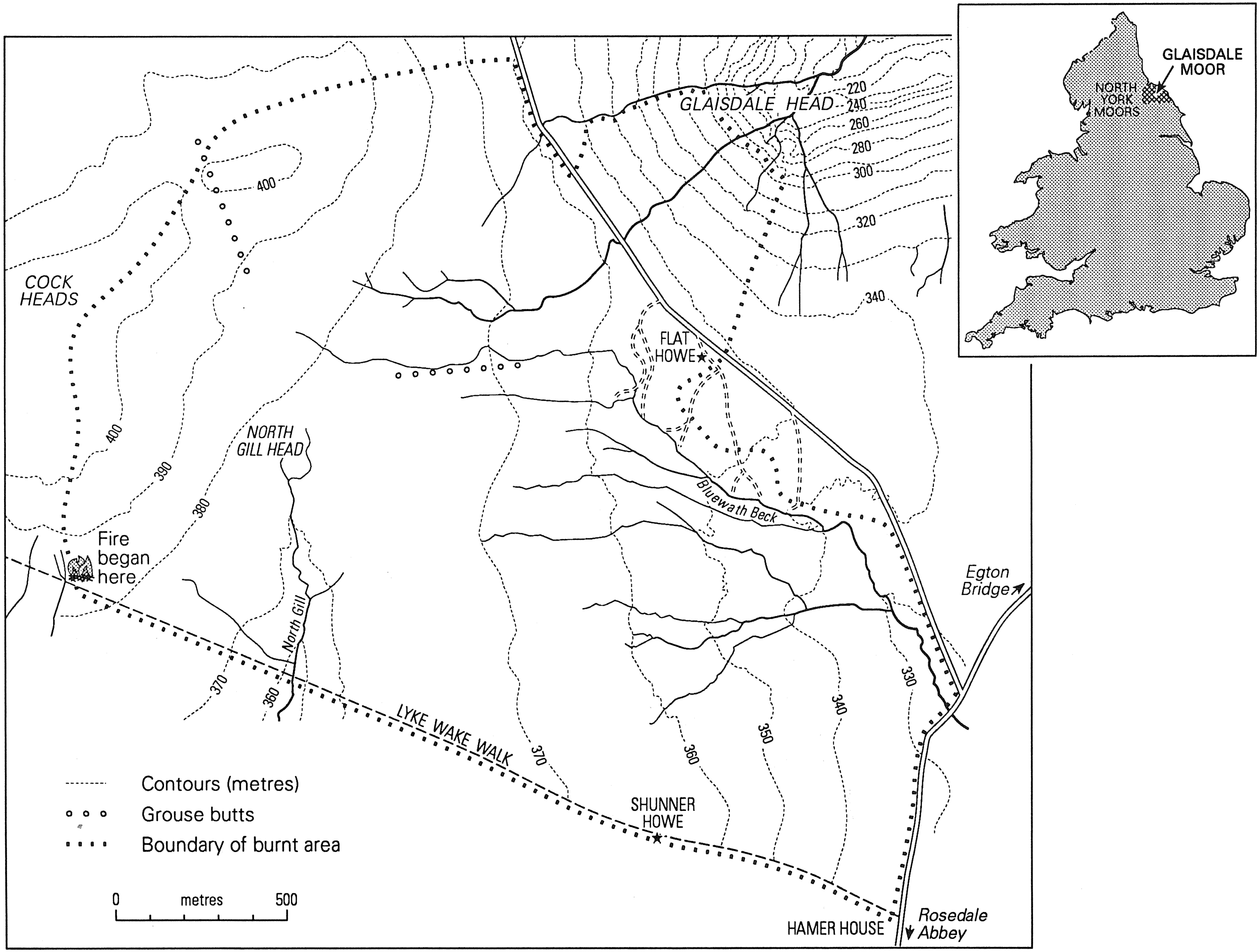
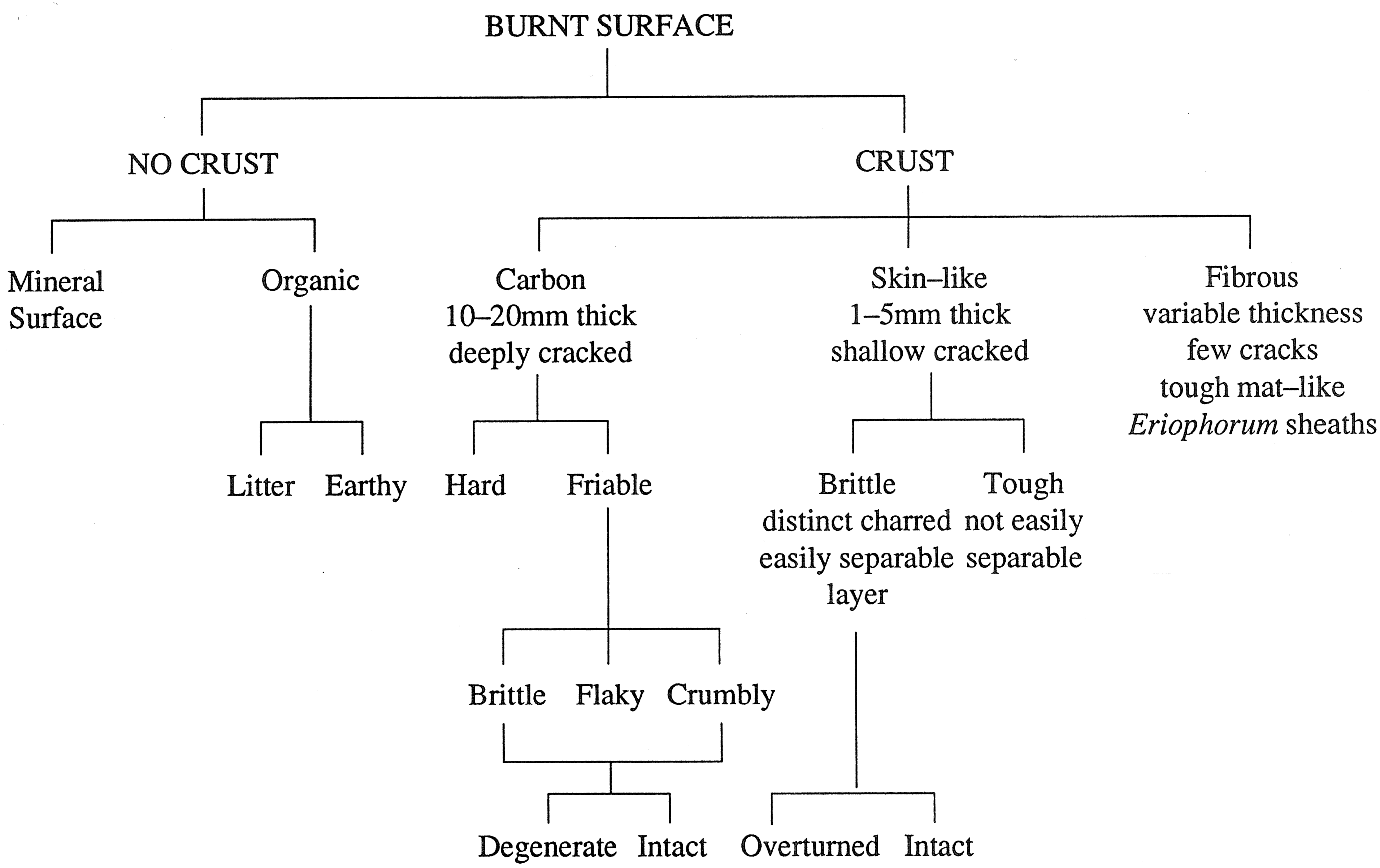


Figure 1: Burned area on Glaisdale Moor showing Bluewath Beck catchment (field site) and inset location in northern England

Figure 2: Types of surface on the burnt moor



mineral subsoil during the wet winter following the fire. Remaining areas of deep peat possessed some form of crust which was created either by intense drying out and charring during the fire or by subsequent weathering and biogenic processes.

Observation of the study area in 1977 showed little sign of surviving vegetation to start the process of recovery. It was thought that the site had been rendered sterile and that natural revegetation would depend upon seed introduced by wind and vertebrate fauna. The fire-crust also appeared to hinder the establishment of seedlings by inhibiting root penetration leaving them vulnerable to desiccation and to uprooting. The experiments described in this paper were designed to evaluate methods of overcoming these difficulties and accelerating the process of revegetation including, in particular, the fencing of areas to protect vegetation from sheep grazing.

Experimental Methods

16 experimental areas (blocks) measuring 45 by 30m were marked out on blanket peat within the burned area. They were arranged in pairs occupying similar surface types with one member of each pair fenced in July 1979 to exclude sheep. As a result of observations of the blocks between 1979 and 1983 it was decided to fence a much larger area including most of the experimental blocks. This was carried out in May 1984 by the North York Moors National Park with the assistance of the Countryside Commission and the landowner, Danby and Wykeham Estates. The locations of the original blocks are shown in Fig. 3. Those designated by the letter A were fenced in 1979; those with a letter B remained unfenced until 1984. The internal layout of each experimental block is illustrated in Fig 4. Treatments were laid out across the slope with an uncultivated strip at the top followed downslope by a raked, rotavated, and finally, a rotavated and fertilised strip. This sequence was chosen so that any drainage water from the more drastic treatment would not affect other parts of the block. Cultivation by raking and rotavation was implemented in July 1979. Raking simply broke up the surface crust while rotavation mixed and aerated the top 15cm of peat. Half the rotavated area in each block was given a low application of NPK fertiliser at a rate of $32g.m^{-2}$.

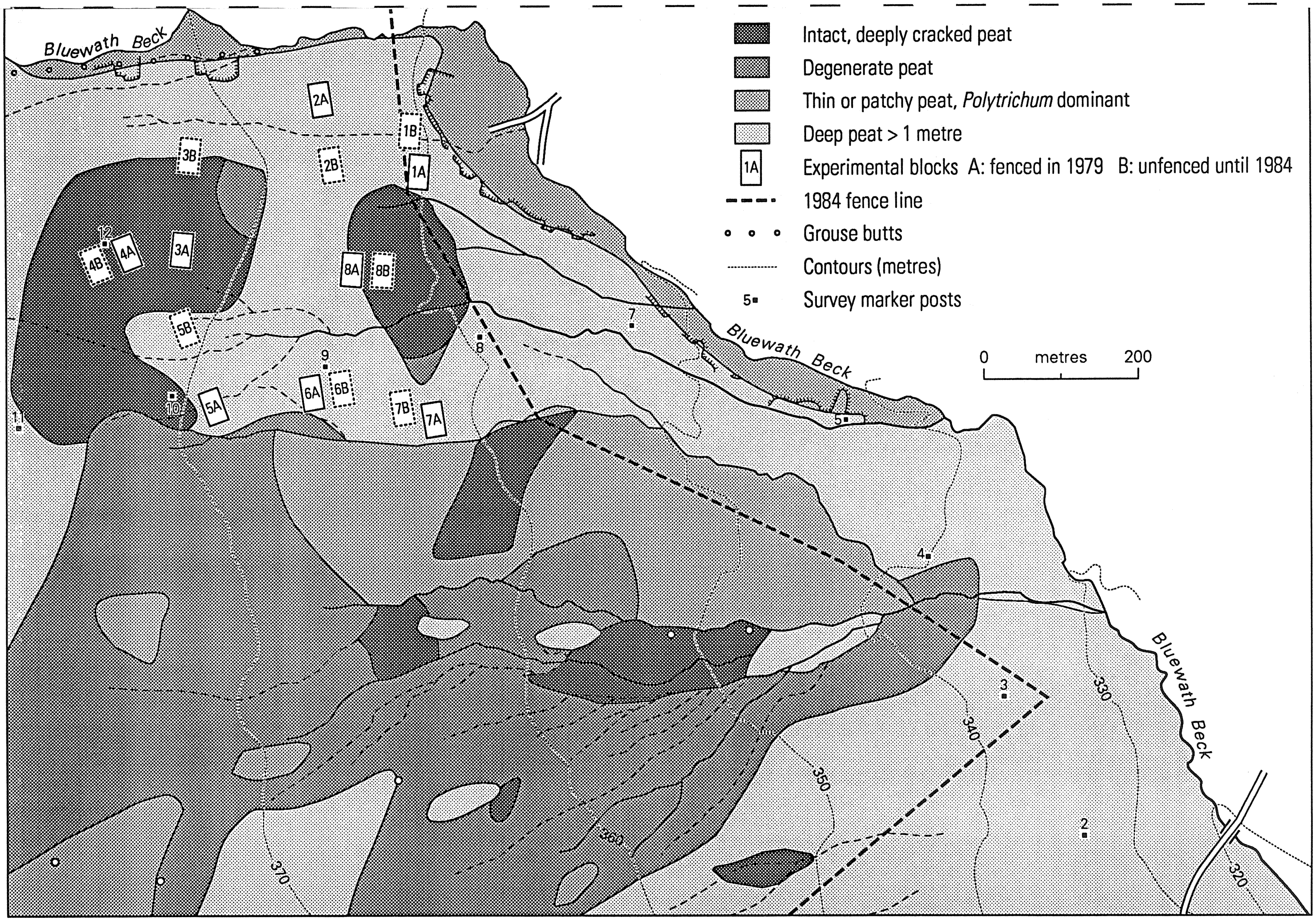
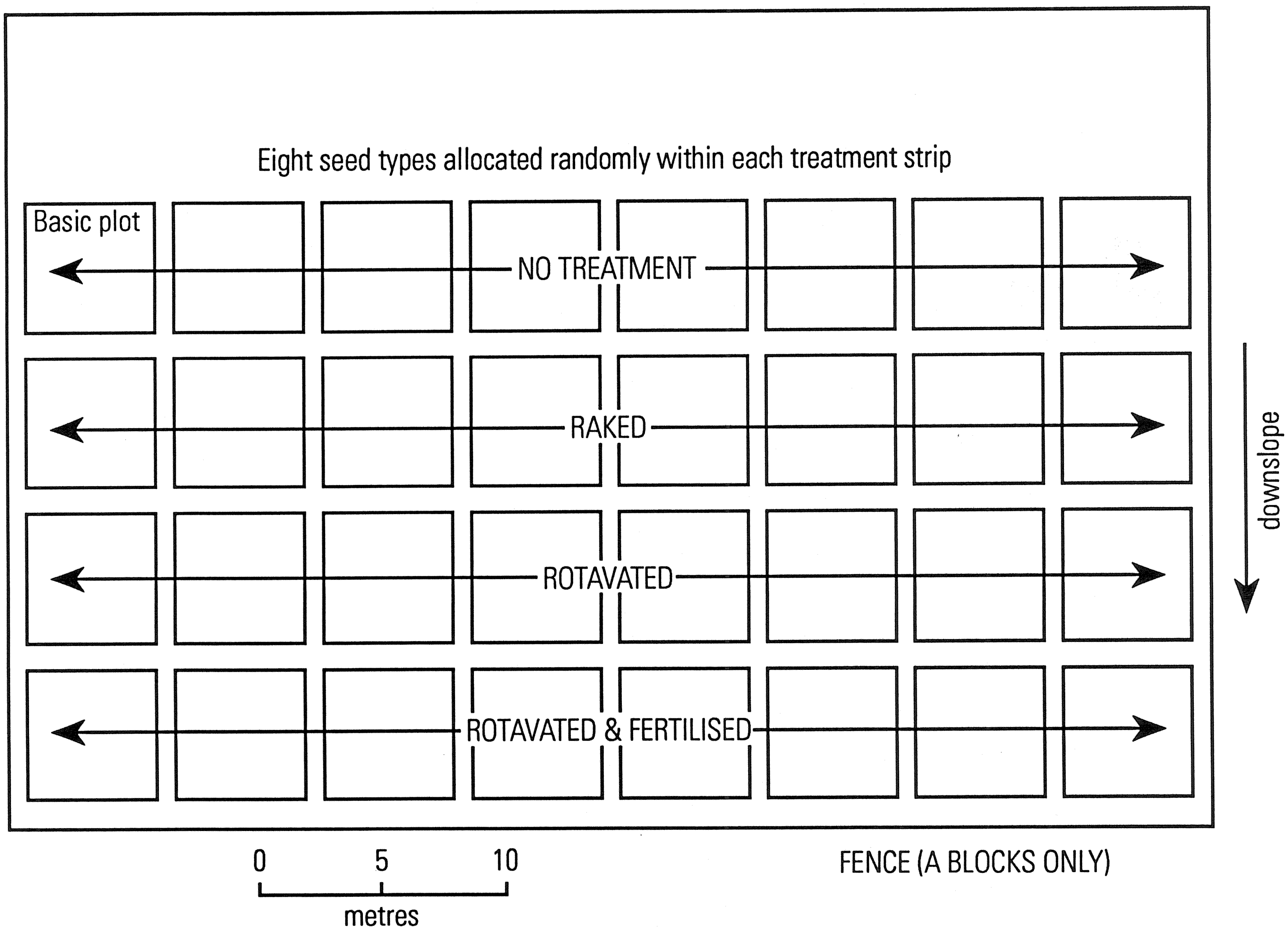


Figure 3: Central Bluewath Beck catchment showing layout of experimental blocks and principle moorland surface types

Figure 4: Internal Layout of experimental blocks



Different types of seed were broadcast in a random manner on the plots in each treatment strip. Calluna mulch collected from neighbouring moorland was sown in October 1979 and reinforced by seed vacuumed directly from Calluna plants the following May. One tree species was tried: Betula pubescens. Several grasses were sown using commercially available seed: Festuca ovina, F. rubra, Agrostis tenuis, Poa pratensis, Deschampsia flexuosa and Holcus lanatus. The last two were sown as a mixture which also included A. tenuis and Lotus corniculatus, a legume.

Vegetation cover was estimated in each 25m^2 sowing plot in September 1980 and August 1981 from 250 points located by 10 random positions of a quadrat with 25 intersections. Population counts of the sown species and Calluna were made for each plot in September 1980, May 1981, August 1981 and September 1982.

These data were analysed using the non-parametric Wilcoxon test for paired samples. In the first instance this was used to test for the effects of fencing as between pairs of sowings (A and B) which had similar treatment and then, to test for treatment effects between sowings within the same block. In the analysis of Calluna data the Kruskal-Wallis one-way analysis of variance was used together with parametric analysis of variance. The non-parametric tests are described in Siegel (1956).

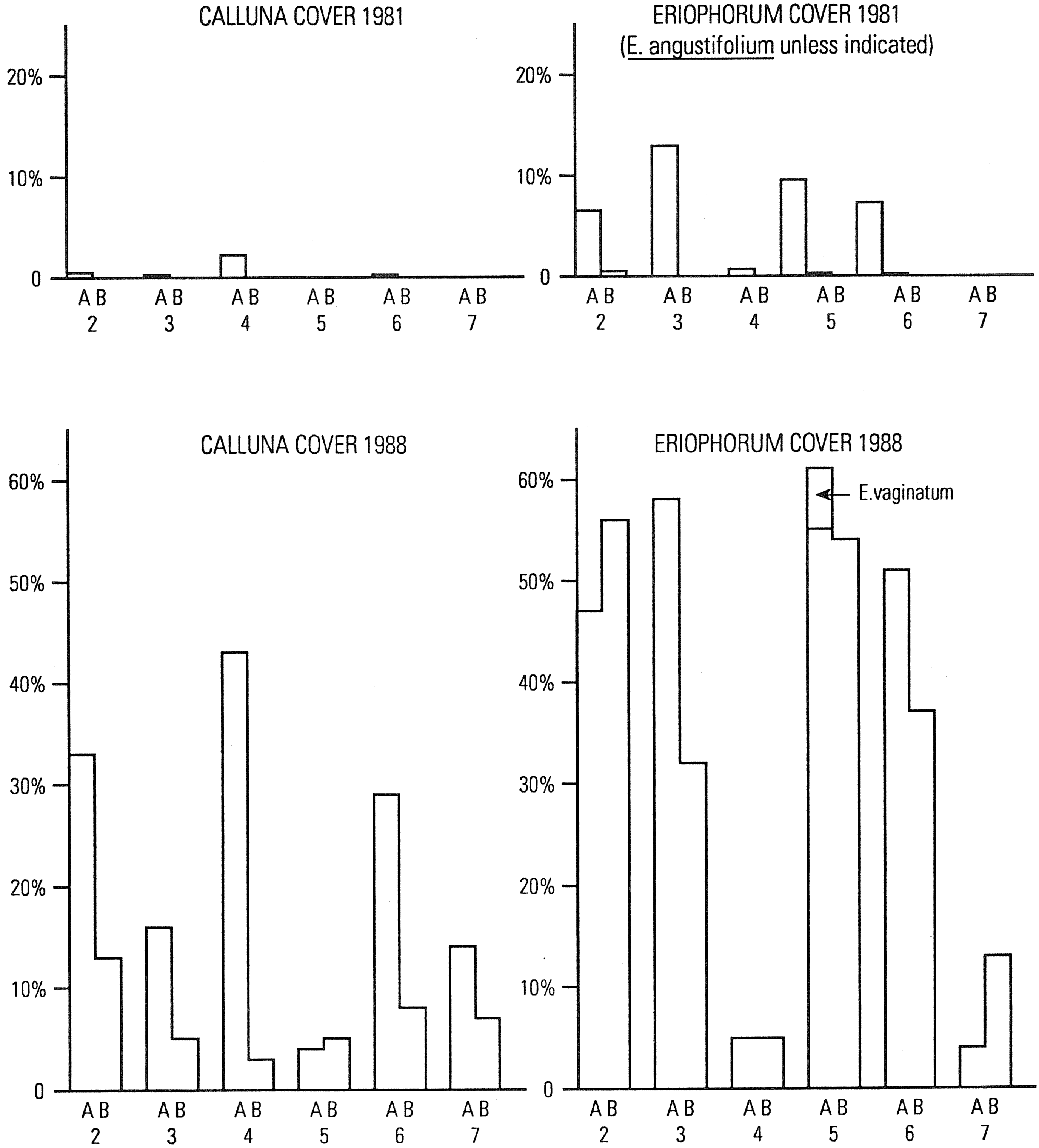
In 1988 vegetation cover (excluding mosses and lichens) was again estimated, this time from a less intensive survey of 150 points per block.

Results

1. Effect of Fencing

Fig. 5 shows the results of cover measurements for Calluna and Eriophorum in 1981 and 1988 comparing blocks fenced in 1979 with those which remained unfenced until 1984. In unfenced blocks sheep grazing suppressed the spread of both Calluna and Eriophorum species (mainly E.angustifolium with some E.vaginatum). A group of 9 sheep was observed regularly during the summer grazing the

Figure 5: Percentage cover of Calluna and Eriophorum in 1981 and 1988 showing the effects of fencing.



area on and around the experimental blocks. When sheep were excluded from the A blocks in 1979 E.angustifolium spread rapidly from rhizomes which had survived the fire. It did not lose its ability to spread during the years of suppression as evidenced by the small difference in 1988 between the originally fenced blocks (mean 37%) and those unfenced until 1984 (mean 33%). The blocks with low percentages of Eriophorum in 1988 were either very dry (4A and B) or lacked surviving rhizomes (7A and B).

Calluna responded more slowly to fencing because of its development from seed and the almost complete destruction of the local seed bank in the disastrous fire; vegetative spread was virtually absent because the Calluna plants were either destroyed in the fire or too old to regenerate. In 1988, the B blocks which had by then been fenced for only 4 years had a substantially lower cover of Calluna (mean 5%) than those which had been fenced for 9 years (mean 23%). These more recently fenced blocks also had, on average, 20% more bare ground than those fenced five years earlier.

The biggest contrast between a fenced and unfenced pair was for blocks 4A and B. In 1988 4A had the highest Calluna cover of all blocks and 4B the lowest. The dry, deeply cracked peat at this site was particularly vulnerable to the effects of sheep trampling which left a loose, unstable rooting medium with poor moisture retention.

Fencing clearly improved the survival of three of the sown grasses. Fenced blocks showed significantly higher populations and cover percentages of Deschampsia flexuosa and Festuca ovina than unfenced blocks in 1980. The difference in 1981 was even greater for Deschampsia and Agrostis tenuis and was also significant for Festuca.

2. Success of Introduced Species

Only the above three grass species survived in any number. Of these only Deschampsia was able to increase its cover in the second year of growth. It flowered in 1981 and produced a second generation of seedlings. The other two species flowered in 1980 but no seedlings resulted. Apart from grazing, drainage appeared to be the main restricting factor and Deschampsia was most successful in the driest area (Block 4A).

Festuca rubra germinated well in the first autumn but did not survive beyond 1980. Poa pratensis only germinated sporadically in the fertilised plots and few survived. Holcus mollis and Lotus corniculatus germinated sporadically but did not survive. Betula appeared as isolated seedlings in 1980, some of which survived although they did not grow successfully because of the removal of buds over-winter by birds.

3. Response to cultivation

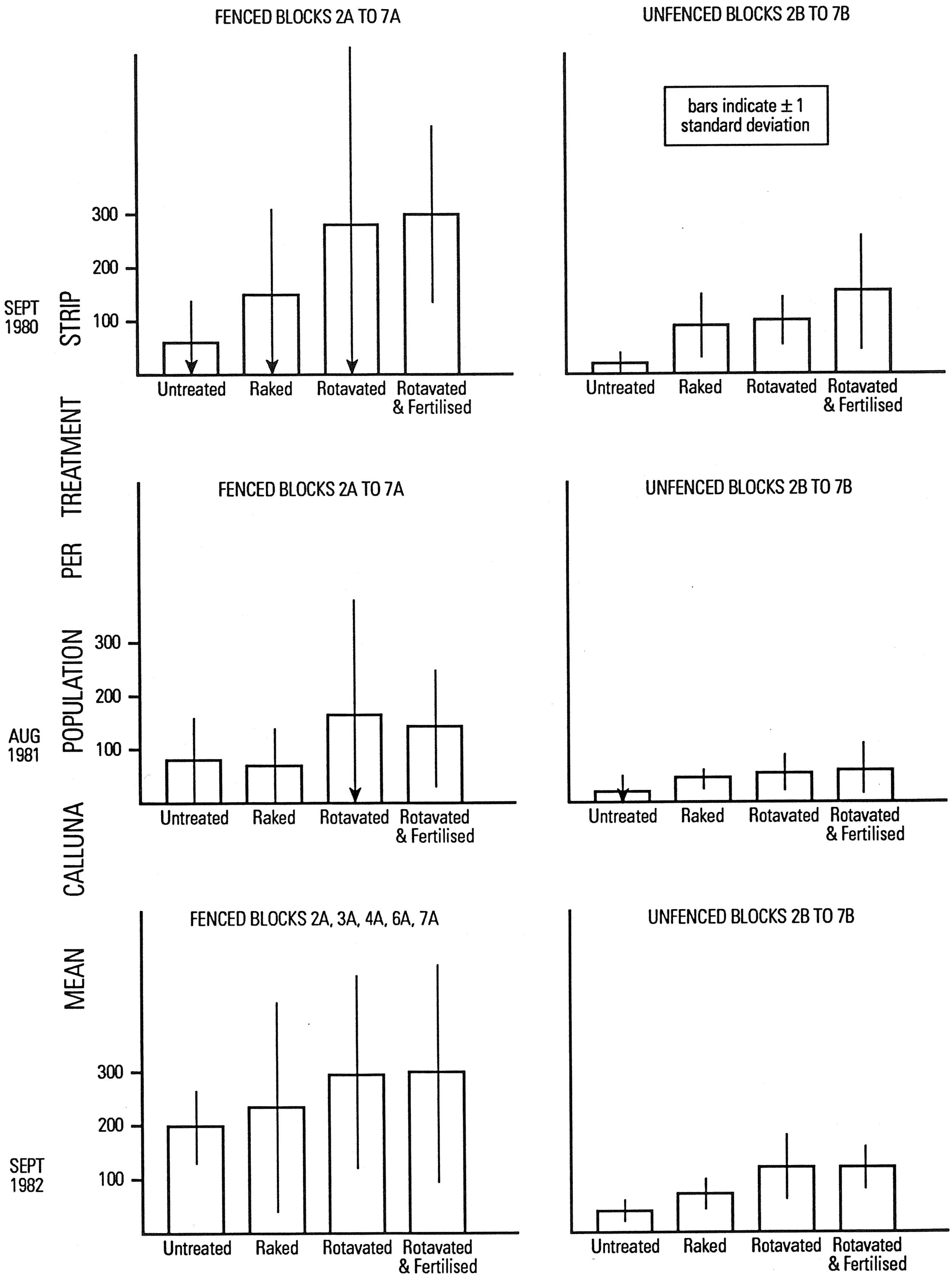
The germination of both the Festucas and Deschampsia was improved by cultivation alone. Cultivation also improved the establishment of Deschampsia measured in 1980, with rotavated plots having a higher population and percentage cover than raked plots (significant at the 0.05 level). By August 1981 the effect of cultivation alone on Deschampsia had largely disappeared. Festuca ovina showed little response to cultivation alone after germination while in the case of Agrostis more plants survived in untreated plots than in plots which were cultivated alone (significant in Aug. 1981 for the comparison between untreated and raked plots at the 0.05 level).

4. Response to cultivation and fertiliser

The addition of fertiliser improved the germination of all three main grasses. The improvement lasted into 1980 but by August 1981 the effect on F.ovina had declined to non-significance. Agrostis continued to show the benefit of fertilisation although this was partly masked by the negative effect of cultivation. Deschampsia retained consistently higher values of population and cover in fertilised blocks.

There was a marked flush of Calluna germination in June 1980. More drastic cultivation was associated with increasing Calluna populations as Fig. 6 illustrates. The effect declined over time, most markedly between May and August 1981, with mortality higher in the cultivated plots. The exceptional

Figure 6: Effect of cultivation treatment on Calluna populations 1980 – 82



and 4B shows that if plant cover is not established early on, this potential is lost. This is because the surface degenerates rapidly and is liable to erode completely with the additional risk of further drying out and gully extension, eating into the adjacent areas of deep wet peat. The best form of treatment for these vulnerable surfaces is simply to protect them from grazing by fencing as soon as possible. The introduction of additional Calluna seed may be necessary because of the lack of surviving seed in such severely charred peat but cultivation of such areas is certainly inappropriate. The early identification of this vulnerable surface is possibly the most cost-effective means of reducing long-term damage following severe fire.

Conclusion

With growing evidence for a warming climate and in particular hotter, drier summers - particularly marked in the last decade - severe moorland fires would appear to be increasingly likely whether or not people are more careless in starting them and particularly if a solution to over-age heather growth on grouse moors (a major factor in serious moorland fires) is not found. With this in mind, when heather moors do suffer from damaging as opposed to routine fires it is vital that strategies are available to assist their rapid recovery.

The importance of fencing to prevent sheep grazing is the fundamental conclusion to be drawn from this research. Similar conclusions have been drawn from Moorland Restoration experiments in the Peak District National Park (Moorland Restoration Project 1984) and from the recovery of vegetation after experimental fire on Ilkley Moor (Smith and Atherden 1984, 1992).

It is clear that particular types of burned surface may, unless quickly protected, not only fail to recover themselves but even pose the threat of instability to a much wider area of moorland. Early identification of vulnerable surface types is therefore important.

Other measures which this research has investigated contribute subsidiary means of accelerating recovery, in particular the addition of heather seed and mulch. Additional methods may have application in particular circumstances but the experience gained here suggests that at worst they could prove a high risk venture and at best might not prove cost effective.

Acknowledgements

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Appendix

Data for Fig 5

Calluna Cover % 1981

Block	2A	0.56
	2B	0.05
	3A	0.39
	3B	0.03
	4A	2.36
	4B	0.10
	5A	0.08
	5B	0.06
	6A	0.30
	6B	0.02
	7A	0.00
	7B	0.00

Eriophorum Cover % 1981

Block	2A	6.45
	2B	0.64
	3A	12.94
	3B	0.00
	4A	0.84
	4B	0.04
	5A	9.46
	5B	0.16
	6A	7.36
	6B	0.19
	7A	0.00
	7B	0.03

Calluna Cover % 1988

Block	2A	33.0
	2B	5.0
	3A	16.0
	3B	5.0
	4A	43.0
	4B	3.0
	5A	4.0
	5B	5.0
	6A	29.0
	6B	8.0
	7A	14.0
	7B	7.0

Eriophorum Cover % 1988

Block	2A	47.0
	2B	56.0
	3A	58.0
	3B	32.0
	4A	5.0
	4B	5.0
	5A	55.0 + 6.0 E.vaginatum
	5B	54.0
	6A	51.0
	6B	37.0
	7A	4.0
	7B	13.0

Data for Fig. 6

Calluna Populations across all blocks 2-7

Sept 1980

	FENCED BLOCKS 2A TO 7A				UNFENCED BLOCKS 2B TO 7B			
Treatment	Untreated	Raked	Rotav	Rotav + Fert	Untreated	Raked	Rotav	Rotav + Fert
Mean Population	64	151	281	297	19	89	100	154
Standard Deviation	73	165	337	167	18	62	45	109

Aug 1981

	FENCED BLOCKS 2A TO 7A				UNFENCED BLOCKS 2B TO 7B			
Treatment	Untreated	Raked	Rotav	Rotav + Fert	Untreated	Raked	Rotav	Rotav + Fert
	81	74	166	144	21	44	57	59
	82	65	220	118	33	20	32	46

Sept 1982

	FENCED BLOCKS 2A, 3A, 4A, 6A, 7A				UNFENCED BLOCKS 2B TO 7B			
Treatment	Untreated	Raked	Rotav	Rotav + Fert	Untreated	Raked	Rotav	Rotav + Fert
	197	235	294	298	42	73	118	119
	64	193	178	206	42	27	59	44

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