TEST MANAGEMENT PROJECT, CATCOTT PARISH PLOT: A SUGGESTED METHOD FOR THE CONTROL OF *MOLINIA CAERULEA*

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SUMMARY

A method of managing the development of tussocks of *Molinia caerulea* Purple Moor-grass in a species-rich peat fen-meadow is discussed and assessed. Flailing maintains a high species diversity, whereas scraping off the tussocks with a Hymac digger causes damage and initially reduces stability of the community.

KEYWORDS

Catcott, fen-meadow, flailing, management, *Molinia caerulea*, scraping, tussocks.

BACKGROUND

Catcott Parish Plot is probably the most important field on the whole of the Somerset Levels and Moors for the richness and diversity of its flora, containing many nationally and locally rare fen plants, including *Cladium mariscus* Great Fen-sedge and *Lathyrus palustris* Marsh Pea.

The field, left in trust to Catcott Parish Council, has not recently been managed, apart from tree felling at the southern end of the field in 1988. However, the timber was left on site, tree stumps were left untreated and have now developed dense coppice growth. Natural succession, together with the increased drainage in the Levels over the last decade has seen an incursion of plants more typical of a drier habitat (Willis 1964, Hill-Cottingham and Smith 1990); notably the invasion by scrub and the development of 30–40 cm high tussocks of *Molinia caerulea* Purple Moor-grass, which compete with the typical fen flora for light and space, thus endangering the survival of this unique site. A previously used method of management, spasmodic burning, has been shown to cause a short-term setback for *Molinia* growth, but it has subsequently flourished on the nutrients in the ash. Species diversity initially improved after burning but then decreased once more. After burning, *Holcus lanatus* Yorkshire-fog initially takes over from *Molinia* as the dominant grass, but then declines as the nutrient ash is depleted (Hill-Cottingham and Smith 1990). The situation was not helped by deep draining of, and application of fertilisers to, the fields to the north (now part of Somerset Wildlife Trust's Test

Management Project, Catcott Parish Plot Catcott Lows Reserve), especially as the fen vegetation depends on a low nutrient status. *Molinia*, however, prefers a somewhat drier habitat, and development of Catcott Lows as a wet site for waders should help in maintaining a higher water table in future on the Catcott Parish Plot itself. Meanwhile, it was felt that action was urgently required to remove the scrub and *Molinia* growth to ensure the future of the site as fen-meadow. The concern voiced by many finally prompted action by Catcott Parish Council.

Collaboration between English Nature and Catcott Parish Council culminated in a meeting held on site on 5 November 1992 between Peter Mackay (Chairman of Catcott Parish Council), David Reid (Somerset Wildlife Trust Peat Moors Warden), Eileen Chilcott (Catcott Parish Councillor) and Dennis and Pat Hill-Cottingham (Managers of the encircling Catcott North SWT Nature Reserve). The purpose of the meeting was to witness a demonstration of a flailing machine as a possible method of reducing the *Molinia* tussocks following removal of scrub. The machine cut two strips approximately 30 m long and about 1 m wide, the width of the machine; one strip receiving a single cut, and one a double traverse to simulate shallow rotovation. Half of these two strips were later cleared of the chopped plant litter. Tussocks of *Molinia* were removed from a further strip by scraping off the surface vegetation using a Hymac digger. An untreated 'control' strip was selected to the west of the others, leaving approximately a 1 m gap between it and the scraped strip to avoid the area used by the Hymac. Fig. 1 shows these areas in relation to the whole field. Fig. 2 shows the trial areas and their treatment.

By the end of November, a method of monitoring was devised and agreed by all parties and approved by English Nature. On 31 January 1993, the experimental areas, including the control strip to the west, were marked off by permanent posts and strings, and surveyed.

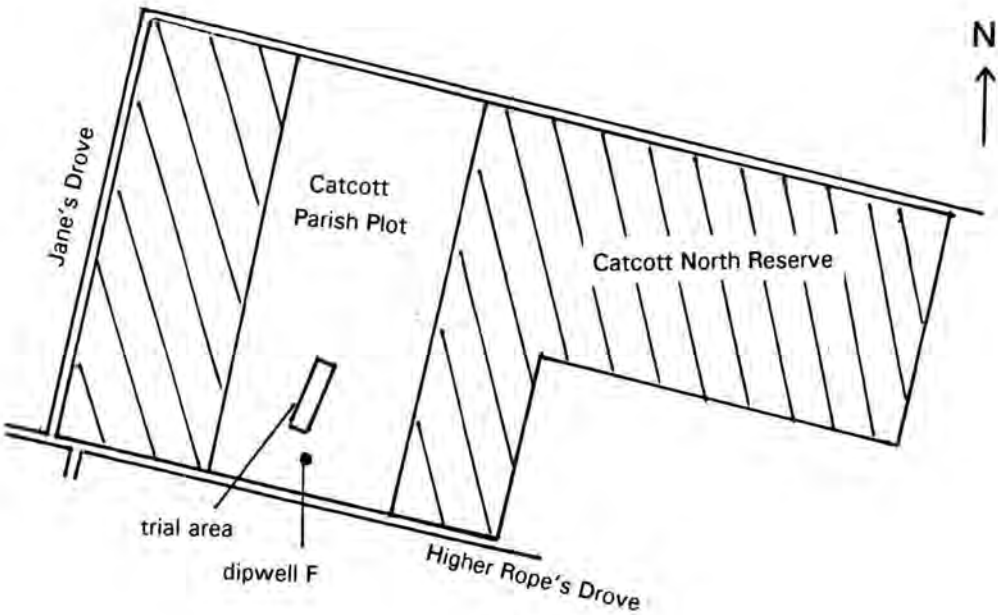

Fig. 1

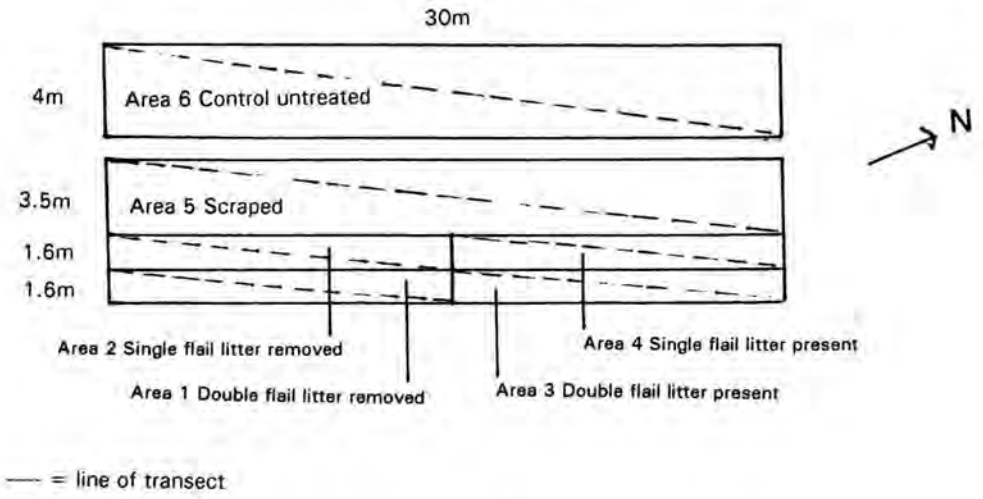

Fig. 2

METHOD OF MONITORING

Line transects were set up using a measuring tape from the SW to the NE corner of each strip. The first set of data collected in May and June 1993 identified all the plants along the line and their positions. Data recorded in July 1994 used the same transects but plants were recorded in a belt to include all parts of plants in contact with the line. Because Areas 5 and 6 were twice as long as the other four, just the data from the northern half of these areas were considered in the assessment of diversity. Because the southern end of these two areas included many large wet hollows, the plants there were less representative of the area as a whole and so were excluded.

RESULTS

The six areas monitored were:

1. Double flailed, litter removed.
2. Single flailed, litter left *in situ*.
3. Double flailed, litter left *in situ*.
4. Single flailed, litter removed.
5. Scraped and surface vegetation removed.
6. Control, untreated.

For each area the following calculations were carried out:

i. The frequency of each species expressed as a percentage of the total number of plants recorded and
ii. The species diversity.

The diversity index used is Simpson's:

$$D = \frac{N(N-1)}{\Sigma n(n-1)}$$

where D = species diversity
N = total number of individual plants
n = number of individuals per species
Σ = sum

The results are given in Tables 1 and 2. A summary is given in Tables 3 and 4 and Fig. 3 so that areas submitted to different treatment can be compared with the control area.

Table 1 Numbers of each species expressed as a percentage of the total number of plants in each area, May 1993

Species	*Areas*					
	1	2	3	4	5	6
Angelica sylvestris	0.53	1.04		1.8		4.23
Caltha palustris	1.06	0.52	1.43	0.9		4.23
Carex disticha	7.49	9.9	5.71	4.5	12.32	8.45
Cirsium dissectum	1.06	2.08		2.7		
Cirsium palustre						0.7
Filipendula ulmaria	15.51	11.46	18.57	22.52	15.07	21.83
Galium palustre		1.6		1.43		
Galium uliginosum	1.6	1.04				
Geranium dissectum	5.34	0.52	4.29		2.74	0.7
Holcus lanatus		25.67	12.5	10.0	3.6	
Iris pseudacorus	2.14	7.29	10.0	4.5	9.59	8.45
Juncus subnodulosus	5.88	4.69	17.14	20.72	31.51	0.7
Lathyrus palustris	4.81	3.45	1.43	3.6	5.48	0.7
Lathyrus pratensis	0.53					
Lotus uliginosus	8.56	9.89			5.48	4.93
Lysimachia vulgaris	2.67	3.13	10.0	7.21	5.48	3.52
Mentha aquatica		0.52		0.9		
Molinia caerulea		6.25	1.43	5.41		15.49
Ophioglossum vulgatum		0.52				
Phalaris arundinacea	2.67	1.56	4.29	2.7		1.4
Poa pratensis		3.21	6.68	1.43	0.9	1.37
Rumex acetosa		2.14	1.04			1.37
Rumex hydrolapathum		0.52				
Stachys palustris	1.6	3.65	1.43	1.8	2.74	2.82
Stellaria palustris		0.52				1.4
Thalictrum flavum	3.74	9.9	8.57	11.71	4.11	16.9
Thelypteris palustris				0.9	1.37	0.7
Urtica dioica	0.53		1.43	1.8		0.7
Valeriana officinalis	0.53	0.52				0.7
Vicia cracca	1.06	3.13	1.43	1.8	1.37	1.4

Table 2 Numbers of each species expressed as a percentage of the total number of plants in each area, July 1994.

Species	*Areas*					
	1	2	3	4	5	6
Agrostis canina	0.5	0.21		0.21		
Angelica sylvestris	4.71	4.29	2.16	2.71	0.24	5.06
Caltha palustris	1.18	0.43	0.43		0.48	
Cardamine pratensis					0.24	
Carex demissa					5.23	
Carex disticha	10.59	12.23	9.7	5.63	4.51	6.33
Carex flacca			0.22			
Cirsium dissectum	0.84	1.5	0.86	0.63	0.24	
Cirsium palustre				0.21	0.24	
Epilobium ciliatum				0.21		
Epilobium tetragonum	0.17				0.24	
Equisetum fluviatile	0.17			0.42		
Festuca arundinacea	0.34	0.21	0.22	0.21	0.48	1.9
Filipendula ulmaria	8.94	7.08	8.62	9.79	9.5	29.75
Galeopsis tetrahit						0.63
Galium palustre	1.35	1.72	3.66	1.04	2.61	2.53
Galium uliginosum	2.87	2.15	1.29	5.42	5.23	4.43
Holcus lanatus	16.69	16.13	9.7	12.29	3.8	
Hypericum tetrapterum					0.48	
Iris pseudacorus	2.36	4.52	3.88	3.96	4.04	4.43
Juncus acutiflora			0.22		0.71	
Juncus articulosus					0.71	
Juncus bufonius					0.24	
Juncus inflexus					0.24	
Juncus subnodulosus	9.61	11.18	19.83	19.17	27.08	5.71
Lathyrus palustris	3.71	3.66	1.08	1.25	1.66	0.63
Lotus uliginosus	10.62	10.54	4.96	1.04	2.85	3.8
Lycopus europaeus					0.24	
Lysimachia vulgaris	2.7	4.09	10.78	8.96	9.74	5.06
Lythrum salicaria						0.63
Mentha aquatica					0.24	
Molinia caerulea	4.55	3.44	4.74	4.17	3.09	6.96
Peucedanum palustre	0.17	0.21			0.24	0.63
Phalaris arundinacea	0.67	0.86	4.31	3.96	1.66	3.8
Phleum pratense			0.65	3.96	0.71	
Poa pratensis	0.51		1.29	0.42	0.48	
Poa subcaerulea		0.21				
Ranunculus acris	0.17					
Ranunculus flammula					0.48	
Ranunculus repens					0.24	
Rumex acetosa	1.69	0.43	0.65	0.42	0.24	
Rumex hydrolapathum			0.43			
Samolus valerandi					0.7	
Salix cinerea					0.48	
Stachys palustris	2.7	1.07	2.16	1.67	0.48	2.53
Stellaria palustris		0.21	0.22	0.21	0.48	0.63
Thalictrum flavum	4.22	6.02	2.8	3.13	2.85	3.8
Thelypteris palustris	0.17		0.86	1.25	2.61	1.27
Valeriana officinalis	0.51	0.64				
Vicia cracca	7.25	7.1	4.31	7.71	4.04	9.49

Table 3 Numbers of species along the line transect in each area and species diversity (D) 1993.

Areas	1	2	3	4	5	6
Number of species	23	25	17	20	14	2
Total no. of plants	187	192	70	111	73	142
Species diversity (D)	8.87	14.44	10.32	8.45	6.77	8.53

Table 4 Numbers of species along the belt transect in each area and species diversity (D) 1994.

Areas	1	2	3	4	5	6
Number of species	28	25	27	27	40	21
Total no. of plants	595	466	464	480	421	158
Species diversity (D)	12.18	11.71	11.25	11.28	9.33	8.37
Mean D 1993 and 1994	10.53	14.55	10.78	9.87	8.05	8.45

DISCUSSION

Frequency

In 1993, *Molinia* had a lower percentage frequency and *Holcus lanatus* a higher frequency in the treated areas, contrasting with *Molinia* which was higher and *Holcus* absent in the control area.

By 1994, in the treated areas, *Molinia* frequency was rising again and *Holcus* decreasing. The latter was highest in area 1, 25.67% in 1993, falling to 16.69% in 1994. *Thelypteris palustris* Marsh Fern, about which we had many reservations with regard to the effect of flailing, decreased in frequency from a mean in the two areas 4 and 5 in which it was recorded in 1993 of 1.14 to 1.06 in the same areas in 1994. However, in 1994, it was found in all areas except 2, indicating some recovery. Other typical fen-meadow plants could be split into two types, those that flourished in 1993 and then declined, and others that did the opposite. This was shown especially clearly in the scraped area 5. For example, *Carex disticha* Brown Sedge, after an initial increase in frequency of 12.32, then declined to 4.51 and another low-growing sedge *Carex demissa* Common Yellow-sedge appeared. In contrast, *Cirsium palustre* Marsh Thirtle was recorded in area 4 in 1994 and not in 1993. Another surface plant which is rapidly declining as drying occurs on the wetlands, *Caltha palustris* Marsh-marigold, absent in the scraped area 5 in 1993, was recorded there in 1994. Its frequency is low, less than 1%, and the low crown could be vulnerable.

Species Diversity

Although more species were recorded in 1994, this may well be because we used a belt transect rather than the line transect used in 1993. Also, the second set of data were taken later in the year than those of 1993. However, using a species diversity index enables a more direct comparison to be made between the six areas during the two years of the monitoring.

From Tables 3 and 4 it can be seen that species diversity is highest in the four flailed areas and lowest in the scraped and control areas. In 1993, area 2 had the highest species diversity, 14.44; in 1994 area 1 was the highest, 16.99. The overall mean for each area over two years gave the highest value (D = 14.55) for area 2 – a single flail with the litter removed. In contrast, area 5 showed a mean of 8.05 for the two years, while the mean for the control area was very similar at 8.53. Although the largest number of species was found in area 5 in 1994, its species diversity was lowest. Both the range and value of

species diversity in areas 1–4 was lower in 1993 (8.45–14.44) than in 1994 (9.33–16.99) and indicates the time required for stabilisation of the habitat. Removal of the litter seems to produce a somewhat higher diversity, namely 13.0 as opposed to 10.32 (mean values for 1993 and 1994), but double flailing has little advantage over a single flail (11.86 compared with 11.47) and may even be deleterious as the data for *Thelypteris palustris* seems to indicate. (Fig. 3)

Water Table

As part of our continuing monitoring of the height of the water table above ordnance datum (OD) on both the Parish Plot and Catcott North reserve, Table 5 records the measurements taken during the period of the investigation at dipwell F (Fig. 1) near the experimental areas. In 1993, the water table fell below OD in early April and mid August. In 1994 it fell below OD during the period between June 12 and August 27. The highest water table level was in December 1993 and January 1994. These figures compare favourably with past years in which the summer water table regularly dropped below OD and to almost 1 m below in the summers of 1983 and 1984. Combined with the low rainfall and higher summer temperatures during the 1980s, this weather was probably a major factor in the drying effects observed during the decade. Willow cannot survive long periods of waterlogging of the roots and *Molinia* prefers somewhat drier conditions, so the high rainfall during the winter of 1994–95 should obviate the need for more management than suggested in the recommendations given below.

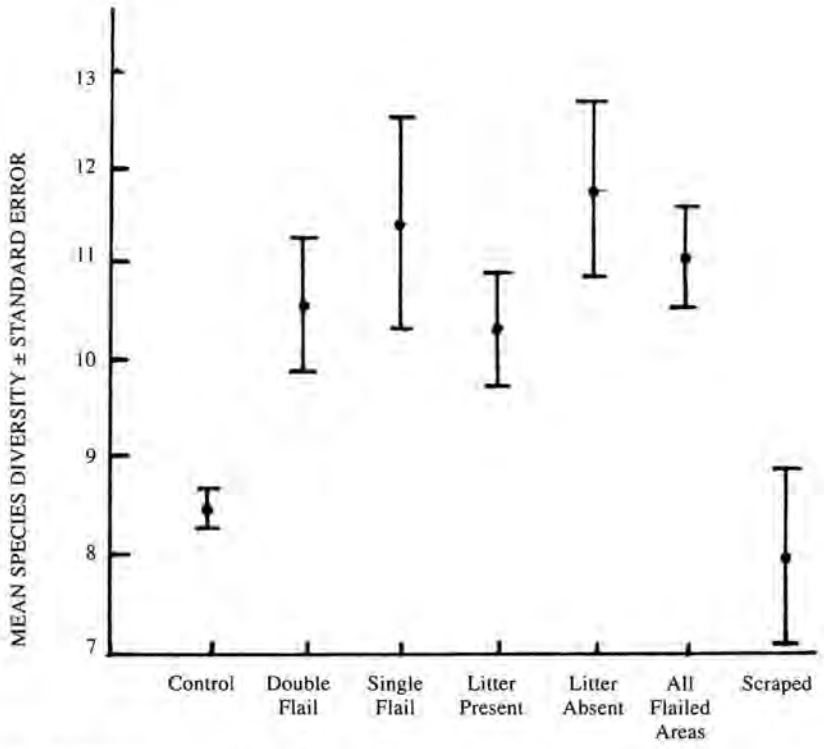

Fig. 3 Summary of mean values of species diversity ± standard error under categories of treatment 1993–94.

Table 5 Measurements of the heights of the water table, above (+) or below (–) ordnance datum (OD) in dipwell F 1993–4.

Date (1993)	Height (cm ±OD)	Date (1994)	Height (cm ±OD)
7/2	+85	16/1	+192
7/3	+47	23/2	+137
21/2	+25	20/3	+47
23/3	–8	17/4	+87
4/4	+3	15/5	+43
19/4	+3	29/5	+112
1/5	+44	12/6	–25
16/5	+14	15/7	–133
6/6	+32	6/8	–31
20/6	+67	27/8	–103
17/7	+73	18/9	+85
29/8	–123	16/10	+5
12/9	+75	31/10	+152
26/9	+32	20/11	+175
10/10	+175	26/12	+25
7/11	+111		
28/11	+10		
26/12	+187		

The ground at dipwell F is 197cm above OD

EVALUATION

The fen flora on Catcott Parish Plot approximates to M22 *Juncus subnodulosus-Cirsium palustre* fen-meadow under the National Vegetation Classification (Rodwell 1991). In the whole field, *J.subnodulosus* Blunt-flowered Rush is the dominant rush, especially in the many shallow hollows in the peat where it grows alongside *Thelypteris palustris*. *Cirsium palustre*, although present, is less abundant at the southern end of the field and may well have been adversely affected by shading. *Filipendula ulmaria* Meadowsweet is another dominant plant; its frequency in the control area was greatest in 1994, illustrating its ability to grow above the height of the dominant *Molinia*. A full species list for Catcott Parish Plot can be found in Ecology in Somerset (Hill-Cottingham and Smith 1990).

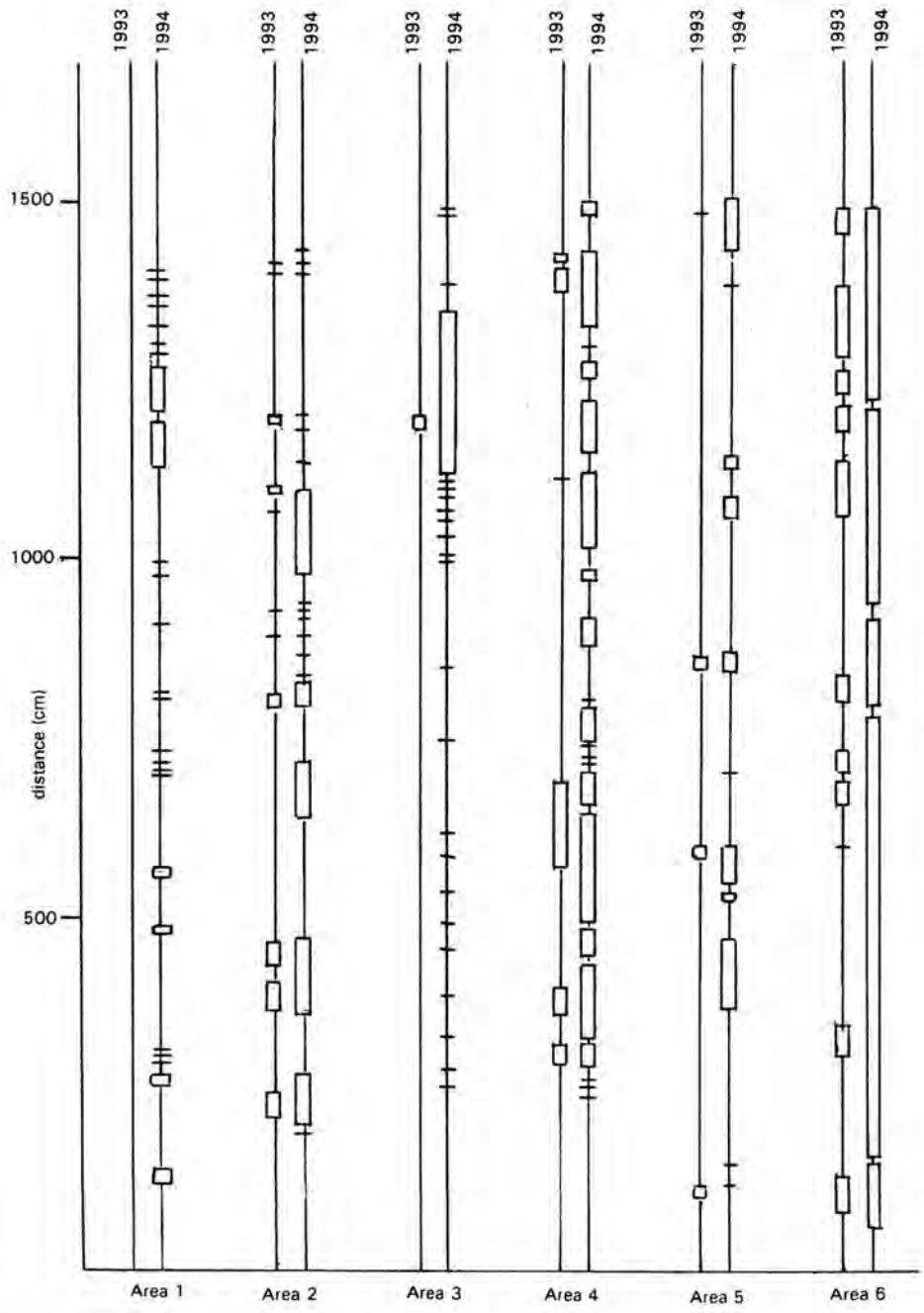

Fig. 4 Profile showing the increased cover of *Molinia caerulea* plants along the transects in each area from 1993 to 1994. Lines represent single plants; blocks show the extent of tussocks.

Although the whole field is dominated by the tall stems of *Molinia*, because single plants are large, the frequency of its occurrence appears artificially low (Tables 1 and 2). However, when its distribution is plotted as a profile, the spread of the tussocks and the arching of the stems can be clearly seen (Fig. 4). It is only with the development of high tussocks that *Molinia* starts to affect the presence of other plants seriously. It causes considerable shading, contributes to a build-up of dense surface litter and restricts the growth of small surface-growing plants (Hill-Cottingham and Smith 1988). It is also known that withdrawal of minerals, notably nitrogen and phosphorus, from the leaves takes place before abscission and that the tussock itself acts as an over-wintering organ for the storage of sugars and proteins. Leaching of considerable amounts of minerals into the soil also occurs in late autumn. These minerals cannot be of advantage to plants of low-nutrient demand (Morton 1977).

CONCLUSIONS

Flailing has several advantages:

1. Although it does not remove the deeply-penetrating roots, flailing removes the tussocks of *Molinia*, enabling other plants to compete more successfully, and, by decreasing their size, lowers the availability of minerals in the surface peat.

2. Flailing appears to have no adverse long-term effect on rhizomatous plants such as *Thelypteris palustris*, or even *Iris pseudacorus* Yellow Iris with its surface rhizomes. The percentage frequency of *T. palustris* was higher in 1994 after an initial set-back in 1993, which indicates an ability to survive the treatment. In spite of this, we would recommend avoiding flailing of the main stands of *Cladium mariscus* great Fen-sedge and think that judicious hand-removal of tussocks within these stands would avoid any possible risk to this rare plant. There are also four remaining plants of *Osmunda regalis* Royal Fern in the field, with well established caudices rising about 30 cm or more above the ground surface. Since these ferns have their growing point at the apices of the stems, flailing would not allow their survival. Map 1 includes the distribution of both these species.

3. The ground surface is opened up considerably, especially where litter is removed, giving an opportunity for development and spread of lower-growing plants such as *Cirsium dissectum*. Plants grow less tall and are sturdier.

4. Disturbance is kept to a minimum and the ground returns to a rich fen flora within two years.

One reservation, however, concerns the single plant of *Ophioglossum vulgatum* Adder's-tongue recorded in Area 2 in May 1993 and which was not seen in 1994. Its single spike appears early in the year and dies down by summer, so that the sampling in July 1994 may have been too late to record it.

RECOMMENDATIONS

It is clear that the removal of *Molinia* now developing on the Plot is essential to retain the typical and important fen vegetation. The results from the control area (with a species diversity declining from 8.53 to 8.37) indicate the folly of lack of management. However

for the future of the Plot, it is necessary to use suitable management strategies. Fig.4 summarises data in terms of such strategies.

The greatest damage was caused by scraping (area 5) where the mean species diversity was lowest (a mean of 8.05). Movement of the large Hymac digger caused a lot more damage to the fragile peat surface than the lighter flailing machine and scraping cannot be recommended as an acceptable method of *Molinia* control. Double flailing has no advantage over a single flail and we would not recommend this. There is a slight advantage in removing litter but the extra expense involved probably outweighs the advantages.

Following scrub removal, we would recommend single flailing of the field as the best way of reducing *Molinia* tussock formation. If this can be coupled with maintenance of a higher water table with surface flooding throughout the winter, both *Molinia* and scrub growth should be inhibited. The development of Catcott Lows Reserve could be a valuable asset to both the Parish Plot and Catcott North Reserve.

The monitoring of this plot will continue in 1995; leaving the marker posts in place will enable anyone to view the long-term effects of this management technique. Future management may require flailing about every five years. Other monitoring work on the plot (Hill-Cottingham and Smith forthcoming) has indicated that this is the time-span during which noticeable tussocks of *Molinia* are established.

It is apparent from data derived from the control area that, unless management is carried out to control the growth of *Molinia* tussocks, the future of this nationally important wet fen-meadow will be jeopardised as succession proceeds to a climax vegetation of alder-willow carr. We think this flailing technique promises to be the best method, both environmentally and economically, for future management.

ACKNOWLEDGEMENTS

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