MOOR HOUSE

18th Annual Report, 1977

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THE NATURE CONSERVANCY COUNCIL

MOOR HOUSE

1977

18TH ANNUAL PROGRESS REPORT

M. RAWES

C O N T E N T S

I. GENERAL

a) Introduction

The Report covers the period 1 October, 1976 to 30 September, 1977, a year in which there have been changes in staff, permanent, temporary and attached personnel, that have much affected the smooth running of the Field Station.

In October 1976, Linda Teasdale (now Robinson) married and subsequently retired at Easter. Linda came to Moor House from school in 1967 and over the years that she was here made herself virtually irreplaceable, participating in a wide range of duties, from secretarial to botanical, and even estate work, all willingly. Meanwhile, the office is neglected and in the absence of typing and clerical assistance, difficulties are numerous. So we hope that when Jill is older, Linda will be back.

Another serious loss is the retirement at the end of the summer, of Mrs. Dunn, she has been Housekeeper for 7 years. Her friendliness and concern for hostel user's comfort are well known.

Over the winter the Scientific Officer post previously held by R. Williams, was filled temporarily by D. Tattersfield, who on Linda's retirement accepted the vacant Assistant Scientific Officer position. He left at the end of September. For the first six months of 1977 Miss I. Wood, a geographer, was temporarily employed.

It was with great regret that we heard of the death last winter of Alex. Mason. Alex, who had lived for many years at Birkdale, had been gamekeeper of Dufton Fell. He looked after Moor House during the interim period (1951-52) between its purchase and occupation by Conservancy staff. A good field naturalist, he was a valued friend and during the first part of his retirement from Lord Hothfield's employment acted as an honorary Reserve Warden, from 1962-1970. An appreciation was written for the local paper.

The Freshwater Biological Association, Cow Green Section, which had occupied laboratories at Moor House since 1968, left in 1977. Dr. P. Armitage was transferred to the River Laboratory, Wareham, Dorset, in June, and Dr. T. Crisp and staff moved to Lartington, in Teesdale, in September.

b) Reserve Management

Although the programme of replacing old fencing gets disrupted by lack of staff time and the unpredictability of the weather some progress has been made. The Nether Hearth tree enclosure and the long-term grassland exclosure on Little Dun Fell have been completely re-fenced, the latter with the help of a Snowcat in transporting stakes across from Great Dun Fell. As a contribution towards the commemoration of the Queen's Silver Jubilee, the Conservation Corps has made a start in fencing Hardshins Mine, at the Reserve entrance, by the River Tees. Half a hectare is involved. The plan is to introduce trees and shrubs, such as pines, rowan and willows, and by methods such as diverting old water leats into the area constructing a wet area. Judging by the success of other tree enclosures on the

Reserve the effect on wildlife, especially birds, will be considerable. However, there will be difficulties; apart from the latent zinc and lead toxicity, and harsh physical nature of the mine waste, the main problem for successful scrub and tree establishment will be in controlling rabbits and excluding sheep.

The storms and a long period of snow lie during the 1977 winter were particularly severe on the tree plantings. Thirty percent of the Scots Pines have died in one enclosure and some of the deaths are attributable to winter damage. The results of a survey of this enclosure are given later.

Snow and poor spring weather prevented heather burning, which must be completed by 31 March, and held up much of the work on draining, planting and maintenance. The backlog in repairing and renewing enclosure fences is considerable.

Cumbria County Council has accepted the responsibility of maintaining the Pennine Way, which is eroding in some places severely, as it traverses the summit ridge. The Council has agreed to submit a project for aid to the Manpower Services Commission and it is expected that a Job Creation Programme team will be assembled to carry out extensive remedial work next summer. Official way marking will supersede the carved signs erected by us in 1974, and now largely removed by souvenir hunters (vandals), who have also removed, and possibly stolen, a Reserve sign complete with post. Damage, and misdemeanour by the public, and mining operators, is mostly confined to the west and summit areas of the Reserve. Overspill of mine effluent from the Silverband Mine occurs and a project to monitor streams is described later in this Report. However, vandalism by persons unknown is affecting this, and other projects where sample traps are involved.

Failure of the ski-ing fraternity to accept responsibility resulted in the scheme to permit ski-ing under licence coming to an end. As a temporary expedient ski-ing was permitted within the original area boundaries, but with more snow and better ski-ing conditions than for a number of years the possibilities of trouble were great. Fortunately Mr. J. Rose had the assistance of Roy Walmsley (Task Force North), whilst snow-blocked roads reduced pressure on occasion. Once again Brian McArthur, honorary warden, helped with wardening in the latter part of the season, when Mr. Rose left for Ravenglass Local Nature Reserve.

c) Natural History

The Warden reports the sighting of two bird species, a Tree Creeper and Stock Dove, new to the Reserve list which has been published as an Occasional Paper this year. The decrease in Dippers breeding on the Reserve this year - there were only 6 pairs - may be due to the severe winter. There was also a decline in the number of duck recorded during the breeding season, and neither Grey Wagtail nor Wren was found breeding. Short Eared Owl was another failure, although two pairs were present throughout the spring and early summer. The only species to show a marked increase in breeding numbers was Redshank, otherwise the remaining species were present in their usual numbers.

It has been a poor year for moths and butterflies. Only five species of butterfly were recorded: Green Veined White, Small White, Small Heath, Small Tortoiseshell and Peacock.

The leaves of some Willow and Birch trees were eaten by sawfly larvae, and Puss Moth caterpillars were found on Willows.

Although Rabbits were much reduced by the winter, numbers increased again in late summer whilst the Fox population has been very low throughout the year.

d) Survey and Research

For the first time a Nature Conservancy Council in-house project has been based on Moor House. The project, a survey of Grade 1 upland sites in northern England, is part of a wider exercise initiated in collaboration with the Regions concerned, by Dr. Art Lance, Upland Ecologist, of the Chief Scientist's Team, originally to cover Scotland only.

Two teams have been recruited for six months, one team for north-west England (Dr. D. Horsfield and Miss J. Brodie) and another for north-east England (Miss A. Pickering and Miss G. Hutchings). A fifth member, B. Larking (Job Creation Programme) has been engaged to draw the resulting vegetation maps using air photographs and ground survey data.

Although the objectives of the project are several the main aim is to survey the sites, assemble the data, principally botanical and put this into a form in which conservation value can be assessed. Agricultural improvement, afforestation and recreational uses pose, often unpredictable, threats to the conservation interests of much hill land. Ultimately advice on the management requirements of these areas will be needed and the survey will give a firm base on which to give this. Advice on the conservation of wildlife, and where possible methods by which conservation value can be enhanced, depend on reliable information on the distribution within sites of the communities they comprise and the conditions under which these occur.

By using similar phytosociological methods of data collection mutual advantage will be achieved by co-operating with the National Vegetation Classification commissioned by the NCC. This will further the aims of the National Vegetation Classification in producing a new classification of the British vegetation.

The method of survey employed involves collecting quadrat data of plant groups from areas selected as representative, cover being assessed on a Domin rating. Vegetational boundaries from field and air photograph interpretation are drawn on O.S. maps of 1:10,000 scale. Six colour codes distinguish the main vegetation groups within which the more precise vegetation types are shown by number code.

The following sites are being surveyed:-

N.W. Region - Crossfell, Bellbeaver and part of Yad Moss, Appleby Fells, including High Cup Nick and Warcop Fell, Mallerstang and Swaledale Head, and Helvellyn and Fairfield.

N.E. Region - Geltsdale and Tindale, Kielderhead, Cheviot, Simonside and Harbottle, all in Northumberland with the exception of Geltsdale.

The project is supervised by Mr. M. Rawes, assisted by other Moor House staff. The absence of administrative help has made this an exceptionally time consuming task, which has seriously affected the regular field programme of the Field Station.

The use of the Reserve by Universities has continued although it must be said that most of the studies are of marginal value to the Conservancy. From Durham Dr. J. Coulson, with Dr. J. Butterfield as a Research fellow, uses 10 sites on the Reserve in his NCC commissioned survey of North England titled "The Geographical characteristics of Moorland using invertebrates". Dr. Coulson continues his work on the moorland invertebrates and the factors affecting their abundance. He also has a number of students under supervision; Martin Randall is in the first year of a Ph.D. study of parasitism in Coleophora alticollela, the moth whose larvae are found on Juncus seed heads; Shirley Jones has had a preliminary season of studying waders, in particular the sandpiper, prior to starting a Ph.D. this autumn; and two undergraduates have looked at the biology of the dipper, their numbers, territorial size and food supply. Dr. S. Goddard, of the same department, has started a comparative investigation of invertebrates on lightly and more heavily sheep-grazed blanket bog. She has also had a student looking at the biology of certain enchytraeid worms. Dr. Lewis Davies was persuaded to apply for assistance under the Job Creation Programme to look at aspects of stream biology relevant to possible present and future pollution from the open cast mining activities at Silverband, where barytes is being extracted. A graduate and technician are employed.

From Lancaster University Dr. J. Whittaker has continued his sampling of Cercopids. Professor H. Woolhouse (Leeds) has two students involved in physiological studies of plant growth; Adam Kwolek completes his Ph.D. work on Calluna this year and Ken Robertson is looking at aspects of growth in Eriophorum vaginatum. Duncan MacKay (Westfield College), supervised by Dr. R.S. Clymo, has finished a year's sampling of Sphagnum on Burnt Hill and Peter Hayward, from the same College, has collected mosses for laboratory study.

An ambitious programme of work on the effects of sheep grazing on limestone soils was started by Gunnar Ulmanis (Sheffield), whilst Lance Tufnell (Huddersfield) continued his long-term study of periglacial activity, mainly at sites on Great Dun Fell. Dr. J. Ollerenshaw and Dr. Stewart (Newcastle) hoped to test the frost resistance of grass and clover varieties under field conditions, but at present the problems of lead and zinc toxicity in many soils have interfered with their plans.

II. SCIENTIFIC - Moor House Staff

a) Climatology (R.B. Marsh)

The weather summary for 1976 is given in the appendices and observations covering the reporting year are shown below the 24 year mean.

Table 1

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Yea
Maximum - Mean	9.5	5.1	3.6	2.4	1.9	4.0	7.1	10.7	13.9	14.8	14.7	12.5	8.
1976-77	8.9	4.7	0.5	0.7	1.7	4.9	5.1	10.4	12.7	15.6	14.5	11.3	7.
Minimum - Mean	3.7	0.1	-1.7	-2.3	-3.3	-1.7	-0.1	2.5	5.5	7.2	7.3	5.9	1.
1976-77	4.5	-0.1	-3.7	-3.9	-2.6	-0.2	-0.7	0.5	3.8	6.9	6.7	5.8	1.
Mean-$\frac{1}{2}$(Max+Min)	6.6	2.6	0.9	0.1	-0.7	1.1	3.5	6.6	9.7	11.0	11.0	9.2	5.
1976-77	6.7	2.3	-1.6	-1.6	-0.5	2.3	2.2	5.5	8.3	11.3	10.6	8.5	4.
Mean earth	7.8	4.7	2.8	1.8	1.6	2.0	3.8	6.4	9.9	11.6	11.7	10.3	6.
1976-77	8.2	4.7	2.7	1.5	1.4	2.7	3.1	5.8	8.6	11.1	11.1	9.3	5.
Mean rainfall(mm)	181.3	200.4	213.8	195.8	147.1	130.3	120.0	124.5	106.8	141.5	157.3	164.3	1883.
1976-77	239.2	165.4	302.4	520.9	198.5	179.4	185.7	80.5	44.6	86.2	103.8	181.6	2388.
Mean sun(hr/day)	2.55	1.39	0.91	0.94	1.75	2.76	4.04	5.19	5.97	4.73	4.55	3.37	3.1
1976-77	1.49	1.92	0.99	1.01	1.49	1.78	3.39	7.35	6.22	6.05	4.93	2.61	3.2
Mean air frost/days	4	14	20	22	21	21	15	7	1	+	+	2	127
1976-77	1	14	29	25	23	15	15	12	4	0	1	0	139
Mean ground frost	10	19	22	24	24	24	20	12	7	4	4	6	176
1976-77 /days	11	23	31	29	27	20	21	22	7	4	8	5	207
Mean snow-lie/days	+	5	11	15	16	12	5	1	+	0	0	0	65
1976-77	0	4	31	29	17	8	5	0	0	0	0	0	94

+ - less than $\frac{1}{2}$ day

The most obvious point demonstrated by this table is that all temperature means are below average while the number of days of air and ground frost and snow lie are above average. Maximum temperatures only rose above the average in two months, March and July. This implies that the recent warm period of climate has ceased and this year compares well with 1968-1969 and 1969-1970, see Table 2.

Table 2

	1968-69	69-70	70-71	71-72	72-73	73-74	74-75	75-76	76-77
Maximum-Mean	7.8	8.1	8.6	8.1	8.6	8.1	8.9	8.9	7.6
Minimum-Mean	1.7	1.7	2.2	1.9	2.2	1.7	2.3	2.4	1.4
Mean $\frac{1}{2}$(Max + Min)	4.7	4.9	5.4	5.0	5.4	4.9	5.6	5.5	4.5
Earth	6.1	5.9	6.6	6.4	6.4	6.0	6.4	6.5	5.9
Rainfall(mm)	1555.8	2061.3	1650.5	1586.3	1662.9	1844.5	2111.9	1495.9	2388.2
Sunshine-av. Hr/day	2.95	3.44	3.32	2.89	3.39	3.30	3.61	3.52	3.27
Air frost days	144	140	119	116	127	133	124	122	139
Ground frost days	175	182	178	194	195	208	207	200	207
Snow lie-days	94	102	53	61	54	44	47	44	94

December and January had figures that correspond to those of the early 1960's. The December maximum temperature was the lowest we have recorded, the previous lowest being 1.6°C in 1963, and there were records for air frost, ground frost and days of snow lie. January was the coldest since 1963 and total precipitation, mostly as snow, was a record high.

In contrast, March was the warmest for 10 years with the highest minimum temperature since 1966, but the lowest amount of sun recorded since 1969. The next three months were cold and air frost was recorded in August, but not in September, an unusual record.

This information points to the local climate reverting to normal, if this is how the period 1953-1970 can be described.

b) Studies of vegetation and sheep (M. Rawes, R.B. Marsh and D.M. Tattersfield.

Whilst vegetation maps and air photographs give a base against which major and generalised changes in vegetation and physiognomy can be shown, the time scale in which we are involved requires a more detailed investigation. Nevertheless it is important to repeat overall surveys from time to time and this year Miss I. Wood was engaged to re-map, from air photographs (1956 and 1975), the bracken areas on the west side of the Reserve. A report is held in the Reserve Record. Whilst there are difficulties in interpretation with two sets of photographs it appears that bracken has not so much changed in extent as in its boundaries, receding in some places and increasing in others.

Miss Wood also looked at changes in the course of the River Tees and measured the amount of bank erosion and build up of shingle at several sites. These two studies are a foundation for repeat examination.

The detailed study of botanical composition, and its change, is centred on 17 monitoring sites, representative of the Reserve's vegetation. The sites normally have an area from which sheep are excluded, some now having been maintained for 23 years, and grazed plots. Apart from these sites others previously analysed and open to grazing, may be used.

Effect of present day sheep grazing of the open fell

In the study of a poor grassland dominated by Juncus squarrosus (Moor Rush) it has been shown that there have been significant increases in 10 years in Festuca ovina (Sheeps Fescue), Carex nigra (Common Sedge), and Juncus itself as well as a number of mosses. Festuca and Nardus stricta (White Bent) have likewise increased on a Nardus grassland. Although there are likely to be seasonal differences, the numbers of sheep (under investigation this year) using these grasslands vary from those recorded in the last survey in 1966.

The high-level fescue grasslands of Little Dun Fell and Hard Hill have been re-examined. Although the point quadrat data have yet to be analysed it appears that only small changes have taken place since the last, but incomplete examinations in 1974 and 1970 respectively.

Effect of removing sheep grazing

Significant increases in cover of Deschampsia flexuosa, Eriophorum vaginatum and Galium saxatile have occurred in a Juncus squarrosus grassland after 10 years without sheep grazing. As elsewhere Juncus has declined under enclosure and so have Festuca ovina and Eriophorum angustifolium.

In the case of the Nardus enclosure the only significant changes in 10 years has been an increase in Galium saxatile and Nardus itself and a decrease in Agrostis tenuis. A spectacular increase in pleurocarpous moss cover has been recorded and the overall plant cover has increased from 2.8 to 3.6 species hit/point quadrat. In the Juncus sward the cover increase has been less than 0.1.

Preliminary examination of the Little Dun Fell and Hard Hill field results show that in the first fescue enclosure there has been a substantial increase in Deschampsia flexuosa and Carex bigelowii over the past 3 years, whilst on Hard Hill there has been a decline in Festuca ovina, Nardus stricta, Carex bigelowii and Juncus squarrosus. Both sites have been fenced for 22 years.

The increase in Carex bigelowii cover after removing sheep grazing has been measured on numerous occasions and its increase in leaf size has been observed. Miss J. Drage (Sheffield), in a student project paid for by NCC was encouraged to look at this sedge and measure differences under grazing and enclosure. Her report for the Reserve Record details differences in leaf size and shape and in root form.

Effect of burning

R. Hobbs (Edinburgh), employed temporarily, made a brief study to assess the relationships between performance (growth and flowering) of Calluna vulgaris (Heather) and age of stand, and also to illustrate any differences due to site. Age of stand is related to burning. He found considerable differences between sites, but that within a particular site, performance varies with age of stand, reaching a maximum and declining as the stand matures. The results are given in a report for the Reserve Record.

c) Natural grassland communities (M. Rawes)

It has only been possible to make occasional checks on the performance of the introduced plants. Dwarf Willows in Rough Sike enclosure continue to flourish and cuttings of Moor House grown Salix phylicifolia have taken and are growing well. Saxifraga aizoides, which has increased its status by seeding on ledges and by the Sike, and Draba incana have flowered particularly well. Angelica sylvestris is spreading rapidly and encourages the prospect of the development of a tall herb vegetation.

d) Red Grouse - Moorland Management (M. Rawes, R.B. Marsh and P. Holms)

An improved map recording the positions of heather burns was drawn by Miss I. Wood from air photographs. Inability to burn this year delays the assessment of burning as an improving factor in the management of blanket bog for grouse. Counts of birds continued as in previous years, but the time spent on the survey was less than desirable.

P. Holms's report follows:-

Introduction

With the exception of the Dipper (Cinclus cinclus), the Red Grouse (Lagopus lagopus scoticus) is the only year round bird resident in this area. The aim of this work is to gain a more accurate picture of annual fluctuation of the population.

Area counts are carried out on a fortnightly basis. Counts of adult breeding birds in the spring, of nests and eggs in the summer, and of the young birds in August.

This season follows a year of high autumn numbers. April and May minimum temperatures were approximately two degrees below average and June was colder, so heather growth was later than usual.

The Study Areas

The eight study areas vary but all are between 500 and 650 metres in elevation. They have a total area of 141 hectares.

Method

The grouse were flushed using a pointer which ranged on either side of the observer. The birds were identified as cocks or hens, young or old and in the case of territorial birds, plotted accurately on area maps. All counts were repeated as even single birds missed, constituted a gross error.

Results

The spring population was similar to that of the previous year (0.69 birds/ha) when the autumn counts showed a young to old ratio of 2.82/1.

The first chicks were found on 19 May, three days later than last year. The mean hatching date was the 24 May compared with the 22 May in 1976. No predation of grouse chicks by black headed gulls was witnessed this year though they were quite abundant on the Reserve.

Table 1 Spring density of Red Grouse per study site, 1977.

Site	Area (ha)	No. Adults	Birds/ha
Bog End	10.2	10	0.98
Burnt Hill	20.3	14	0.69
The Drive	20.2	12	0.59
Hard Hill 2	14.0	6	0.43
Hard Hill A	21.2	16	0.75
Hard Hill B	24.5	16	0.65
Green Burn A	15.6	12	0.77
Green Burn B	14.7	12	0.82
	Overall Average	=	0.71

Breeding Success

The table below shows the August counts to estimate breeding success as a ratio of young to old birds. Over a period of two weeks two counts were carried out on each of the eight study sites. An overall young to old ratio of 2.6/1 is good and compares well with 2.8/1 in 1976 and 2.2/1 in 1975.

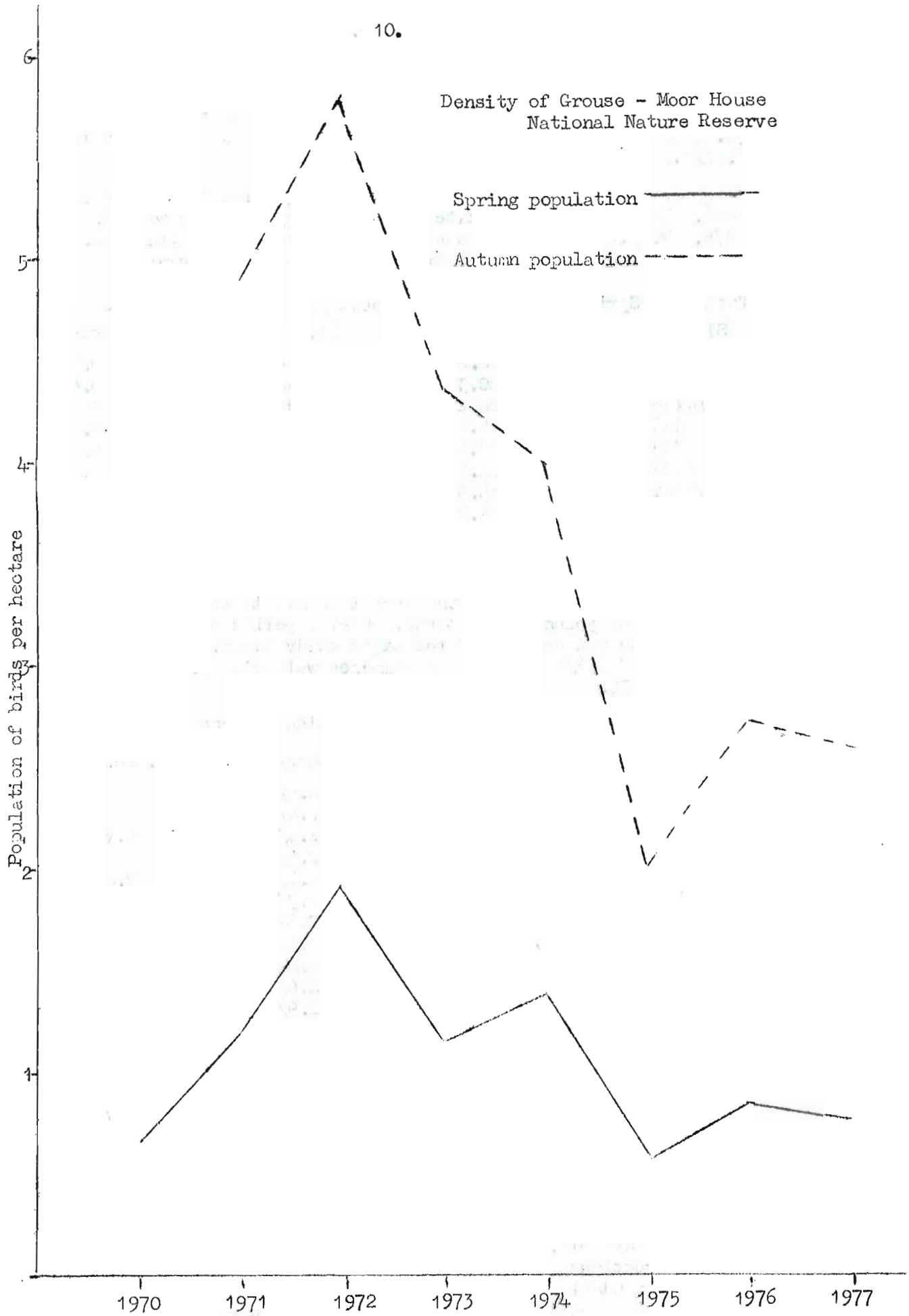
Table 2 Sample counts to estimate breeding success, 1977.

Area	Adults	Young	Young/Old	Av. for area
Bog End	7	18	2.6/1	
	5	12	2.4/1	
	13	31	2.4/1	2.5/1
Burnt Hill	8	20	2.5/1	
	13	35	2.7/1	2.45/1
The Drive	11	32	2.9/1	
	4	11	2.8/1	2.8/1
Hard Hill 2	3	7	2.3/1	
	10	24	2.4/1	2.55/1
Hard Hill A	5	13	2.6/1	
	7	20	2.9/1	2.5/1
Hard Hill B	6	18	3.0/1	
	9	24	2.6/1	2.95/1
Green Burn A	6	16	2.6/1	
	8	21	2.6/1	2.6/1
Green Burn B	8	23	2.9/1	2.75/1
		Overall Average	=	2.63/1

Chick Ringing

Ringing began in the first week of June when most broods were at least ten days old. When flushed at this early stage the brood disperses in all directions and the dog must be used to locate chicks individually. Plastic expandable pigeon rings were used at this stage until the chicks could not be caught easily, at about six weeks.

All the chicks captured were aged accurately using the primary moult and development method (Raymond Parr, 1975).


Density of Grouse - Moor House
National Nature Reserve
Spring population
Autumn population
Population of birds per hectare
6
5
4
3
2
1
1970
1971
1972
1973
1974
1975
1976
1977

Nesting

The nest of a Merlin (Falco columbarius) was found between the Green Burn census areas A and B early in May. All work stopped on the areas from that time; there is therefore no grouse nest data available for these sites this year. The young to old counts were however, carried out as usual on these areas.

A total of 16 nests were located on the main study areas. On the Drive a nest was deserted, two eggs having been taken by gulls. The remaining eggs were lying adjacent to the nest and partially covered by sphagnum moss. Not far from the nest a hen had been killed by a fox.

Clutch size was down this year, only averaging 7.81 on last years 8.69. Overall hatching success was 95.8%.

Table 3 Estimation of clutch size 1977.

Site		Total	Av./Area
Bog End	9, 8	17	8.5
Burnt Hill	8, 6, 8	22	7,3
The Drive	6, 9, 8	23	7.6
Hard Hill 2	7	7	7.0
Hard Hill A	8, 8, 8	24	8.0
Hard Hill B	6, 9, 10, 7	32	8.0
Green Burn A Green Burn B	no data		
	total No. of eggs	125	
	overall average	7.81	

Conclusion

It has been a good breeding season, following a year of moderate spring numbers and a high young to old ratio. Though the spring growth was later than usual, young heather growth was in abundance at the critical early nesting period.

e) Tree growth and effects on habitats (M. Rawes and R.B. Marsh)

Overcrowding may be responsible for the death and poor performance of many trees. To enable the trees to be managed a start has been made on dividing enclosures into compartments and thinning the trees to at least 1½ m intervals. The enclosure, the Pasture, that has suffered most from storm damage has been the first to receive attention. Last winter was particularly severe on this plantation and numerous trees were killed and more damaged to such an extent as to raise doubts on the future of this enclosure.

R. Hobbs undertook a census and found that 28% of the Scots Pine were dead, 22% were bent and 25% had the top portion of the tree dead.

Lodgepole Pine suffered no deaths and was less damaged although the top portion of 31% were dead. The hardwoods, Swedish Whitebeam and Rowan, showed variable amounts of damage and growth, a large proportion being damaged or suppressed by conifers. Hobbs' report will be placed in the Reserve Record.

III. RESEARCH BY THE INSTITUTE OF TERRESTRIAL ECOLOGY

a) Plant ecological studies of peat (A.J.P. Gore, Monks Wood Experimental Station)

1. Routine clipping and sampling of the long-term experiment (Gore, 1975) at Bog End was carried out in August. Annual clipping and removal of the plant material to peat level since 1958 has shown changes in proportions of the main species but there has been no overall decline in yield. In 1977 the more sloping plot 1A had a total standing crop of 73 gm^{-2} and the less sloping plot 1B, 89 gm^{-2}. These were not significantly different and were not appreciably different from the overall means of the first 10 years namely: 83 gm^{-2} (Block A) and 69 gm^{-2} (Block B) but which were significantly different. Evidence from this experiment suggests that annual total removal of above ground material is not associated with a decline in fertility.

Interestingly, Calluna vulgaris and Deschampsia flexuosa continue, each year, to occur on plot 1A in spite of the drastic disturbance caused by clipping. These species do not occur on plot 1B.

Ref: Gore, A.J.P. (1975) J. appl. Ecol., 12, 349-366.

2. Water balance studies. The RF interference at Holme Moss was not overcome. A new Automatic Weather Station has been installed at Snake Pass. Snake Pass is about 5 miles to the south of Holme Moss at a similar altitude. First results are encouraging in that the solar sensor is recording properly at Snake Pass. The records from Moor House continue to be satisfactory and continued help from Brian Marsh is gratefully acknowledged.

b) Competition between grass species (Helen E. Jones, Merlewood Research Station)

This experimental attempt to compare the growth of Festuca ovina and Agrostis tenuis in pure stands and in competition with each other is continuing.

A second experiment has just been completed in which the two species were grown for two seasons in monoculture and in 1:1 mixed culture, and either left uncropped or cut at 2-weekly intervals. Six harvests were made during the course of the experiment. One set of uncropped pots was placed at Moor House for the duration of the experiment, to compare growth in the natural site with the growth made in the greenhouse by the uncropped treatment at the sixth harvest. Preliminary results indicate that Agrostis tenuis is more vigorous than Festuca ovina in the uncropped mixture, although Festuca ovina is not wiped out. Results from the cut treatment were variable, partly because the cutting regime was too severe in the very hot summer of 1976, but it appeared that Festuca ovina was more able to compete than when uncropped. From dry weights of tops and roots at each harvest, the relative replacement rate of the one species over the other can be calculated.

It is intended to continue with the experimental approach, and to study the effect of differential cutting on mixtures of the two species.

IV. RESEARCH BY THE FRESHWATER BIOLOGICAL ASSOCIATION

a) Studies on freshwater fauna - fish (D.T. Crisp)

Apart from our autumn examination of spawning reservoir trout in the Tees system within the Reserve, most of our work is now concentrated at Cow Green.

The routine work at Cow Green is expected to continue for several years. Additional Freshwater Biological Association studies in the general area are expected to begin soon in connection with the transfer of Kielder water to the Tees. This work will mainly be done in the Tees and its tributaries in the Middleton - Barnard Castle region and a temporary laboratory is being set up at Lartington. The Cow Green group will also use this temporary laboratory. We are most grateful for the facilities and help given to us by the Nature Conservancy Council at Moor House during the past ten years and hope that a fruitful and cooperative relationship between Nature Conservancy Council (Moor House) and the new Freshwater Biological Association unit will continue.

During 1977 thermographs have been set up in Mattergill Sike and Red Sike. It is expected that these will run for about 1 year.

V. RESEARCH BY UNIVERSITIES

a) A study of the factors influencing the abundance of invertebrates on blanket bog (J.C. Coulson and Jennifer E.L. Butterfield, University of Durham)

The data from this study have now been analysed. In addition to the results given in the 17th Annual Report there is now information of the relative rates of decay of the same plant material on blanket bog and on mineral grassland. These are summarised in Table 1. Surprisingly the rate of decay of all but two substrates was higher on peat than on mineral soils. Phleum pratense leaves were alone in having a significantly more rapid decomposition rate on the mineral area.

Paired samples of different vegetation types in fine mesh (20μ) and coarse mesh (800μ) bags were used to assess the contribution of soil animals to decomposition processes. We found that the proportion of substrate taken by animals varied according to the type of soil on which the bags were placed and according to the plant material itself. Animals made a substantial contribution to the decay of Rubus and Calluna (27.4% and 42.6% respectively on peat and 65.2% and 35.4% on mineral soils) but very little to the decomposition of Eriophorum vaginatum on either soil.

Table 1 Percentage loss of weight due to decomposition of vegetation in coarse mesh bags on peat and mineral soils for a twelve month period (except in the case of the second Rubus which was exposed for 3 months - July to October).

Vegetation substrate	Mineral soils N	% loss ± SE	Peat soils N	% loss ± SE	't' for difference
Phleum pratense leaves	10	81.2±3.0	10	57.1±1.3	7.4'''
Festuca ovina leaves	10	42.6±3.6	10	48.9±1.2	1.7
Juncus squarrosus leaves	10	40.9±4.7	10	32.3±3.8	1.4
Rubus chamaemorus leaves	10	41.3±3.8	10	70.8±2.1	7.2'''
Rubus chamaemorus leaves (3 months only)	8	10.7±1.7	8	21.8±2.0	4.2''
Eriophorum vaginatum leaves	10	38.8±3.3	10	44.2±2.4	1.3
Calluna vulgaris young shoots	10	34.7±2.5	10	48.4±5.6	2.2'
Sphagnum recurvum shoots	10	18.6±2.8	10	14.2±2.1	1.3

' = p .05 '' = p .01 ''' = p .001

b) Survey of invertebrate animals on upland sites (J. . Coulson and Jennifer E.L. Butterfield, University of Durham)

This survey is being carried out at a series of selected sites over the whole of the north of England. Five sites on Dun Fell and four sites on the eastern part of the Reserve are being monitored by pitfall trapping. We have information of the fauna of these areas from a number of years and this will prove useful as a baseline for comparison with the other sites and to supply information on the relationship between pitfall trap catches and absolute abundance.

c) Sampling of streams near Silver Band Mine to assess effects of barytes quarrying (L. Davies, University of Durham)

Methods

Samples by the kicking-netting method, and by metal trays (filled with the natural substratum materials, lifted after 2+ weeks and animals removed) have been obtained. The main components have been sorted and most identified to varying degrees of precision. Other methods have been used on certain streams. Where appropriate, streams have been sampled above and below the point at which possible pollution effects enter as a result of the barytes quarrying near the site of the former Silver Band Mine.

Results

In the interests of brevity figures for numbers of animals are given only where there was some difference between sampling points on a particular date.

(1) Knock Ore Gill

No difference in numbers or composition of the fauna was shown in 6 sets of samples, above and below the entry of the Silver Band Hush on 6 dates between 28 June and 27 September 1977. Throughout this period the lower 300 m length of the Hush has been dry, so the absence of any detectable faunal effect on Knock Ore Gill is not surprising.

(2) Middle Tongue Beck

Marked reduction in numbers of three stone-fly larval species below the entry point of the small stream draining part of the quarry site, as compared with above the stream entry, is shown in Table 1 which also shows that there was a marked reduction in adult and larval Elminthid beetles (species not yet determined). This effect did not apply to the only abundant may-fly larvae (Baetis rhodani), nor to Chironomid larvae.

Evidence on the spot show that a major flood came down the small tributary into Middle Tongue Beck about 7-10 days prior to the first sampling date of 28 June 1977. This flood was due to the bursting of the peat dam storing clean water above the quarry site. The flood water ran through part of the quarry site and washed away all fine material and gravel from below the entry into the Beck, and so has presumably altered the nature of the substratum below this point. This is thought to be the reason for the reduction in Stone fly larvae and Elminthid's shown in Table 1, a reduction of which persists to date. The lack of effect on Baetis rhodani argues against any pollution effect by toxic material, since may-fly larvae in general are as susceptible to metals and other poisons as are stone flies.

A small mine tributary itself often has low flow and supports chironomid larvae in silt pockets in its bed, which fact also suggests no acute toxic chemical levels at present.

(3) Silver Band Hush stream

The volume of flow down this Hush is rather small in summer, and this makes it difficult to sample quantitatively. The settling pond below the quarry and crushing mill often discharges a small volume of brown silt-rich water into the Hush which is thus visibly silt-covered along its narrow stream bed for the first 50-100 metres below its start. Qualitative examination showed no visible macroscopic animals for the first 100 metres or so. From 100 to 500 metres distance however, the stream does contain Limnephilid caddis larvae, water beetles (Agabus sp.) and some chironomid larvae, all suggesting that metal or other toxic material levels are not high in the settling pond overflow water at present. The possible danger would appear to reside in the deleterious effects of inorganic silt material if discharged in quantity into the Hush, and from there washed into Knock Ore Gill.

Jars sunk into the bed of the Silver Band Hush stream as silt-measuring traps showed that 0.5 to 4 cm of silt was deposited in two weeks in September 1977 at points 200 to 500 metres distance from the mine. This shows that the settling-pond system is not sufficiently big to be self-containing in this regard, and this situation will get worse with time unless the pond system is cleaned or enlarged.

More detailed studies on the Silver Band Hush stream and one or two other small streams are planned for the immediate future.

Table 1

Numbers of certain insects in Middle Tongue Beck, above and below the entry of the small tributary draining part of the Silver Band site (1977)

	Samples 5-50 m above mine stream entry			Samples 5-50 m below mine stream entry		
	D	L	P	D	L	P
28 June	105	157	172	4	13	10
15 July	18	6	21	3	15	9
8 September	24	5	1	1	1	0
27 September	64	9	2	1	46	1

	EA	EL	EA	EL
28 June	127	198	0	3
15 July	2	38	0	0
8 September	4	42	0	11
27 September	24	91	1	7

D = Dinocras cephalotes
L = Leuctra moselyi
P = Protonemura montana
} All stone-fly larvae

EA = Elminthid adults
EL = Elminthid larvae

d) A study on the effects of altitude on the insect parasitoids of the rush moth, Coleophora alticolella (M.G.M. Randall, University of Durham)

The larvae of Coleophora alticolella feed mainly on the seeds of the rush Juncus squarrosus, and are found on the western slopes of the Reserve. This year they occurred up to an altitude of 580 m O.D. However, the hymenopterous parasitoids, which attack the larvae of this moth, were not found above 335 m.

This summer sampling has been carried out on a transect from 240 m to 610 m, on the Middle Tongue area of the Reserve (and on farm-land below the Reserve boundary). The development of the moth larvae and the incidence of parasitism at these altitudes are being compared with similar populations of the same moth on lowland areas (15 m) at Drumburgh Moss (O.S. NY587254) and on the Ravenglass Gullery; Local Nature Reserve (O.S. SD065965).

The role of Juncus effusus as an alternative source of food for the moth larvae, and any difference in the parasitoids attacking the larvae on the two species of rush, is also being investigated.

e) Studies on the Common Sandpiper (Tringa hypoleucos). (Shirley Jones, University of Durham)

In 1977, twenty-eight pairs of Common Sandpiper bred on the Reserve. Only four pairs bred on the western part of the eserve on Crowdundle Beck. A total of twenty adults and two fledglings were colour ringed for future studies of survival and territorial behaviour.

In general, streams more than 3 m wide were used as breeding areas and the larger islands were often selected as nest sites. Nests were made in grassy tussocks (usually Nardus stricta), the distance to the nearest water being, with one exception, less than 10 m.

The first eggs were laid in mid-May and the average clutch size was 3.2 eggs. The earliest hatching date is estimated as 6 June and the last clutch hatched during the second week of July. Fledging success is estimated as 1.0 young per pair.

f) Population dynamics of Neobisium muscorum (Leach) (Pseudoscorpion:Arachnida). A preliminary report. (S.J. Goddard, University of Durham)

Neobisium muscorum is the only species of pseudoscorpion recorded at Moor House. Previous workers investigating the soil arthropod community have reported only occasional specimens of this species. A sampling programme devised specifically for N. muscorum has revealed that this species occurs at much higher densities than previously reported.

The sampling programme began in October 1976 at Sike Hill. Each month, ten 0.1 m^2 sample units of heather litter are taken by the stratified random sampling technique. The pseudoscorpions are extracted from the litter in Berlese funnels.

Previous investigations of the life cycle of N. muscorum (Beier 1950; Gabbutt and Vachon 1965; Gabbutt 1970: Goddard 1976) have shown that two generations a year are produced, a spring generation and an autumn generation. In environmentally extreme situations, the spring generation is suppressed: it was thought that this might be true at Moor House. The samples taken in the autumn of 1976 revealed high densities (360/m^2) in October, with a high proportion of the population (55%) occurring as the deutonymphal shape.

Sampling was not possible over the winter months due to snow conditions, but when sampling was resumed, the density of the population had fallen to 20/m^2 (April, 1977) with no life stage predominating.

So far (September, 1977) no increase in population density has occurred, and a further year's sampling will be necessary to elucidate the life cycle of this species at Moor House.

g) The ecological distribution of the enchytraeid worm Cognettia sphagnetorum (Margaret Aspley, University of Durham)

The intention of this project was to study the microhabitat distribution of four Mesenchytraeus species and hence observe their differing roles in primary decomposition. However, due perhaps to the time of year, or effect of 1976 drought, only 12 members of the genus were found in the study period. This compares with Springett, 1967 who found Mesenchytraeus sanguineus to be an important species in Juncus squarrosus bog. The only worm found in large enough numbers to study quantitatively was Cognettia sphagnetorum.

Cores taken from Juncus squarrosus bog were layered so that a survey of numerical distribution according to depth and/or organic content of the soil could be carried out. High numbers of worms were found living at a depth of 2-4 cm in layers containing roots and well decayed vegetation (normally Juncus squarrosus).

Cognettia sphagnetorum reproduces by fragmentation at Moor House and high numbers of fragments were found in the top two cm. to suggest that this is the site of fragmentation due to high temperatures (average temperature at 1 cm was 15°C on the days of sampling). Larger worms, 5-25 mm seem to live below 2 cm, maybe due to food preference, less extreme temperature change compared with the top 2 cm, or higher humidity.

h) The feeding ecology and breeding biology of the Dipper (Cinclus cinclus). Elizabeth Myers and Peter Smith, University of Durham)

A study was carried out on the general ecology of the Dipper (Cinclus cinclus) on the Reserve, from 16 May to 9 June, 1977. Particular emphasis was placed on the feeding ecology in relation to territory size. Fourteen territories and twelve nests were found (River Tees - 8, Trout Beck - 2, Knock Ore Gill - 2, and Crowdundle Beck - 2). Most of these abutted each other, or were separated by a length of 'inter-territory'.

Measurements of stream width and depth were made. Stream bed structure, moss and algal covering were also recorded. The territory sizes ranged from 450 m to 2350 m in length and from 1340 m^2 to 16210 m^2 in area. Full details are shown in Table 1. No correlation between territory length and width was seen ($r = -0.20$). Territories did not appear to shorten further downstream, where streams were wider.

The streams were divided into areas of definite, possible and non-feeding portions using field observations of feeding behaviour. Factors taken into account in determining feeding areas included stream depth, speed of flow, the nature of the surface and of the substratum. Definite feeding areas were composed of fast-flowing, shallow water running over pebbles and small boulders. The surrounding water surface was often broken with rocks projecting through it. Non-feeding areas were composed of deeper, sluggish or non-flowing water. Water flowing over bedrock (sedimentary or whin sill dolerite) was also classified as non-feeding. Possible feeding areas included those where Dippers had not been observed feeding in, but which could be used for feeding. Only a small proportion of the total territory area was definite feeding area (generally less than 10%). Inter-territory areas had significantly less definite and possible feeding areas than did the territories.

A quantitative survey of the available food in each territory was made. After a preliminary sampling survey, three methods of sampling were compared for their efficiencies. The method finally chosen was a kick-sampling method based on that of Morgan and Egglishaw, 1965. Twelve standardized kicks were made, 40 cm in length, each one digging deeper into the substratum, upstream from a net. Afterwards the stones from the area sampled were scrubbed (with a scrubbing brush) and the scrubbings filtered through the net. Definite and possible feeding areas only were sampled; two transects of four samples being taken from each territory and inter-territory.

The fauna found comprised of the larvae of Ephemeroptera, Plecoptera, Trichoptera, Diptera and Coleoptera. Of these Ephemeroptera larvae were the most numerous, with all items tending to increase in number downstream. Trichoptera, Ephemeroptera, Diptera and Plecoptera larvae were taken to be prey items. This agrees with Jost, 1975, who writes "the principle source of food includes Ephemeroptera, Plecoptera, Trichoptera, Diptera, Gammaridae, Coleoptera etc."

The sampling results were combined with the measurements of area to give relative indices of the total food available in each territory and inter-territory. Territory size did not appear to be correlated with the amount of available food present, but inter-territory areas had significantly lower indices than did the territories.

Table 2 shows a decline in the number of breeding pairs on the Reserve over the past year. Two factors are possible for this decline: the long, dry summer of 1976 and the long winter of 1976 to 1977. We believe that the latter was responsible as winter downstream movement was observed for the first time ever last year (Jim Parkin, pers. comm.) Nest sites found included peat banks (6), bridges (2), waterfalls (2), stone walls (1), and rock faces (1). Double brooding was observed for the first time ever on the Reserve.

Observations on general behaviour included flight, swimming and locomotion underwater, locomotion on land, dipping, winking, grooming and resting, perching, singing, defecation, and behaviour towards the observer.

Finally, we wish to thank Mr. M. Rawes, Jim Parkin, and the staff at Moor House for their help and encouragement; Dr. J.C. Coulson and Dr. S. Goddard for their supervision; and the Technicians of the University of Durham for the loan of equipment.

Table 1 Measurements of territory size

Territory	Length (m)	Width (m)	Depth (m)	Area (m^2)
Force Burn:				
Tees	1000	12.4±2.0	21.6±2.4	12500
Force Burn	1175	2.2±0.08	9.2±1.6	2630
Total	2175	6.9±1.4	15.0±1.9	15130
2.	1150	10.6±1.1	27.1±8.1	13000
"Black Bib"	875	12.5±1.4	11.7±1.6	9720
Crook Burn:				
Tees	1400	9.2±0.7	11.8±0.9	14520
Crook Burn	675	2.5±0.02	8.5±0.9	1690
	2075	7.6±0.8	10.9±0.7	16210
5.	600	11.1±1.9	26.9±16.2	6960
Tees Bridge				
Tees	725	8.1±0.7	12.8±1.5	5960
Trout Beck	250	5.8±1.0	12.2±1.7	1370
	975	7.4±0.7	12.6±1.0	7330
Fall Crag, lower	450	4.6±0.6	17.0±2.0	1970
Fall Crag, upper	1100	4.5±0.3	16.7±0.7	4940
Trout Beck Bridge	575	3.6±0.7	27.4±11.7	2070
Trout Beck, upper	750	1.8±0.09	9.0±0.7	1320
Knock Ore Gill, lower	2350	2.1±0.2	8.6±0.9	5070
Knock Ore Gill, upper	2300	0.8±0.08	7.7±0.8	1760
Crowdundle Beck, lower	1525	1.8±0.2	9.3±0.7	2740
Crowdundle Beck, upper	1875	0.8±0.06	7.2±0.8	1590

Table 2 Numbers of breeding pairs on the Reserve, 1974-1977.

1974	17
1975	18
1976	19
1977	14

i) Autecology of the genus Geum. (K. Taylor, University College London)

The field experiment described in the 1974 and 1975 reports was repeated in October 1976 to June 1977. The rabbit proof exclosures were again used with an altitudinal range from 243-746 m. Seedlings were raised in standard potting compost from seed collected from the same local populations, Green Hole (Geum rivale) and Helbeck Hall, Brough (Geum urbanum).

Some of the data is presented in the Table. The most striking feature of these results is the greater success of Geum urbanum at higher altitudes, completely opposite to the results for the previous experiment. The plants of Geum rivale were also larger but flowering was drastically reduced as compared with 1974-5. The obvious climatic difference between the two experimental periods was the long winter snow-lie during the course of this 1976 experiment.

Site	altitude (m)	mean no. inflorescences	Mean oven-dry wt (g) above ground	roots	total
Geum rivale					
Knock Fell	746	0	0.511	0.374	0.885
Rough Sike	548	0.5	0.755	1.454	2.209
Helbeck Wood	365	1.6	1.290	1.382	2.672
Geum urbanum					
Knock Fell	746	1.3	1.103	0.956	2.059
Rough Sike	548	2.3	1.497	2.317	3.814
Helbeck Wood	365	5.0	2.869	2.072	4.941

j) A study of the movement of solutes and particles through the surface layers of peat bogs (D. MacKay, Westfield College).

The experiments which were started in May 1976, to look at the movement of tracer substances through Sphagnum profiles, have continued this year.

The sites into which the tracers had been injected were left undisturbed until June. This gave a 13 month period during which vertical and horizontal movement could occur. In June cores were taken from these sites, so that the new distribution of the tracers could be determined. A number of precautions had to be taken to ensure that the tracers did not move as a result of coring and subsequent handling. To this end a corer was designed that not only caused minimal mechanical disturbance to the core, but also prevented water draining from it before freezing. The frozen cores were then cut into segments and transported back to London for analysis.

At present the concentrations of the tracers, which include metal ions, dyes and pollen are being measured in the segments. Preliminary results on cores taken at the start of the experiment, show that all tracer material is deposited initially within 1 cm either side of the intended position. More than 90% of this material is associated with the sites rather than in the moveable water phase (except pollen).

Further results will be obtained during the coming year and will be summarised in the next report.

k) Adaptation to growth at low temperatures in geotypes of Trifolium repens (J.H. Ollerenshaw and R.H. Baker, University of Newcastle upon Tyne).

Introduction

It was clear from the data presented in the previous report that certain genotypes of Trifolium repens collected from the Moor House Reserve were adapted to grow at low temperatures. However, other genotypes from Moor House exhibited little growth at low temperatures and appeared to be winter dormant.

Further experiments have been conducted with the object of establishing whether there is any physiological basis to the adaptation of these genotypes from Moor House to growth at low temperatures. When growth is adapted to low temperatures there is evidence that there are associated changes in the rates of photosynthesis and dark respiration (Pisek, 1973). The higher photosynthesis and dark respiration rates of plants from high altitude and/or latitude are thought to compensate for the lower temperatures and shorter season experienced (Mooney and Billings, 1961).

Methods

Two ecotypes from the Moor House Reserve, one of which was known to exhibit good and the other poor growth at low temperatures, and eight genotypes of the cultivar S.184 were grown in a cold cabinet at 5°C and two growth rooms at 10° and 15°C for a period of six weeks. Fluorescent tubes provided a light intensity of approximately 15 W/M^2 over a 10 hour photoperiod. Conditions in the cold cabinet and growth rooms were maintained as similar as possible, except for temperature. The eight genotypes of S.184 had previously been selected from the range of genotypes in the cultivar for ability to grow at low temperatures. The two ecotypes and the genotypes from cv. S.184 were recorded for stolon growth, new shoot weight production and new leaf and stolon development as reported earlier.

The method of obtaining rates of photosynthesis and dark respiration rates of the two ecotypes and the cultivar at 5°, 10° and 15° is described in Ollerenshaw, Stewart, Gallimore and Baker (1976).

Results

As was shown in previous reports, ecotype Trout Beck 1 was better adapted to growth at 5°C than the ecotype Meadow 3 (Table 1). Trout Beck 1 also showed better growth at 5°C than the selected genotypes of the cultivar S.184. Similar results were obtained at 10° and 15°C (Table 1).

Trout Beck 1 had higher rates of dark respiration and photosynthesis than Meadow 3 and the selected genotypes of cv. S.184 at all three temperatures (Table 2). The ratio of photosynthesis to dark respiration shows that Trout Beck 1 had a greater excess of photosynthate than Meadow 3 at all three temperatures but similar to cv. S.184 at 10° and 15°C. As a result of its higher rates of respiration the more cold-adapted ecotype Trout Beck 1 may be better able to use photosynthate for growth at low temperatures than Meadow 3. This is substantiated by the amounts of shoot weight produced by the two ecotypes over the period of the experiment.

Hence it may be concluded that the ecotype Trout Beck 1 is physiologically better adapted to grow at low temperatures than the ecotype Meadow 3 and the cv.S.184, especially as only the better adapted genotypes of cv.S.184 were used in these experiments.

Table 1 Average rate of stolon extension (mm stolon/week), dry weight increment of shoot tissue (mg/week), average number of new leaves and secondary stolons (number/stolon/week) of two T. repens ecotypes and cv.S.184 grown at 5°, 10° and 15°C (mean of 15 plants)

Ecotype	Stolon growth	Shoot weight	No. of new leaves	No. of new stolons
5°C				
Trout Beck 1	1.78	5.65	0.72	0.14
Meadow 3	0.49	1.76	0.13	0.08
Cv.S.184	1.00	4.31	0.42	0.12
10°C				
Trout Beck 1	10.43	21.53	3.14	0.70
Meadow 3	5.22	9.02	2.43	0.49
Cv.S.184	6.33	16.42	2.52	0.38
15°C				
Trout Beck 1	20.33	41.50	4.78	0.87
Meadow 3	15.08	22.58	4.73	0.80
Cv.S.184	15.25	32.50	5.00	1.09

Table 2 Rates of photosynthesis (P) and dark respiration (R) of two T. repens ecotypes and cv.S.184 at three temperatures ($mgCO_2/gD.M./h$).

Ecotype	P	R	P/R
5°C			
Trout Beck 1	10.51	1.14	9.31
Meadow 3	3.53	0.77	4.58
Cv.S.184	6.72	1.10	6.11
10°C			
Trout Beck 1	23.37	1.55	15.08
Meadow 3	11.67	1.43	8.16
Cv.S.184	17.00	1.14	14.91
15°C			
Trout Beck 1	46.96	2.96	15.86
Meadow 3	19.38	2.38	8.14
Cv.S.184	38.75	2.83	13.69

l) A study of two environmental factors affecting the growth of Sphagnum (P.M. Hayward, Westfield College)

An experiment has been started to investigate the effects of water supply and shading on growth. Material was collected in April from Bog End and Burnt Hill and transported back to London where the experiment was started outdoors near the laboratory. Three species were collected; Sphagnum rubellum, S. papillosum and S. flexuosum which tend to be found in hummock, lawn and pool habitats respectively. The plants were packed at a natural density into straight sided pots 11 cm square. Forty plants in the centre of each pot were cut to a standard length before the experiment and tied into a loose bundle so they could be retrieved later for re-measurement. 75 pots in all were prepared which allowed for five degrees of shading and five different water table levels, from 0 cm to 14 cm below the surface, for each species. The water tables were maintained by connecting the pots via tubes to a series of constant level devices fed with distilled water. Shading was provided by covering the pots with from 0 to 4 layers of black nylon gauze with an absorbance of about 0.35 per layer. The pots were randomised at weekly intervals throughout the experiment.

The experimental plants were harvested after 10 weeks and increases in length and mass of plants of each species under the various conditions are now being measured. These results will then be included, together with measurements made in the field and laboratory of light and water profiles in Sphagnum canopies, in a computer model which will eventually simulate the effect of water and shade on growth form and plant interactions.

m) Studies of periglacial phenomena (L. Tufnell, Huddersfield Polytechnic)

The movement of five ploughing blocks was recorded for the twelfth consecutive year. Although the total displacement of these blocks was greater than for the previous year (ie. August 1975 - August 1976), it was still less than on most other occasions.

Table 1 Movement of five ploughing blocks on the Reserve between August 1976 and August 1977. Block numbers correspond with those in the 1975 report.

Block No.	Amount of movement recorded (cm)
1	5.1
2	3.5
3	1.0
4	0.3
5	0.0

As shown on p.43 of the 1975 report, block movements are far greater during the colder part of the year than in the summer months. On the other hand, the figures in Table 1 demonstrate that an increase in the severity of winter[1] does not necessarily produce an acceleration in the rates of block movement.

[1] Mean temperatures for the 1976-7 winter were below normal over most of Britain.

n) The effects of animal exclusion on soil fertility of a limestone grassland in the Moor House National Nature Reserve, Cumbria (G.A. Ulmanis, University of Sheffield)

Object and Method

This investigation requires the use of animal exclusion areas (exclosures). Comparisons will be made between the exclosures and comparable grazed areas of limestone grassland to assess the role and importance of the grazing animal in nutrient cycling and the maintenance of soil fertility.

The site at Moor House to be investigated is the Rough Sike limestone grassland. Nat. Grid Reference 756327.

Comparisons will be made initially between the long established (since 1956) non-grazed area and that of a comparable area in the adjacent grazed limestone grassland at Rough Sike.

Variability of major soil physical and chemical properties in these two sites will be investigated. For instance chemical properties such as amount, availability (and distribution) of N, P, K in soil, plant and faeces and soil physical properties such as bulk density and depth to bedrock. Plant type and distribution in both sites will be studied.

From this initial period of investigation both the variability and overall differences of selected soil and plant properties of the two sites will be estimated. This initial period of investigation commences in November 1977, at the end of the year's grazing season.

The second phase of experimentation will commence early in 1978. A new exclosure on part of the grazed and previously investigated grassland site will be set up. Comparisons of selected soil and plant variables at monthly and seasonal time intervals will be taken throughout 1978 from both exclosures and a comparable area of grazed grassland. The properties to be investigated and sampling plan are to be determined from models proposed and the initial period of investigation. It is hoped to keep the soil type under each investigated site as near constant as possible - Rendzinas and Brown Earths. From the investigation of the newly established exclosure details on the rates of change and processes occurring due to removal of grazing pressure will emerge.

Inputs, for instance of nutrients in rainwater, and outputs of nutrients for instance in leaching, will also be assessed during this period.

A preliminary site investigation was carried out in April 1977 to test soil and plant collection and analytical techniques.

Results from the first phase of experimentation are expected to be available by December 1977 or early 1978.

o) Overwintering and dormancy in Calluna vulgaris (A. Kwolek and H.W. Woolhouse, University of Leeds)

Work carried out during 1976 suggested that:-

i) The time taken to bud break on bringing Calluna plants into a warm growth room decreases from November till April.

ii) A dormant state could be induced by low temperatures, irrespective of the photoperiod.

iii) Winter pigmentation of Calluna is stimulated by a low temperature/light interaction since the light facing surface of the shoots show greater leaf pigmentation. Temperatures of $5^{\circ} \pm 2$ are sufficiently low.

iv) Calluna is not subject to an endogenous dormancy, since the plants will grow throughout the winter in a warm growth room and under a long photoperiod.

Work completed during 1977 shows that:-

i) Calluna could not be made dormant as in (ii) above, the reason for this is not known.

ii) Calluna will not become dormant under short days alone, although there are marked morphological changes under short days, particularly formation of the 'end of season habit' ie. terminal 'end of season' short shoots and the formation of lateral short shoots.

iii) Exogenous application of abscisic acid by spraying and root feeding does not induce dormancy.

iv) Applications of solutions of abscisic acid and gibberellic acid to dormant cut shoots produces the following results : ABA inhibits bud break compared to distilled water controls, but nevertheless buds still open, and there appears to be no difference between gibberellic acid and water treated shoots.

v) Bioassays conducted to detect growth inhibitory activity in extracts of Calluna shoots showed no overall trend as bud-break approached, although zones of inhibitory activity always corresponded to abscisic acid Rf's. Despite there being no trend, there was some growth promotary activity a fortnight before bud break took place and on the approximate date of bud break there was little inhibitory activity associated with the Rf of ABA, compared with the rest of the Rf's.

vi) Erica tetralix shows a similar degree of winter dormancy to Calluna but Empetrum nigrum is very quick to resume growth on bringing into a warm growth room.

vii) In conclusion it can be said that Calluna does have a period of dormancy, induced by a combination of short days and low temperatures in the autumn. Dormancy cannot be induced in the laboratory, early in the growing season and possibly not until flowering has taken place.

The type of dormancy which Calluna exhibits appears to be the type in which pre-dormancy is followed by post-dormancy with no true rest in between, ie. Calluna can be induced to bud break at any time in its dormant phase, but only by temperature and photoperiodic conditions which would not normally be found in nature at that time.

p) Seasonal dynamics of foliage in Eriophorum vaginatum (K. Robertson, University of Leeds)

The initiation, development and senescence of leaves of E. vaginatum was examined in two ways:-

1. Area basis

Cropping was initiated in April and continued through the season to measure community production.

The production of living above ground material was 23 ± 6 $gm^{-2}gr^{-1}$, a peak biomass of 41 ± 8 gm^{-2} occurring in late August. The proportion of green leaves rise from 32% to 66% between April and August, communieity dieback beginning in mid-August.

2. Single plant basis

125 tillers were marked in April and the fate of individual leaves was monitored throughout the season. Leaves were divided into 5 categories 1) Developing; 2) Developed; 3) Dead tip; 4) Overwintering; 5) Dead.

Preliminary results indicate that:-

a) Leaves may have a life-span of 4 months. 50% of the leaves reached in April were still green in early August.

b) From April to mid-July, developing leaves comprise 70-100% of the current seasons leaves.

c) From mid-July to mid-August, developing and mature leaves are present in equal numbers. However, by the end of August the number of developing leaves begins to decline.

d) Within the current seasons leaves, a high rate of turnover was found between categories eg. from mid-June to mid-July, the number of developing leaves was constant at 120 leaves per 100 shoots. This constancy however, concealed the addition of 80 leaves/100 shoots, balanced by the transfer of 80 leaves/100 shoots to the mature category.

The shoot study will be continued over the next season in an attempt to understand the categorisation of leaves marked at the start of the season.

APPENDICES

Publications

It is noted that continued use is made of Moor House data in publications of wider coverage. For instance A.M. Cucklaine King uses much information on periglacial soil movements in 'The geomorphology of the British Isles: northern England' and K.L. Bocock and J.K. Adamson in Merlewood Research and Development Paper No. 68 'The effects of land-use and management on upland ecosystems with particular reference to soils in the Lake District.

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STANDEN, V. & LATTER, P.M. 1977. Distribution of a population of Cognettia sphagnetorum (Enchytraeidae) in relation to microhabitats in a blanket bog. J. Anim. Ecol., 46, 213-229.

TUFNELL, L. 1976. Ploughing block movements on the Moor House Reserve (England), 1967-1975. Biuletyn Peryglacjalny, 26, 311-317.

WOTTON, R.S. 1976. The distribution of Blackfly larvae, (Diptera: Simuliidae) in Upper Teesdale streams, northern England. Hydrobiologia, 51, 259-263.

Occasional Papers

PARKIN, J. 1977. Birds of Moor House National Nature Reserve. In: Aspects of the Ecology of the Northern Pennines. Moor House Occasional Paper No. 10. 20pp.

STAFF LIST

Officer in Charge	M. Rawes
Scientific Staff	R.B. Marsh
	D.M. Tattersfield
Warden	J. Parkin
Estate Worker	P.J. Holms
Housekeeper	Mrs. G.G. Dunn (April - October)
Part-time Wardens	J. Rose (November - March)
	R. Walmesley (November - March)
Honorary Wardens	B.J. McArthur
	J. Hollington
	O.W. Harrison
F.B.A. Staff	Dr. D.T. Crisp
	Dr. P.D. Armitage
	P. Cubby
	Mrs. S. Robson (nee Miss S. Ebdon)

Meteorological Summary for Moor House 1976 (Met Office Station No 7188)
c 558 m OD (Main Instrument Site) Lat 54° 41'N, Long 2° 23' W Nat Grid Ref NY/758328

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean Max Temp °C	3.3	2.7	2.7	6.7	10.1	15.7	17.8	17.5	11.6	8.9	4.7	0.5	8.5
Mean Min Temp °C	-0.7	-1.3	-2.5	0.2	3.4	7.9	7.2	6.1	5.9	4.5	-0.1	-3.7	2.2
½ (Max + Min) °C	1.3	0.7	0.1	3.4	6.7	11.8	12.5	11.8	8.7	6.7	2.3	-1.6	5.4
Highest Max Temp °C	7.7	8.1	8.0	12.4	16.5	25.6	25.5	23.7	15.7	14.3	7.1	2.5	25.6
Lowest Min Temp °C	-8.4	-7.7	-8.5	-7.6	-0.9	1.2	2.4	1.6	-0.7	-0.4	-5.1	-9.7	-9.7
Lowest Max Temp °C	-3.4	-2.0	-1.7	0.3	5.5	9.5	11.4	9.8	5.1	5.1	-0.4	-2.8	-3.4
Highest Min Temp °C	5.7	4.1	2.0	7.4	8.4	12.2	12.7	11.6	11.0	9.7	4.1	0.4	12.7
Lowest Grass Min Temp °C	-13.5	-10.2	-12.0	-13.5	-7.5	-2.7	-4.9	-5.7	-5.7	-3.5	-9.9	-13.2	- 13.5
Earth Temp 30cm 0900 hr	3.4	1.6	1.9	3.9	6.4	10.3	12.8	12.0	9.6	8.2	4.7	2.7	6.5
Rainfall (mm)	258.1	123.2	130.3	104.0	182.2	50.5	63.2	29.0	228.7	239.2	165.4	302.4	1876.2
Rain Days (0.2mm)	24	19	21	15	26	16	13	6	19	26	20	25	230
Wet Days (1.0mm)	20	15	18	12	22	10	10	3	15	23	16	20	184
Days Snow/Sleet	8	10	13	6	3	0	0	0	1	1	5	21	68
Days Snow Lying	9	12	16	3	0	0	0	0	0	0	4	31	75
Days Hail	1	0	1	1	4	1	0	0	0	0	1	1	10
Days Snow/Ice pellets	3	6	8	1	0	0	0	0	0	0	1	1	20
Thunder	0	0	0	0	3	0	0	0	0	0	0	1	4
Fog	3	10	9	1	4	3	1	1	2	3	4	13	54
Air Frost	17	20	27	13	3	0	0	0	1	1	14	29	125
Ground Frost	20	25	29	18	8	2	9	16	9	11	23	31	201
Av Daily bright sun (hr)	0.52	1.01	2.62	3.28	3.20	7.53	8.16	7.73	2.30	1.49	1.92	0.99	3.40
Total Bright Sun (hr)	16.2	29.4	81.2	98.5	99.1	225.8	252.9	239.7	68.9	46.2	57.7	30.7	1246.3
Total Snow (cm)	50	27	44	14	0	0	0	0	0	0	30	308	473
Greatest Depth Snow (cm)	24	14	10	8	0	0	0	0	0	0	20	29	29
Days with Gales	13	4	5	3	2	0	1	0	2	1	5	1	37
Solar radiation gm cals/cm^2	965	1875	4679	6796	8131	12,995	15,082	11,808	4,955	2,544	1,814	1,358	73,002